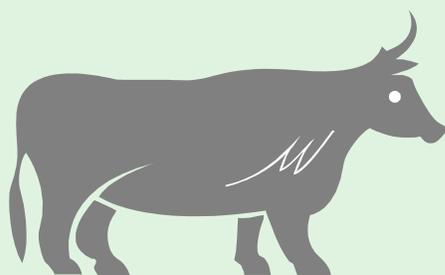


# Intermountain Pasture and Hay Meadow Handbook: Pasture, Hay and Profit



UNIVERSITY OF NEVADA  
**C**OOPERATIVE **E**XTENSION

---

A COUNTY–STATE–FEDERAL PARTNERSHIP

**EB-00-02**

# Intermountain Pasture and Hay Meadow Handbook: Pasture, Hay and Profit

## *Table of Contents*

### **Preface**

Dr. Hudson Glimp

### **Why Irrigated Pastures**

Dr. Hudson Glimp.....Chapter 1

### **Establishing Irrigated Pastures**

Jason Davison and Roby Kettle.....Chapter 2

### **Choosing the Right Forage for Your Conditions**

Roby Kettle, William Riggs and Jason Davison.....Chapter 3

### **Irrigation Management for Irrigated Pastures**

Jerry Neufeld.....Chapter 4

### **Soil Fertility**

Roby Kettle, Jason Davison and William Riggs.....Chapter 5

### **Beef Cattle Management on Pastures**

Dr. Ben Bruce, Ron Torell and Roby Kettle .....Chapter 6

### **Sheep Production on Irrigated Pastures**

Dr. Hudson Glimp.....Chapter 7

### **Economics of Stocker Cattle**

Roby Kettle, Ron Torell, William Riggs and Dr. Ben Bruce.....Chapter 8

### **Northeastern Nevada Native Hay Budget**

William Riggs, Roby Kettle and Ron Torell .....Chapter 9

### **Parasite Prevention and Control Under Intensive Grazing Management ..**

Dr. Bill Kvasnicka, Dr. Ben Bruce and Ron Torell .....Chapter 10

### **Improving Grass Hay Quality through Fertilizer and Irrigation Management**

Ron Torell and Jason Davison .....Chapter 11

### **Matching Hay Quality with Cow Needs**

Ron Torell and Jason Davison .....Chapter 12

### **How Cutting Dates Relate to Grass Hay Quality in Northeastern Nevada**

Jason Davison and Ron Torell.....Chapter 13

### **Weed Control in Pastures**

Robert Wilson and Kent McAdoo .....Chapter 14

### **Water Quality and Public Policy**

Dr. Susan Donaldson and Dr. Sherman Swanson .....Chapter  
15

### **Managing Irrigated Pastures for Water Quality**

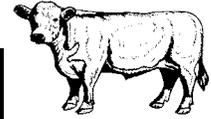
Dr. Susan Donaldson and Dr. Sherman Swanson .....Chapter  
16

### **Managing Water Supplies for Water Quality**

Dr. Susan Donaldson and Dr. Sherman Swanson .....Chapter 17

### **Irrigation Diversion Structures for Sustained Pasture and Meadow Production**

Dr. Susan Donaldson and Dr. Sherman Swanson .....Chapter 18



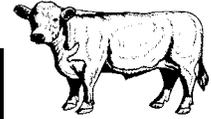
## **Preface**

### ***The Nevada Irrigated Pasture Manual***

This manual has been developed in response to (1) increased inquiries we have received concerning irrigated pasture development, use and management, and (2) our belief that irrigated pasture may be an economically viable alternative for Nevada farmers and ranchers.

Due to lack of irrigated pasture in the past in Nevada, the information available on this subject is limited. Many of us have had experience with intensive pasture production systems in other states or regions, and have attempted to incorporate our experiences into programs that we believe will work in Nevada.

The publication of this manual in loose-leaf form is deliberate. As our knowledge of and experience with irrigated pasture grows in Nevada, we pledge to continue to update this manual with the best information available to help our producers increase both productivity and profitability.



## Chapter 1

### *Why Irrigated Pasture?*

Dr. Hudson Glimp, Livestock Specialist

Why should Nevada livestock producers be interested in irrigated pastures? There are several reasons we should seriously consider irrigated pasture as an alternative or supplement to our traditional ranching or cropping systems. Some of the reasons are:

- The need to seriously consider alternatives to public land use in certain situations.
- Using irrigated pasture as strategic supplementation for range livestock operations.
- The use of irrigated pasture to add value to range produced feeder calves and feeder lambs.
- Improving productivity of our native irrigated hay meadows.
- The development of irrigated pasture as an alternative crop on marginal irrigated lands.
- Use of irrigated pasture in crop rotations to improve soil organic matter content and break crop pest cycles.

Many ranchers are being required to either reduce numbers on their public land grazing permits or to reduce grazing pressure at certain times of the year. Their only option at this time is to either obtain another grazing lease, which may be very expensive to obtain and manage, or to sell stock to meet the reduction requirements. Improved irrigated pasture on their private lands, or purchase or lease of land for irrigated pasture development, may in certain cases be an economically viable option.

Research has shown that ranchers can not afford to not breed heifers to calve first at 2 years of age; however, much of our rangeland can not support heifer development to an adequate body weight and condition for breeding at 13–16 months of age, and will only marginally support first-calf heifers during early lactation for re-breeding as 3 year olds. Supplemental feeding may be required, and may be marginally economically viable depending on supplemental feed costs and cattle prices. Irrigated pasture use may be an economically viable option for these critical development and management periods in the beef production cycle.

---

***Many ranchers are either being required to reduce numbers on public land grazing permits or to reduce grazing pressure...***

---

A significant portion of our arid rangelands will not support calf weaning weights above 450-500 lb. or lamb weaning weights over 80 lb. Profitability may be limited for producers without marketing options other than the traditional sale of calves or lambs at weaning. Most of the cost in a ranching enterprise is in maintaining the reproducing cow

or ewe. Use of improved pasture and crop residues to obtain economical post-weaning gains can reduce costs per pound of beef or lamb produced.

Native irrigated and sub-irrigated hay meadows, usually on private land associated with ranches that use public land grazing permits, have generally been viewed as required only to produce winter hay needs plus some aftermath grazing for the ranch. Many ranchers now realize that these lands are producing far below their potential.

Improving soil fertility, pasture grass and legume varieties, and improved water management can significantly increase the productivity of these lands, providing management alternatives to the enterprise previously discussed.

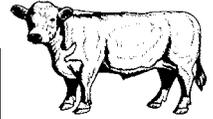
Many Nevada irrigated crop producers are currently faced with difficult economic decisions. Due to marginal dairy production economics and competition for our traditional hay markets, alfalfa hay production on most of our marginally productive irrigated lands may not be economically viable in the future. Irrigated pasture and livestock production may be a viable alternative on these lands. Further, demand for alternative uses of water other than crop irrigation may require development of alternative crops such as irrigated pasture that require less water to maintain productivity of the land.

---

***...alfalfa hay production on most of our marginally productive irrigated lands may not be economically viable in the future.***

---

Irrigated pasture must be considered a crop, and as an economic activity that must compete with other crops for optimum land use. Where irrigated pasture has been incorporated into farming systems, several farmers have realized secondary economic benefits to having improved pasture and livestock in their farming system. The livestock production system provides an alternative market for other crops on the farm, and for crop residues. Irrigated pasture may also be managed for hay or seed production as well as for livestock production. A major long term benefit of pasture and livestock in the farming system is improved soil fertility, particularly increased soil organic matter, when land is rotated from pasture into cash crops. Rotation of crop land into irrigated pasture for 3 – 5 years may also help reduce crop insects, weeds and other pest problems. Other benefits of improved pasture are soil conservation, improved nutrient cycling, improved animal performance, and fewer environmental problems.



## **Chapter 2**

### ***Establishing Irrigated Pasture***

Jason Davison, Central Area Plants and Soils Specialist  
Roby Kettle, Extension Educator

<a href="#">Introduction</a> .....	1
<a href="#">Site Selection</a> .....	1
<a href="#">Planting Dates</a> .....	2
<a href="#">Spring</a> .....	2
<a href="#">Early-Summer</a> .....	3
<a href="#">Late-Summer or Fall</a> .....	3
<a href="#">Late Fall</a> .....	3
<a href="#">Seeding Irrigated Pasture</a> .....	4
<a href="#">Interseeding</a> .....	5
<a href="#">Grazing Management of New Seedings</a> .....	5
<a href="#">Summary</a> .....	5

#### **Introduction**

When planting a new field of irrigated pasture, the goal of most successful growers is to establish a long-lived, highly productive stand on the first attempt. The process of successfully establishing a new irrigated pasture stand is risky and dependent on several factors. If a grower ignores any of these factors the chance of failure is greatly increased. This chapter discusses the most critical factors influencing the process and provides a guide to successfully establishing a long-lived, high-yielding stand.

#### **Site Selection**

Although irrigated pasture can be grown on a wide variety of sites, yields and stand life can be significantly reduced if site conditions are too harsh or the plant species selected are not adapted to the site selected for planting the pasture (see next chapter). Mixtures of several forage plant species are commonly seeded on irrigated pastures in an attempt to meet the various conditions found on many sites.

Most forage plants prefer deep, well-drained soils that are neither too alkaline nor too acid. High alkalinity soils are a more common problem in the intermountain region than soils that are too acidic. Many forages will tolerate moderately salty conditions but production will suffer if the salt levels are too high. Sites that are flooded for long periods in the spring also limit production of many forage species. Table 1 lists the soil conditions that are desirable and undesirable for productive pasture production. Forage plants can be produced on undesirable sites but economic production levels are doubtful.

**Table 1** Soil characteristics that influence irrigated pasture production.

<b>Characteristic</b>	<b>Desirable conditions</b>	<b>Undesirable conditions</b>
Soil texture	Sandy, silt, or clay loam	Sand or clay
Soil depth	More than 20 inches	Less than 12 inches
Soil pH	More than 6.0, less than 7.7	Less than 6.0, more than 8.5
Soil moisture conditions	Well drained with no long-term standing water	Standing water over one week in duration,
Soil salt levels	Electrical conductivity less than 4 mmhos/cm, exchangeable sodium percentage less than 8	Electrical conductivity more than 10 mmhos/cm, exchangeable sodium percentage greater than 15

Another site factor that can determine success or failure is water quality and amount. As with soil factors, an adequate supply of high quality water will reduce the risk of stand failure and/or low production. Water quality guidelines for irrigating pasture are available from most Cooperative Extension offices or the State Bureau of Water Quality offices. On sprinkler irrigated fields, inadequate water supply may be the most limiting factor affecting irrigated pasture survival and production in the intermountain region. Optimum pasture production systems normally require sprinkler systems that can deliver at least eight gallons of water per minute per acre. A 100-acre pasture requires a system that can deliver eight hundred gallons a minute.

### Planting Dates

The date that irrigated pasture is seeded can have a significant impact on successful stand establishment. Irrigated pasture is normally planted during the spring or fall in the Intermountain region. Fall plantings may actually be late summer as most plantings are completed by mid-September. The exception is on higher elevation sites when early summer plantings are the norm. Each of the seasons has advantages and disadvantages to the irrigated pasture producer. The producer is advised to evaluate each season and determine which one best fits their operation.

#### *Spring*

Most spring seedings are planted in the months of April or May. The advantages of planting in the spring include better potential for rainfall, which will assist germination and emergence. The cool temperatures facilitate rapid growth and minimize seedling death due to dry conditions. Another advantage is that first year yields will normally be greater during the seeding year than with early-summer plantings. On the other hand, yields will be lower than with fall or late-summer plantings the previous year. Spring seedings also carry the risk of frost damage to the seedlings from late cold weather. Weed competition from winter annual weeds can be severe. Flood irrigation can be difficult due to the limited root production of the young irrigated pasture plants, which benefit from frequent, light irrigations.

### *Early-Summer*

Early-summer plantings are those that are planted in mid-to late-June and have the advantage of rapid, uniform emergence due to warmer temperatures. The danger from damaging late frosts is much lower with early-summer seedings, but early hot temperatures increase the chance of damage from droughty conditions. The warm temperatures necessitate frequent light irrigation that may be difficult for flood irrigators to achieve. Production is normally less the seeding year than either spring or fall seedings, and competition from summer annual weeds can be tremendous.

### *Late-Summer or Fall*

Fall seedings are very popular in the Intermountain region for several reasons. Late summer seedings normally occur during late August to September. They are planted at this time to avoid the heat of summer but, with enough time to allow the seedlings to become established before growth stops for the year. That means the plants should have at least three true leaves prior to a killing frost. Production the following year is the higher than seeding at any other season. Weed competition can be lower than other seasons due to the cooling temperatures and rapid growth of irrigated pasture. Root development is rapid and irrigation is less critical due to the cooling temperatures, although irrigation is still required. Frost damage or heaving is possible if the seeding is put in too late to become established before the dormant season (after early September). In some areas, irrigation water may be lost before the seeding is well established. Fall seedings also remove acreage from aftermath grazing that would normally occur in the fall.

