

Perennial Forage Species for Irrigated Pastures and Hay in New Mexico

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INTRODUCTION

Selection criteria and establishment methods for forage crops are described in NMSU Extension Circular 695, *Forage Selection and Establishment for Irrigated Pastures and Hay in New Mexico* (https://aces.nmsu.edu/pubs/_circulars/CR695.pdf). Most of the perennial forage crop species listed in this publication have demonstrated adaptation and are prominently used in irrigated pastures and hay fields in New Mexico. A few are included that have not yet been widely used but show promise. Other species might be well adapted, but are not included because of low productivity or insurmountable antiquity factors, or they simply might not be as well adapted as the species listed in this publication. With a couple of exceptions, the species presented here are non-native, “improved” forages that have greater production potential under irrigation than many of our native species (e.g., range-land grasses). For most species described here, specific varieties are not listed because of differences in seed availability and local adaptation. This publication describes perennial forage species options. For more information on annual forage options, see Circular 697, *Annual Forage Species for Irrigated Pastures and Hay in New Mexico* (https://aces.nmsu.edu/pubs/_circulars/CR697.pdf).

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PERENNIAL COOL-SEASON LEGUMES

Alfalfa

Alfalfa (*Medicago sativa*) is a long-lived perennial that continues to be the legume of choice in most irrigated hay and pasture situations. It is a major component of dairy rations and is a popular horse hay throughout the state. It has the potential to fix substantial amounts of nitrogen while providing many other environmental benefits, such as soil stabilization, wildlife forage and habitat, and insect diversification. Alfalfa has a deep taproot that is capable of extracting nutrients and water from considerable depths (>10 feet). The plant grows erect with multiple shoots rising from the crown, and may grow as tall as 3 feet. Leaves are trifoliate or multifoliate (>3 leaflets per leaf), and flowers are mostly purple in color (yellow and white flowers are possible). Both hay and grazing types are available. Grazing and low cutting might damage the crown, providing an entry for disease organisms. However, new varieties have been developed that exhibit a crown located below the soil surface where it is protected from trampling and cutting/traffic effects. These varieties also have broader crowns, a spreading growth habit, taproots that maintain greater carbohydrate reserves, and shoots that produce leaves below the grazing horizon so the plants can continue to photosynthesize while being grazed. Alfalfa is a high-yielding, nutritious, palatable species, but the possibility of bloat in ruminant animals exists, even in grazing-tolerant varieties.

Alfalfa is adapted to most regions of New Mexico, from the cooler, higher elevations in the north to the hot, desert climates in the southern part of the state. It grows best on loamy, fertile soils, but can grow on most soil types as long as they are well-drained. In fact, alfalfa is often one of the few species that can thrive on very sandy soils where water and nutrient management can be a challenge. Alfalfa does not persist well on poorly drained soils where water stands for extended periods or where roots are continually exposed to waterlogged conditions. Once established, it can tolerate considerable amounts of drought and salt stress, and has more heat tolerance than most other cool-season forage legumes. Alfalfa produces high yields as a monoculture, but also performs well in mixture with many grasses. In monoculture hay situations, alfalfa requires approximately 5–7 inches of water to produce one ton of hay, depending on location. In mixtures, water use will depend on the species with which alfalfa is blended and the proportions of each species in the mixture. If planted as a monoculture, seed alfalfa at 15–20 lb/acre; for mixtures, use only 4–5 lb/acre of alfalfa seed.

Alfalfa is allelopathic. That is, when a stand is more than a year old, a compound is released into the soil that kills newly germinated alfalfa seedlings or reduces the

production potential of plants that do establish. This toxic compound remains in the soil for approximately one year after all alfalfa is removed, depending on environmental conditions and field management. In a pasture situation, once alfalfa is no longer contributing enough to yield and quality, renovation (e.g., overseeding) with another legume, such as birdsfoot trefoil or red clover, is advisable. The remaining alfalfa will need to be chemically removed, and after at least one year alfalfa can be reestablished successfully. Otherwise, the entire pasture or hay field should be rotated to an annual crop for at least one complete growing season so that tillage and irrigation practices can help dissipate the toxic compound. Rotating out of alfalfa for two growing seasons is recommended, especially if tillage is not used.

Alfalfa weevil (*Hypera postica*) is a major pest of alfalfa in the early spring, and can severely damage plants and compromise stand longevity if not controlled. The larval form of this insect defoliates alfalfa plants as temperatures warm in the spring. Those considering alfalfa should be aware that annual control of this pest may be necessary in many regions of the state. NMSU Extension Guide A-338, *Alfalfa Weevil Control Options in New Mexico* (https://aces.nmsu.edu/pubs/_a/A338.pdf), provides more information on alfalfa weevil management and control options.

Alfalfa varietal performance is tested at several locations each year in New Mexico and summarized in an annual report. Additionally, variety selection guidelines are presented in Circular 654, *Selecting Alfalfa Varieties for New Mexico* (https://aces.nmsu.edu/pubs/_circulars/CR654.pdf). These and other alfalfa publications are available from your county Cooperative Extension Service office (<https://aces.nmsu.edu/county/>) or through NMSU's College of Agricultural, Consumer and Environmental Sciences forages website at <http://forages.nmsu.edu/resources.html>.

Birdsfoot trefoil

Birdsfoot trefoil (*Lotus corniculatus*) is a winter-hardy perennial with a semi-erect to prostrate growth habit. It has a taproot and several lateral roots, but rooting depth is shallower than alfalfa. It is adapted only to the state's cooler regions or higher elevations because it lacks heat tolerance. In most of New Mexico, it is considered a short-lived perennial. Birdsfoot trefoil is adapted to most soil types and can be grown on heavy, poorly drained, or swampy soils unsuited for most other legumes. Birdsfoot trefoil has good tolerance to flooding and salinity. It is highly palatable and is considered non-bloating. Birdsfoot trefoil does not have the yield potential of alfalfa and other legumes under more favorable soil conditions. While it is suited for mixing with grass, the mixture's yield will be similar to that of a well-fertilized monoculture of the associated grass. Quality of

the hay or pasture mixture is similar to an alfalfa-grass mixture of comparable proportions.

