

Forage Selection and Establishment for Irrigated Pastures and Hay in New Mexico

Mark Marsalis, Leonard Lauriault, and Craig Gifford¹

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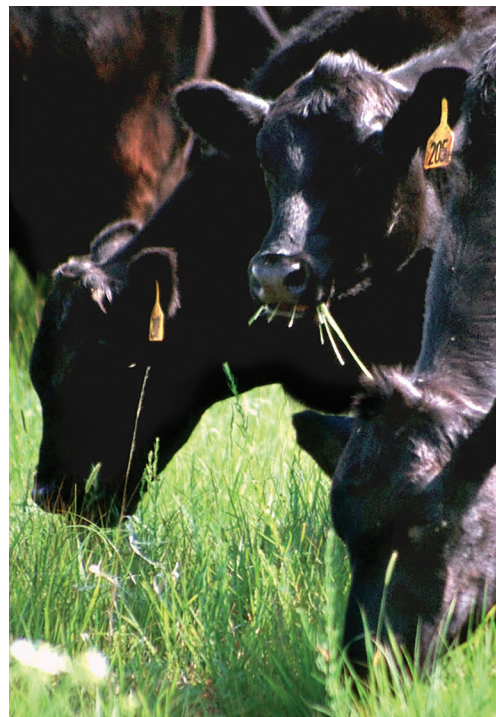
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INTRODUCTION

Forage crops comprise the greatest amount of cropland acres in New Mexico, and their overall value in the state is second to none. Many species of forages are grown in the vastly diverse climates of New Mexico, and are harvested in many forms to be used to feed a wide variety of livestock. New Mexico's hay industry is the premier agricultural crop industry, contributing over \$200 million annually to state revenue. Irrigated pastures, likewise, are an important component of cropping and livestock production in the state. Many forages are harvested to be utilized as silage for animal feeding operations. Using grazing



animals to harvest forage crops, such as irrigated pastures, requires much less labor and equipment than hay and feeding operations and allows for an increase in net farm income. There are numerous other uses for irrigated forages that are not driven by generating income. In many areas, small tracts are used to pasture horses or hobby livestock. Ranchers use irrigated pastures as holding sites, calving pastures, horse pastures, hay sources, or as a supplement to rangeland grazing.

To assist New Mexico's irrigated pasture and hay producers with selecting and establishing forage plant species, New Mexico State University's Agricultural Experiment Station has conducted research throughout the state and accumulated information from other states and producers. That information is presented here as a guide to developing productive irrigated forages in New Mexico. The primary focus of this publication is irrigated forages grown for pasture and hay situations. Descriptions for adapted perennial and annual species are presented in NMSU Extension Circular 696, *Perennial Forage Species for Irrigated Pastures and Hay in New Mexico* (https://aces.nmsu.edu/pubs/_circulars/CR696.pdf), and Circular 697, *Annual Forage Species for*

¹ Respectively, Extension Forage Specialist, Department of Extension Plant Sciences/Agricultural Science Center at Los Lunas; Forage Crop Management Scientist, Department of Plant and Environmental Sciences/Agricultural Science Center at Tucumcari; and Extension Beef Specialist, Department of Extension Animal Sciences and Natural Resources, New Mexico State University.

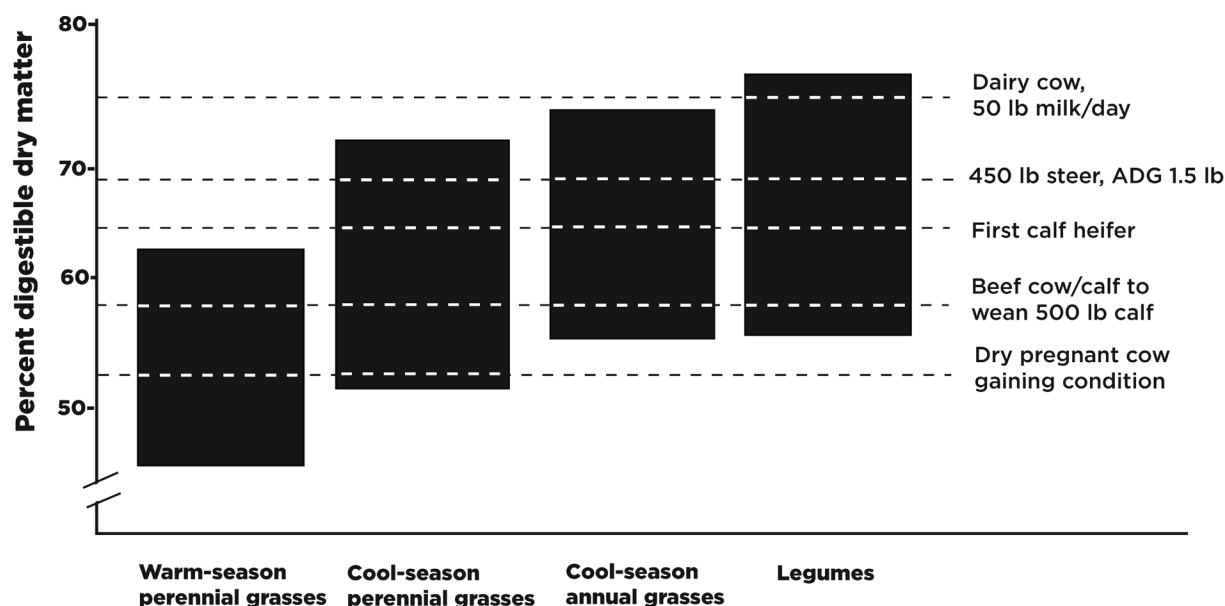


Figure 1. Relative digestibility of forage crop types and requirements of different cattle classes (source: Ball et al., 2015). ADG = average daily gain.