### *Late Fall*

Late fall or dormant seedings are another alternative for intermountain producers. Dormant seedings are planted from late October until the ground freezes hard enough to prevent fieldwork. The advantages of a dormant season seeding are several. Traditionally this is a relatively slow time and equipment and manpower is readily available for seeding. The seed is in place when environmental conditions are right for germination and growth. Often this occurs before fields can be worked in the spring. The early growth allows increased production during the first year. The primary drawback to dormant seedings is that the seed remains in the ground a long time before germinating. This long time period extends the time that the seed can be destroyed by rodents, birds and other pests. The potential damage from disease is greater than with other alternatives especially with extremely wet spring weather.

## Seeding Irrigated Pasture

Irrigated pasture prefers a deep soil. Ripping is often recommended if a restricting layer is present at 12 inches or less. Irrigated pasture also requires a smooth, weed-free, firm seedbed for best emergence. A rule of thumb is that if a boot heel sinks more than ½ inch, the seedbed needs to be firmed up. Rolling with a cultipacker can firm loose soils as can an

irrigation prior to seeding. Another common problem occurs when heavy soils have been over worked. If heavy soils are overworked, “bug dust” or a very fine soil layer that tends to crust will be formed.

---

***A rule of thumb is that if a boot heel sinks more than ½ inch, the seedbed needs to be firmed up.***

---

Irrigated pasture can be seeded by broadcasting or drilling. Broadcasting the seed is fast and can be fairly uniform. It can be accomplished by everything from airplanes to cyclone type seeders pulled behind a 4-wheeler. However, broadcasting requires more seed than drilling due to high seed loss as a result of a lack of cover. Rolling afterwards is recommended to increase the soil-seed contact and for better germination rates. Drill seeding allows for precise seed and fertilizer placement, but is slow and expensive when compared to broadcasting. The biggest risk with drilling is placing seed too deep. Irrigated pasture seed should be planted no more than ½ inch deep in most soils. Sandy soils will permit seeding a little deeper than heavy soils but in no case should it be planted deeper than 1.5 inch.

Seeding rates vary by seeding method and by species (see the next chapter for rates). Although seeding 4 pounds per acre of seed can theoretically result in acceptable plant densities, actual seeding rates needed are usually higher. Broadcasting usually requires 50-100% more seed than drill seeding. Most seeding recommendations are based on a Pure Live Seed (PLS) calculation. This is determined by multiplying the purity percentage by the germination percentage listed on the seed tag and dividing the result by 100. This figure will indicate the PLS in the seed lot represented by the seed tag. This figure is then divided into the recommended seeding rate to determine the total amount of seed needed to achieve the recommended seeding rates.

A light starter fertilizer such as 30-10-0 or 27-14-0 applied at 100 to 150 pounds per acre (30-45 lbs of actual N) will often increase establishment and growth rates. Adequate phosphorous levels are especially important to legume survival and production. Weed growth will also be improved with fertilization and on extremely weedy locations a starter fertilizer may not be advisable. The fertilizer should be applied before to the actual seeding and lightly disked into the upper soil layer. After the plants have grown to twelve inches or more in height, heavier rates (200-225 lbs./acre) of the same fertilizer will usually provide increased growth rates and production. Soil test results should be used to guide future fertilization programs on the pasture.

## Interseeding

On many established pastures it is possible to interseed clovers into the established pasture. Interseeding is normally used when a producer wants to increase the feed quality of a pasture by adding legumes. Pastures are also interseeded when they have been invaded by low producing species such as bluegrass. Reducing the competition from the existing grasses using a light disking or heavy grazing in the early spring will increase success. White or red clover broadcast at 3-4 pounds per acre following a treatment to reduce competition will often result in the successful establishment of clovers.

---

***On many established pastures, it is possible to interseed clovers into the established pasture.***

---

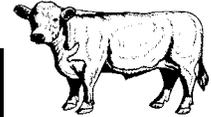
Seeding grass or alfalfa into existing pastures is more difficult. Successful establishment of these plants requires a severe reduction in competition from existing pasture species. This can be from herbicide or mechanical treatments. As a general rule, unless significant bare ground exists in the pasture or the existing grasses are killed, interseeding with more desirable grasses or alfalfa will not be successful.

## Grazing Management of New Seedings

Newly seeded pastures should not be grazed until the young plants are firmly established. Normally that means at least 1 full growing season with no use. It may also mean using herbicides to control broad leaf weeds the first year of production. Chapter fifteen discusses this point in more detail. It maybe possible to use pastures seeded in late fall or spring, late in the first year after seeding if conditions for establishment are ideal. A general rule of thumb is that if seed heads are present on some plants the first growing season, light grazing may be acceptable. If the new seeding is grazed, the producer must make sure that the plants are not being pulled from the ground during the grazing process, and that stubble heights are adequate to protect the new plants. On most species that means a minimum stubble height of 4 inches on average throughout the stand must be maintained.

## Summary

Stand establishment is the most risky period of the entire irrigated pasture production cycle. By following several recommended practices, a grower can greatly reduce the risk inherent in establishing an irrigated pasture stand. Select a site that is the most advantageous to irrigated pasture production. Planting at the time that meshes with other farm practices and planning to meet the limitations of the planting season selected are critical. Select a plant species that matches the soil and climatic limitations of the site. Plant adequate amounts of seed into a firm, smooth seedbed and roll afterwards if the seed is broadcast. The use of a starter fertilizer can improve emergence and production. Delay the first grazing until the new seedlings have become established.



## Chapter 3

### ***Choosing the Right Forage for Your Conditions***

Roby Kettle, Extension Educator  
William Riggs, Extension Educator  
Jason Davison, Area Plants and Soils Specialist

<a href="#">Forages for Good Soils and Management</a> .....	2
<a href="#">Forages for Wet Pastures or Hay Meadows</a> .....	6
<a href="#">Forages That do Well With Limited Irrigation</a> .....	7
<a href="#">Forages for Saline or Alkaline Soil Conditions</a> .....	8
<a href="#">Establishing Forages on Saline or Alkaline Conditions</a> .....	11
<a href="#">Forages that will Tolerate Excessive Grazing or Abuse</a> .....	11
<a href="#">Conclusion</a> .....	12
<a href="#">Additional Reading</a> .....	12

Many different forages are available. Often producers replant the same forage because of familiarity. However, forages are adapted to a variety of environmental conditions. Therefore, it is important to assess these conditions and intended use and choose the right forage. Often local suppliers of seed carry "seed that is traditionally planted" and may not carry the seed you want. Establishing a forage stand is a long-term investment, and you will be rewarded or penalized for years to come on your decision of which forage to plant. Many suppliers are available within a short shipping distance if your local supplier does not have the seed variety you want. Usually local suppliers can order your desired seed.

---

***Picking a forage that meets your water, soil and intended use will pay for itself with years of top production and quality***

---

When assessing which forage to plant it is critical to assess the following environmental factors:

- 1) Water availability: there is a big difference between dryland conditions, spring irrigation only and season long irrigation. Water availability is a critical factor in determining which forage to plant.
- 2) Soil conditions: can vary dramatically from site to site. Soils can vary in texture (such as sand, clay, or loams) and also in salt and alkaline levels. A soil test is recommended to help assess the soil texture, salt levels, alkalinity and nutrient levels (see previous chapter for desired soil conditions).
- 3) Intended use: the final use of the forage is important in determining which forage to plant. Strictly haying a forage is dramatically different than season long, heavy grazing. The forage planted should be adapted to your intended use.

This chapter is intended to give an overview of forages available to producers. However, due to space, it will not cover the level of detail that is available in joint publications between Nevada Cooperative Extension and USDA Natural Resource Conservation Service. Those publications reference seeding mixtures, soil types by areas, and irrigation needs. You can attain a copy at your local Nevada Cooperative Extension Office or the USDA Natural Resource Conservation Office. They are titled:

- Irrigated Forages for Northern Nevada-Type Climate, BE-91-01
- Irrigated Forages for Western Nevada-Type Climate, BE-91-02
- Irrigated Forages for Southern Nevada-Type Climate, BE-91-03
- Management of Irrigated Forages in Nevada, BE-91-04

## Forages for Good Soils and Management

Ideal conditions are pastures that receive season long irrigation that is available when the pasture needs it. The soils are deep, well drained, loamy, with good fertility. Management for haying or grazing allows the plant adequate time for recovery after harvest. All grasses and forages do well under ideal conditions, however some grasses and forages will be more productive for grazing livestock and hay production. This can be attributed to increased quality and/or quantity of the forage.

---

***Some grasses and forages will result in higher productivity for grazing livestock and hay production.***

---

### Meadow Brome

Results of most trials show that Meadow brome has the highest production of total forage. It is high quality forage that has excellent palatability for livestock. The variety most often used is 'Regar'. However, two new varieties have been produced and are now on the market, 'Fleet' and 'Paddock'. These new varieties were developed in Canada and have not had extensive longevity testing in the intermountain area. However, they show promise. All three varieties are very productive, yet it appears the newer varieties may have a slight advantage in yield. With adequate fertility, Meadow brome can produce 5 or more tons per acre.

Meadow Brome is a bunch grass that is slightly rhizomatous (or slowly expands). This is an advantage in the fact that Meadow brome does not get sod bound and lose productivity like Smooth brome. A disadvantage may be that if some of the grass dies, it does not fill in as well. Meadow brome works well with legume plantings because it does not crowd out the legume. It has good seedling vigor, which makes it easier to establish. It regrows quickly after cutting or grazing. Meadow brome likes good deep soils, and season long water with good fertility. If you do not have fall irrigation it tends to "winterkill". Meadow brome does not like alkaline, wet, or saline conditions. A straight stand should be seeded at 12 lbs Pure Live Seed (PLS) per acre.

## Orchardgrass

Orchardgrass is one of the most productive grasses, often following Meadow brome in yield trials. It has excellent regrowth after harvest. It does well under the same conditions as Meadow brome; deep, well-drained soils, with adequate season long water and fertility. Many varieties are available including early, mid or late season maturing types. Early season varieties are 'Hallmark' and 'Potomac'; mid season varieties are 'Akaroa' and 'Ambassador'; and the late season variety is 'Latar'. 'Paiute' is a dryland Orchardgrass, which is more tolerant to drought than the other varieties and has more winter hardiness. Orchardgrass is a bunchgrass, which works well with legumes such as alfalfa or clover. It is very palatable to cattle (sheep will often avoid Orchardgrass), and has excellent re-growth after grazing or cutting for hay. Forage quality decreases rapidly after seed head production. It does not like drought, wet soils (wet all the time), or saline/alkaline soils. Furthermore, it may be susceptible to winter kill, and is dependent on regular fertilization with nitrogen to produce good yields. For a straight stand of Orchardgrass, seed 3-4 lbs PLS per acre.

## Tall Fescue

Tall fescue is the most common grass in the U.S. Varieties often used include 'Alta', 'Fawn', or 'Kenhy'. 'Johnston', a Tall fescue - Perennial ryegrass cross, is being used successfully in Idaho. Tall fescue is very adaptable and will produce well in a variety of conditions. These conditions include wet or dry sites, saline or alkaline soils, high or low levels of fertility, and constant or minimal grazing. It likes precipitation around 18" per year, but will do well in Nevada with a couple supplemental waterings. If Tall fescue receives extra water, it will respond with increased forage production. With adequate water it has excellent production capabilities. It also responds well to N fertilizer. Tall fescue is one of the most tolerant grasses to grazing. It is also very tolerant to trampling. It is usually used in football fields because of its excellent tolerance to high levels of traffic.

---

***Tall fescue is an excellent choice for a grass that will be stockpiled for fall or winter use.***

---

Tall fescue is less desired by livestock (less palatable) in the summer than most other forage species. Therefore, during summer grazing, livestock that have a choice of Tall fescue or other forages will select other forages (unless livestock are intensively managed). The system used in the southeastern U.S. is to hay fescue (with or without a legume) in early summer and "stockpile" regrowth until fall or winter. Tall fescue cures well (retains nutrients) and accumulates sugars (carbohydrates) becoming more palatable after a series of frosts. Livestock will graze Tall fescue in the fall and early winter, when they would not graze it earlier in the year. Tall fescue is an excellent choice for a grass that will be stockpiled for fall or winter use.

Older varieties of Tall fescue can cause livestock to experience "fescue toxicity", which is caused by a fungus that is borne in the seed. This problem is minimal in our dry

climates, but can be avoided by planting "endophyte-free seed". These plants do not have the same vigor as the endophyte infected Tall fescue. A pure stand should be seeded at 7-8 lbs PLS per acre.

### Perennial Ryegrass

Perennial ryegrass is a cool season, short-lived perennial bunchgrass. It establishes quickly and easily. The forage grows rapidly in the spring, or cool seasons of the year. It is very palatable to livestock, both sheep and cattle. It is favored forage for sheep grazing on irrigated pasture. Both sheep and cattle will have excellent gains grazing Perennial ryegrass during its active growing season. It requires very good fertility and irrigation management. It is susceptible to winter kill. It usually needs to be re-seeded every 2-3 years or "thickened" yearly. Seeding rates for a pure stand are 20-25 lbs.

### Alfalfa

Alfalfa is often referred to as "the queen of forages" due to its high production and high quality forage. Planting alfalfa with Meadow brome or Orchardgrass is beneficial for haying or grazing. Alfalfa in the mixture will increase forage production and quality. Alfalfa will add diversity to the complex of plants, resulting in a higher level of production. It will help add supplemental nitrogen, as it fixes atmospheric nitrogen. Alfalfa, Meadow brome, and Orchardgrass all like the same conditions: deep, well-drained soils, adequate water and fertility.