Birdsfoot trefoil seed is small and seedling vigor is poor; hence, careful management is necessary for successful establishment. This includes proper inoculation of seed, a firm soil seedbed, and proper seeding depth. It should be sown at 4–6 lb/acre in mixtures, and at depths of 1/2 inch or less. Developing seedlings require two years to become well established, and competition (e.g., shading) from companion grasses should be controlled. After establishment, ensuring that grasses do not outcompete the trefoil is critical. While birdsfoot trefoil tolerates grazing, adequate stem regrowth is necessary for future productivity and to maintain stands. Grazing below 3–4 inches should be avoided. It should be managed to permit natural reseeding, with light grazing at least every other year to allow for seed set and dispersal. Prostrate, erect, and semi-erect types are available. Prostrate and semi-erect types are more suited for grazing pastures, while erect types are better suited for haying situations.

Cicer milkvetch

Cicer milkvetch (*Astragalus cicer*) is a winter-hardy, leafy, high-quality legume that has a low, creeping, rhizomatous growth habit. It is drought-tolerant, but must be irrigated to maintain stands in most of New Mexico. It does not have the drought tolerance and recovery that alfalfa does, but it performs better on wet or sub-irrigated sites. Cicer milkvetch is adapted to a wide range of soil textures, pH, and salinity conditions. While cicer milkvetch has the advantage of being non-bloating, it has been reported to cause photosensitivity (sunburn) in livestock. Nutritive value is comparable to or greater than alfalfa and other legumes; however, palatability is lower and it may not be readily consumed if growth is mature.

Seedling emergence and growth are slower than either alfalfa or sainfoin, but once established, it can become aggressive due to its sod-forming rhizomatous habit. It may take two to three years to completely establish, at which time it will produce approximately half the yield of alfalfa. Mixing with a perennial grass may increase forage yield and help with hay curing, palatability, and photosensitivity; however, cicer milkvetch generally does not perform well in mixed pastures. If used in a mixture with grasses, the milkvetch and grasses should be planted in alternating rows. Additionally, although cicer milkvetch is thought of as a grazing-tolerant legume, its persistence under intensive grazing has been questioned in New Mexico. However, for low or rotational stocking with a longer rest period (45–60 days), cicer milkvetch can perform satisfactorily. The seeding rate for cicer milkvetch is 5–8 lb/acre in grass mixtures or 10–15 lb/acre in

monoculture. Due to the high percentage of very hard seedcoat of cicer milkvetch, scarification is highly recommended and aids in higher germination rates.

Kura clover

Kura clover (*Trifolium ambiguum*) is another winter-hardy, rhizomatous, long-lived legume that is very similar in appearance to white clover, but plants are larger. It has a prostrate growth habit, which makes it more suitable for grazing than haying. Kura clover establishment is directly related to the number of plants that nodulate, but it does not nodulate well in the field. Therefore, when seeding kura clover, it is crucial to use properly inoculated seed (see Circular 695) or to use seed that has been factory treated within the previous year. Using the proper strain of rhizobia bacteria specific for kura clover is critical to establishment.

This species is much slower to establish than most other legumes. However, once established, kura clover is an aggressive spreader and can displace other plants in a mixed stand. It even overtook tall fescue sown at the same time in a trial in north-central New Mexico at NMSU's Sustainable Agriculture Science Center at Alcalde. In that study, it yielded as well as alfalfa after four years and was still maintaining stand and yield after eight years when the trial was concluded. In trials in eastern New Mexico at the NMSU Agricultural Science Center at Tucumcari, kura clover did not perform as well as it had in north-central New Mexico, indicating that its adaptation area might be limited to the higher elevations of northern New Mexico.

Over time, kura clover establishes well when sown in mixtures if grass competition can be minimized. It is likely that drilling the kura clover in rows (4–6 lb/acre for mixtures) and broadcasting the associated grass on the soil surface would help enhance stand establishment. Data indicates that initial yields will be mostly grass that will provide grazing until the kura clover is established. Once established, kura clover will become dominant in the stand. Common seeding rates are 8–10 lb/acre for pure stands or 4–6 lb/acre in a mixed grass stand. Seed is small, and the target seeding depth is 1/4–1/2 inch.

Like white clover, most of the grazed material is leaf and, therefore, higher in quality than alfalfa. Protein is generally high and fiber is low. Kura clover can cause bloat in ruminants, and bloat preventives should be provided to animals grazing pastures that include kura clover, even in the early years when the stand is greater than 50% grass. Although high-yielding and considered “grazing tolerant,” kura clover may not tolerate repeated and frequent defoliation when grown in marginal areas (hot, low elevation).

Red clover

Red clover (*Trifolium pratense*) is generally a biennial or short-lived perennial that might act as an annual in some areas. It is adapted to the state's cooler regions (northern half or higher elevations in the south), but does not tolerate extremely hot, droughty conditions. The stems and leaves are usually covered with hair, and flowers are pink-purple in color. It has an erect growth habit, making it more suitable for hay production than some of the other clovers. Although yields can be high, red clover can be difficult to dry, and it often cures to a brown appearance, which may negatively impact perception of hay quality. Nutritive value of red clover is similar to that of alfalfa. Red clover does not tolerate frequent close grazing. However, in a rotational stocking system similar in frequency to that of hay management (30–45 days), it can perform quite well. Red clover does best on fertile, well-drained soils with a moderate pH range (6–8). It is more tolerant than alfalfa of poorly drained soils, but less tolerant of salinity. Diseases common to red clover that contribute to its short life span in other areas might not be prevalent in New Mexico's well-drained soils. Four-year-old stands of red clover at NMSU's Agricultural Science Center at Tucumcari still yielded comparably to two-year-old stands without reseeding. Bloat is a concern with red clover, but when grown with compatible cool-season grasses, the potential for bloat is reduced significantly. Also, a fungus found on red clover plants can cause excessive salivation in horses, a condition known as "slobbers." Although red clover is usually a short-lived species (two to three years), it establishes quickly, and stands can be maintained by allowing it to reseed naturally approximately every other year. Use 8–12 lb/acre when seeding monoculture red clover or 4–6 lb/acre for mixtures.

