COLLEGE OF AGRICULTURAL, CONSUMER AND ENVIRONMENTAL SCIENCES

Irrigated Pasture Management in New Mexico

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INTRODUCTION

Irrigated pastures are used for a variety of purposes in New Mexico. Some are used for generating income or reducing feeding costs because it is cheaper to harvest forage crops with animals than with equipment. Other pastures are not used specifically for generating income, but might be used for hobby livestock, such as pleasure horses.

This publication offers recommendations for New Mexico's irrigated pasture managers based on research conducted by New Mexico State University's Agricultural Experiment Station and in other states, as well as feedback from producers. These recommendations are subject to change as more information becomes available.

Other resources that provide more information about topics covered in this publication are available from NMSU's College of Agricultural, Consumer and Environmental Sciences forages website at http://forages.nmsu.edu, and from NMSU's Cooperative Extension Service publications website at http://aces.nmsu.edu/pubs. Several such resources are mentioned by name in this publication.

PASTURES AND GRAZING METHODS

Grazing methods

There are two basic grazing methods: rotational and continuous. Other methods are variations or a combination of these. Rotational stocking in-

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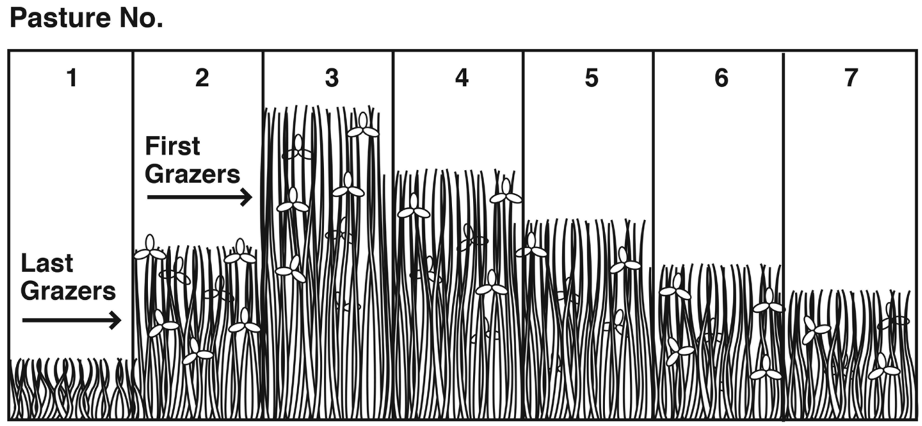

Figure 1. **Available forage when using leader-follower (first and last) grazing in rotationally grazed pastures.** (Source: Blaser et al., 1986)

volves subdividing a pasture into paddocks so that animals graze limited areas more completely and uniformly. Paddock size can be flexible if using portable fencing materials, and should be determined by the amount of forage the animals require for a specified period, usually seven days or less. Pasture species, soil type/land productivity, animal species, and number and weight of animals all affect paddock size. The goal of rotational stocking is to use 50–60% of the pasture's available forage before moving animals to a fresh paddock to allow sufficient rest for that paddock before it is grazed again. The number of paddocks used is determined by how intensively the manager wants to graze the pastures. A shorter grazing period (three days or less) in which all forage above a minimum level is removed maintains diet quality better than longer periods (four to seven days), but requires more paddocks and labor. Pasture rest periods generally are only slightly shorter than what is used for hay management of the same species (21 to 28 days for rotational stocking versus 28 to 35 days for hay).

In continuous stocking, animals remain in the same pasture with unrestricted or uninterrupted access to the entire pasture throughout the grazing period. Many producers (pasture managers) prefer this system because there is less fencing cost and less animal handling labor than for rotational stocking systems. Returns per acre have been thought to be lower with continuous stocking due to lower stocking rate or reduced animal performance. Generally, pasture species' seasonal growth patterns produce too much forage at some time during the season and not enough the rest of the time. This leads to poor pasture use, selective grazing, and pasture quality decline, all of which reduce animal performance. To compensate for early underutilization, many producers stock pastures heavier and then run out of feed when productivity declines. However, research at NMSU's Agricultural Science Center at Tucumcari shows that if producers use an appropriate stocking rate and pay attention to pasture health, there is no difference in animal gain per acre between irrigated grazing-tolerant alfalfa-tall wheatgrass pastures stocked with yearling beef cattle rotationally, or pastures stocked continuously all season (mid-April to late September). In continuously stocked pastures, if defoliation is limited so that plants retain enough leaves (photosynthetic material) for maintenance and growth, pasture rest is achieved. There may be a fine line between overgrazing and under-use in continuous stocking systems. Stocking rate should be based on the land's long-term productivity and carrying capacity, which are often restricted by the amount and timing of available irrigation.

Rotational stocking focuses management on the forage removal rate and ability to forecast forage use. However, when this same level of management is applied to continuous stocking, similar results in productivity per unit of land can be achieved, although forecasting may be more difficult. Another benefit of continuously stocked legume-grass pastures might be a reduced incidence of bloat. The incidence of bloat may be increased with rotational stocking when animals grazing pastures with a legume, such as alfalfa or clover, are moved after consuming most of the available forage because diet quality increases significantly when they are moved to the next paddock. In a continuously stocked pasture, if stocking density is matched to the pasture growth rate, grazing occupation could be extended for longer periods and diet quality should be maintained at a more stable level, thereby reducing the incidence of bloat. Nonetheless, using a bloat preventive is always recommended when legumes that cause bloat are present in the pasture regardless of grazing method.