---

*Alfalfa is often referred to as "the queen of forages"*

---

Since you are planting on a site that has good soil, fertility, and water, plant a variety of alfalfa that has the ability for high production. Many varieties are available. Some that have shown excellent production include 'Rushmore', 'DK 143', '5396', 'Reward', and many, many other productive varieties. Some varieties have been chosen for tolerance to grazing. They have a spreading or prostrate growth habit. They tend to have lower yields than hay-type varieties, and sometimes less resistance to pests. Some of these varieties include 'Spreader II & III', 'Alfagraze', 'Pasture Plus', 'Magna Graze', 'Forager', 'WL ProGraze', 'Teton', 'Renovator' and 'Travois'. Choose a variety that will produce well for an extended period of time, even if you pay more for the seed (it will pay off in the long run). Alfalfa does not do well in areas that are constantly wet or if the water table is within three feet of the surface. Be aware that all alfalfa, even grazing alfalfa, can cause bloat. Alfalfa alone should be seeded at 12-15 lbs PLS per acre, however, it is not recommended to seed alfalfa straight for grazing.

### Clover

Many different types of clover are available. Clover can be a viable alternative to alfalfa. However, clover still has the potential for bloat and production is lower than alfalfa. Although some types of clover are more resistant to flooding than alfalfa, alfalfa is usually more drought resistant. Usually clover is seeded with other grasses at 2-5 lbs per acre, depending upon the type of clover planted.

- Red clover has excellent winter hardiness and good seedling vigor with medium production potential. It prefers good soils with adequate irrigation. It

is considered a short-lived perennial. Seed at 8-10 lbs for a pure stand or 1.5 - 2 lbs for a mixed stand.

- White Dutch clover has fair winter hardiness and good seedling vigor, but low forage production potential. It has poor drought tolerance and fair tolerance to excess water. Seed at 2-6 lbs for a pure stand or 1 to 1.5 lbs for a mixed stand.
- Strawberry clover has good seedling vigor, but low production potential. It has excellent tolerance to flooding or high water tables and good tolerance to salt or alkali. Seed at 10-15 lbs for a pure stand or 3-4 lbs for a mixed stand.
- Ladino clover has good seedling vigor with medium production potential. It prefers good soil with adequate water. Seed at 4-6 lbs for a straight stand or 1 - 2 lbs for a mixed stand.

### Mixed Plantings

Mixed plantings are usually beneficial. They add diversity to the plant community and often result in higher productivity. An irrigated pasture planted on deep, well-drained soils, with good fertility and water optimally would include a legume such as alfalfa or clover, Meadow brome, and Orchard grass. It may also include Perennial ryegrass if a high quality and palatable forage was needed (ex: stocker cattle or lambs). A seeding mixture for a pasture used for grazing may include Orchardgrass at 1-2 lb, Meadow brome 5-6 lbs, and alfalfa at 1.5-2 lbs PLS per acre. This will give a stand that is 65-75% grass. If the field will just be used for hay, increase the seeding rate of alfalfa to 4-5 lbs, Orchard grass 1-2 lbs, and Meadow brome to 4 lbs PLS per acre. These seeding recommendations are based upon ideal seeding conditions.

If the field will be used for fall grazing or will experience wide fluctuations in grazing patterns, environmental factors or management, consider Tall fescue with clover or alfalfa. Tall fescue is very adaptable and will tolerate a variety of management techniques, soil and environmental conditions. Tall fescue should be seeded at 4-5 lbs with 2 lbs of alfalfa or clover, under ideal seeding conditions.

Mixed stands of forage can be a mixed blessing. If you mix two grasses and don't intensively manage there is a strong chance that the grazing animal will overgraze or selectively graze certain varieties over others. For example, if you have a pasture of orchard/fescue/White Dutch clover the cattle will graze the orchardgrass much harder than the fescue and then you eventually end up with a fescue/clover mix. Fescue is particularly hard to manage with other forages due to its lower palatability in the summer.

On the other hand, producers usually have had good responses in mixing forages as long as the palatability is similar. The main factor to consider is the intended use. If it is haying followed by grazing in the fall mixing grasses works very well. If grazing is season long with little management, then a simple mix is usually best. Mixed forages can be very valuable when future water levels are uncertain (i.e. flood irrigation from mountains) or fields are very large and soils change dramatically (i.e. lower poorly drained salty ground vs. higher better-drained upper ground). Mixtures are not only desirable in these conditions but necessary to get a long term productive stand.

## Forages for Wet Pastures or Hay Meadows

If conditions are wet all or most of the time you need to plant a forage that is tolerant to excessive water. The following forages will do well in conditions where the soil is saturated for all or most of the season. They will also do well in soil that has adequate moisture, but is not excessive; for instance they will grow well in fields that alfalfa does well in. They do not like drought, and will die out under extended periods of dry soil.

### Creeping Foxtail

A grass that works very well in wet meadows or pastures is '*Garrison*' Creeping foxtail. '*Garrison*' Creeping foxtail will result in the highest production of grass forage on wet meadows. It responds well to nitrogen fertilizer; with adequate fertility it will produce excellent yields. '*Garrison*' Creeping foxtail is slow to establish. Unless seeding conditions are ideal it usually takes 3-4 years to fully establish through its strong rhizomes (root structure). It is a grass that is established once in a lifetime, or in other words, seedings last a lifetime. Once established, it is very persistent and will remain productive for many, many years. It can be invasive; once it is planted it will tend to dominate the wet areas. It forms a dense sod, often making it possible for livestock to graze areas that were once too "boggy".

'*Garrison*' gets "rank" or lower in quality quickly after seedhead production, which occurs earlier than other species. It will tolerate some salinity, however if the soil is highly saline/alkaline other grasses are more tolerant. For a pure stand seed at 3 lbs per acre. Because of the light fluffy seed, it is easiest to drill in the seed with rice hulls or cracked corn. '*Garrison*' should be seeded at a shallow depth, approximately 1/4 inch. This holds true for ALL forages, the number one seeding failure is from planting too deep. Another method to establish is by feeding garrison hay on site. Animal hoof action will help cover the seed.

### Timothy

The variety of timothy most readily available is '*Climax*'. Timothy will not produce as much forage as Creeping foxtail, but it does have a niche in the horse hay market. It is also easier to establish. Forage quality and palatability are moderate to good. Unlike '*Garrison*', timothy is a bunch grass that is not aggressive in spreading. It will re-seed when conditions are right. Because it is a bunchgrass, it works well in seedings with legumes. It will grow well in soils that are wet or saturated most or all of the time, or in soils that have adequate water but are not constantly saturated. Early season grazing can damage the plant. For a pure stand, plant 4-5 lbs PLS per acre.

## Cicer Milkvetch

Cicer milkvetch is one legume worth trying on wet sites. Although it is slow to establish, it can produce an excellent 'no bloat' pasture in wet conditions. Its production potential is similar to alfalfa. It should not be planted for hay, as it is hard to cure. It is recommended to plant Cicer milkvetch with a 50% seeding of grass. Newly released varieties are '*Monarch*', '*Lutana*' and '*Windsor*'. Seeding rate is high for a pure stand 20-25 lbs/acre. For a mixed stand plant 6-12 lbs depending upon the desired mix.

## Clovers

Most legumes do not like conditions where the soil is constantly wet. There are a few clovers, such as alsike clover, white clover and red clover that will tolerate moderately wet conditions. Strawberry clover will grow in soil that is constantly wet, however productivity is lower. Seed 2-3 lbs of clover with your desired grass.

## Forages That do Well With Limited Irrigation

We refer to "limited irrigation" as irrigation that is available early in the season when creeks are full, but that dry up early in the growing season. One or two supplemental waterings will provide adequate moisture for the following forages to be very productive. These forages will sustain themselves through the dry period and be productive the following year.

## Intermediate and Pubescent Wheatgrass

If you have early season water, Intermediate or Pubescent wheatgrass will produce excellent yields of forage early in the season, often equal to Meadow brome. They both respond well to fertilizer. If the pasture dries up in the mid or late summer, Intermediate or Pubescent wheatgrass will go dormant until the following spring. They are a semi-rhizomatous grass, which spreads some, but not aggressively. They are late maturing, long-lived grasses. Both have excellent palatability for livestock, and produces large amounts of forage when water is available. They do best in deep, well-drained soils, but will also perform well in tight (clay based) soils. They prefer a precipitation zone of 14-20 inches of water, but will do well at low precipitation zones (8") with one or two supplemental waterings. For semi-drought conditions, they are an excellent choice for a forage grass.

Recent trials (1995-1997) conducted on the Curlew National Grasslands, 12-16" precipitation, by the Aberdeen Plant Materials Center show that '*Slate*', '*Manska*', and '*Rush*' are the top performers. These are all relatively new varieties. Trials in Nevada have shown '*Greenar*' intermediate, '*Greenleaf*', '*Luna*' and '*Topar*' produced the highest forage yields during the five-year testing period. For a pure stand of Intermediate wheatgrass plant 8-9 lbs PLS per acre or plant Pubescent wheatgrass at 12 lbs PLS per acre.

## NewHy

'NewHy' hybrid wheatgrass, a new grass on the market, shows exciting potential for limited irrigation. It easily survives on 16" precipitation, or even lower. It is fairly productive and is high quality forage, which can be grazed or hayed. It has as much salt tolerance as Tall wheatgrass (see section on salt tolerant forages for a more detailed description of 'NewHy') and much better palatability. Seeding rate is 12-14 lbs/acre.

## Alfalfa

The addition of a legume in sites that receive early season water only is a wise choice. The preferred legume is alfalfa. Alfalfa is very drought tolerant and often used by the BLM in dryland re-vegetation seedings. In these dry rangeland seedings it is one of the more dependable plants in getting established. The challenge that is faced in these seedings is that the alfalfa is so palatable to livestock, wildlife, rodents and insects that it tends to get overgrazed out under the normal long rotations we see in the Great Basin. Usually it only persists in rangeland conditions under short rotation grazing schemes where the livestock can't concentrate on it for long periods. Alfalfa likes the same soil conditions as Intermediate or pubescent wheatgrass, and is a flexible plant on the amount of water it receives.

Two varieties have worked well on dryland seedings at Curlew Grasslands. '*Spreador II*' and '*Travois*'. They had the highest yields on the test plots in the 12-16" precipitation zone. '*Ladak*' is usually used by the BLM in re-vegetation range seedings, with excellent establishment in the 8-10" precipitation zone. Many varieties of alfalfa are available. Most will do very well with a seeding of Intermediate or Pubescent wheatgrass.

The amount of alfalfa to include in the seed mixture depends upon the desired mix. For a 50/50 mixture, seed 5 lbs of alfalfa and 7 lbs of Intermediate or Pubescent wheatgrass. If the field will be used for livestock grazing cut the amount of alfalfa in the mixture to 1.5-2 lbs, with 9-10 lbs of the wheatgrass. It works okay to seed the wheatgrass and alfalfa in the same drill row, however excellent results have been obtained by alternating rows of alfalfa and Intermediate or Pubescent wheatgrass.

## Forages for Saline or Alkaline Soil Conditions

Saline or alkaline conditions are often one of the toughest to grow plants in. However, there are plant species that are adapted to these conditions. The plants that do well depend largely upon the amount of salinity/alkalinity and the amount of water present.

---

***Saline or alkaline conditions are often one of the toughest to grow plants in.***

---

### Creeping Foxtail

'*Garrison*' Creeping foxtail does well in moderately alkaline conditions that have high levels of water. It should be planted at a seeding rate of 3-4 lbs per acre.

### Beardless Wildrye

'*Shoshone*' Beardless wildrye is an excellent grass for alkaline/saline sites. It has a higher level of tolerance to saline or alkaline conditions than does Creeping foxtail. '*Shoshone*' Beardless wildrye will do well in moderate or wet conditions. It does not like dry conditions (see '*Altai*' wildrye or '*NewHy*' Hybrid wheatgrass). It has good palatability early in the season for livestock, but gets "course" later in the season, causing declines in palatability. It is an excellent forage for winter grazing, holding high levels of protein in the plant. Care must be taken when grazing it in the spring, as it has elevated growing points and is easy to overgraze. It produces high levels of forage when considering the poor soil conditions it is usually planted in. Its seedling vigor is moderate to poor, and it takes a few years to fully establish. It is one of the preferred grasses for saline/alkaline sites. It should be planted at a seeding rate of 12 - 16 PLS per acre.

### Hybrid Wheatgrass

'*NewHy*' Hybrid wheatgrass is a new grass on the market. It is a cross between Blue bunch wheatgrass and Quack grass. It has a semi-rhizomatous root system with excellent tolerance to saline/alkalinity (i.e. it spreads some but not vigorously). It has better seedling vigor than does '*Shoshone*' Beardless wildrye making it easier to establish. Due to its short time on the market its long-term production is yet to be assessed. It does have excellent palatability for livestock, with good forage production for the poor soil conditions it is usually planted in. It has good tolerance to wet or dry saline conditions, showing itself to be very adaptable. It needs about 16" of precipitation a year. It promises to be one of the best opportunities for marginal soils. It has as much salt tolerance as Tall wheatgrass. It should be planted at a rate of 12-14 lbs PLS per acre.