Irrigated Pastures and Hay in New Mexico (https://aces.nmsu.edu/pubs/_circulars/CR697.pdf), respectively. Recommendations in this publication, as well as in the species circulars, might change as more data and improved understanding of species performance and management become available.

Additional information on forage crops, including Circular 586, *Irrigated Pasture Management in New Mexico* (https://aces.nmsu.edu/pubs/_circulars/CR586.pdf), is 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 (<http://forages.nmsu.edu/resources.html>).

FORAGE SPECIES SELECTION

Several factors to consider in pasture and hay species selection fall into two broad categories: local adaptation and intended use. Within those two categories, there are questions producers should answer before developing their forage program.

How long will this land be in pasture or hay production?

Forage cropping systems generally fall into three categories: permanent, annual, and rotational. Permanent pastures and hay fields consist of perennial species that remain on the site indefinitely. Benefits of permanent forages include establishment costs spread over multiple years, soil and water conservation, and soil quality

improvement, particularly on marginal land. Annual forages are planted for seasonal use. They can be used to supplement permanent pastures or hay fields during times of low forage productivity, or they may constitute the entire forage program. Many producers prefer to use a combination of annual species year-round for pastures because they provide a valuable source of high-yielding, nutritious forage. While annual species generally yield more than permanent forages, the additional cost of land preparation, seed, and planting each year could more than offset any differences in production. Irrigated forages that will be rotated with row crops are part of a rotational cropping system. The forage species used in this situation, whether annuals or perennials, cool-season or warm-season, depend on the length of rotation, season of the year, and desired amount of forage.

What kind of animals will utilize the forage?

Different animal species and classes of animals within each species have different nutrient requirements (Figure 1). Animals with high nutritional demands, such as working horses, lactating cows, or growing steers, need greater amounts of higher-quality forage. Often, protein is one of the biggest expenses in a feed budget. Most irrigated pastures that are properly fertilized will have sufficient protein for all classes of cattle. However, it is always good practice to sample new pastures and conduct a nutrient analysis. Lactating cows and growing steers can require 11–15% crude protein (% dry matter), and occasionally unfertilized grass pastures may be deficient in protein for those classes of cattle.

Generally, irrigated pastures will be adequate in energy for all classes of cattle, but gains on stocker calves can be enhanced with supplementation. A good mineral supplementation program is still required, and in some cases it may be necessary to formulate the mineral program to offset grass tetany risks. In the case of horses, if quality is too high and fiber too low, colic or other metabolic disorders can become a problem. Also, if pastures are managed only for aesthetics or as a low-maintenance turf, less-productive pasture species might be more desirable.

Additionally, different species of animals apply different kinds of grazing pressure to pastures. Some, like beef cattle, graze uniformly across a pasture. Horses, in contrast, tend to spot graze, leaving some areas to become overmature while overgrazing others.

Finally, while legumes are usually higher in yield and quality than grasses, many legumes cause bloat in ruminants, which can lead to death. Producers need not avoid legumes entirely, but need to manage pastures with legumes to lessen the likelihood of the occurrence of bloat. More information about bloat and protecting animals against bloat is presented in Circular 586.

In hay production systems, the same principles of matching animal requirement to plant nutritive value apply. However, in these systems, forages are usually harvested at a more mature growth stage to maximize yield. As plants mature, factors such as protein, sugars, digestibility, intake, and energy decline, whereas fiber and lignin proportions increase. The associated quality decline that comes with plant maturity must be accounted for when matching the forage to the animal. Utilization of forage for hay (or silage also) is quite different from that of pasture systems, and associated animal performance should be expected to be different as well. In general, the concerns of bloat and some plant toxicities are lower in dried hay and ensiled forages, although not eliminated entirely (e.g., nitrates).

What forage crop species can be grown?

Local adaptation is the single most important factor to consider when selecting a forage species. New Mexico has vast differences in elevation and latitude. The wide range of climatic conditions allows for a broad range of species that may be adapted when irrigated. However, not all species are adapted to all locations and uses. Another consideration in determining adaptability is the types of insects and weeds found in the area that will potentially hinder forage productivity. Soil type and quality also play a key role in selecting pasture species. Forage performance can be affected greatly by poor or excessive drainage, soilborne diseases and nematodes, soil depth, pH, and salinity. The United States Department of Agriculture soil survey information (i.e.,

Web Soil Survey), along with a soil analysis, will help determine the soil conditions and constraints on your property that should be considered when selecting forage species. Once the forage species are selected, variety selection can also be a critical decision and should be based on the same criteria as that used for species selection. Contact your local county Cooperative Extension Service office for more information.

DESCRIPTION OF FORAGE SPECIES TYPES

Forage species known to be well adapted to certain region(s) of the state and that have value as livestock feed are discussed in Circular 696 for perennial species and Circular 697 for annual species. The description of each species in those publications includes limitations on adaptation and utilization.