Sainfoin

Sainfoin (*Onobrychis viciifolia*) has a growth habit similar to alfalfa, but the majority of production is generally limited to early to mid-spring. Although it is heat-, drought-, and cold-tolerant, sainfoin's stand persistence is often questionable, especially when grown under intense irrigation or in wet or high water table areas. Production is usually limited to three years. Sainfoin's crown is weak and will not tolerate trampling by grazing animals; if used in pastures, it should be planted in wide rows to reduce trampling. Additionally, it is not tolerant of frequent close grazing. Persistence of sainfoin has been correlated with harvest or grazing that is delayed until 50% of the buds have opened on each seedstalk, on average, and maintaining a high stubble height (3–4 inches minimum). Keeping grazing height above 8 inches will further extend stand life. Allowing reseeding may also increase stand persistence.

Sainfoin requires a well-drained soil and is adapted to calcareous and sandy or cobbly soils that might be unsuitable for other forage legumes. It is resistant to the alfalfa weevil, but is susceptible to many other alfalfa pests, such as Lygus bugs. Sainfoin is also susceptible to root and crown diseases. It is nutritious, highly palatable, and non-bloating. These qualities make sainfoin susceptible to overgrazing if not managed properly. It is compatible with many cool-season grasses, but also makes an excellent pasture as a pure stand. It can be difficult to establish, and sainfoin is not an efficient nitrogen fixer and might suffer a mid-season slump in production due to nitrogen deficiency. Production and persistence under dryland conditions in New Mexico are questionable. Seeding rates for sainfoin grown under irrigation are 35–40 lb/acre (seeds with pods) as a monoculture and 15–20 lb/acre in mixtures. For more information on sainfoin, see Guide A-311, *Sainfoin Production in New Mexico* (https://aces.nmsu.edu/pubs/_a/A311.pdf).

Strawberry clover

Strawberry clover (*Trifolium fragiferum*) is a long-lived, stoloniferous perennial with a growth habit similar to white clover. Because it is a very low-growing species, it is well suited for grazing, but not for hay production. While strawberry clover is best adapted to the state's cooler regions, it has fair heat tolerance. It also has good salt tolerance, and prefers wet soils with high pH. It is noted for its ability to establish and persist in wet, saline areas and under harsh environmental conditions where other legumes fail. Strawberry clover is not used widely for irrigated pastures in New Mexico, but it has potential for use in low-maintenance areas (e.g., orchards, vineyards) and is compatible with many cool-season grasses. It tolerates close grazing and can be continuously or rotationally stocked. Strawberry clover can cause bloat and should be managed accordingly. Use 2–4 lb/acre when seeding strawberry clover as a monoculture or in mixtures.

Sweetclover

Sweetclover (*Melilotus officinalis* and *M. alba*) includes species that are cool-season biennials or annuals with an erect growth habit. Plants in these species usually grow to heights of more than 2 feet, with stems that are coarse and become woody toward maturity. Plants look very similar to alfalfa, with only slight variation in the serration of leaflets on the trifoliate leaf. Another distinguishing characteristic is that flowers of sweetclover are either yellow or white. Sweetclover not only causes bloat but also contains a chemical called coumarin, which has an undesirable taste, affecting palatability. If sweetclover hay becomes moldy, the coumarin can be converted to

dicoumarol, a toxic substance that reduces the blood's clotting ability, causing animals to bleed to death from slight wounds or internal hemorrhaging. Low concentrations of dicoumarol can be problematic. Sweetclover also has a low leaf-to-stem ratio, which negatively affects quality. It can also be difficult to dry properly as hay, increasing the molding problem. Although it is adapted to most soil and climatic conditions in the state and makes an excellent cover crop, green manure crop, and bee nectar source, sweetclover is generally not recommended as a pasture species because of its antiquity factors.

White clover

White clover (*Trifolium repens*) is one of the more common clovers grown in mixed pastures in New Mexico, and does particularly well when mixed with cool-season grasses, such as tall fescue and orchardgrass. Yields of pure white clover stands are generally not high enough to justify growing it as a monoculture. The benefit of white clover is clearly the complementary effect (nitrogen contribution) it has on grass pasture quality and productivity. It is a short-lived perennial and has a creeping, stoloniferous growth habit. It can reseed itself under favorable conditions. It is adapted to a wide variety of soil types and will grow on poorly drained soils, but it does not tolerate salinity. Stolon and root rot diseases can deplete white clover stands. It is also susceptible to leaf diseases and root knot nematodes, although some varieties have tolerance to nematodes. Like alfalfa, white clover can cause bloat. It can be grown in most areas of New Mexico, but it is best adapted to the northern half of the state and higher elevations in the southern half.