### Tall Wheatgrass

Tall wheatgrass will result in the highest production of forage on saline/alkaline sites. It will also result in the poorest forage quality. Tall wheatgrass is late maturing, but extremely tolerant to saline/alkaline and high water tables. It does have good palatability early in the season, but the mature plants have large course stems that are not readily grazed by livestock. Last years growth often prevents livestock from grazing the current year's growth. It will not stand constant grazing or continuous haying. It makes fair winter forage (with supplementation) because of its upright stems sticking up above the snow. '*Alkar*', '*Jose*', and '*Largo*' are the most common varieties of Tall wheatgrass. It is not recommended to plant other plants with Tall wheatgrass, as it will usually dominate the stand within a few years. Plant Tall wheatgrass at 8-10 lbs PLS per acre.

## Altai Wildrye

'*Praireland*' Altai wildrye has excellent tolerance to saline/alkaline soil conditions on dry sites that receive limited irrigation. It prefers sites with 14-20" inches of precipitation, but will do well with one or two early season supplemental irrigations. Altai wildrye has good forage palatability early in the plants growth phase, but a decline in quality as the plant matures. It is an *excellent* grass for winter grazing, holding a higher protein level than any other grass. It is slow to establish and will not tolerate excessive grazing. It has an elevated growing point that if continuously grazed will cause stand decline (especially early season grazing). It does not like high water tables (see Beardless wildrye). A strait stand of Altai wildrye should be seeded at 12 lbs PLS per acre on 21" or wider rows.

## Legumes

We have already noted that when possible it is preferred to seed legumes into seeding mixtures. However, legumes are not well adapted for alkaline or saline conditions. There are a few that will do fair under alkaline or saline conditions.

## Yellow Clover

Yellow Clover is a biennial, which must be allowed go to seed every other year for it to maintain itself in the stand. It has the advantage of being easy to establish. It is also drought tolerant and has good forage production capabilities. It has fair palatability to livestock when it is young, but has lower palatability as is matures. It contains a blood anti-coagulant, thus death may occur in animals foraging pure stands. It should only be a small part of any seeding mixture, being planted at 1-2 lbs per acre.

## Strawberry Clover

Strawberry clover has lower production capabilities than most clovers. However, it will tolerate high water tables and salinity or alkalinity. It does not tolerate drought. Seed with other forages at 2-3 lbs/acre.

## Sainfoin

Sainfoin is a non-bloat legume. It is usually a short-lived perennial. It has good drought tolerance, but poor tolerance to excessive water. It has little disease resistance, particularly the root-rotting diseases associated with irrigation. It has good tolerance to saline or alkaline conditions on dry or irrigated sites (if not over irrigated). On some dryland sites it has remained productive for many, many years.

## Alfalfa

Alfalfa has good salt and fair alkalinity tolerance. It does not do well in areas that are consistently wet.

## Establishing Forages on Saline or Alkaline Conditions

Saline/alkaline soils are often the hardest to establish plants on. Saline/alkaline soils have poor soil structure. Tillage usually results in further decline of soil structure. In most cases the best way to establish plants in this situation is with no-till

---

***Seeding in the fall will give the seedling plant a chance to start to establish in the spring when salt levels are still low in the soil.***

---

seeding methods. Use a herbicide to take out the existing vegetation in the fall (2 quarts of glyphosate in early September). In November, seed with a disk type drill at 1/4" depth. Sometimes a rangeland or no-till drill will be required if seeding conditions are difficult. Seeding in the fall will give the seedling plant a chance to start to establish in the spring when salt levels are still low in the soil.

## Forages that will Tolerate Excessive Grazing or Abuse

Two forages, Tall fescue and Smooth brome, will do well on pastures that receive constant, close grazing or high levels of traffic or trampling. This does come at a price, usually decreased production or palatability to livestock. When possible, other forages should be used that have higher levels of productivity or palatability. However, under constant grazing or other pressure these grasses do well.

### Smooth Brome

'Lincoln' or 'Manchar' are the varieties of Smooth brome most often used. It does well in sites that receive 14" of precipitation or more, or one or two supplemental waterings. Smooth Brome is a grass that forms a tight sod. Because of this, it tends to get "sod-bound" after a couple of years. It reaches its peak productivity 3-4 years, and rapidly declines in production.

It is very tolerant to repeated, close grazing and has excellent livestock palatability. It is also tolerant to high traffic. It does not like saline or alkaline soil conditions. It has lower levels of forage productivity than most forages. In addition to becoming "sod bound" after a couple of years, it tends to go dormant in the heat of the summer. Smooth brome is very competitive against weeds or other invading plants because of its extensive root system. It should be planted at a rate of 7-8 lbs PLS per acre.

### Tall Fescue

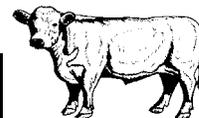
Tall fescue is an excellent choice for areas that receive season long grazing, heavy traffic, or harsh environmental conditions. It is very adaptable and works well under a variety of environmental and management conditions. If it is planted with other forages, livestock will usually avoid Tall fescue due to its lower palatability (see Tall fescue in the preceding section for more information).

## Conclusion

Picking a forage that meets your water, soil, and intended use will pay for itself with years of top production and quality for your situation. A little care in picking the right forage and getting it established is worth the time and expense it takes to find the seed and get it established.

## Additional Reading

- Aberdeen Plant Materials Center 1997 Annual Technical Report*. 1998. USDA - NRCS Plant Materials Center Annual Report, Aberdeen, ID.
- Aberdeen Plant Materials Center 1996 Annual Technical Report*. 1997. USDA - NRCS Plant Materials Center Annual Report, Aberdeen, ID.
- Aberdeen Plant Materials Center 1995 Annual Technical Report*. 1996. USDA - NRCS Plant Materials Center Annual Report, Aberdeen, ID.
- Gray, A., P. Allen, L. Bjornestad, J. Cecil. 1998. *Wyoming Alfalfa Variety Yield Trials*. University of Wyoming Agricultural Experiment Station Progress Report.
- Holzworth, L. and J. Lacey. 1991. *Irrigated Pastures in Montana and Wyoming, Species Selection, Seeding Techniques and Management*. Montana State University, EB-99.
- Holzworth, L. and J. Lacey. 1987. *Species Selection Criteria for Seeding Dryland Pastures*. University of Montana, EB 19.
- Irrigated Forages for Northern Nevada-Type Climate*. University of Nevada Cooperative Extension and U.S. Soil Conservation Service. University of Nevada Cooperative Extension BE-91-01.
- Irrigated Forages for Southern Nevada-Type Climate*. University of Nevada Cooperative Extension and U.S. Soil Conservation Service. University of Nevada Cooperative Extension BE-91-03.
- Irrigated Forages for Western Nevada-Type Climate*. University of Nevada Cooperative Extension and U.S. Soil Conservation Service. University of Nevada Cooperative Extension BE-91-02.
- Koch, D. 1995. *Forage Research and Demonstration Progress Reports*. University of Wyoming Cooperative Extension Service, MP-84.
- Lawrence, T. 1983. *Altai Wildrye Grass*. Agriculture Canada. Contribution 1983-3E.
- Proceedings of the Third Intermountain Meadow Symposium*. 1991. Colorado State University Agricultural Experiment Station.
- Management of Irrigated Forages in Nevada*. Nevada Cooperative Extension and U.S. Soil Conservation Service. University of Nevada Cooperative Extension BE-91-04.
- Putnam, D., G. Peterson, R. Kallenbach, S. Orloff, L. Gibbs, D. Kirby, K. Taggard, and L. Teuber. 1997. *Alfalfa Cultivar Forage Production and Fall Dormancy Trials Results*. University of California, Davis Agronomy Progress Report No. 257.
- Technical Notes - Improved Grass, Forb, Legume and Woody Seed Species for the Intermountain West*. 1998. USDA Natural Resources Conservation Service, Boise, Idaho, TN Plant Materials No. 24.
- Technical Notes, Plants Materials for Saline-Alkaline Soils*. 1996. USDA - NRCS Plant Materials Center, Bridger Montana, TN Plant Materials No. 26.



## Chapter 4

### *Irrigation Management for Irrigated Pasture*

Jerry Neufeld, Extension Educator/Crops  
University of Idaho Cooperative Extension System

<a href="#">Introduction</a> .....	1
<a href="#">Pasture Irrigation Management</a> .....	1
<a href="#">Soil and Water</a> .....	2
<a href="#">Texture</a> .....	2
<a href="#">Plants</a> .....	3
<a href="#">Pasture Management</a> .....	4
<a href="#">Irrigation Scheduling</a> .....	4
<a href="#">Feel and Appearance Method</a> .....	4
<a href="#">Coarse Texture</a> .....	5
<a href="#">Medium Texture</a> .....	5
<a href="#">Fine Texture</a> .....	5
<a href="#">Checkbook Method Using Crop Evapotranspiration</a> .....	5
<a href="#">Soil Moisture Sensors</a> .....	6
<a href="#">Saturated soil</a> .....	6
<a href="#">Neutron Probe</a> .....	7
<a href="#">Literature Cited</a> .....	7

#### Introduction

Proper pasture water management requires that irrigation water be applied at the right time and in the correct amount to optimize production. In Nevada, less emphasis is often placed on properly irrigating pastures than with other more intensively cultured crops. This may be due to crop value and the perceived lack of response following proper pasture irrigation management practices. However, irrigation affects both the quality and yield of pasture crops. In pastures, irrigation must be managed along with grazing and fertility practices to optimize production.

#### Pasture Irrigation Management

Pasture irrigation practices are no different than the irrigation practices used with any other crop. Knowledge is required of the soil, water, and plant relationships in the pasture, as well as the overall pasture management.

## Soil and Water

Soil is a mixture of minerals, pore space, and organic matter. Organic matter in Nevada soils is usually in the range of one to three percent and consists of decaying plant material and animal substances. It is distributed throughout the mineral content of the soil. Pore space in a typical soil is about 50 percent and is filled with a varying combination of air and water depending on when the soil last received water. The mineral content of soil is generally about 47 percent. Mineral matter consists of a combination of sand, silt, and clay. The relative amount of each mineral constituent in the soil determines the soils texture. Soil texture, and to a much lesser degree percent organic matter, determine how much water a particular soil will hold. Finer soils consisting primarily of clay and silt hold more water than coarser soils with more sand. Table 1 shows a typical range of available water holding capacities for soil based on texture. Sandy soils will require more frequent and lighter irrigation than heavier soils.

**Table 1.** Available Water Holding Capacities of Soil Based on Texture

<b>Texture</b>	<b>Available Water (inches/foot)</b>
Fine and very fine (clay, silty clay, sandy clay, silty clay loam, clay loam)	1.6 – 2.5
Medium (silt loam, sandy clay loam, loam, very fine sandy loam)	1.4 – 2.4
Moderately coarse (fine sandy loam, sandy loam)	1.0 – 1.6

Source: Miles, D.L. (1994) Irrigation. Colorado State University Cooperative Extension.

Soils in pasture consisting mostly of grasses should be managed to a depth of approximately two to three feet. However, most of the moisture depletion will occur in the top 18 inches (Hill, 1999). If the pasture includes alfalfa in the mixture, a deeper root zone will need to be managed to maintain the alfalfa plants. It is recommended that pasture irrigation take place when 50 percent of the available water in the root zone has been depleted. Available water is the amount of water between field capacity and permanent wilting point and is expressed in inches of water per foot of soil depth. Field capacity is the upper limit of available water. It refers to the moisture condition of the soil approximately 24 to 48 hours after saturation at the point where drainage has slowed dramatically. Permanent wilting point is the point where the water content of the soil is so low that plants wilt during the day and are not able to recover at night and regain turgidity.

**Example:** A silt loam soil in a pasture is being managed to a depth of three feet. The soil will hold 4.5 inches of available water (1.5 inches / foot \* 3.0 feet). If soil moisture is depleted to 50 percent available water the plants can use 2.25 inches of water before irrigation is needed. If the irrigation system is 100 percent efficient, 2.25 inches of water is needed to fill the root zone. However, no irrigation system is 100 percent efficient due to losses from evaporation, deep percolation, runoff, etc. Therefore, to arrive at the gross amount of water that should be applied at the next irrigation, divide the amount of water needed to fill the root zone by the irrigation system efficiency. Sprinkler irrigation efficiencies can range from 65 percent to 95 percent (Irrigation,

1983) depending on weather and irrigation system conditions. Care should be taken not to apply more water than is needed as this will wash nitrogen out of the root zone and greatly reduce the effectiveness of fertilizer applications, as well as increase the chances of groundwater contamination.

## Plants

Pasture plants, like all plants, have different water needs depending on stage of growth, weather conditions, and plant species. When plants are young their evapotranspiration (ET) needs are less than when they are approaching full maturity. ET is the combined amount of water transpired and evaporated from leaf surfaces and bare soil.

---

***Care should be taken to not apply more water than is needed as this will wash nitrogen out of the root zone...***

---

Young plants, especially seedlings, are moisture sensitive and require frequent irrigation, to a shallow depth in the soil since they have small root systems. At this point in time the evaporation component of ET is larger than the transpiration component. ET is greatest when the plants are mature, and especially in the heat of the summer at full plant canopy when the soil is completely shaded. At this point transpiration is the major component of ET. During the hottest part of the summer when plants are nearly mature the pasture will use about 1/4 to 1/3 inch of water per day.