Another tactic livestock producers can use to better manage forage supplies is a forage accumulation (or grazing deferment) technique called stockpiling. In stockpiling, forage is allowed to accumulate longer than in a traditional rotational stocking system, and the grazing period is also longer, often as long as or longer than the stockpiling period. Stockpiling warm-season grasses may be for all or any part of the season. For cool-season grasses and mixtures, stockpiling usually lasts only about two months. In the case of monoculture grasses, it is typically preceded by a nitrogen fertilizer application. Stockpiled pastures are grazed until available forage is removed to a specified level. Continuous stocking results in animals trampling forage and accumulating manure, thus creating ungrazed areas and wasting stockpiled forage. However, strip-grazing or rotational stocking prevents trampling and soiling over the whole pasture and allows for stockpiling to begin on paddocks grazed earlier in the season. Generally, stockpiling uses fewer pastures than more intensive rotational stocking. Stockpiling works well with many monoculture grasses or grasses mixed with most legumes. Clovers and birdsfoot trefoil are good choices for stockpiling; alfalfa is the least favorable. Tall fescue and tall wheatgrass are excellent candidate grasses for stockpiling; however, orchardgrass, bromegrasses, and other species with “soft” leaves do not stockpile well. Most perennial warm-season grasses are good for stockpiling, but nutritive value will be lower than with cool-season species.

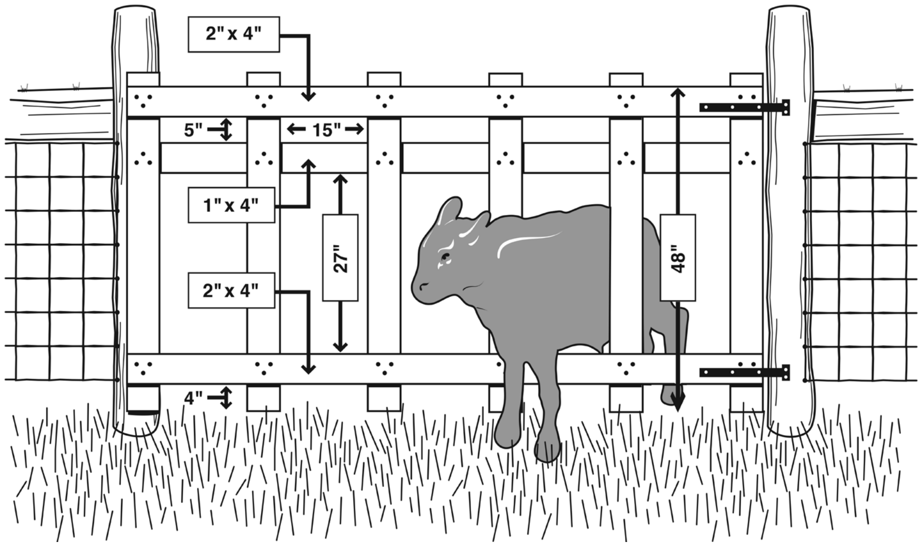

Figure 2. **A 12-foot creep gate to allow smaller animals (up to 700 lb) access to higher-quality forage areas.** (Source: Blaser et al., 1986)

Other grazing methods

Animal performance can be enhanced by certain grazing methods, particularly when different classes of livestock are kept on the farm. Two such methods are leader-follower (or first-last grazers) and creep grazing. Each of these gives higher-producing animals access to higher-quality forage. For example, in a beef operation, the leader-follower method allows stockers to graze the paddock first and harvest the higher-quality forage. This method fits well with rotational stocking. Once available forage has declined to a specified level, which also implies reduced quality, the stockers (first grazers) are moved to another paddock and cows and nursing calves (last grazers) are brought into the first paddock to clean up the leftovers (Figure 1). The grazing and rest periods can be the same as for traditional rotational stocking, but the grazing period is divided between the two animal classes.

Creep grazing can be used with any grazing system. A gate or small opening is provided between the pasture and a higher-quality forage area through which only young animals can pass (Figure 2). In rotational stocking, the creep gate would be between the paddock grazed by cows (dams) and the next paddock to be grazed to allow the juvenile animals access to that paddock, which will usually be higher in nutritive value. In fact, leader-follower grazing can be used in combination with creep grazing. In continuous stocking, the creep gate is between the pasture and an adjacent field set aside for hay production or sown with annual forages. Creep grazing might reduce some of the stresses associated with weaning because animals become accustomed to grazing in separate pastures and are given access to forage with higher nutritive value prior to being weaned. Fenceline weaning can then be used in conjunction with creep grazing.

PASTURE AND PADDOCK DESIGN

Many factors are involved in pasture design, including management goals, soil type, irrigation technique, field shape, and location of livestock watering points. Accommodation of all of these factors is driven by available capital and whether the goal is to make a profit or maintain pleasure animals. The design goal in any pasture system is to balance pasture or paddock sizes with the forage demand of a group of livestock for a specific time period and to provide regular or continual access to water and supplements.

Management goals

Management goals determine how intensively a manager wants to rotate animals, which in turn determines the amount of time that animals use a given pasture or paddock. Some producers prefer to use very small paddocks and move animals daily or even twice a day. Others prefer continuous stocking, which almost relieves them of animal handling responsibilities altogether. It is likely that some animal rotation increases productivity of both the pasture and the animals. However, research at Tucumcari indicates that animal productivity per acre might not be compromised in lower-intensity systems when grazing a high nutritive value forage (e.g., a grazing-tolerant variety of alfalfa) at an appropriate stocking rate.

Soil factors

Soil type (which affects natural fertility, water-holding capacity, and drainage, among other things), slope, and aspect of exposure all affect land productivity. Some areas may be more or less productive than others. Consequently, paddock size needs to be adjusted to account for differences in productivity so that animals can flow through paddocks in rotational stocking, allowing a sufficient rest period for each paddock and maximum forage use. There is not much concern in continuous stocking systems for rest periods because plants should not be stressed to the point of needing a rest and **if pastures are properly stocked**. That being stated, a uniform stand of pasture species equally acceptable by livestock is necessary to prevent overgrazing of some species and avoidance of other species within the pasture, whether rotationally or continuously stocked, which is one reason to combine stockpiling with continuous or more long-term stocking and to fence pastures based on uniform productivity.