Forage species are classified by their growth characteristics—when they grow, how long they live, and how they spread. Cool-season species grow best between 60 and 80°F and produce most of their biomass in the spring and fall seasons; they may or may not go completely dormant in the summer. Warm-season species grow best between 80 and 95°F, and most go dormant at temperatures below 32°F. Introduced, non-native warm-season species can be killed when temperatures consistently fall below 10°F. Annual species complete their life cycle in one year or less, and biennials need two growing seasons or years to complete their life cycle. Species that persist for three or more years are considered perennial. Generally, cool-season species are higher in quality than warm-season species, annuals are higher in quality than perennials, and legumes are higher in quality than grasses (Figure 1).

Seasonal yield distribution of the plant is another factor to consider when making species selections so that forage production will match animal demand (Figure 2). Cool-season perennial species generally have their highest production in the spring, followed by a summer slump and another growth period in the fall. Alfalfa is often an exception because irrigated alfalfa can continue to produce high yields throughout the summer when cool-season grasses reduce growth (Figure 2). Cool-season winter annuals grow some in the fall, followed by a period of dormancy or minimal growth in the winter and highest production in the spring. Generally, warm-season annuals and perennials grow actively from mid-May until a hard freeze in the fall. Peak production for most warm-season species is in mid-summer (Figure 2).

Irrigation allocation and/or quantity are constant concerns for most agricultural producers in New Mexico. The availability of irrigation water for crop establishment in either spring or fall can be an issue in many areas of the state, and adequate production of established stands might be a concern during times

Normal forage availability by months

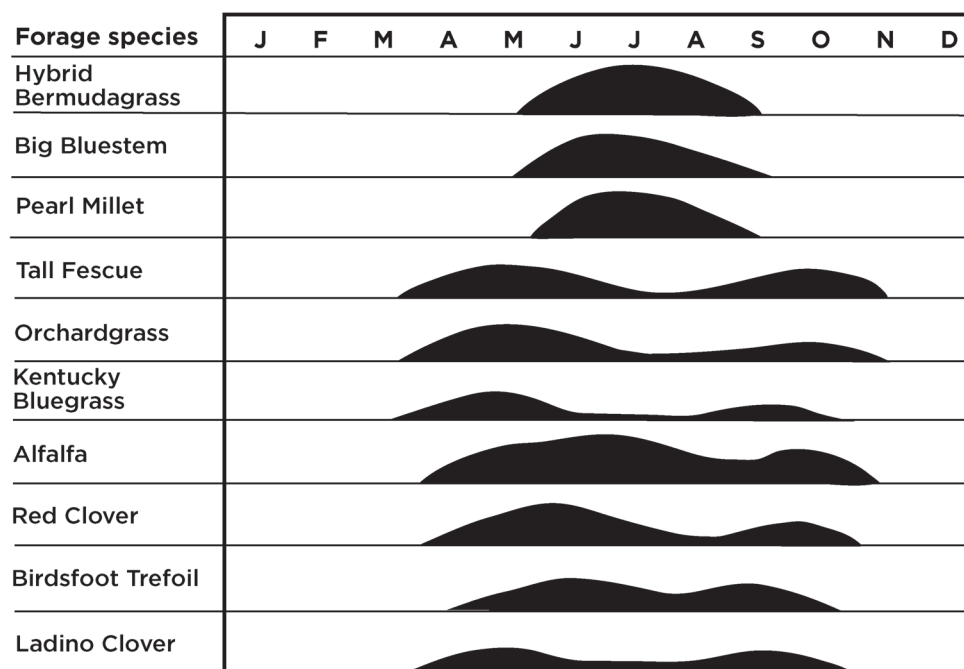


Figure 2. Seasonal yield distribution of selected forage crop species adapted to New Mexico (source: Ball et al., 2015).

of water shortage. Prior to planting, producers should familiarize themselves with the growth patterns of the forage crop to best match the crop water needs (greatest growth potential; Figure 2) with their irrigation supply and/or precipitation patterns. In general, cool-season grasses and legumes will use more water per unit of dry matter produced and have a longer growing season than warm-season forages. Hence, total water used is greater for cool-season species in most forage-based systems in New Mexico. This is particularly true in the southern reaches of the state, where cool-season forages struggle to produce adequately and stand longevity is shortened. Warm-season forages generally have a higher production potential and higher water-use efficiency, and grow for a shorter period of time, thereby using less total water. This is especially true of annual species such as sorghums and millets. However, warm-season species often produce less at higher elevations and northern locations in the state.

Most forages will spread by seed. Additionally, some species have a bunch-type growth habit and can spread slowly by tillering, or crown expansion (e.g., tall wheatgrass, tall fescue). Other species reproduce vegetatively, with lateral stems either belowground (rhizomes; e.g., Johnsongrass) or aboveground (stolons; e.g., buffalograss) that can form new plants by rooting at nodes. Bermudagrass is somewhat unique in that it can spread by rhizomes, stolons, and seed.

All forage crops need nitrogen for maximum productivity, but legumes live in cooperation (symbiosis) with

certain nitrogen-fixing bacteria (rhizobia), which form nodules on the roots and convert atmospheric nitrogen into a form the plant can use. For this reason, little or no nitrogen fertilizer is necessary for legumes. Grasses do not have this capability and must have their nitrogen requirement met by other means, such as fertilizers or being grown with a legume (Figure 3).