Major weather parameters affecting ET are rainfall, windspeed, humidity, solar radiation (sunlight), and temperature. Weather conditions change during the course of the growing season from April to October. In the early part of the growing season when plants are small and weather is cooler ET needs are relatively small. As the growing season progresses and plants mature under the harsher weather patterns of summer, ET is greater. The ET needs of the crop can be estimated empirically with due consideration to weather conditions, or with irrigation scheduling methods. Regardless of which method is used, the irrigator needs to realize the affect weather conditions have on ET throughout the growing season.

Different crops have different water requirements and can handle different amounts of moisture stress. It is recommended to irrigate alfalfa when 50 percent of the available water in the root zone has been depleted. Moisture depletion beyond these levels has the potential to reduce yield and crop quality. In addition, some crops such as alfalfa require more total water than a crop such as soybeans. Research conducted by an irrigation specialist from Utah State University indicates that seasonal ET from an intensively managed, well-watered pasture is about 80 percent of the seasonal ET of alfalfa (Hill, 1999)

## Pasture Management

Proper pasture management requires that irrigation be coordinated with other activities such as grazing, fertilization, and clipping. Never graze immediately following irrigation as this will compact the soil and may damage plant roots. Irrigate as soon as possible after animals have grazed the field and make sure the pasture

---

***Never graze immediately following irrigation as this will compact the soil.***

---

has rested for 3 – 4 weeks following grazing before it is grazed again. Grass pastures are large users of nitrogen. However, be careful not to over-apply nitrogen and wash it off the field or through the root zone where it is unavailable to plants and results in water pollution.

## Irrigation Scheduling

There are numerous irrigation scheduling methods to choose from to help producers decide when to apply water and how much to apply. Some methods such as the feel and appearance and checkbook method are relatively simple to use and are also inexpensive. Other methods, such as weather stations and neutron probes are relatively complex and can cost several thousand dollars. Which method to use depends on several factors such as the value of the crop, level of accuracy and precision desired, and amount of management time available to operate the irrigation scheduling system. Irrigation scheduling allows the producer to know exactly how much water to apply and when to apply it. The following are benefits of irrigation scheduling:

- reduced water application since the producer is not over-irrigating
- reduced deep percolation losses since water stays in the root zone
- reduced energy costs since less water is pumped
- reduced runoff and loss of fertilizer in water that was previously washed off the field
- water-logging and soil drainage problems are reduced

Following are several irrigation scheduling methods available for use on pastures.

### Feel and Appearance Method

The Feel and Appearance method is a very simple procedure and subject to interpretation by the user. For this reason it has a relatively low degree of accuracy but it gets the grower out in the pasture to actively assess its moisture condition. All that is needed for this method is a shovel and someone knowledgeable in its operation. Choose several areas of the pasture that are representative of the entire pasture. Dig down to the desired depth in the root zone and take a handful of soil. Lastly, assess the moisture condition of the soil based on the interpretation in Table 2.

**Table 2.** Feel and Appearance Interpretation Chart

Soil Moisture Deficiency	Coarse Texture	Medium Texture	Fine Texture
0% (Field Capacity)	Upon squeezing no free water appears on soil but wet outline of ball is left on hand		
0 – 25%	Forms weak ball, breaks easily when bounced in hand*	Forms ball, very pliable, slicks readily*	Easily ribbons out between thumb and forefinger*
25 - 50%	Will form ball, but falls apart when bounced in hand*	Forms ball, slicks under pressure	Forms ball, will ribbon out between thumb and forefinger*
50 – 75%	Appears dry, will not form ball with pressure*	Crumbly, holds together from pressure*	Somewhat pliable, will ball under pressure*
75 – 100%	Dry, loose, flows through fingers	Powdery, crumbles easily	Hard, difficult to break into powder

\* Squeeze a handful of soil firmly to make ball test

Source: Miles, D.L. (1994) Irrigation. Colorado State University Cooperative Extension.

### Checkbook Method Using Crop Evapotranspiration

Irrigation can be easily scheduled with the Checkbook method if several parameters are known. One piece of needed information is the available water holding capacity of the soil. This can be determined from your county’s soil survey or with the assistance of the Natural Resources Conservation Service. Also needed is the daily ET of the pasture ( $ET_c$ ). This can be estimated with a weather station or an atmometer and crop coefficients. The Checkbook method requires the recording of daily rainfall, estimated  $ET_c$ , and accumulated net  $ET_c$ .

**Example:** A silt loam soil in a pasture is being managed to a depth of three feet. The soil holds 4.5 inches of available water (1.5 inches / foot \* 3.0 feet). If soil moisture is depleted to 50 percent available water depletion before the next irrigation the plants can use 2.25 inches of water. As seen in Figure 1. Daily  $ET_c$  is recorded in Column 3. Accumulated  $ET_c$  in Column 5 is simply the running total of Daily  $ET_c$ . Rainfall is subtracted from Accumulated  $ET_c$ . If there are rainfall events that cause Accumulated  $ET_c$  to be a negative value,  $ET_c$  is zero on that date. This is because a negative value represents soil moisture in excess of the soil’s water holding capacity and will leach below the root zone. This field should be irrigated to field capacity on August 3.

**Figure 1.** Checkbook Method Record Keeping

Column 1	Column 2	Column 3	Column 4	Column 5
Action	Date	Daily $ET_c$	Rainfall	Accumulated $ET_c$
Pasture is at field capacity	7/24			
	7/25	.23		.23
	7/26	.25		.48
	7/27	.24	.10	.62
	7/28	.27		.89
	7/29	.27		1.16
	7/30	.29		1.45
	7/31	.30		1.75
	8/1	.31		2.06
	8/2	.30		2.36
Irrigate to field capacity	8/3			

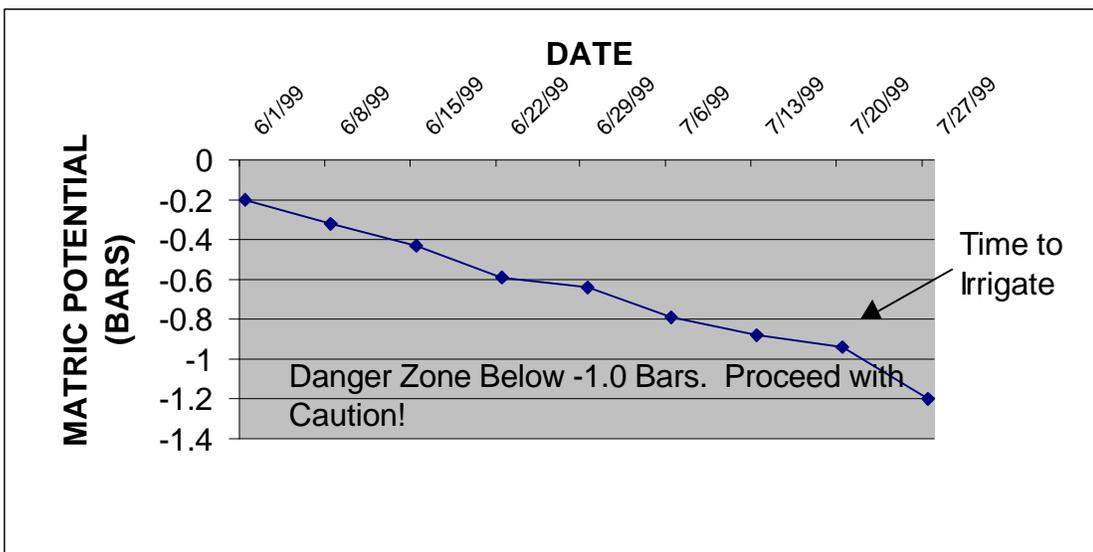
## Soil Moisture Sensors

Granular matrix sensors are becoming more popular as irrigation scheduling tools because they are easy to use and relatively inexpensive. Matrix sensors measure soil matric potential (units used are bars) as opposed to soil moisture content. Matric potential is an expression of the energy level in the soil system. Dry soils have a greater matric potential than wet soils (indicated by a larger negative number) and therefore plants must use more energy to extract water from them. The sensors themselves consist of two wire leads encased in a granular material on one end. After a short time in the soil, the granular material assumes the same moisture content as the surrounding soil. Wire leads from the sensor are connected to a meter that reads the electrical resistance between the two leads in the sensor. The wetter the soil and the granular material in the sensor the smaller the electrical resistance between the leads and vice versa. The meter is calibrated to convert electrical resistance to matric potential. Table 3 shows general guidelines on how to interpret matric potential values.

**Table 3.** Soil Matrix Potential Interpretation

Bars	Soil Moisture Condition
0 to -0.1	Saturated soil
-0.1 to -0.2	Soil is adequately wet (except for coarse sands which are beginning to lose water)
-0.2 to -0.6	Usual range for irrigation (except heavy clay soils)
-0.6 to -1.0	Usual irrigation range for irrigation for heavy clay soils
-1.0 to -2.0	Soil is becoming dangerously dry for maximum production. Proceed with caution!

**Figure 2.** Soil Matric Potential Graph



Source: Irrrometer Company; Riverside, CA

Sensors should be placed at several sites in the field at two different depths in the actively growing root zone. For pasture, sensors should be placed at approximately 10 and 20 inches in depth. Place sensors in locations that are representative of the entire field and

free from any impediments such as shade from a tree. Read the sensors every couple of days until you get a feel for how the moisture condition of the pasture changes over time. (With more experience the irrigator may determine the sensors can be read less frequently.) It is also strongly advisable to plot the data on graph paper to better monitor the soil moisture trends (Figure 2). If the top sensor indicates a dry soil and the bottom sensor indicates adequate moisture, the pasture can be lightly irrigated. If both sensors indicate dry soil the pasture can be irrigated more heavily.

## Neutron Probe

Neutron probes are used to measure the actual water content of the soil in inches of water per foot of soil depth. They do not take into account how much water is available for plant use. Neutron probes use a small radioactive source contained in a probe. The probe is lowered into an access tube preinstalled in the root zone in the pasture and emits neutrons into the surrounding soil. Each access tube can be used to measure soil moisture content at several depths. Neutrons that collide with hydrogen atoms bounce off the hydrogen atoms and return to the probe. The probe counts the returning neutrons and converts that amount to a water content. There are drawbacks to the neutron probe in that they are expensive, require special training and licensing, and the user must follow other miscellaneous regulations. The advantages to the neutron probe are that it is relatively easy to use and with proper calibration very accurate.

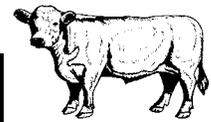
**Example:** A silt loam soil in a pasture is being managed to a depth of three feet. The soil holds 4.8 inches of water per foot of depth of which only 2.3 inches is available for plant use. If soil moisture is depleted to 50 percent available water depletion before the next irrigation the plants can use 1.15 inches of water per foot of soil depth. After the 1.15 inches of available water has been used there will be 3.65 inches of water per foot left in the soil ( $4.8 - 1.15 = 3.65$ ). As seen in Table 4, moisture measurements were taken at three depths. Column 2 contains the actual data. Column 3 is arrived at by subtracting the value in Column 2 from 4.8. With the neutron probe the irrigator will have to decide when to actually irrigate since there are typically different amounts of water in the soil at different depths. In this example the top foot is dry and there is more water in the soil at lower depths. Since the soil is so dry at the top foot assume it is time to irrigate. Therefore, the irrigator should apply approximately 2.55 inches of water to refill the soil profile to field capacity.

**Table 4.** Neutron Probe Data

Column 1	Column 2	Column 3
Depth	Neutron Probe Measurement (in./ft.)	Moisture Removed by Plants (in./ft.)
1	3.65	1.15 (4.8 - 3.65)
2	3.90	0.9 (4.8 - 3.90)
3	4.30	0.5 (4.8 - 4.30)
	Total	2.55

## Literature Cited

- Hill, R.W. (1999). Pasture Irrigation Management in Utah: Hopes and Realities. Utah State University. Logan, Utah
- Miles, D.L. (1994). Irrigation. Colorado State University Cooperative Extension.
- Irrigation. (1983). Fifth Edition. The Irrigation Association.



## **Chapter 5**

### **Soil Fertility**

Roby Kettle, Extension Educator  
Jason Davison, Area Plant and Soils Specialist  
William Riggs, Extension Educator

<a href="#">What Nutrients Do Irrigated Pastures Need?</a> .....	1
<a href="#">Response of Irrigated Pasture and Meadows to Nitrogen</a> .....	2
<a href="#">Dry Matter Yields of Six Meadow Types Fertilized at Five Nitrogen Rates</a> .....	2
<a href="#">How Species Composition Change in Response to Nitrogen Fertilizer</a> .....	3
<a href="#">Effects of Phosphorus on Irrigated Pasture and Hay Meadow Yields</a> .....	3
<a href="#">Nitrogen and Phosphorus Applications</a> .....	4
<a href="#">Response to Fertilizer Under Continuous and Intermittent Irrigation Methods</a> .....	4
<a href="#">Effects of Nitrogen on Dry Matter Yields on Continuous and Intermittent Irrigation</a> .....	4
<a href="#">Fertilizer Application Under Grazing Situations</a> .....	5
<a href="#">When to Apply Fertilizer</a> .....	5
<a href="#">Nutrient Requirements of Pasture Used for Hay vs. Grazing</a> .....	5
<a href="#">Fertilization as a Management Tool</a> .....	6
<a href="#">Economic Levels of Application</a> .....	6
<a href="#">Conclusion</a> .....	6
<a href="#">Additional Reading</a> .....	7

Several factors influence the response of irrigated meadows and pastures to fertilization. They include the type of nutrients applied, irrigation timing and application, the plant species composition of the meadow or pasture and grazing management. If appropriate irrigation management, species composition, or grazing management are lacking, additional fertility will not result in higher yields. This chapter describes situations in which economic response is attained through fertilization and when other factors may limit the response to fertilizer.