Irrigation

Pasture design must take irrigation management into account. For surface-irrigated (flood and furrow) fields, each pasture or paddock should be irrigated as a unit, without interfering with management or use of other fields or paddocks. Pastures should not be irrigated while being grazed. Animal damage to the soil and pasture stand is as much of a concern for sprinkler-irrigated pastures as for surface-irrigated pastures because the potential of surface compaction still exists, although it depends on the amount of water applied and soil type, which determines the infiltration rate and wetting depth. When surface irrigating, it may be necessary to use long, narrow pastures or paddocks so that the water stays within the paddock rather than crossing a fence. Continuously stocked pastures should be cross-fenced so that animals can have continuous access to pasture, water, and supplement but be temporarily excluded from portions being irrigated. Special gates have been designed to allow sprinklers to cross fences without damaging them or interfering with the flow of electricity to the rest of the fence.

In rotationally stocked pastures, irrigation water is generally applied to all paddocks at the beginning of the growing season and then after each paddock is grazed to promote regrowth for the next grazing cycle and as needed in the rest period to sustain growth. For continuously stocked pastures, water should be applied as needed to sustain productivity with consideration to temporarily removing the animals to allow for soil drying. In either system, excluding animals is only necessary until the ground is sufficiently dry to prevent hoof damage to the pasture plants.

Water, supplements, and parasite control

Every pasture needs an area set aside for cattle to access water and supplements. This is usually where cattle will loaf unless shade is available elsewhere. Water and supplements should be located away from each other and from shady areas to encourage animals to roam and graze throughout the pasture. Water and supplements should be located in well-drained areas. Placing them on a slope or providing a platform of firm soil or gravel helps move water away so that the area does not become muddy or excessively rough. In continuous stocking and stockpiling systems, water and supplements should be located near the pasture's center, particularly for larger pastures (up to approximately 120 acres if circular). This also will work for larger, rotationally stocked paddocks. In smaller pastures, waterers may be placed in the fence line between two paddocks or pastures to minimize installation and maintenance costs.

Water needs to be safe for livestock (see NMSU Extension Guide M-112, *Water Quality for Livestock and Poultry* [http://aces.nmsu.edu/pubs/_m/M112.pdf], for more information), always available, fresh, and offered in a way that keeps animals from standing in it. Water can be kept fresh by providing, at most, a week's supply at a time. Automated waterers using a float system that refill the tank as it is emptied can be installed to water lines using garden hoses. If water is not directly available to the pasture via a pipeline, portable tanks can be used and refilled whenever visits are made to check on pasture or animal condition. Coarse rock can be used around installed waterers to encourage animals to drink and then retreat to minimize trampling there. Pastures should be visited on a regular basis in any system to make sure fences are secure, check livestock for illness, make sure the water and supplement supplies are adequate, and make sure that forage has not become limiting.

Supplements, even in block form, should be kept in feeders to minimize ground contact, loss, or deterioration. Research at NMSU's Corona Range and Livestock Research Center and Southwest Center for Rangeland Sustainability indicates that animals are more likely to visit open rather than covered feeders and stay long enough to ingest a satisfactory amount of the supplement.

When using leader-follower or creep grazing methods, the calves or yearlings can be enticed into the higher-quality forage area using a supplement feeder stocked with an intake-limited concentrate ration. This also will provide supplemental energy to promote growth. Be sure to provide salt and mineral supplements and bloat preventives in both pastures so that all animals have access to them at all times.

Dust bags or back rubbers for external parasite control can be placed such that animals have to come in contact with them when coming and going for water or supplement. Nonchemical options are available as well.

Shade and wind protection

Other factors that promote animal comfort, and therefore performance, include shade and wind protection. Providing an area out of direct sunlight offers more comfort during rumination. Also, photosensitivity (sunburn) can be reduced if shade is available when forages that cause sunburn are included in the pasture. Wind and extreme weather events (e.g., blizzards) are common in New Mexico. Wind protection is especially important during the winter for newborns to reduce illness or to provide a snow-free area for loafing and feeding.

Distance to water, supplements, and other amenities

Research at the Forage Systems Research Center in Linneus, MO, indicates that animals will regularly walk 800 feet to their water source to graze. Longer distances may reduce water intake and/or grazing time. Animals spend time lying in pastures between grazing sessions rather than going to water. Or, when they do come to water, they spend more time loafing in the alley. Shorter distances may result in paddocks being too small, requiring managers to move cattle more often than desired. In any case, distance to water affects dry matter intake as well as diet quality and selectivity.

Fencing

There are many fencing designs available on the internet as well as from dealers. Producers should look at available options and decide what will work best for their particular irrigated pasture program to keep animals where they should be and maintain the flexibility the pasture system demands.

In rotationally stocked or stockpiled pastures, paddocks should be fenced so that each can be managed individually without interfering with any other, particularly for irrigation. It is often beneficial to set aside a sacrifice area in or near the pasture, but not considered part of it, to provide water, supplements, and loafing. This area should be easily accessible from all paddocks. For pivot-irrigated pasture systems, paddocks may be arranged like pie slices with the common area at the center. This makes it easy to provide water to livestock since that is also where the irrigation water supply is located. In pastures irrigated by side-roll or surface irrigation (flood or furrow), paddocks are more likely to be in a line at a right angle, or nearly so, to the direction of water movement. An alley above the ditch is usually satisfactory. Cattle easily become accustomed to wooden bridges covered with dirt, especially if manure is mixed in. However paddocks are laid out, gates are needed that allow animals access from the pasture to the common area but prevent them from entering pastures being rested or stockpiled.