Cool-season annual grasses, such as small grains and most legumes, can cause bloat; animals grazing pastures that include these species should have a bloat preventive available at all times. Try to monitor animals daily, especially when first turning out on the pasture,

and be aware that some animals may not consume bloat preventive.

Finally, grass tetany, a livestock disorder caused by magnesium deficiency, can occur if soils are low in magnesium. This disease is most common in monoculture grass pastures during periods of rapid growth from fall through spring. Some grass species are more likely to cause grass tetany, generally because they are poor magnesium accumulators, or they have a period of extremely rapid growth in the spring, which dilutes magnesium concentrations in the plant. More information on bloat and grass tetany can be found in Circular 586.

Mixtures

Grass-legume mixtures are often preferred over monocultures because forage yield and quality usually increase, seasonal growth can become more uniform (Figure 3), and the legume supplies nitrogen to the grass, reducing fertilizer costs. Pastures with at least 50% grass reduce the incidence of bloat, although bloat preventives should always be available to the animals. Furthermore, using grass-legume mixtures can reduce the likelihood of grass tetany because legume forage is generally higher in magnesium. Grass-legume mixtures also make excellent hay that is often in high demand for horse feeding.

With few exceptions, legumes should be used in pastures as mixtures rather than as monocultures. However, some monoculture legumes make excellent hay in New Mexico, as evidenced by the large alfalfa hay industry

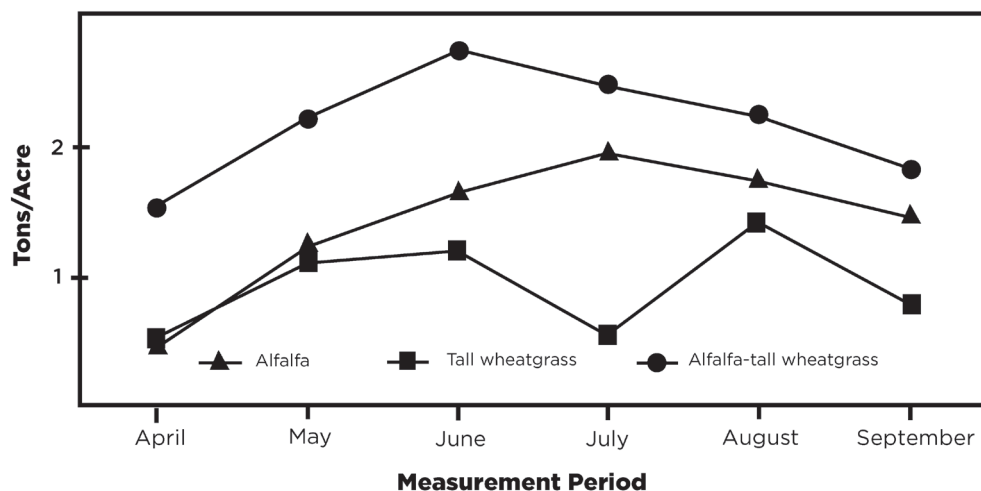


Figure 3. Seasonal yield distribution (35 days regrowth) of alfalfa and tall wheatgrass pastures at the New Mexico State University Agricultural Science Center at Tucumcari, 1999–2001 (adapted from Lauriault et al., 2005).

in the state. Simple mixtures (no more than two grasses and/or two legumes) are better than complex mixtures because complex mixtures present several problems. Differences in cultural practices (harvest timing, fertility, irrigation), grazing management, and ability to compete for light, water, nutrients, and space make it difficult to maintain all species in the stand. Additionally, animals will selectively graze more-palatable species and eliminate them from the stand, leaving less-palatable species to become overmature.

While mixing perennial cool- and warm-season grasses in the same field has not been successful in most irrigated areas, including perennial cool-season legumes in warm-season grass pastures has been successful in the Southeast. Overseeding dormant, warm-season pastures, such as bermudagrass, with annual cool-season grasses like wheat, triticale, annual ryegrass, or legumes has also been successful. However, in these mixtures, the warm-season grass needs to be going dormant prior to planting in the late summer, and the cool-season species should be grazed out or killed before the warm-season grass greens up in the spring.

ESTABLISHING IRRIGATED PASTURES

Seed and plant stock selection

When establishing an irrigated pasture or hay field, use the best-quality seed or planting stock available to improve your chances of obtaining a uniform, productive, and long-lasting stand. Once a species or combination of species is chosen, variety selection is critical to get the best genetics for your irrigated pasture system. Use certified or plant variety protected seed to ensure the genet-

ics in the bag are true to the variety name (see NMSU Extension Guide A-131, *Certified Seed* [https://aces.nmsu.edu/pubs/_a/A131.pdf]). Read the seed label because several factors listed involve seed quality and directly affect the pasture species performance, including seed purity, inert matter, weed and other crop seed, germination rate, and seed treatments.