#### **What Nutrients Do Irrigated Pastures Need?**

The nutrients needed most for optimal plant production are nitrogen (N), phosphorus (P), and potassium (K), often called macronutrients. However, plants also need micronutrients such as sulfur, iron and zinc. On irrigated pasture in Nevada, the nutrients most likely to be limiting are N and P. Potassium is seldom limiting. A positive economic response is rarely seen from applying K or micronutrients in irrigated pasture.

## Response of Irrigated Pasture and Meadows to Nitrogen

If meadows are properly irrigated and have the right species composition, a positive economic response is normally attained from the application of nitrogen. Plants species found in irrigated meadows and pastures do not respond the same to fertilization. The response can be minimal to dramatic. The following table shows the average yield response to nitrogen fertilizer of common meadow plant communities found in Nevada. The data is based on the result of over 2,500 plots established over a 15-year period in Nevada (Hackett 1973-1987).

### Dry Matter Yields of Six Meadow Types Fertilized at Five Nitrogen Rates

Meadow Type	Pounds of Nitrogen Applied per Acre				
	0	50	100	150	200
	Hay Yield in Tons of Dry Matter Per Acre				
Improved Mixed Grasses <sup>1</sup>	3	4.3	5.2	5.5	5.6
Unimproved Timothy & Clover	2.7	3.6	4.4	4.6	4.8
Unimproved Mixed Grasses <sup>2</sup>	1.6	2.5	3.3	3.5	3.6
Unimproved Sedge & Bluegrass (dry site)	.8	1.3	1.7	2.1	2.7
Unimproved Sedge-rush (wet site)	1.7	2.0	2.3	2.5	2.7
Unimproved Sedge-rush (flood plain)	1.2	1.6	1.8	1.9	2.1

Generally, a positive economic response to nitrogen fertilizer is obtained from nitrogen application of 50-100 lbs (actual N) on improved mixed grasses, unimproved timothy/clover, unimproved mixed grasses, and from lower applications (50 lbs N) on unimproved sedge and bluegrass. A soil sample should be taken before applying any fertilizer to determine the nutrient level already in the soil.

---

***The best economic response to nitrogen is generally between 50-100 lbs of actual nitrogen per acre.***

---

<sup>1</sup> Includes grasses such as Creeping meadow foxtail, Intermediate wheatgrass, Reed canarygrass, brome & Tall fescue

<sup>2</sup> Includes grasses such as Timothy, Red top, Meadow fescue, Meadow barley, sedge and rush

The economic response of N application depends upon the price of nitrogen and the value of the forage (for grazing or hay). The additional forage obtained must have a greater value than the cost of the fertilizer to have a positive economic response.

- Cost of Additional Fertilizer < Value of Additional Forage (Price x Quantity)

### How Species Composition Change in Response to Nitrogen Fertilizer

The plant community found in irrigated pastures is a function of irrigation, fertility and grazing/harvesting. With the application of N fertilizer and proper irrigation, the plant community tends to change from sedge/rush components to mixed grasses. The following table shows the typical response of plant species to nitrogen fertilizer over time and a change from continuous to intermittent irrigation.

Plant Composition With The Application of Nitrogen & Intermittent Irrigation Over Six Years	
End of Year	Meadow Composition With Nitrogen Fertilizer
0 <sup>3</sup>	85% Sedge Rush, 10% Bluegrass, 5% other
1	80% Sedge & Rush, 10% Bluegrass, 10% Clover and Other
2	75% Sedge & Rush, 15% Bluegrass, 5% Meadow Barley and 5% Clover and other
3	60% Sedge & Rush, 15% Bluegrass, 5% Meadow Barley, 20 % Clover and other
6	10% Sedge & Rush, 85% Meadow barley, Timothy & Meadow foxtail, 5% Clover and other

When applying nitrogen fertilizer to irrigated pastures and meadows that are composed primarily of rush, bluegrass, or sedge, the response may not be immediate. However, over time the plant community will change and become more responsive to fertilizer if some remnant desirable grasses are present.

### Effects of Phosphorus on Irrigated Pasture and Hay Meadow Yields

Phosphorus is often overlooked as a critical nutrient in fertility programs. If phosphorus is limiting, then a positive economic response will not be obtained from nitrogen until the phosphorus requirement of the plant is met. It is important to meet the phosphorus requirements of the plant in order to get the full benefit of N application.

Phosphorus is not mobile in the soil. Phosphorus can be built up in the soil over time when excess amounts are applied. A soil test should be taken and phosphorus applied as needed. In most cases the phosphorus is not lost when applied, however, it is expensive to apply when it is not needed. Furthermore, when the pH of the soil is high, some of the phosphorus can become tied up in the soil and become unavailable to the plants.

Fertilizer Applied	Actual Applied Pound per Acre		Tons/Acre of Hay produced
	Nitrogen (N)	Phosphorus (P)	
No Nitrogen or Phosphorus	0	0	.8
21-0-0	100	0	1.0
34-0-0	100	0	1.5
22-22-0	100	100	3.0
27-14-0	100	52	3.2

<sup>3</sup> Plant composition with no nitrogen fertilizer & continuous irrigation

If phosphorus (P) levels in the soil are less than 5 parts per million (ppm), P is deficient and plant response to nitrogen will be small until the P requirements are met. If the P is between 5-15 ppm, it is considered marginal and applications should be made with nitrogen fertilizer. If phosphorus is over 15 ppm it is adequate for production on irrigated pastures and meadows.

### Nitrogen and Phosphorus Applications

The best economic response to nitrogen is generally between 50-100 lbs of actual nitrogen per acre. Applications greater than 100 lbs of N yield a productive response, but often are not worth the additional cost. Phosphorus should be applied on an as needed basis. Thirty to 50 lbs of phosphorus is required each year for production. If soil levels are low (>15 PPM) additional P needs to be added for optimal production.

### Response to Fertilizer Under Continuous and Intermittent Irrigation Methods

Plant response to fertilizer will be limited if proper irrigation techniques are not followed. If irrigation is applied season long (continuous irrigation) and taken off only to cut hay, then the soil oxygen levels will be low. Plants that can survive in these situations, such as rush and sedge, will dominate. As shown in the previous section, sedge and rush have limited response to fertilizer. Furthermore, continuous irrigation washes nitrogen fertilizer from the field and out of the root zones of the plants, which results in an economic loss.

In order to benefit from fertilizer application, irrigation must be changed from continuous to intermittent. Intermittent irrigation is the application of water when the plant needs it and in amounts to wet the soil to the rooting depth of the plant. The water is taken off once it reaches the rooting depth of the plant and applied again as needed (see Chapter 4 Irrigation Management).

### Effects of Nitrogen on Dry Matter Yields on Continuous and Intermittent Irrigation

Year	Irrigation Method	Nitrogen, pounds per acre			
		0	50	100	150
		Hay Yield in Tons/Acre			
1	Continuous	2.1	2.9	3.2	3.4
2	Intermittent	1.6	2.0	2.2	2.2
3	Intermittent	3.6	3.6	4.0	4.3
6	Intermittent	2.5	3.3	4.4	4.6

Initially as irrigation changes, yields will drop (see year 1 vs 2). As the soil becomes too dry for sedge and rush, production improved grass increase. Over time the pasture will become more productive. When irrigation practices change from continuous to intermittent and fertilizer is applied, plant composition will change more rapidly than in irrigation only and become more responsive to fertilization faster..

## Fertilizer Application Under Grazing Situations

When a pasture will be grazed in the spring, fertilizer applications should be delayed. The most rapid part of the plant growth is in the cool season. During the spring, grass growth is often more rapid than livestock can consume. This results in the grass maturing and becoming "rank", or declining in palatability, protein and energy. The animal cannot keep up with the grass and keep it in the vegetative stage (see Beef Cattle Management). Applying fertilizer in the spring causes an even greater spurt of early growth, compounding this problem.

When applying nitrogen fertilizer in a grazing situation, apply it as soon after grazing as possible. Nitrogen is stored in the leaves of the plant and used by the plant as needed. When the plant is vegetative and grazed, the animal removes the nitrogen. Therefore, it is most beneficial to apply N immediately after grazing to allow time for plant response before the next grazing.

### When to Apply Fertilizer

Nitrogen is mobile and can be leached out of the soil. Therefore, care must be taken not to apply too much N in one application. Production will be increased if N can be applied in 40-50 lb/acre per application. If soils are sandy, the full year's nitrogen should not be applied in one application. The full year's N applied in one application will result in a loss of N below the roots of the plant. In areas that experience excess flooding, applications should be done in the spring after flood season. In other areas fall application work well. Because N is readily dissolved in water, unless managed well, there is a risk of N loss.

Phosphorus movement in the soil is very slow, therefore it can be applied in one application anytime of the year. However, applying phosphorus in increments with nitrogen has resulted in increased production. Phosphorus moves slowly in the soil, with most research showing that it moves one inch a year in the soil. Therefore, phosphorus applied this year may not be fully available for several years. Phosphorus can be applied in the fall or spring but fall is preferred in most cases.

### Nutrient Requirements of Pasture Used for Hay vs. Grazing

Over the long run, fields that are grazed instead of used for hay require less fertilizer. Most nutrients (minerals) pass through the cow and are returned to the soil in manure and urine. Livestock return nutrients if they are on the field during excretion. If livestock lounge under a tree or around a water tank, up to 80% of the nutrients may be deposited in these areas, instead of on the field. The only way to increase efficiency of where the manure and urine is deposited is through more controlled grazing. Animals spend a greater amount of their time on the fields and deposit urine and manure more evenly when they are rotated around the pasture (rotationally grazed). Haying, on the other hand, removes the nutrients permanently. Over time, the fertility requirements of a properly grazed pasture can be kept in balance and the need for commercial fertilizer is reduced.

## Fertilization as a Management Tool

Fertilization can be used as a management tool. For example, if you want to encourage legumes in your pasture, applying phosphorus without nitrogen will help stimulate the growth of legumes. Legumes such as alfalfa and clover require high phosphorus levels, yet can fix their own atmospheric nitrogen if they are inoculated with *Rhizobium melioli* (inoculated seed) when planted.

Nitrogen can also be used to manipulate production. The most rapid part of the plant growth cycle for most forages in Nevada (cool season forages) is April, May and June. Livestock grazing during these months often cannot keep up with the growth of the forage; hence the forage supply exceeds the rate of consumption and the forage declines in value as it matures. One way to help increase the production of forages season long is to delay the application of nitrogen until late June or early July. This will stimulate production during the months when it is usually at its lowest production. Phosphorus does not cause the same peak in production after application as nitrogen; thus the time of application of P is not as critical.

---

***The most rapid part of the plant growth cycle for most forages in Nevada...is April, May and June. Livestock grazing during these months often cannot keep up with the growth...***

---

Another example of using nitrogen to manipulate production is stockpiling forages for winter use. The most valuable forage is winter forage, because that is the most expensive time to feed livestock. Therefore, nitrogen can be applied in the late summer to increase production of forages late in the year that could be used as stockpiled forage for winter use. Enough time must be available in the growing season for plant response, and irrigation water must be available.

## Economic Levels of Application

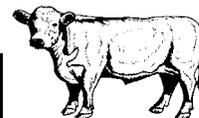
Although production can be increased with increased fertilization, that does not always equate to increased profit. Many ranchers are in equilibrium with the amount of hay they put up and the number of cows they have. Increasing fertility may increase hay production resulting in more hay than the cows can utilize. Much of the meadow hay is difficult to sell because it is low quality and put up in round bales. In this situation producers must assess their goal for increasing production. One option is to reduce the number of acres put up as hay (when the production per acre increases) and increase the number of acres grazed with livestock. Test strips of fertilizer can be valuable in determining potential yield increases and economic returns.

## Conclusion

Soil Fertility is a critical part of optimal pasture production. Factors such as irrigation methods, plant species and grazing management can limit the response to fertilizer. Time should be allowed for plant growth between nitrogen application and grazing. Livestock should be managed so the maximum amount of nutrients is returned to the soil. If grazing is properly managed, the amount of commercial fertilizer applied can be reduced.

## Additional Reading

- Blaylock, A.D., K. Belden and H.W. Hough. 1996. *Guide to Wyoming Fertilizer Recommendations*. B-1045, University of Wyoming Cooperative Extension Service. College of Agriculture, Laramie, WY.
- Koch, D. 1995. *Forage Research and Demonstrations Progress Reports 1991-1993*. MP-84 University of Wyoming Cooperative Extension Service. College of Agriculture, Laramie, WY.
- Hackett, E.I., E.H. Jensen and C.D. Leedy. *Planning a Fertilizer Program for Hay Meadows in Nevada*. College of Agriculture, University of Nevada.