Generally, perimeter fences should be more structurally sound than internal fences. If electric or high-tensile fencing is used, animals should be trained to the fence before being left unattended. When using electric fencing, perimeter fences should include at least one hot wire and one ground wire. Single-strand hot wires may be sufficient for internal fences. In dryer soils, two hot wires with a ground wire in between and a deeper ground rod may be needed to maximize electrical strength. Proper and consistent grounding is essential for electric fencing to be effective. Be sure to design electric fences so that opening a gate does not interrupt electricity flow to other parts of the fence. Temporary fencing is available that can be valuable for internal fencing in a rotational stocking system. Since these materials are easy to install and remove, paddock size can be adjusted based on available forage and animal demand to provide pastures for a set time.

PLANT MANAGEMENT IN ESTABLISHED PASTURES

Fertilization

Proper fertilization of a good pasture stand improves forage yield, palatability, and nutritive value. In addition, proper fertilization can enhance stand life, weed control, disease tolerance, and water-use efficiency. Pastures, like all other crops, require appropriate amounts of nitrogen (N), phosphorus (P), and potassium (K); however, approximately 90% of the ingested forage is returned as manure, along with the nutrients it contains, eventually leading to nutrient recycling that offsets the need for significant fertilization. Depleted pastures may require large amounts of fertilizer initially, but subsequent applications can be reduced due to nutrient recycling. Consequently, it is impossible to provide a standard fertilizer recommendation because of the variability in pasture composition (species and proportion of plants in the mix), soils, climate, and water. Test soil each year for the first three years and then occasionally (at least every three years) to verify that the applied fertilizers or recycled nutrients are meeting the needs of the pasture without having a surplus, or that there are no deficiencies in secondary and minor (micro) nutrients. (See NMSU Extension Circular 676, *Interpreting Soil Tests: Unlock the Secrets of Your Soil* [http://aces.nmsu.edu/pubs/_circulars/CR676.pdf], for more information on soil testing.) Managers of permitted animal feeding operations are required to soil test fields receiving manure applications every year regardless of whether those will be used as pastures for backgrounding or for stored feed production.

Nitrogen, the nutrient most often deficient in the soil, is essential for growth of all species. Deficiency symptoms include poor growth and yellowing (chlorosis) of the leaves. Nitrogen is a mobile nutrient and can be leached out of the root zone by heavy precipitation or irrigation, leading to nitrate contamination in groundwater. Therefore, it is best to apply it in split amounts or increments over the growing season rather than in a single application. This not only reduces the chance of leaching but also lessens the likelihood of injury to plants from fertilizer (salt) burn, allows more efficient use of the nutrient, and reduces the potential of excessive uptake by nitrate-accumulating plants and weeds (see NMSU Extension Guide B-807, *Nitrate Poisoning of Livestock* [http://aces.nmsu.edu/pubs/_b/B807.pdf], for more information).

Perennial cool-season grasses can use up to 250 pounds of nitrogen per acre per year, including that provided through nutrient recycling. This should be applied in as many applications as possible made throughout the growing season at rates up to about 40 pounds per acre per application. For perennial cool-season grasses, to avoid overproduction in the spring and to promote growth during the summer, the first application should be made after the rapid growth period. Subsequent applications can be at uniform intervals throughout the growing season. In a test at Tucumcari, NM, furrow-irrigated tall wheatgrass yields under four-cut hay management declined when the nitrogen schedule changed from three applications of 50 lb/acre to two applications of 75 lb/acre.

Nitrogen can be applied to pastures at any time, but it should be done in conjunction with irrigation or imminent precipitation to help incorporate the nitrogen and prevent volatilization losses. Nitrogen uptake and use are more efficient if the plants are actively growing before the application and if adequate moisture is applied afterward to incorporate the fertilizer. In the test at Tucumcari, tall wheatgrass responded very well when precipitation or irrigation occurred within two weeks before and after the nitrogen application. When nitrogen was applied in mid-December, in conjunction with irrigation or precipitation, yields were higher the following spring. Producers might benefit from scheduling nitrogen applications one to two weeks after a significant growth-promoting rainfall and then watering in the nitrogen. Introduced perennial warm-season grasses and all annual grasses also respond well to nitrogen fertilization, even when applied at higher rates of 100 pounds per acre per application. In southern New Mexico, bermudagrass can probably use up to 400–500 pounds of nitrogen per acre per year, with lesser amounts in the middle third of the state, making it desirable as a catch crop for nitrogen in dairy or other manure applications. Native grasses like blue grama will decrease productivity if too much nitrogen is applied.

The nitrogen requirement on irrigated pastures can be reduced greatly or avoided altogether with grass-legume mixtures. In most cases, the legume will fix enough nitrogen to meet the needs of the mixture. See NMSU Extension Circular 585, *Species Selection and Establishment for Irrigated Pastures in New Mexico* (http://aces.nmsu.edu/pubs/_circulars/CR585.pdf), for more information on legume species selection.

Phosphorus is commonly deficient in New Mexico soils. It is rapidly bound up in soils with a high pH, becoming unavailable to plants. But unlike nitrogen, phosphorus is not leached readily from the soil, even in its plant-available state. Phosphorus is essential for both legumes and grasses. Legumes require more phosphorus than grasses and are therefore more sensitive to phosphorus deficiency. Deficiency symptoms include stunted growth and/or purpling of the leaves. Much of the plant phosphorus ingested by grazing animals will be returned to the soil in manure. To replace phosphorus retained by grazing animals, apply phosphorus fertilizer in a single application made in late winter or early spring. As previously mentioned, occasional soil testing will help determine how much phosphorus should be added. Be sure to ask for the Olsen P (bicarbonate) test when the soil sample is submitted to a laboratory for testing. More phosphorus must be replaced if any of the forage is harvested as hay. If soil testing indicates low phosphorus levels, applications over several years might be necessary; however, if soil tests indicate near sufficient phosphorus levels, larger applications every three years are likely more economical than smaller applications each year.

The botanical composition of grass-legume pastures can be altered by fertilization. When nitrogen is reduced and phosphorus is increased, the legume tends to become the dominant species, or is at least maintained in the stand. The opposite occurs when nitrogen is increased and phosphorus is reduced.