There are three basic types of white clover: large (Ladino), intermediate, and small (common/wild). Small and intermediate types are often referred to as White Dutch clover. Ladino types tend to grow taller, produce more leaves, and yield more than intermediate and small types, but are not as long-lived. Tall and intermediate types are often difficult to distinguish from each other due to slight differences in the length of their petioles and overall plant height. Small types are usually very short and do not contribute much to overall pasture biomass. The various white clover types are well adapted to grazing, but because of their prostrate growth habit they are not well suited for hay. White clover tolerates frequent close grazing and trampling by livestock, but it persists best when it is allowed to recover. White clover is compatible with most cool-season bunchgrasses, and should be sown at 2–4 lb/acre in mixtures. As with the other small-seeded legumes, target seeding depth is 1/4–1/2 inch. Follow up interseeding may be necessary in subsequent years if white clover percentage in the stand declines.

PERENNIAL COOL-SEASON GRASSES

All perennial cool-season grasses described in this publication are compatible with cool-season legumes. Unless otherwise specified, seeding rates should be 15–20 lb/acre for monocultures and 12–14 lb/acre for mixtures. See the specific legume species for accompanying legume seeding rate. General seeding depth for most of these cool-season grass species is 1/4–1/2 inch, unless otherwise specified.

Orchardgrass

Orchardgrass (*Dactylis glomerata*) is a commonly grown, long-lived cool-season grass used for hay and pasture. It is adapted to New Mexico's cooler regions, but has persisted well under irrigation at lower elevations in the central part of the state. It has a bunch-type growth habit and tolerates a wide range of soil conditions, but prefers fertile, well-drained soils. Orchardgrass is characterized by soft leaves, and is very palatable and of high nutritive value when fertilized well and grazed frequently. It also makes a high-quality hay when cut at the boot stage in the spring, and every 30–35 days thereafter.

It is one of the more widely used pasture grasses at the higher elevations in northern New Mexico, but it is not as winter-hardy or long-lived as tall fescue or tall wheatgrass and is not very salt-tolerant. However, nutritive value and animal performance are generally better on orchardgrass. Research at NMSU's Agricultural Science Center at Los Lunas has shown that orchardgrass is slower than tall fescue to establish and slower to produce adequate forage. Orchardgrass yields are generally lower than tall fescue grown under the same irrigation and fertility, particularly during the hot summer months (greater summer slump). However, hay quality can be high, and demand for orchardgrass hay is usually great. In addition, orchardgrass does not have the negative perception that tall fescue has due to fescue's potential toxicity concerns (see *Tall fescue endophyte* section below). Like tall fescue, orchardgrass matures (seeds out) early in the spring, and subsequent regrowth after initial harvest remains vegetative and high-quality the rest of the growing season.

Stand persistence has been associated with grazing or hay harvest height. Consequently, a 3- to 4-inch stubble height should be maintained to promote stand longevity. Close, continuous grazing is an all too common cause of stand decline in orchardgrass pastures. It is also more susceptible to trampling/traffic damage than tall fescue and smooth brome grass. Orchardgrass performs well when mixed with a legume, and pasture quality can be improved by incorporating species like white clover or alfalfa. It responds very well to nitrogen fertilizer applications. Orchardgrass is a poor accumulator of magnesium, and grass tetany on pastures can be a problem

(see Circular 586, *Irrigated Pasture Management in New Mexico* [https://aces.nmsu.edu/pubs/_circulars/CR586.pdf]). Two traditionally grown varieties in New Mexico are ‘Paiute’ and ‘Potomac’, and these varieties have been shown to perform well in recent performance tests at Los Lunas, NM.

Perennial ryegrass

Perennial ryegrass (*Lolium perenne*) is a very high-quality, short-lived perennial with a bunch-type growth habit that can reseed when managed properly. It should only be considered for short-term pasture or hay use in much of New Mexico. Of all the cool-season grasses used in New Mexico, perennial ryegrass appears to be the most sensitive to cold, heat, and drought. Best adapted to New Mexico’s cooler regions, it prefers fertile, well-drained, medium-textured soils with nearly neutral pH. However, perennial ryegrass lacks the cold tolerance to survive multiple winters in the northern part of the state. The same could be said for its lack of heat tolerance in southern New Mexico.

Perennial ryegrass is often included in grass “blends” (3–4 species) from seed companies. Because it is one of the first species in the blend to establish, it can provide early ground cover and soil stability in new plantings. This feature gives protection to the later-germinating grasses in the blend. Over time, the perennial ryegrass will die out, giving way to the other, hardier grass species that will eventually dominate the stand. Perennial ryegrass is generally not recommended for monoculture pastures in New Mexico. For some producers, the benefits of easy establishment and high nutritive value and animal performance on a short-term pasture may outweigh the drawbacks of having to reseed pastures every few years. More long-term persistence information of newer perennial ryegrass varieties is needed in the state.

Perennial ryegrass contains a fungal endophyte that is responsible for a condition in livestock known as “ryegrass staggers”; however, many newer varieties have been developed that contain a non-toxic endophyte. Ergot can reduce seed yield and quality and limit re-seeding. Newly developed hybrids, known as *Festulolium*s, are a cross between ryegrass and fescue. These grasses are gaining in interest because they combine the benefits of both species; however, they have yet to be tested in New Mexico.

Smooth brome grass

Smooth brome grass (*Bromus inermis*) is a rhizomatous, sod-forming perennial with an erect growth habit. It has an adaptation area similar to that of orchardgrass and is used mainly in the higher elevations of northern New Mexico. Smooth brome grass tolerates periods of drought, temperature extremes, and salt better than orchardgrass. It tends to become sod-bound because

of heavy rhizomes, which can reduce productivity. To overcome this, stands may need to be renovated by disking or chiseling every three to five years to improve air, water, and fertilizer infiltration, and to stimulate new growth from buds.