## Chapter 6

### ***Beef Cattle Management on Pastures***

Dr. Ben Bruce, State Livestock Specialist

Ron Torell, Area Livestock Specialist

Roby Kettle, Extension Educator

<a href="#">Introduction</a> .....	1
<a href="#">The Kind of Forage Available</a> .....	2
<a href="#">Grazing Behavior of Beef Cattle</a> .....	2
<a href="#">Effects of Livestock Grazing Selection on Plant Composition</a> .....	3
<a href="#">Efficiency of Forage Use</a> .....	3
<a href="#">Rotational Management</a> .....	4
<a href="#">Classes of Beef Cattle and Forage Uses</a> .....	4
<a href="#">Stocker Cattle</a> .....	4
<a href="#">Weaning Calves in the Fall</a> .....	5
<a href="#">High Production Cow/Calf Pairs</a> .....	6
<a href="#">Stockpiling Forages for Winter Use</a> .....	7
<a href="#">Buffer for Forage Shortfalls</a> .....	7
<a href="#">Which is More Profitable, Intensive or Extensive Management?</a> .....	7
<a href="#">Works Cited</a> .....	8

### Introduction

In Nevada, irrigated pastures (meadows) have historically been used for hay production and the aftermath is grazed in the fall. In recent years, many ranchers have started to graze their irrigated pastures and meadows earlier in the season. Some of the reasons are:

- θ Shortage of forage on the range from a lack of rain or fire
- θ Reduction in grazing AUM's on public grazing allotments
- θ Greater profit potential from grazing vs. haying
- θ Adding sale weight to the calves
- θ Preserving or adding body condition to the cows

Successful use of irrigated pasture involves an understanding of the forage available, grazing behavior by livestock, the classes of beef cattle on the ranch, and the individual needs of each class.

## The Kind of Forage Available

Forages are the backbone of beef cattle production. In order for your beef business to be profitable, it must be built around your forage base. If the livestock do not "fit" the forage, the business will struggle for profit and cash flow.

In Nevada, forages usually start actively growing in late March or early April. Most are cool-season forages that grow rapidly from April until early to mid June. During this period of rapid growth they are also the highest quality. In late June, most forage begins to drop in quality and quantity of production. Often, production levels are very low in the heat of the summer. Then as fall begins, if water is available, the forages will have a spurt of high-quality growth. In November, most forages go dormant and stay dormant until they begin growing the following spring.

Take an inventory of your forages. Do your forage patterns fit the "normal" forage patterns in Nevada? When do you have an excess of forage? What is the quality of your forage? What class of livestock will most profitably graze that forage? When are you short of forage? Can you plan marketing around this shortage (for example, with stocker cattle)? When is that forage at its highest quality? Do the peak demands of your livestock meet the peak production and quality of the forage?

## Grazing Behavior of Beef Cattle

It would seem that nice, large clump of grass in the field would be ideal for a cow to graze. After all, it is the easiest to graze and there is a lot of it. Unfortunately, that is not necessarily true. Cattle have grazing preferences, like a kid who eats the ice cream and leaves the spinach.

---

***If cattle are allowed access to the whole pasture they selectively graze the forages they like.***

---

If cattle are allowed access to the whole pasture at once, they will selectively graze the forages they like. It seems logical that after they grazed those forages, they would go back and graze the others. However, they graze the original forage (the one they liked) each time it begins to grow a little. This keeps this forage very young and vegetative, which means it is high quality and they graze it even more.

The forage that was not grazed originally gets older. There is a lot of it, but it is lower in quality and mature compared to the new growing forage from the plants they have already grazed. Thus, they leave the ungrazed plants and continue to graze the growing ones. This allows the ungrazed plants to get even more mature and lower in quality.

Allowing cattle access to the whole field at once results in the forages being unevenly grazed. Some plants are over utilized and some are underutilized. Overall, efficiency of use is low. The only way to increase the efficiency of use is through more intensive rotational management.

## Effects of Livestock Grazing Selection on Plant Composition

If livestock are allowed to selectively graze, plant composition will change over time. The degree of selectivity is greater in more diverse plant communities. Generally, the plants that are less palatable will increase and the ones that are heavily grazed will be replaced by less palatable plants, or plants that withstand heavy grazing pressure.

An example of this is replacing a productive stand (like meadow brome) with bluegrass (like your lawn). Bluegrass is very palatable and will withstand heavy grazing. However, it is very low in productivity. Another example is fields that are a mixed planting of fescue. Although fescue has some positive traits, it is less palatable than many other forages. Therefore, mixed plantings with fescue, and free-choice grazing, may result in a field being dominated by fescue.

## Efficiency of Forage Use

Efficiency of use refers to how efficiently livestock utilize the forage in an irrigated pasture. How efficiently a pasture is utilized is often compared to windrowing the pasture for hay. If we assume that a windrower is 100% efficient (i.e. no trampling, and the windrower takes all of the forage) we can use this as a base to compare against. For example, assume that the production on a field has a capacity of 2 tons per acre in hay. To determine how efficiently livestock utilize the field, compare how many grazing days you got from each acre. To make the comparison, assume a cow/calf pair utilizes 800 lbs. of dry matter per month or around 26 lbs. of forage each day. To harvest the same amount of forage with the cow, you would need to be on the pasture for 5 months. In that case, we could say the cow was 100% efficient, or she harvests as much forage as a windrower does.

Livestock grazing can harvest anywhere from 25-100% of what could be harvested with a machine on irrigated pasture. The higher efficiencies of pasture utilization require closer management. This may include rotational grazing, by moving the livestock weekly or even daily with the use of an electric fence. It may include having the pasture split-up into paddocks with water centrally located in each paddock.

The plant grows fastest in what is known as the vegetative stage. This is also the time when the plant is the most nutritious to livestock. With intensive grazing management, the goal is to keep livestock on vegetative growth as much as possible. This can result in as much or more forage being harvested with livestock than with machinery. It can result in more protein (CP) and energy (TDN) being harvested per acre, because the plant is harvested in a stage when it is the most nutritious.

Livestock trample, lay, leave manure, and selectively graze forages, a windrower does not. The amount of trampling, waste and selective grazing is usually a function of how closely the pasture is managed. Livestock that are moved daily with only enough forage

allocated for that day, do far less selective grazing and less trampling than livestock allowed free access to a pasture all summer long.

Keep in mind that a cow generates revenue, a windrower only costs money. Do not think that because you can harvest more forage with machinery that it is more profitable. There are many costs associated with harvesting forages with machinery that are not incurred with grazing.

Grazing must be somewhat flexible to insure proper utilization of the forages. Cool season forages grow rapidly in the spring and growth slows during July and August. One alternative is to stock the pasture heavily enough to utilize the forage in the spring and then sort off and sell cattle weighting 750-800 lbs. (stocker cattle) while keeping the smaller cattle. Usually the market in July and August is at seasonal highs for that class of cattle, which adds to the advantage of marketing the heavier end of the cattle.

### Rotational Management

Rotational grazing is generally done with electric fences. Cattle are moved weekly, or even daily throughout paddocks. Water must be available in each paddock. When cattle are rotationally grazed, they do not have a chance to select which forage they eat, for there is only one day's worth of forage in front of them. This results in higher gains per acre. Keeping the plants vegetative will also result in higher gains per animal than free choice grazing (unless stocking rates are very low with free choice grazing).

### Classes of Beef Cattle and Forage Uses

Irrigated pasture has the potential of higher production and higher returns per acre than rangeland. It also has higher costs per acre. Therefore use a class of livestock that is capable of giving a higher return/acre or graze during a period when the forage is most valuable. Some options for using irrigated pasture in Nevada are:

- θ Stocker cattle
- θ Weaning calves in the fall
- θ High production cow/calf pairs
- θ Stockpiling forages for winter use
- θ A buffer for forage shortfalls
- θ Improving body condition on cows in preparation for winter
- θ Replacement heifer development

### Stocker Cattle

Using stocker cattle to graze irrigated pasture is a great option for many producers. Stocker cattle are in the growth phase of their life, therefore they will result in higher gains per acre than other classes of livestock. For example, a cow/calf pair has a 1200 lb.

mother cow that is simply maintaining herself, but consuming large amounts of forage. Stocker cattle, on the other hand, are all in the growth phase. Stocker cattle are better able to utilize the higher nutrient quality of the forage.

Many Nevada producers may find a profitable enterprise in retaining ownership of their lighter calves, wintering them on a cheap winter ration, and followed by growing them until mid summer on irrigated pasture. In some cases it may be more profitable to purchase hay and run stocker cattle than to produce your own hay.

Stocker cattle should be managed for high gains. The pasture needs to be kept in a vegetative stage for the cattle to achieve adequate gains. Most likely the cattle will need to be rotationally grazed in order to keep the pastures vegetative. Generally, there is a negative buy/sell spread. Therefore, the cattle must put on enough weight to overcome this negative price margin and still maintain a profit. Most stocker operators shoot for a 2-lb. average daily gain.

When grazing stocker cattle, take into consideration all of the factors that affect profit. This includes, costs, the relationship of purchase price to selling price (buy/sell spread), the phase of the cattle cycle, seasonal cattle markets and the weight gain of the stocker cattle. See chapter 8 for information on these factors.

## Weaning Calves in the Fall

Weaning calves or grazing cow/calf pairs on irrigated pasture in the late summer or early fall can be a way to put additional pounds on the calves and money in your pocket. Rangeland forage quantity and quality in Nevada drops off sharply in July and so does calf performance.

Cows with calves at their side on native range in the fall often begin to lose body condition. Furthermore, the calves at their side do not gain well. Therefore, it may be more profitable for some ranchers to wean their calves in late summer or early fall and allow

---

***Weaning calves or grazing cow/calf pairs on irrigated pasture in the late summer or early fall can be a way to put additional pounds on the calves and money in your pocket.***

---

them to graze on native meadows, than to keep them on the cow. Keep in mind this process takes extra labor, facilities and good quality feed for the freshly weaned calves.

A study in Nevada showed that after adjusting to a 205-day weaning date, the average weights of calves that were early weaned (July) were 401 lbs. compared to 421 lbs. for the calves weaned at normal times (October). The lost revenue and additional feed costs for the early-weaned group was \$35.50. However the cost to bring the mother cows (first calf heifers) of the late weaned group up to that of the early-weaned group (BCS 4-5) was \$100 (Conely 1995). Calves weighing 400 lbs., which is often around September in Nevada, can be weaned from their mothers on irrigated pasture with little or no weight

loss. They often have higher gains than if they were on low quality range forage with their mothers.

Another advantage of weaning calves on irrigated pasture is that the cow can be put back onto the range as a dry cow. Nevada rangelands, in most cases, will not support a lactating cow in the late summer or early fall. Therefore, the cow's body condition begins to drop, milk production decreases and calf gains slow down. If the cow is dry during this time period the forage on the range is adequate to support her. She may add body condition as compared to losing body condition with a calf at her side.

### High Production Cow/Calf Pairs

As previously mentioned, gains per acre with cow/calf pairs will not be as high as gains per acre with stocker cattle. However, if cow/calf pairs are utilized on irrigated pasture, choose pairs that have the potential for higher performance.

High performance cattle are large framed cows that have higher milking ability and bred to bulls with high EPD's for growth. Utah State University has developed a system where calves weigh 1150 lb. in less than a year. They have large frame (1,350 lbs.) heavy milk production (15-20 lbs./day milk) crossbred cows, bred to calve in March and April. The cows are artificially inseminated to Simmental and Angus bulls high EPD's for yearling weight. The cows are grazed on high quality irrigated pastures from May 15 - October 31. They are rotated in new paddocks every 24 hours. The calves are given a creep feed at 80-100 days of age. In October, the calves are put into a feedlot and fed for 90 days. Weights going into the feedlot in October average 828 lbs., and the calves finish in February weighing an average of 1176 lbs. Approximately 40% of the calves grade choice. On average, the calves were 300 days of age when slaughtered (Wiedmeier 1998).

Although your production goal may not be as high as the Utah system, if you are going to graze cow/calf pairs, you should target higher production. If you put typical Nevada range cows on irrigated pasture, the cows will get fat, but that doesn't insure bigger calves. This is because Nevada range cows generally have a lower genetic potential for milk production and are geared for beef production on limited feed resources.

If cow/calf pairs are used on irrigated pasture, it is important to build your grazing program around your forage base. You want the peak demands of your livestock synchronized with the peak production and quality of your forages. The peak nutritional demand for the cow is directly after calving. For the highest biological efficiency (and most likely the optimum economical efficiency), the livestock producer should try to time calving as close as possible to the green productive forages in the spring. Although circumstances may force you to calve in January, it leaves you three months of feeding hay before green grass is available. Standardized Performance Analysis (SPA) data revealed an inverse correlation between the amount of hay fed in relation to using

standing forage and the profitability of a livestock enterprise. The more hay fed, the less profitable the livestock enterprise.

## Stockpiling Forages for Winter Use

Winter represents the most expensive time for the cow/calf producer. This is when harvested forages are providing the majority of the nutritional needs of the cow. This is often described by ranchers as "all summer hauling the hay to the stacks and all winter hauling it to the cows." A study in northern Nevada showed that 44% of the yearly ranch expenses are in winter-feed costs. These costs amount to \$144.21 per winter per cow (Torell 1995).

Stockpiled forages for winter use can save a lot of money and labor. Irrigated pasture can be used to stockpile forages for winter use and reduce winter feed costs. One advantage irrigated pasture has is its potential for fall re-growth. After hay has been taken off or summer grazing finished, irrigated pasture can be watered and the re-growth stockpiled. This re-growth can be enhanced with a fall application of fertilizer (see chapter 5).