Potassium is another essential nutrient for plant growth. New Mexico soils generally are high in potassium, and its application to many crops has not been beneficial in the past. However, in situations where soil tests indicate low or very low potassium levels or in fields that have been utilized for continuous hay production over time, plant response to potassium fertilizer may be significant. As with phosphorus, legumes are more sensitive than grasses to potassium deficiencies, symptoms of which include white-speckled leaves, excessive wilting, and top or marginal burn of older leaves. Soil tests using water-extractable potassium might give a better estimate of potassium needs in New Mexico soils than ammonium acetate tests. Plant tissue analysis should also be used to determine if a deficiency exists. Some plants (e.g., bermudagrass) are luxury consumers (take up) of potassium and can concentrate high amounts of it in the forage. Too much potassium in forages can lead to metabolic disorders in certain classes of livestock.

Secondary and micronutrients are rarely a concern on irrigated pastures. One exception may be grasses deficient in magnesium (Mg), which are often accompanied by excessive potassium levels. This pasture and animal condition is discussed further in the *Grass tetany* section. Another limiting nutrient may be boron in pastures that contain alfalfa or clover species, which require higher amounts of boron than grasses. Sulfur can occasionally be limiting on sandy, low-organic-matter soils, and some grasses such as tall fescue and bermudagrass have been observed to benefit from fertilizers that contain sulfur as part of a fertilizer blend (e.g., ammonium sulfate). Soil tests, confirmed with associated tissue tests, can indicate the need and subsequent rates of any secondary and micronutrient fertilizers.

Irrigation

Introduced forages will almost certainly need irrigation to survive and be productive in New Mexico's semiarid climate. A good, productive pasture can use 40 to 60 acre-inches of water annually, including precipitation, to maximize production, although the amount will be much lower at cooler, higher-elevation areas in the state. The irrigation amount and application frequency vary with temperature, humidity, wind velocity, soil type, irrigation system, and pasture species. High temperatures, low humidity, and high winds increase the water requirement. Sandy soils have less water-holding capacity than heavier soils and require lighter but more frequent applications. Sprinkler systems cannot apply water at the same rate as surface irrigation (flood and furrow irrigation), so irrigation frequency is usually higher, possibly as often as weekly or biweekly depending on plant demand and soil water infiltration rate. Poor management of surface irrigation can result in the loss of one-third or more of the applied water to evaporation, runoff, or percolation below the root zone. Irrigations should be applied often enough to prevent obvious moisture stress to the plants.

Cool-season grasses may use less water than alfalfa hay to maximize production, but their yield potential is usually lower even with unlimited water. In general, cool-season forages require between 4 and 7 inches of water per ton of dry matter forage produced. Depending on soil texture, some species need to be irrigated more frequently (1–2 inches per week, on average, applied weekly or semimonthly) because of their shallow, fibrous root system. Others are more drought-tolerant or have deeper root systems and can be irrigated every 28–35 days if 4–6 inches of water are applied. One disadvantage to using cool-season grasses is that, although they may not be as productive during the summer, many do not truly go dormant and still require supplemental water to survive. Stocking pressure should be adjusted accordingly during summer to prevent additional stress on the plants or livestock should be moved to a more productive pasture. Additionally, research at Tucumcari shows that while irrigating alfalfa and other cool-season legumes during winter semi-dormancy increases yield in the spring, irrigating cool-season grasses during that period may decrease summer yield. This may be associated with shallow root system development in winter that limits acquisition of deeper moisture during the summer.

Warm-season grasses utilize water more efficiently, are more heat-tolerant, and seem to conserve water because they need to be irrigated fewer times during their growing season, which is shorter than that of cool-season grasses. In general, warm-season species require between 2 and 4 inches of water per ton of dry matter forage produced, depending on location and irrigation system efficiency. Because of their high water-use efficiency, good heat tolerance, and poor cold tolerance, perennial warm-season forages such as bermudagrass are best adapted to the southern third of the state, with marginal adaptation at lower elevations along the I-40 corridor. These grasses are only productive from late spring to fall. Consequently, costs of forage harvesting and storage for feeding at times when they are not productive may increase unless other species are used to fill forage-deficient gaps. Some varieties of tall fescue go dormant during the summer, negating the need for irrigation. This frees up water for use on summer annual species that are more productive during that period (see NMSU Extension Circular 585, *Species Selection and Establishment for Irrigated Pastures in New Mexico* [http://aces.nmsu.edu/pubs/_circulars/CR585.pdf]).

When pastures are furrow irrigated, the animal trampling effect may necessitate cutting new furrows as often as every year. This should be done in winter when desirable species are dormant by using a narrow shank cultivator. Excluding animals from areas being irrigated will reduce this damage. In pivot-irrigated pastures, several options are available to prevent wheel rut formation that can lead to further damage to the pasture and other equipment as well as causing possible injury to animals. Producers can consult their local NMSU Cooperative Extension Service county office (http://aces.nmsu.edu/county/) or NRCS Field Office (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs), or search the internet for options to decide which might best fit their circumstances. Horses are prone to injury due to uneven land, such as that formed for furrow irrigation or rutted by irrigation pivot tires. Sprinkler irrigation rates should be adjusted to be less than the soil water infiltration rate to prevent runoff or ponding.