Smooth brome grass provides high-quality pasture and hay. It is often seeded with a companion legume, such as alfalfa, which typically increases yield and quality. Planting can be difficult, and the seed is light and chaffy, which can cause feeding and metering problems through standard grain drills. When planting smooth brome grass through a drill, a native grass attachment (fluffy seed box) is needed to allow seed flow through the drill due to the excessive chaffiness of the seed. If a fluffy seed box is not available, mixing the seed with a coarser “carrier” that will not separate out (e.g., cracked corn, rice hulls) to facilitate feeding into the standard drill box may help, but agitation may still be needed either as an additional attachment or manually. A 1:1 ratio of cracked corn and smooth brome grass seed is effective for providing enough weight and texture for the flutes to grab onto the brome grass seed, but the corn will not germinate since it is cracked.

Like orchardgrass and tall fescue, smooth brome grass requires large amounts of nitrogen fertilizer for optimal productivity, unless it is planted with a legume; however, high nitrogen applications also increase sod binding. It performs best on well-drained silt or clay-loam soils. Poor seasonal distribution can make smooth brome grass difficult to manage. It is susceptible to overuse, and rotational grazing and carefully timed hay cuttings (early heading to early bloom) are critical to stand persistence. Smooth brome grass should not be grazed or cut below 4 inches. In some areas, smooth brome grass may become invasive due to its aggressive spreading nature.

Tall fescue

Tall fescue (*Lolium arundinaceum*) is a long-lived species with a bunch-type growth habit, although it is weakly rhizomatous and can form a dense sod over time. Tall fescue can be grown throughout New Mexico, but it performs best in the northern half of the state, particularly along the Rio Grande and Pecos corridors. It does exceptionally well in the flood-irrigated systems in these regions. It is one of the hardiest cool-season perennial grasses recommended for New Mexico. It is adapted to a wide variety of soil types and pH, and tolerates wet, poorly drained soils as well as moderate drought, heat, salinity, and shade. Tall fescue is quite tolerant to grazing, trampling, machinery traffic, and other management stresses. Although it might be less palatable than some cool-season grasses, livestock will graze it and perform well when it is fertilized properly and grazed frequently.

Tall fescue yields can be considerably greater than orchardgrass and smooth brome grass, and it is more tolerant of environmental and management stresses. Hay nutritive value can be outstanding when harvested on a 30-day schedule after initial heading (first cut) in the spring. Research conducted at the NMSU Agricultural Science Center at Los Lunas has shown that tall fescue hay cut at 30-day intervals can have as much as 65–70% total digestible nutrients, 15–18% crude protein, and >70% neutral detergent fiber digestibility. This same study showed that tall fescue was quicker to establish in the fall, and first-year productivity was 4–5 tons/acre greater than orchardgrass.

Tall fescue is compatible with most cool-season legumes in mixtures. If grown in monoculture, tall fescue will require nitrogen fertilization for optimal productivity. It responds well to nitrogen fertilizer, and total seasonal requirements can be as high as 250–300 lb N/acre in irrigated, high-production hay operations. These amounts can be reduced significantly in grazing situations due to animal recycling of nutrients, or when fescue is grown with a companion legume.

Stockpiling is a management technique where forage is allowed to accumulate in late summer for utilization in fall and winter, thereby reducing hay feeding. This technique involves removing cattle and applying 40–75 lb N/acre just prior to the fall growth period of the grass. Tall fescue is one of the best forages suited for stockpiling because it responds well to late-season fertilizer applications and maintains its high quality through the fall and winter. Varieties are available that are summer dormant, which could be a water saving feature, allowing the use of irrigation water on more productive annual grass pastures during summer; however, these have not been evaluated under New Mexico conditions.

Tall fescue endophyte

Poor animal performance on tall fescue pastures in other regions of the U.S. has been linked to a fungus, *Epichloe coenophialum*, found within the plants (endophytic) that is transmitted through the seed. This endophyte causes tall fescue to produce alkaloids that are associated with the plants' ability to withstand mismanagement and other stress factors, such as drought, insects, and disease. These alkaloids have also been linked to poor animal performance, such as reduced intake, weight gains, conception rates, and milk production, and increased birthing difficulties. These problems in cattle have not been as readily apparent in the western U.S. as they have been in the eastern U.S., particularly in the humid climate of the Deep South. However, reproductive disorders and foaling difficulties in horses have been reported with mares that have consumed endophyte-infected tall fescue late in pregnancy. Not all fescue is toxic, and endophyte-free varieties are grown extensively. Produc-

ers who want to know the endophyte status of their tall fescue pastures can submit a plant sample for analysis. Contact your county Cooperative Extension Service office about the sampling technique and laboratories that conduct the analysis.

Because the endophyte is more active in reproductive tillers, declines in animal performance can be reduced or avoided by maintaining the tall fescue in a vegetative state. This can be accomplished by grazing until approximately early May when seedstalk elongation begins and mowing after grazing to remove the seedstalks. Additionally, any time the tall fescue is stressed from heat or drought, the endophyte's negative effects will be magnified. Negative effects on animal performance can also be reduced by including a legume (or other grass) with tall fescue. This allows the animal to consume a non-toxic alternative forage in the stand that effectively dilutes the toxic alkaloids in the diet.

While endophyte-infected tall fescue is common in New Mexico, endophyte-free varieties that perform as well as the older, endophyte-infected varieties are also utilized in New Mexico. These endophyte-free cultivars do not cause problems in livestock, but might not persist as well under mismanagement, such as overgrazing or drought. As such, endophyte-free fescue should not be grazed below 3–4 inches. In addition to endophyte-free varieties, more recently developed "novel" endophyte tall fescue types are now available. These "friendly endophyte" fescues contain an endophyte that does not produce the toxic alkaloids characteristic of the old wild-type fungus, yet they impart pest resistance, grazing and environmental stress tolerance, and stand persistence to the grass. These new fescues (along with endophyte-free varieties) are safe for all classes of livestock, including horses. Grass hays, including safe tall fescue, are highly sought after by horse owners looking for alternatives to alfalfa hay. As such, the small-bale horse market is well suited for these grasses. Several newly released novel endophyte and endophyte-free varieties are currently being tested at Los Lunas.