Seed purity affects seeding rate and stand uniformity, as well as establishment of weeds and undesirable crop species. High inert matter, which includes stems, chaff, dirt, and rocks, is usually due to inefficient or poor seed cleaning techniques. As a result, higher seeding rates must be used, increasing costs. Excessive inert matter can plug planting equipment or restrict seed flow, causing inconsistent seed distribution. Weeds and other crop species compete for water, space, and nutrients and reduce forage production and quality. A relatively weed-free field can be contaminated if seed containing weed seeds is sown. Be sure that no noxious weeds are listed on the label. The test date on the label should be within the previous year to adequately reflect germination, which is also important for determining the seeding rate and obtaining a uniform stand. Seeding rate of many species is given as pure live seed (PLS, calculated as purity × germination). Seeding rates for many warm-season grasses are given as PLS values because they are generally very chaffy (high inert matter) and have low germination rates. Germination is affected by crop species and the seed's dormancy, age, damage, weathering, and storage conditions. Seedling vigor might be affected by the same factors as germination. However, even seeds that germinate might not have enough energy to produce viable plants. Seed treatments are beneficial for seed delivery (e.g., increasing size and weight of very small seed), legume inoculation, and protection from seedling diseases and insects.

Producers should never select seed or variety based solely on seed cost (e.g., purchasing the cheapest seed available or VNS [variety not stated] seed). Cost differences between cheap seed and that of improved varieties are a minor proportion of the total establishment costs and long-term expenses associated with the life of the stand. However, poor seed and/or an un-adapted or low-yielding variety can quickly become problematic

and significantly reduce profits. In many cases, the additional expense of selecting quality seed of a variety with superior genetics can be recovered within the first year of production through improved yields and/or animal performance.

Preplant fertility and legume inoculation

Before ground is broken for a new planting, a soil sample should be taken and submitted for analysis. Guide A-114, *Test Your Garden Soil* (https://aces.nmsu.edu/pubs/_a/A114.pdf), gives information about soil sampling and testing. In addition, Guide A-146, *Appropriate Analyses for New Mexico Soils* (https://aces.nmsu.edu/pubs/_a/A146.pdf), provides information on the proper laboratory soil tests for common New Mexico soils.

Often it is best to make phosphorus applications when it can be incorporated into the root zone during primary tillage prior to final seedbed preparation/leveling. Nitrogen demand is much lower during establishment, and heavy nitrogen fertilizer applications at planting only serve to promote weed growth and may lead to leaching/volatilization losses. If planting a monoculture grass pasture, apply only 20–25 lb/acre of starter nitrogen to help with grass establishment. If planting a grass-legume mixture, pay attention to phosphorus and potassium recommendations. Legumes have the ability to fix nitrogen from the atmosphere. If inoculated with the proper bacteria, they can meet their own nitrogen requirement and provide nitrogen to the companion grass (see Guide A-129, *Nitrogen Fixation by Legumes* [https://aces.nmsu.edu/pubs/_a/A129.pdf]). Adding excessive nitrogen at establishment will inhibit nitrogen-fixing nodule formation. Without good nodulation, legumes will produce stunted, yellow plants typical of nitrogen deficiency, necessitating the addition of supplemental nitrogen. Natural inoculation can occur if the legume has been grown in the field within the previous five years. However, if there is any doubt, it is best to inoculate and minimize the use of any preplant nitrogen.

Different legume species require specific bacteria, and it is important that the proper inoculant is used. The cost of inoculant is relatively low compared to the cost of nitrogen fertilizer over the life of the stand. Commercially available seed of many legumes will be pre-inoculated. The treatment date should be within the previous year. If untreated seed is purchased, inoculate the seed just before planting. Be sure to use the inoculant strain labeled specifically for the legume to be planted (e.g., the alfalfa strain is different from the white clover strain). Apply the inoculant evenly to the seed. Be sure to follow the instructions on the inoculant package, including those related to using a sticker to ensure uniform contact between the seed and the inoculant. Beware of using carbonated soft drinks, 10% syrup mix-

tures, or other homemade stickers because they might be too acid or alkaline and kill the bacteria. When adding a liquid sticker, do not get the seed too wet or it will become clumpy. Seed should feel sticky, but it must be uniformly moist. Mixing by hand in a large bucket, using a hoe in a larger pan, or using a cement mixer are equally effective for a uniform treatment. More information about legume inoculation can be found in Guide A-130, *Inoculation of Legumes* (https://aces.nmsu.edu/pubs/_a/A130.pdf). Non-peat-based dry inoculants that use static electricity to adhere to seed work very well without any additional sticker, but they still require thorough mixing with the seed.

Land preparation

Proper land selection and preparation are important for successfully establishing and maintaining an irrigated pasture or hay field. Producers need to be realistic about the suitability of their land for any cropping endeavor. Some land is not conducive to intensively managed forage production. Sites that are rocky, on steep slopes, extremely saline or sodic, and those that have poor drainage make growing forages very difficult and often result in wasted time and money.

Fields should be prepared so they provide for efficient and uniform distribution of water. The type of irrigation system and soil condition determine how much land preparation is necessary. Sprinkler systems only require that the land be level enough to allow easy operation of the sprinklers and other equipment. Flood and furrow irrigation, on the other hand, require the land to be level (e.g., laser leveling for flood irrigation or floating for furrow irrigation) across the flow pattern, with the proper slope for water to flow freely while also allowing sufficient time for infiltration.