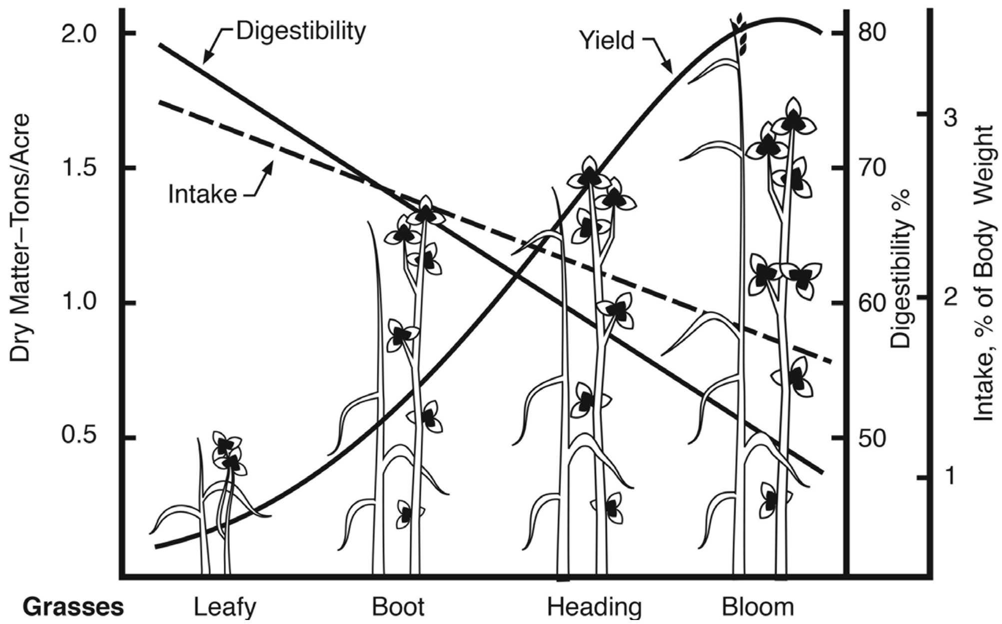

Figure 3. **Relative yield, quality, and intake of grasses and legumes.** (Source: Blaser et al., 1986)

Pest control

While a limited number of herbicides were available to help producers in the past, more products are becoming available that, when properly used, can be effective in controlling weeds. These include both pre- and post-emergence herbicides. Nonetheless, good pasture management in regard to species selection, establishment, fertility, irrigation, and grazing practices will produce a dense, vigorous stand of plants and provide the safest and most economical weed control. For more information about weed control in permanent pastures, see NMSU Extension Guides A-325, *Managing Weeds in Alfalfa* (http://aces.nmsu.edu/pubs/_a/A325.pdf), and A-340, *Integrated Weed Management in Irrigated Permanent Grass Pastures and Hayfields in New Mexico* (http://aces.nmsu.edu/pubs/_a/A340.pdf).

Occasionally, insects can be a problem in irrigated pastures, particularly those containing alfalfa. Beneficial insects are valuable tools for keeping many insect pests under control. However, some insect pests apply peak pressure in early spring before beneficial insect populations exert adequate control. Also, populations of certain insect pests can escalate very rapidly, and some have few, if any, natural predators (e.g., grasshoppers in summer). It is in these times that irrigated pasture producers should scout fields for damage and resort to labeled insecticides when necessary.

Plant diseases usually are not a problem in forage crops that have been properly managed, beginning with species and variety selection. However, it is not uncommon for seedling diseases (e.g., damping off and root rots) to infect newly planted grass-legume stands, particularly in heavy soils and when fields are poorly drained. When diseases do occur, chemical control measures are limited and not usually feasible.

If chemicals are used to control any pest, be sure to read the label and follow all instructions, especially those about safety, cleanup, target pests, application rate and timing, and grazing or harvest restrictions.

ANIMAL MANAGEMENT

Determining livestock numbers

Livestock numbers or paddock size (stocking density) can be determined by estimating how much dry matter each animal will consume or waste during the grazing period. The grazing period length in a pasture or paddock can be estimated with a little math. One animal unit month (AUM), allowing for about 25% waste, is considered to be about 1,000 lb of air-dry forage (33 lb/day). Animal units (AU) may be made up of different ages and classes of livestock based on the following: mature (1,000-lb) cow and calf = 1.00 AU, bull = 1.25 AU, beef/dairy yearling = 0.60 AU, horse = 1.25 AU, and sheep = 0.20 AU. Forage mass or availability can be estimated roughly by harvesting a known area to ground level and allowing the material to air dry before weighing or by weighing it fresh and using a standard dry matter estimate (0.20 for alfalfa or 0.25 for grasses). Several samples should be collected from throughout the pasture and averaged to adequately represent growth. Experienced pasture managers can often use forage height and percent ground cover to estimate forage availability, and these should also be measured or estimated at sampling time and compared to harvested availability estimates to gain experience. Forage availability (in pounds) of a monoculture grass (25% dry matter) pasture is then calculated as:

$$\frac{\text{Fresh weight (lb)} \times 0.25 \times 43{,}560 \times \text{pasture area (acres)}}{\text{Harvested area (sq ft)}}$$

For example, if an average of 1.9 lb of tall wheatgrass were harvested per square yard from a 40-acre pasture,

$$\frac{1.9 \times 0.25 \times 43{,}560 \times 40}{9} = 91{,}960 \text{ lb}$$

Intake of cool-season forage species by beef cattle is limited when forage availability drops below 1,000 lb/acre (Figure 3). Grazing period length can be estimated by:

$$\frac{\text{Forage availability (lb)} - (\text{pasture area [acres]} \times 1{,}000 \text{ lb/acre})}{33 \text{ lb/day} \times \text{no. of AU}}$$

This will give an estimate of how many grazing days a pasture or paddock will provide. Continuing with the example above to feed 75 yearlings (0.60 × 75 = 45 AU):

$$\frac{91{,}960 - 40{,}000}{33 \text{ lb/day} \times 45 \text{ AU}} = 35 \text{ days of grazing}$$

Alternatively, the number of animal units over a specified period also can be calculated showing that 231 AU could graze the pasture for 7 days:

$$\frac{91{,}960 - 40{,}000}{33 \text{ lb/day} \times 7 \text{ days of grazing}} = 231 \text{ AU}$$

However, this could be an underestimate, particularly in a system that uses continuous stocking or long rotations because the pasture will continue to grow and add available forage while being grazed. Additionally, because cattle are larger now than when the animal unit was defined, producers divide the total body weights of an animal group to be in the pasture by 1,000 to more accurately estimate the number of animal units to be in the pasture.