Timothy

Timothy (*Phleum pratense*) is a winter-hardy, short-lived perennial bunchgrass adapted to the cooler, wetter areas at higher elevations of northern New Mexico. It reproduces vegetatively by vertical tillers. It is utilized mostly as a high-quality hay crop for horses. Timothy also provides high-quality pasture, but it will not persist under close, continuous grazing or frequent cutting. It has a shallow root system and is not heat- or drought-tolerant and recovers slowly under limited moisture. Timothy does not persist at the lower elevations in the southern two-thirds of the state. In general, it is later-maturing than other cool-season species, although early types are available.

Because it is short-lived with a unique growth habit, carefully managing timothy is critical to stand maintenance. To allow sufficient storage of carbohydrates (in bulb-like storage structures called “corms”) important to vegetative reproduction, the first harvest each year should occur between flowering and the soft-dough stage. This is in contrast to most other cool-season grasses, which should be harvested at the boot to early heading stages to maximize yield and quality. Fully headed timothy hay is fairly standard, and negative perceptions in the marketplace are not as great with timothy as with other “mature” hays.

In general, regrowth of timothy is inferior to other grasses. Additionally, even more crucial than for all other cool-season grasses, nitrogen should be applied in lesser amounts more often to timothy. This species produces two generations of tillers each year, the second of which overwinters and becomes the primary growth for the following year. To encourage second-generation growth in both years, nitrogen and phosphorus need to be available in the fall and early spring. Without split applications, poor fall growth will occur with even poorer regrowth the next spring. Management similar to that which maximizes yield and quality of other cool-season forage grasses, namely single, higher applications of nitrogen and early harvest, will consistently reduce timothy stands.

Seed is very small; hence, a firm seedbed to ensure shallow seeding is critical. The seeding rate is lower than many other cool-season grasses at 6–10 lb/acre for monoculture timothy and 4–6 lb/acre for mixtures. Timothy is less competitive in mixtures with legumes than other grasses. Mixtures should be managed to favor the persistence of timothy as described above (i.e., later harvest).

Wheatgrass, tall

Tall wheatgrass (*Thinopyrum ponticum*) is a long-lived bunchgrass that, like tall fescue, can form a dense sod. While most perennial cool-season grasses decline in quality and palatability when mature, tall wheatgrass does more so than other species. As such, it is better suited to grazing rather than hay production. It is adapted to a wide range of soil types and has the best salt tolerance of any of the perennial cool-season grasses described in this publication. It is used extensively in high-saline and sodic soils and where drainage is poor (e.g., high water tables). Tall wheatgrass can withstand frequent grazing but not overgrazing (best to leave 6–8 inches of growth), and because of the quality decline, grazing is best if done early in the season when palatability is highest. Because the vegetative growth remains tall and upright into late summer and fall, tall wheatgrass stockpiles well for winter forage. This can be useful in areas where snow covers other, shorter grasses, making

them inaccessible to livestock. Although it is adapted to most of New Mexico, its primary use will be in the lower elevations of the state’s northern two-thirds. Tall wheatgrass can be slow to establish. The cultivar ‘Jose’ tall wheatgrass was selected and released from the NMSU Agricultural Experiment Station and USDA Natural Resources Conservation Service Plant Materials Center at Los Lunas in 1965. This cultivar has shown excellent adaptation to New Mexico’s climate and growing conditions, and seed availability is good.

Wheatgrasses, other

Other wheatgrasses (western, crested, slender, intermediate, pubescent; *Agropyron* spp., *Thinopyrum* spp., *Elymus* spp.) are all perennial cool-season grasses that have potential for spring grazing pasture and occasionally hay. Their primary use is in rangeland and dryland and limited-irrigation situations. Western and slender wheatgrass are native to the U.S. In general, productivity of these wheatgrasses will be less than improved cool-season grasses, such as tall fescue, orchardgrass, and brome grass, under high-input conditions. Western wheatgrass is blue-green in color and can be found throughout New Mexico at elevations from 3,000–10,000 feet. It is common on lowland and flooded sites that receive runoff, as well as in mountain grasslands. Due to their upright growth, intermediate, pubescent, and western wheatgrass are more conducive to haying than crested. They are also sod-forming grasses that spread by rhizomes. This is especially true of western wheatgrass, making it a good selection for soil stabilization efforts. Intermediate and pubescent wheatgrass are often considered the same species, with pubescent being a hairy subspecies. Crested wheatgrass is a bunchgrass that makes an excellent grazing forage and is highly sought after for early season grazing on rangeland. Quality declines rapidly later in the summer. ‘Hycres’ is considered a higher-producing forage variety of crested wheatgrass. While all of these species are at least moderately tolerant of grazing, repeated intensive grazing every year will result in stand decline.

These wheatgrasses are often included in grass seed blends for various mid- to high-elevation utilizations in New Mexico. They are broadly adapted and drought- and cold-tolerant, and withstand grazing fairly well. Seeding rates vary widely (5–25 lb/acre) depending on desired stand thickness, seed cost, acreage, and input/production level. For more-intensively managed and irrigated and smaller-acreage situations, use the higher seeding rates of 10–20 lb/acre.

Wildrye, Altai

Altai wildrye (*Elymus angustus*) is a drought-resistant rhizomatous species that looks like a bunchgrass and has a long seasonal growth period. It is known for its salt tolerance in particular. Tests at Tucumcari have shown it to be widely adapted to well-drained and poorly drained, high-saline soils. Under these conditions, it was

among the highest-producing cool-season grass species, giving greater summer and late-season yields than tall wheatgrass and tall fescue. Leaf blades are wide, similar to tall fescue, and coarse, like tall wheatgrass, with a sharp point. However, cattle grazing plots that included several cool-season grasses appeared to have a similar preference for Altai wildrye as for tall wheatgrass. It is better suited for pasture than for hay production. Altai wildrye can be quite competitive once it is established. Because this species holds promise for increasing late-season grass pasture productivity and can be used in saline situations, more research is needed to determine how broadly adapted it is to New Mexico and the best management practices for its use here.