Another important aspect of land preparation involves developing a firm, smooth seedbed to regulate planting depth and achieve good seed-to-soil contact. Many of the perennial forage crops have small seeds and should be planted no deeper than 1/2 inch in heavy soils or up to 1 inch in sandier soils (Figure 4). Uneven ground will cause some seeds to be planted too deep, and the new seedlings will not have enough energy to emerge and begin photosynthesis. It is also difficult to regulate planting depth in loose or cloddy seedbeds. Seed sown at the surface of loose seedbeds can be displaced by irrigation water, leaving unsown areas open for weed infestation. Additionally, loose seedbeds prevent good seed-to-soil contact, limiting access to water and nutrients and decreasing root anchoring strength. Annual species generally have larger seeds and, while cloddiness should be avoided, seedbed firmness and planting depth are not as critical. Planting depth can be more related to the depth of moisture below the soil surface, and planting depths of 1–3 inches are feasible

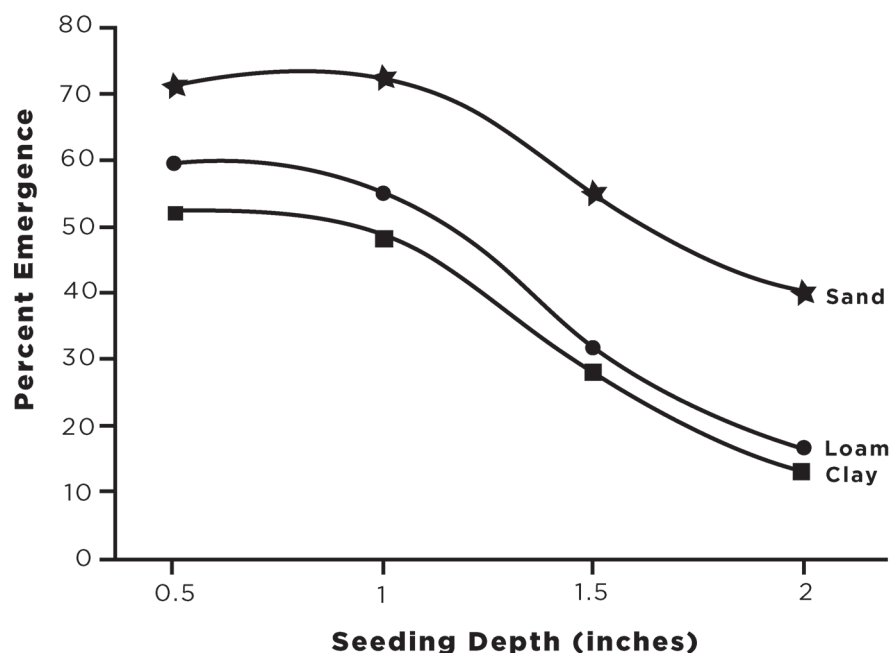


Figure 4. Effect of seeding depth on emergence of alfalfa (source: Sund et al., 1966).

depending on seed size and soil type. Sandier soils allow for deeper planting (Figure 4).

Planting time

Time of seeding is determined largely by season, soil temperature, and species to be sown. Warm-season plants germinate and emerge most rapidly when soil temperature is above 55°F; cool-season plants germinate and emerge when the soil temperature reaches 45°F. Warm-season species should be planted from spring to mid-summer (mid-May through July) to allow sufficient time for the crop to establish a good root system before freezing temperatures occur. Later plantings within that window (e.g., after mid-June) may not complete stand fill in the seeding year, requiring a second year to complete establishment. While cool-season perennial species can be sown in the spring, several factors make mid- to late-summer planting (early August to late September, depending on location) more desirable. Mid- to late-summer seedings give the plants time to establish fully so they are ready to graze or harvest the following spring. Also, there is usually less weed competition in late summer and fall than in spring, and more time is available to control weeds that germinate earlier in the summer. While some summer weeds might germinate after planting, competition is usually low and they may not have time to produce seed before frost. Finally, evapotranspiration and wind generally are less in the late summer/fall, resulting in lower water requirements. Late-summer plantings need to be early enough to allow

plants to establish before freezing. Generally, six to eight weeks before a hard freeze (28°F) are needed for establishment. However, recent research at Los Lunas and Tucumcari suggests that spring seedings of alfalfa can provide an opportunity to recover some or all of the establishment costs in the seeding year, and do not decrease forage yield in at least the first two years after seeding.

Planting methods

Most pasture species are established by seeding, but certain crops, such as some of the improved bermudagrasses, must be established vegetatively. Vegetative planting requires special operations and equipment. The sprigs (vegetative planting material) of bermudagrass must be vigorous and healthy. Plant them as soon as possible after harvesting because they do

not store well. Sprigs can be scattered and covered by light disking or rototilling, or they can be planted with a sprigging machine. Sprigging machines provide more uniform sprig distribution and covering, but they can be expensive and are not always readily available. Sprigging and then irrigating directly are a common practice to improve sprig-to-soil contact.