In some cases, co-grazing different animal species is beneficial to maximizing forage use. For instance, sheep and goats are valuable for weed control and will utilize plants that are avoided and even toxic to other species of livestock, usually without impacting available forage to them or the other species of livestock. If weed pressure is high enough, co-grazing one sheep or goat for every beef AU does not reduce beef cattle productivity. Additionally, sheep and goats can graze more closely than cattle and might be useful for cleaning up a pasture after cattle. On the other hand, horses are spot-grazers, and other livestock might be used to harvest areas horses leave ungrazed. If sheep or goats are used to clean up after grazing by other classes of livestock, be sure to leave enough leaf material to promote rapid regrowth.

Grazing management

Grazing management for newly established pastures is discussed in Circular 585. An established irrigated pasture's forage mass and nutritive value depend largely on grazing/harvest management. While forage mass will continue to increase as the plant grows, palatability, digestibility, and, thus, intake of most species decline rapidly after flowering (heading in grasses) (Figure 3). Immature forage is much higher quality and provides better animal gains. However, grazing too early or too often leads to more frequent defoliation and inhibits the next growth cycle of individual plants, resulting in less available forage, which in turn leads to lower animal intake and performance. Continued, frequent defoliation (overgrazing) leads to weak and noncompetitive plants, weed invasion, and eventual stand loss. Grazing too infrequently allows plants to become over-mature, which also leads to reduced intake and performance because the forage will be refused by animals or is not high enough in quality to meet dietary needs. A balance between forage mass, nutritive value, and use must be achieved to harvest as much forage as possible, hold waste to a minimum, and maintain palatability and nutritive value without compromising pasture health. This usually involves preventing overgrazing or under-use and permitting sufficient, but not excessive, pasture rest for rotationally stocked pastures, or by maintaining the plants in their phase of maximum growth with an appropriate stocking rate under continuous stocking.

Most legumes in established pastures should be grazed at or near early bloom. Plant maturity, or length of rest period, is not as critical for grass recovery as it is for legume recovery. However, monoculture grass pastures should be 6 to 12 inches tall before grazing, depending on plant species. Bunch-type or upright species should be taller than creeping types. Animals should be removed from irrigated pastures before forage becomes limiting to intake. This usually occurs when availability (forage above ground level) falls below about 1,000 lb/acre (Figure 3). When monoculture cool-season grasses and most legumes fall below 3 to 4 inches, animals cannot get enough to eat, and there may not be enough remaining leaf material to promote regrowth. For upright legumes, like alfalfa and sainfoin, remove animals when stems are 6 to 8 inches tall and nearly defoliated. Manage alfalfa-grass pastures for the alfalfa. Grazing-tolerant alfalfa varieties and perennial warm-season grasses, such as bermudagrass and old world bluestem, retain more leaf area below the grazing horizon. But low forage availability can still limit intake. In general, a taller stubble height (6 to 10 inches) should be left for warm-season annual grasses and native tall prairie grasses.

Parasite and fly control

Flies and parasites should be controlled throughout spring and summer. Each animal should be treated for protection against internal and external parasites. There are several methods to control flies, including ear tags, dust bags, back rubbers, pour-ons, and sprays. At least two different methods (e.g., ear tags and pour-ons, as well as different modes of chemical activity) should be used to prevent the flies from building up immunity to one method. Insecticidal ear tags can be installed when animals are treated for parasites in late spring.

Supplements

Supplements should include salt and minerals, mainly calcium and phosphorus. Other supplements, such as monensin (e.g., Rumensin), are growth promoters and are labeled only for certain livestock classes. Monensin is also known to reduce the likelihood of bloat, as is poloxalene (e.g., Bloat Guard blocks). Carefully read the label before putting out any supplement to make sure it is cleared for any class of livestock in the pasture. Monensin in particular is extremely toxic to horses. Do not offer monensin to a labelled class of livestock if horses also will be in the pasture.

Bloat protection

Bloat results from a foam that forms in the rumen that prevents the animal from expelling gas by belching. Gas pressure continues to build up and, unless relieved, can kill the animal by suffocation. Bloat's exact cause is not well understood, but certain plant proteins are believed to create a stable foam in the rumen during digestion. Pastures containing alfalfa, clovers (except berseem), sweetclover, and small grains can cause severe bloat problems. The higher the percentage of these species a pasture contains, the greater the chance of bloat. Maintaining grass levels above 50% in perennial grass-legume mixtures helps to reduce the incidence of bloat, but does not prevent it.

New growth is generally higher in quality and more likely to cause bloat than more mature growth (Figure 3). Additionally, pasture quality generally declines over time due to grazing. In rotational stocking systems, diet quality begins high and declines over time during a particular occupation period. Then the diet quality is dramatically increased when animals are rotated (Figure 1). Care should be taken when turning animals into a fresh pasture. It is best to fill hungry animals with dry hay first. Otherwise, well-managed continuous stocking can reduce the incidence of bloat because diet quality is maintained at a consistently high level by pasture regrowth.

Bloat seems more prevalent during cooler times of the year (spring and fall) when legume growth is more rapid. Additionally, dew is more likely during these times, which increases bloat incidence. Changes in weather also play a role in the likelihood of bloat. Increases in relative humidity, decreased temperature, or increased wind have been associated with increased bloating. Low precipitation or low soil water-holding capacity, leading to low soil moisture, has also been implicated. It is possible that when precipitation (or irrigation) does occur, the bloat-inducing species begin rapid growth.