Wildrye, Russian

Russian wildrye (*Elymus junceus*) is a long-lived, drought-tolerant bunchgrass. It is generally utilized in low-input or dryland situations. It has good salt tolerance. In tests at Tucumcari, it was the most drought-tolerant of the cool-season grasses and responded quickly to precipitation. Russian wildrye is a low-growing species that produces seedheads early and remains vegetative for the remainder of the year, maintaining fine leaves that are palatable and high in quality. Because it has low-growing leaves (stems can be quite tall), it is not well suited for hay production. Growth begins later in the spring and lasts longer into the summer than many other cool-season grasses. Stands usually develop into widely spaced large plants. This species might have value in low-input systems with low stocking density in the northern half of New Mexico and at higher elevations, but production can be increased with irrigation and fertilization. It is often included in grass blends targeted for high-elevation pastures. It is tolerant to grazing and recovers quickly. Establishment can be difficult and slow, and seeding rates are usually lower (5–12 lb/acre). Russian wildrye has been shown to perform better when seeded in wide rows (>15 inches). This method allows for the incorporation of a companion legume (e.g., alfalfa) into the pasture.

PERENNIAL WARM-SEASON LEGUMES

There are no perennial warm-season legumes that are known to be suitable for use in New Mexico's irrigated pastures and hay fields. Sericea lespedeza (*Lespedeza cuneata*) and perennial peanut (*Arachis glabrata*) are examples of perennial warm-season legumes used elsewhere. However, sericea lespedeza performs poorly in calcareous soils such as those prevalent in New Mexico, and it has become an invasive weedy species in several states. Additionally, perennial peanut is not cold-hardy, winterkilling at 15°F, and production potential is reduced after long cool spells. It did not overwinter at Tucumcari.

PERENNIAL WARM-SEASON GRASSES

Bermudagrass

Bermudagrass (*Cynodon dactylon*) is a high-yielding, sod-forming perennial utilized for grazing and haying operations. It establishes rapidly compared with most perennial warm-season grasses utilized in New Mexico. The dense sod is formed by both spreading rhizomes and stolons. It favors well-drained, medium- to light-textured soils, but has done well on heavy clay soils. It is salt- and drought-tolerant, but can require large amounts of water to be productive in the Southwest. Bermudagrass responds well to fertilizer (200–400 lb N/acre in hay systems) and can stand heavy applications of animal manures. It has poor shade tolerance and, due to its aggressive nature, is not compatible with many other grasses or legumes, but might mix well with alfalfa in some situations. Bermudagrass is sensitive to cold; growth slows or ceases when night temperatures fall below 60°F. Therefore, bermudagrass grows best at the lower elevations found in the southern two-thirds of New Mexico. It is a common pasture species for horses in the most southerly reaches of the state, but can make excellent pasture for most classes of livestock. Bermudagrass can tolerate close, continuous grazing and heavy traffic. It also makes a medium- to good-quality hay product. Hay yields are directly related to the amount of water and fertilizer applied, but the common range is 4–6 tons/acre. Harvest frequency can greatly influence forage quality; ideal harvest windows are 21–28 days per cutting. While winterkill has been a problem for bermudagrass in New Mexico, newer varieties are available that are more cold-tolerant.

Bermudagrass can be established either vegetatively (with “sprigs”) or by seed. Some improved bermudagrass varieties are available only as sprigs because they do not produce large quantities of seed or the seed is not viable or true to the variety. Sprigging is more expensive than seeding, and sprig suppliers are few in the region, but sprigs can result in faster stand establishment, even when sprigs are placed on 3-foot centers. Seeded varieties are more readily available and constitute the majority of acres in New Mexico. Many seeded blends contain either ‘Common’ or ‘Giant’ types or both. ‘Common’ bermudagrass has been shown to be lower-yielding than newer improved varieties, and ‘Giant’ has limited persistence due to lack of cold tolerance. In New Mexico, the newer varieties of seeded types are recommended over these poorer-performing lines, although cost will likely be higher. In every situation, selecting a cold-tolerant variety (or blend) is of utmost importance. This is perhaps the most important selection criterion for New Mexico.

Improved forage varieties of bermudagrass have not been tested in New Mexico, but a few have been in neighboring states. In addition to these regional tests, producer experience and successes with certain varieties

has led to a handful of varieties recommended in New Mexico. Contact your local county Extension office for more information on bermudagrass varieties suited for your area.

Bermudagrass has a reputation for becoming weedy in cultivated crops due to its aggressive vegetative spread by rhizomes and stolons. As such, careful planning (including an escape weed management plan) is necessary to ensure that this grass does not spread to unwanted areas. Choosing blends that do not contain 'Common' can help in this regard. If available, sprigged bermudagrass varieties should be planted at 20–30 bushels per acre. This can be accomplished by using a sprigging machine (again, very rare in the region) or broadcasting (e.g., manure spreader) followed by lightly disking in and firming the soil. If a seeded type is selected, drill 5–10 lb/acre shallowly at 1/4–1/2 inch, or broadcast the seed followed by a cultipacker to firm the soil. Bermudagrass seed is very small; hence, seeders used for alfalfa or other small-seeded crops work well to ensure shallow planting into a firm seedbed. Using the legume box on a conventional drill can be adequate, and a common method with small-seeded crops is to pull the tubes to allow the seed to dribble on the ground, followed by a cultipacker to firm and press the seed into the soil.