Seeding is more desirable and common than vegetative planting because of seed and equipment availability and overall lower costs. With conventional tillage, many forage species can be sown either by drilling or by broadcasting. Both methods provide uniform seed distribution and adequate stands. Properly set drills and air seeders with packer wheels provide better seed coverage in the same operation in most situations. Whatever tool is used, seed must be placed at the proper depth. Seed left on the surface can be displaced by wind and water, removed by birds or rodents, or die due to lack of seed-to-soil contact. Large-seeded crops, such as small grains and some heavier-seeded grasses, are best seeded with a drill. For small-seeded species (e.g., alfalfa, clovers, bermudagrass, teff), broadcast cultipacker-seeders (e.g., Brillion seeder) are often more suitable. Removing drill seed tubes and following with drag chains and then a cultipacker is a common broadcast planting method used for small-seeded crops like alfalfa, whether seeded alone or in mixtures. Broadcast plantings must be covered with a harrow or roller (cultipacker or ring roller). Generally, harrowing or rolling is done in a second operation, but equipment is available that will broadcast

and harrow or roll in one operation. Broadcast seeding is easier and takes less time than drilling, but this advantage may be more than offset through seed loss by displacement and the need for secondary operations. In contrast, nearly all the seed is incorporated and covered when drilled, and planting can be accomplished in one pass. When using a drill, it is critical to not blend seed of different sizes and textures and to use the appropriate seedbox for the seed size and texture. Small-seeded species, such as alfalfa, timothy, and bermudagrass, should be planted through a small seed attachment rather than through a grain box. The seed delivery systems of grain boxes and the small seed attachment are nearly the same, but parts will be smaller on the small seed attachment to allow for more accuracy of seeding rates to save on seed cost. Most perennial cool-season grasses can be sown through the grain box. Small-seeded legumes have smooth seed and grasses usually have larger, chaffier seed. Blending these two seed types and seeding through the grain box can lead to separation with every bump to the drill and a non-uniform stand of the intended mixture. One drawback to using a drill, however, is the potential for a drill row skip, which can potentially exacerbate a normal 6- to 8-inch spacing between plants to 12–16 inches. Such skips can reduce stand productivity and allow weed encroachment. Hydroseeding can be an option for establishing smaller pastures and is often available at many larger landscaping companies.

When planting perennial cool-season grass-legume mixtures, the large difference in seed size of the two crops must be accounted for. When using a seed (grass/grain) drill, do not mix the seed. Rather, plant the grass seed through the grain box and the legume seed through the small seed attachment (e.g., alfalfa box). Removing the seed tubes from the legume box will allow that seed to be broadcast while the grass seed is drilled in rows. This will minimize competition between the desirable species during establishment and maximize competition against weeds. Dragging a chain behind the seed drill will improve seed-to-soil contact for the legume, and following with a cultipacker or other roller will firm the soil further. Planting these mixtures can also be achieved in two separate operations using the appropriate equipment for each seed type (e.g., drill for grass and Brillion seeder for alfalfa, or cross-drilling by species). When planting native warm-season grasses or 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 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, granular clay products) 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

has been shown to be effective for providing enough weight and texture for flutes to grab onto the brome-grass seed. Using cracked corn ensures that the corn will not germinate or become competitive in the stand.

If land leveling is not needed to improve conditions for irrigation, no-till or minimum-till planting can save time and money compared to conventional tillage operations. These practices also improve moisture conservation because the soil is mulched with plant residue. No-till planting requires a seed drill designed specifically for penetrating untilled ground and plant residues. Equipment must be heavy enough to penetrate (weights can usually be added for this purpose) and place the seed at the proper depth. Careful attention must be paid to ensure that small-seeded crops are not planted too deeply in no-till situations. Drills with depth bands are best for placing seed at the proper and consistent depth in these situations. Existing vegetation must be managed to prevent competition and allow new seedlings to establish. Additionally, with no-till seedings, insect habitat remains undisturbed, allowing for increased potential for seed predation. Initial herbicide applications should be made at least two weeks before planting to reduce weed competition and remove the established insects’ food sources to encourage them to migrate to another area so they won’t feed on the seed. Insecticide seed treatments help overcome this problem if available. Also, if the same forage species is reseeded, disease pressure on seedlings might escalate, especially for legumes. Fungicide seed treatments (e.g., metalaxyl, mefenoxam, carboxin, thiram, etc.) are relatively effective for protecting seedlings from many diseases. For no-till planting, use the highest recommended seeding rate.

Established grass pastures and hay fields can be renovated with legumes by either of two methods: no-till in late summer or frost-seeding in late winter (early February to mid-March, depending on location). In either situation, apply a non-lethal chemical (if available; read the label) to burn down the grass, or remove as much top growth as possible by grazing or mowing. If mowing is used, excessive litter should be removed to prevent mulching that shades the seedlings and interferes with the initiation of photosynthesis. Grazing is probably the best option, and animals can remain in the pasture until the new seedlings emerge. Once that happens, remove the animals to allow the new seedlings to establish by reaching 25% bloom. Alternatively, use mowing to reduce weed competition, raising the mowing height as needed to avoid clipping the newly seeded plants.

Irrigation

Preplant irrigation can help overcome some problems with land preparation and seed movement caused by post-planting irrigation. Wetting the soil breaks down clods and firms the seedbed, improving seed-to-soil con-

tact at planting time. Soil crusting, which inhibits new seedlings from emerging, can also be prevented with pre-irrigation. But this method also has disadvantages. Planting must be done before the soil has dried too much for satisfactory germination. If the soil is too wet, there can be excessive soil compaction and crusting. Knowing when the soil is moist enough to plant, yet dry enough to drive equipment over the field, is largely a matter of experience. Also, because many perennial forage crop seeds are small and require shallow planting, desiccation of new seedlings must be prevented by keeping the top inch or more moist until emergence. Crusting must also be prevented, possibly requiring more frequent irrigation for improved establishment. This should not be much of a problem when using sprinkler irrigation, which can apply lesser amounts of water more frequently, but flood and furrow irrigation systems are not as efficient and are unable to apply small amounts of water. Pre-irrigating might cause water to be in short supply at another time during the growing season. More often than not, post-planting irrigation will be required to germinate and establish forage crops in New Mexico unless timely rains occur or if seed is planted into uniform moisture. Even in these situations, follow-up irrigations will likely be necessary to complete establishment, especially in the spring and summer.