Relative levels of sodium, potassium, magnesium, and calcium in the forage may also have a role in bloat. When forage low in sodium and potassium and high in magnesium and calcium is grazed, the likelihood of bloat increases. Levels of these nutrients in the forage can be related to soil levels, so soil and plant tissue test results might indicate which fields have an increased likelihood of bloat.

Even if special care is taken to avoid bloat, it is recommended that a bloat preventive, such as monensin or poloxalene (Rumensin and Bloat Guard blocks, respectively), be available a day or two before and throughout the time bloat-inducing forages, such as alfalfa, most clovers, and small grains, are fed or grazed. These products work well, but only if animals ingest the required amount of the compound every day. They should never be allowed to become depleted or deteriorate to the point that animals refuse to consume them. Bloat preventives are available mostly in dry form as blocks or loose supplements for top-dressing feed bunks. However, liquids are also available that can be used in watering systems or mixed with molasses.

Even when all precautions are taken, some loss (up to 3%) is likely to occur because individual animals may not eat enough bloat preventive to be protected. As such, pastures containing legumes require a higher level of management to minimize the risk of animal sickness or death. Also, some animals are more susceptible to bloat than others, and some animals might be more genetically predisposed to bloat. Chronically bloating cows and bulls should be removed from the herd.

Any ruminant animal newly introduced to a field having a legume should be monitored closely for bloat. If not captured in time, bloat can be lethal because the animal suffocates as the expanded rumen compresses the lungs. A "frothy" bloat is the most common type caused by an abrupt change to lush forage. The best method for alleviating "frothy'" bloat is oral application of mineral oil or a product called Therabloat. In cattle, one half-cup of mineral oil should break up the excess gas. Inserting a tube down the throat to the rumen is also an option, but is less successful with this type of bloat. In severe cases, where the animal is immobile, a trocar or knife should be used to create an opening for the gas to escape. The opening should be made on the upper left side of the animal, between the last rib and hip bone.

Grass tetany

Grass tetany is a magnesium deficiency in animals that can occur any time, generally from fall through spring. Classic symptoms include nervousness or twitching, paralysis in the hindquarters, and death. Any or all of the following conditions can contribute to grass tetany: cool temperatures, wet conditions, rapid grass growth, recent nitrogen and/or potassium applications, low soil magnesium levels, high soil potassium levels, and imminent or recent birth. Soil magnesium, nitrogen, and potassium are related to forage levels. Low forage magnesium or high forage potassium can limit magnesium absorption by animals.

Although low soil magnesium can be corrected easily with fertilizer, the problem might actually be high soil potassium, which is prevalent in New Mexico and leads to high forage potassium. Analyzing forage for potassium, calcium (Ca), and magnesium during periods of rapid growth is the best way to determine if grass tetany can potentially be a problem in a particular pasture. A tetany ratio (K / [Ca + Mg]) of 2.2 or above indicates risk, and a ratio of 2.5 or above indicates high risk. Animals grazing pastures with a tetany ratio of 2.2 or above should be offered a salt-mineral supplement that delivers 0.5 to 1 ounce of magnesium per day. Some animals might not consume enough of the supplement, so grass tetany might occur occasionally. If it does, ask your veterinarian to treat the animal immediately.

The potential for grass tetany can also be reduced with timely nitrogen and potassium applications. Apply potassium only at levels recommended based on soil test results and only in late spring after the greatest danger of grass tetany has passed. Nitrogen applications to cool-season grass pastures should be split into multiple applications of 40 lb/acre distributed uniformly across the growing season. Using grass-legume mixtures is another option. In addition to providing the grass's nitrogen requirement, legumes reduce the likelihood of grass tetany because legume forage is usually much higher in magnesium than monoculture grass forage. See Circular 585 for more information about grass-legume mixtures as well as Guide B-809, *Controlling Grass Tetany in Livestock* (http://aces.nmsu.edu/pubs/_b/B809.pdf). Circular 585 also provides information about forage anti-quality factors that are plant species-specific.

Post-grazing management

Removing cool-season perennial grass seedheads forces the grass to become vegetative again, producing leaves instead of seed. This can also help prevent seed production by weeds. This can be accomplished with a higher stocking density or by mowing (clipping). The best time to clip is when the grass first heads. This can be accomplished in either continuous stocking or stockpiling systems. However, in rotational stocking, it is best to wait until after a grazing period so that more of the seed stalk can be removed. Another reason to clip pastures is weed control. Many annual weeds can be controlled effectively and seed production can be prevented by clipping off flowers. Care should be taken when clipping to avoid removing too much leaf of the desirable species, which can reduce growth under rotational and continuous stocking or stockpiling. Manure piles should also be scattered evenly over the pasture at least annually. Animals tend to avoid areas where manure is concentrated; failure to spread it can result in unused forage in those areas. Concentrated droppings may also interfere with the water distribution pattern, especially in flood- or furrow-irrigated fields. In many areas, a chain harrow is pulled behind the shredder to accomplish pasture clipping and manure scattering in one operation.

SUMMARY

In most cases, whether animals are owned to generate income or for ranch work, pleasure, or aesthetics, feeding costs can be reduced greatly by utilizing irrigated pastures in New Mexico. Letting the animal harvest forage by grazing saves equipment and labor costs of harvesting, storing, and feeding hay or other stored feeds. Properly managed irrigated pastures can generally meet the nutritional demands of most livestock. They also lend themselves to easy supplementation for all higher levels of animal productivity, with the exception of high input dairy production and traditional grain finishing for beef. To an extent, better pasture management results in higher forage quality and yields. It also offers savings for some inputs and greater returns for others.

Maximum productivity begins with establishing well-adapted, highly productive pasture species. Circular 585 provides information about what pasture species are well-adapted to New Mexico conditions and how to establish uniform, productive, persistent pastures. Contact your county Cooperative Extension Service office or visit NMSU's College of Agricultural, Consumer and Environmental Sciences forages publications website at http://forages.nmsu.edu for a copy or for other forage-related information.

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