Gramas, blue and sideoats

Blue grama (*Bouteloua gracilis*) and sideoats grama (*Bouteloua curtipendula*) are important native bunchgrasses used on rangelands throughout the region. Blue grama is low-growing (usually less than 18 inches) and highly palatable, and tolerates close grazing and traffic well. It is very drought-tolerant and will go dormant under extreme dry conditions in summer, but it recovers quickly. Under some heavy grazing conditions, it will form a dense sod. Blue grama has been improved for use in more intensively managed pastures and under irrigation as the variety 'Hachita', released by NMSU's Agricultural Science Center at Los Lunas, Colorado State University, and the USDA–NRCS Los Lunas Plant Materials Center. This variety has been shown to be a superior forage producer over other varieties. Because of its rangeland background, improved blue grama is better suited for limited-irrigation and limited-nitrogen situations than the other perennial warm-season grasses listed in this publication, all of which are introduced species. Although some seedstalks can grow 1–3 feet tall, blue grama leaves remain closer to the ground, so it is not well suited for hay production. Additionally, blue grama quality will likely be better maintained in low-input systems and can extend late into and after the growing season.

Sideoats grama is a mid-height (15–30 inches) plant and grows taller than blue grama, making it more suitable for hay production. It also makes excellent-quality

forage for grazing and maintains good quality into late summer and fall. However, it is not as tolerant to heavy grazing and traffic as blue grama, and it can be grazed out easily. 'Vaughn' and 'Niner' varieties are releases from the USDA–NRCS Los Lunas Plant Materials Center that have shown good adaptation to New Mexico's growing conditions.

Production potential of the gramas will be lower than improved introduced species under high-input management. Both species mix well together and with the wheatgrasses mentioned in this publication. Blue and sideoats grama can grow throughout New Mexico, even at high elevations (3,000–8,000 feet). They are adapted to most soil types, but are not tolerant of frequent flooding or poor drainage conditions. Gramas should be sown at 2–5 pounds pure live seed (PLS) per acre, using a drill with a fluffy seed box. While higher seeding rates (10–15 lb/acre) will result in a denser stand, high seed cost is usually a limiting factor on larger-acreage plantings. Germination, emergence, and seedling vigor of sideoats grama are better than other grama species.

Kleingrass

Kleingrass (*Panicum coloratum*) is a bunchgrass introduced to the U.S. from Africa. It is fine-stemmed and leafy and grows to a height of 3–4 feet. Kleingrass spreads by tillering and short rhizomes. It can also establish roots at nodes on the stems that are in contact with the soil, an effect called layerage. Kleingrass is adapted to a fairly wide range of soil and climatic conditions. It can produce large amounts of good-quality forage. However, there are some concerns about its cold tolerance. Although it has been grown successfully during a period of mild winters at Tucumcari, it is currently recommended for use only in the southern half of the state. Kleingrass can cause photosensitization (eye/nose discharge, sunburn, and/or tissue death) and liver damage in small ruminants. Horses are also susceptible to kleingrass toxicity (liver damage). Cattle appear to be unaffected. The seeding rate for kleingrass is 1.5–3 lb PLS/acre.

Old World bluestems

Old World bluestems (*Bothriochloa* spp.; OWB) is a name given to a collection of long-lived bunchgrasses that were introduced from eastern Europe and Asia. Caucasian bluestem (*B. caucasica*) and yellow bluestem (*B. ischaemum*) are the most commonly utilized. They were planted historically in the Central and Southern Great Plains for forage purposes and erosion control on Conservation Reserve Program land and along rights-of-way. Common varieties of yellow bluestem include 'King Ranch', 'Plains', 'WW-Spar', and 'WW-Iron Master'. In 1994, 'WW-B. Dahl' (*B. bladhii*) was released as an improved forage type and has been

studied extensively in West Texas as a pasture grass for use in low-water crop rotational systems. Research has shown that ‘WW-B. Dahl’ produces high yields and remains leafy longer into the season than either Caucasian or yellow bluestems.

These species are not as salt-tolerant as bermudagrass and prefer well-drained soils. They are well adapted to calcareous and high-pH soils. Growth is initiated later in the spring than bermudagrass and is sustained later in the summer, when other species are not as productive or are dormant. This is especially true of ‘WW-B. Dahl’ since it is later-maturing. Establishment can be slow, but good stands can be achieved in one season under good management and optimal conditions. Initially, OWB do not compete well with weeds or other species when sown in mixtures. Once established, they are very competitive, spreading by crown expansion and seed. In general, OWB respond well to nitrogen fertilization. During peak production periods, livestock might not be able to prevent OWB from forming seedheads. Concentrating animals in a smaller part of the pasture and harvesting excess forage as hay might help resolve this problem. ‘WW-B. Dahl’ tolerates continuous grazing, but plant height should be maintained above 3 inches. Quality is generally good early in the season, and excellent cattle gains have been recorded on ‘WW-B. Dahl’ pastures, but nutritive value (e.g., crude protein) and palatability decline rapidly with maturity. Forage yields of 6–8 tons/acre have been reported in the region when grown under irrigation. When seeding OWB, plant 2–3 lb PLS/acre

using a drill with a fluffy seed box into a firm seedbed at a target depth of 1/4 inch.

Note: OWB are prolific seed producers and have become a problematic weed, invading native grasslands in some areas of the Midwest and Southwest, including New Mexico. They (yellow and Caucasian) have been added to some state and local invasive weed lists, and awareness of their invasiveness has been promoted by the U.S. Forest Service. Once established, they can be very difficult to control, and they often displace native species and decrease plant diversity. Yellow bluestem is quite ubiquitous in the region, much more so than Caucasian. Preventing seedhead formation and eliminating seed dispersal are key management strategies for preventing the spread of bluestems outside of their utilization areas. At the writing of this publication, planting yellow bluestem is not recommended, and producers should only consider ‘WW-B. Dahl’ for use in New Mexico.



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