Companion crops

Sometimes an annual crop, usually a small-grained species, is planted with a perennial forage species as a companion (also known as a nurse crop) to protect it until it becomes established. Oats are a commonly used nurse crop for establishing alfalfa in New Mexico since it emerges quickly and produces large amounts of biomass for hay. In general, this practice is discouraged except under special circumstances, such as when seedlings need protection from wind (e.g., spring planting) and/or the soil is highly erodible or where soil crusting can be an issue. The companion crop might help with emergence through crusted soils and/or protect the perennial species from the wind. It will also provide an early hay or grain crop, but it competes directly with the perennial species for water, nutrients, light, and space, delaying stand establishment drastically and possibly resulting in a less uniform stand. If a companion crop must be used, it should be seeded at a low rate (e.g., 15–20 lb/acre for oats) to avoid excessive competition. If possible, maintaining a moist soil surface until emergence is valuable for preventing crusting. For cool-season species, seeding early enough in mid- to late summer for plants to establish a good root system and produce some top growth prior to winter is the best establishment option. Producers can also consider no-till seeding into residue from the previous crop to protect the new seedlings. Spring-planted warm-season species normally establish quickly and vigorously and do not need a nurse crop.

Completing establishment

Once seedlings have emerged from the soil, they need special care to become established as a productive, persistent forage. Management during the first growing season determines the stand's uniformity and longevity. Adequate nutrients are essential. Follow preplant soil test recommendations for the species. Irrigation management is also critical. There must be a compromise between providing enough moisture for the plant to grow rapidly and not overwatering. Too little irrigation causes the plant to use too much energy for root system development rather than top growth. Desiccation can lead to plant death. Too much irrigation causes nutrient leaching, inhibits root development, and encourages plant diseases.

Weed control is always a concern because weeds compete for nutrients, water, light, and space, and they are especially problematic during establishment. The best weed control begins with a weed-free seedbed, assisted by a uniform stand of forage plants that can quickly establish ground cover. It still might be necessary, however, to mow weeds or control them with an herbicide labeled for the weed and the forage crop(s). Be sure to mow high enough to avoid clipping the desirable species during establishment.

Grazing or mowing forages too soon can cause problems. Small grains can be grazed when they reach 5–6 inches in height and summer annual grasses (sorghums and millets) can be grazed at 24 inches, and both types will still be vegetative. Mid- to late-summer-seeded perennial cool-season forages should be allowed to become more mature (reproductive stages; early heading for grasses and approximately 25% bloom for legumes) in the year after seeding before being harvested or grazed the first time. Spring-seeded legumes can be harvested 80 days after planting, but be sure to allow at least six weeks between the last harvest and the first anticipated fall temperature of 28°F, at which time another harvest can be taken. Graze spring-seeded grasses after frost in the fall. If a companion crop is sown to protect the new seedlings, use grazing to remove the companion crop but not the permanent species, as described above. Otherwise, harvest the companion crop as hay or terminate it with a labeled herbicide to reduce shading and competition. In either case, manage the pasture or hay field to protect the new seedlings by not grazing or clipping them until they are mature enough.

When grazing irrigated pastures, it is important to have a holding facility or trap as well as sufficient feed supplies to remove the animals from the pasture and sustain them during stand establishment or irrigation events. Significant field damage can occur if animals are grazed during or too soon after irrigation. In some cases, grazing after heavy rainfalls can have similar effects. Be sure to plan well in advance; stand establishment times

can vary depending on grass species. Finally, talk with your local veterinarian or Extension office for the best insect controls for your area. The environment in irrigated pastures is more conducive for larger insect populations than arid pastures, and some level of fly or insect control will likely be required.

SUMMARY

Irrigated forages serve many valuable purposes, such as generating income or maintaining animals for work, pleasure, or aesthetics. Whatever the purpose, success begins with good species selection and establishment. Forage species should be well adapted to the site where they will be grown and suitable for their intended purpose. The information provided in this publication will be useful in the planning and decision making process. Additional resources are available from your county Cooperative Extension Service office or through New Mexico State University's College of Agricultural, Consumer and Environmental Sciences forages publications website (<http://forages.nmsu.edu/resources.html>). Forage species known to be well adapted to certain region(s) in the state that also have value as livestock feed are discussed in Circular 696 for perennial species and Circular 697 for annual species. The description of each species includes limitations on adaptation and utilization. Circular 586 provides information about designing pasture systems, grazing techniques, and managing pastures for productivity, persistence, and animal health.

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Mark Marsalis is a professor and Extension Forage Specialist in the Department of Extension Plant Sciences at New Mexico State University. He earned his M.S. at the University of Tennessee and his Ph.D. at Texas Tech University. His Extension and research interests include efficient and sustainable management of irrigated and dryland forage crops to maximize yields and profitability in limited-water situations.

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