The most efficient use of stockpiled forages is obtained when the forage is rationed out to the cattle on a daily basis with an electric fence. The electric fence should be moved to allow the cattle one days grazing. If the cattle are allowed to utilize the whole field at once, they will not utilize the forage as efficiently and more waste will result. Consider the extra winter feed obtained versus the cost and labor of an electric fence when determining how much access to give the cattle.

## Buffer for Forage Shortfalls

Irrigated pasture can be an excellent buffer for forage shortfalls in range. Forage shortfalls could be a result of drought, fire, or just a gap in the grazing season on rangelands. Producers have more control of water, fertility and other management aspects on irrigated pasture than they do on rangelands. Therefore irrigated pasture can be an excellent buffer for shortages that occur on rangelands. Furthermore, the management decisions are in complete control of the rancher, allowing more flexibility than is available with many rangelands.

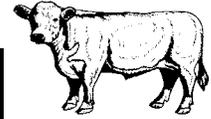
## Which is More Profitable, Intensive or Extensive Management?

Management can be of two types. It can be low cash input and extensive management, with relatively low returns per acre, but with an overall high level of profitability. Or, management can have higher cash inputs per acre with intensive management, and a higher return per acre. Cow/calf pairs fit better into the first scenario, while stocker livestock or livestock capable of high returns fit better into the second scenario. If you are going to have high inputs per acre, you must have a class of livestock that is capable of maximizing these inputs.

A cow/calf operation can be equal to a stocker operation on a return to capital, but generally not on a return to acre. Cows are particularly adept at consuming large amounts of low quality, inexpensive forages, and turning them into energy, and high quality milk. Stocker cattle on the other hand are in a growth phase and cannot consume as much forage; therefore, they must consume lower amounts of high quality forage. High quality forages are utilized more profitably with stocker cattle, or livestock with high production capabilities, while lower quality forages are more profitably utilized with cow/calf pairs (Nation 1998). The bottom line is that they both can be profitable, but the right class of livestock must be grazed on the right type of forage.

## Works Cited

- Conley, K.C., L.B. Bruce, L.J. Krysl, J.W. Burkhardt, W.G. Kvasnicka, R.C. Torell, G.M. Vesperat, and J. Wilker. 1995. *Heifer Development Under a Western Range Environment-Calving and Weaning*. Agri-Pratice. Vol. 16, No. 8:6-9.
- Nation, A. 1998. *Pasture Profits with Stocker Cattle*. Green Park Press, Ridgeland, MS.
- Torell, R.C., Myer, G.L., Bruce, B. 1995. *Costs and Returns for a Cow-Calf Enterprise* in Elko County. University of Nevada Fact Sheet 95-34.
- Wiedmeier, R.D. 1998. *Summary of Slaughter-weight Calf Production System*. College of Agriculture, Department of Animal Science Report. Utah State University, Logan, UT.



## **Chapter 7**

### ***Sheep Production on Irrigated Pasture***

Dr. Hudson Glimp, State Extension Specialist

<a href="#">Introduction</a> .....	1
<a href="#">Pastures and Irrigation</a> .....	2
<a href="#">Pasture</a> .....	2
<a href="#">Irrigation</a> .....	2
<a href="#">Grazing System</a> .....	2
<a href="#">Sheep Production</a> .....	2
<a href="#">Potential Problems</a> .....	3
<a href="#">Alfalfa Aftermath Grazing by Sheep</a> .....	4
<a href="#">References</a> .....	4

#### **Introduction**

Allan Nation (1995) states that irrigated pasture when used in combination with high value-producing animals can be one of our most profitable irrigated crops. Sheep clearly fit his definition of high value producers with their twinning ability and the potential of producing a significant portion of the lambs as slaughter ready with minimal supplemental feed. Western producers convert to irrigated pasture production for a number of reasons. Those most frequently cited include growing frustration with public land use policies, predator losses on rangelands, difficulties in obtaining reliable labor for remote herding operations, and the opportunities for better management control and increased productivity on irrigated pasture.

Range sheep production systems are by their very nature low input (lower cost) and low output production systems. Cost control may be as important as productivity, since the extensive nature of range operations limits their productivity. Irrigated pasture production systems require higher inputs, and thus require higher outputs or productivity for profitability. It is important that we recognize irrigated pasture as a crop, and it must produce more profit per acre than alternative crops. Management skills and requirements are greater for irrigated pasture production systems, since one must become both a skilled crop producer and a skilled sheep producer. With good management, sheep production on irrigated pasture can be more profitable than alternative crops or alternative sheep production systems.

## Pastures and Irrigation

### Pasture

Cold tolerant perennial ryegrass varieties have proven very popular for sheep production on irrigated pasture. Improved varieties of tall fescue are also highly productive with proper management. Improved pastures for sheep should include at least 30% legumes in the mix, with Ladino or white clover as the recommended legume. Birdsfoot trefoil is also considered an excellent legume for irrigated pasture. Alfalfa is excellent pasture for sheep, particularly for ewes and lambs during early lactation and for lambs after weaning. With proper management when introducing sheep to grazing alfalfa, bloat is not a serious problem. Sheep should be gradually introduced to alfalfa for grazing. I recommend 1 to 2 hours on alfalfa after the morning grazing bout for 5 to 7 days, then just leave them on alfalfa pasture on the last day.

### Irrigation

Sprinkler irrigation systems are preferred for irrigated pasture. Center pivot systems are the most desirable in many situations, but require more management to maintain smaller paddock sizes for grazing. Wheel lines are better adapted to small paddock sizes. Solid set hand line is clearly the most desirable system for sheep, but is also the most expensive system to develop. Flood irrigation is the least desirable system, but is also the most widely used due to lower establishment costs. Irrigated pasture works best on well drained soils. Compaction and standing or stagnant water are less of a problem on sandier soils.

### Grazing System

Grazing system selection and management are critical for irrigated pasture. Due to the need to avoid irrigation where the animals are grazing, some form of rotational grazing is required. The major challenge is to keep the pasture vegetative, not allowing seed production and the resulting dormancy. The biggest problem is that peak pasture growth is during the spring months, but one must stock at levels that can be supported during the slower growth summer months. During the spring the producer basically has 3 options: (1) cut hay from a portion of the pasture while using higher stocking rates on the remainder of the pasture, (2) use co-species grazing with stocker cattle or first calf heifers during the peak growing season to utilize excess production, or (3) mow the pasture to keep it vegetative. The latter of these options is the least desirable.

---

***The major challenge is to keep the pasture vegetative, not allowing seed production and the resulting dormancy.***

---

### Sheep Production

In a market lamb production system, the key to profit is to work with nature. Peak nutrient demands of the ewe are during the last 3 to 4 weeks of gestation and the first 6 to

8 weeks of lactation. Peak nutrient demands are during early life when the lamb is nursing mother, when it begins to become a grazing animal, and at weaning at 12 to 14 weeks of age. This strongly suggests that lambing on irrigated pasture should begin in late April or early May, or about one month after the onset of pasture growth. One option to consider would be to stock the irrigated pastures in the spring to their carrying capacity with ewes and lambs, then early wean the lambs in late July or early August. The ewes could then be removed to alternative forage sources such as desert range, leaving the irrigated pasture for the weaned lambs. Another option, if irrigated alfalfa is available, would be to wean the lambs on to alfalfa pasture after second cutting, leaving the irrigated pasture to the ewe flock.

Set stocking is the preferred grazing system during lambing. Small paddocks that would support 50 to 80 ewes each from the onset of lambing until the lambs are at least one week of age are recommended. This system can be enhanced by determining early lambing ewes by real-time ultrasound and sorting ewes into drop (lambing) pastures by lambing date. Once all of the lambs in a pasture are at least 7 to 10 days of age, they can be gradually mixed into larger groups of 250 to 300 ewes with lambs by 20 days of age, and groups of over 500 ewes with lambs after the youngest lamb is 30 days of age.

When the small group mixing process begins, a management intensive grazing (MIG) system should be used. The ewes and lambs should be on a minimum of 6 to 8 pastures, 3 to 4 days per pasture, and on a rotation cycle of 21 to 24 days. This cycle will keep the previously recommended forage mixtures vegetative and will continue to provide fresh, high nutrient value forage available. Again, if the stocking rate is not high enough to uniformly graze the pastures, then either mowing or clean-up grazing by followers will be required.

Another sheep production option on irrigated pasture is the purchase of feeder lambs for growing and finishing, which would work well in combination with stocker cattle. Lambs could be purchased out of Texas in the spring, the southwest in the summer, and from Nevada and other western range states in the fall.

## Potential Problems

Potential problems would continue to be predators and animal health related concerns. Ewes should be immunized against EAE-Vibrio prior to breeding to prevent abortions and treated for external parasites at shearing prior to lambing, and also receive a pre-lambing vaccination for overeating disease – *Clostridium perfringens* Types C and D and Tetanus. The lambs should be vaccinated for overeating at 30 – 40 days of age and again at weaning. Internal parasites can potentially be devastating if not controlled on irrigated pasture. Consult your veterinarian or contact your local extension office and work with qualified people to develop an internal parasite control program and a total flock health management plan. A combination of electric fence and guardian dogs continues to be the recommended predator control program. Maintain contacts with your local animal damage control program officer to trap or remove predators that have penetrated your control program.

## Alfalfa Aftermath Grazing by Sheep

Tom Filbin, Dr. Hudson Glimp and Dr. Ben Bruce

Alfalfa aftermath was grazed on a large farm in central Nevada containing 100 130-acre center pivots with approximately 3200 tons of available forage. The sheep were grazed from mid-October to mid-January. Based on estimated grazing intakes, the available forage was determined to be adequate for 90 days for 9,000 lambs, 2,500 yearling ewes and 8,800 mature ewes. Grazing fees were negotiated at \$.03/day lamb, \$.045/day yearling ewe and \$.05/day mature ewe.

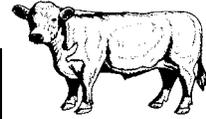
Death loss was less than 1% in the lambs. The lambs gained an average of .31 lbs/day. All costs, including a management fee, amounted to a cost per pound of gain of \$.3374/lb. This was \$.21/lb less than custom feedlot gain costs for a net profit of \$5.67 per lamb from the alfalfa aftermath grazing. The lambs were forward contracted off of the irrigated pasture at the same price they would have received as feeder lambs in October.

The costs of managing the ewes on alfalfa aftermath for 90 days was determined to be \$3.00 per ewe higher than it would have been to manage the ewes on fall and winter desert range. The average % lamb crop was 15% higher in the ewes flushed and bred on alfalfa aftermath when compared to winter desert range breeding. This means there was a net cost of \$20 per additional lamb born. In addition, winter survivability of the ewes was higher on alfalfa than expected on winter desert range. The ewe flock included 800 cull ewes on which the producer was bid \$0.25/lb in October. These ewes gained 30 lb and sold at \$0.35 per lb in January for a net gain in value of \$13.00 on their original weight plus \$10.50 value in the weight gain, or a total increase in value of \$23.50 per head.

It should be pointed out that the farmer received \$73,270.00 in grazing fees, or an average of \$5.64 per acre. The farmer has continued this relationship due to additional perceived benefits of improved weed control, and the sheep do less damage to irrigation equipment and haystacks than cattle. Sheep manure is also better distributed than cattle manure.

## References

- Nation, H. Allan. 1995. Quality Pasture: How to Create It, Manage It, and Profit From It. Green Park Press. Jackson, MS.
- Nation, H. Allan. 1999. Colorado grazer says irrigated pasture creates control. The Stockman Grass Farmer. Vol. 55, No. 10, pg. 1.



## Chapter 8

### ***Economics of Stocker Cattle***

Roby Kettle, Extension Educator  
Ron Torell, Area Livestock Specialist  
Willie Riggs, Extension Educator  
Ben Bruce, State Livestock Specialist.

<a href="#">Stocker Cattle Enterprise Budget</a> .....	1
<a href="#">Buy/Sell Price Relationships</a> .....	2
<a href="#">Seasonal Price Patterns</a> .....	3
<a href="#">Cyclical Cattle Prices</a> .....	5
<a href="#">Buying and Selling on the same Market</a> .....	5
<a href="#">Risk Management</a> .....	6
<a href="#">Conclusion</a> .....	6
<a href="#">Additional References</a> .....	6

Stocker cattle on irrigated pasture can be a profitable enterprise for many western beef producers. The advantage of stockers is their ability to put on rapid growth on high quality pasture. High quality pasture is usually cheaper than concentrates, giving the grazer an advantage over the feedlots. Factors that affect the profitability of stocker cattle are:

- θ The relationship of purchase price to selling price (buy/sell margin)
- θ Seasonal and cyclical market cycles
- θ Cost of running the cattle
- θ Weight gain of the cattle
- θ Death loss

#### Stocker Cattle Enterprise Budget

Consider the possible revenue versus the costs associated with running stocker cattle. Costs that producers may have include: purchase price, pasture charge, interest, tax, veterinary and medicine, salt and minerals, transportation, fencing, fuel, death loss, shrink, commission and yardage at selling, labor, and depreciation.

<b>Stocker Cattle Enterprise Budget</b>				
<b>Gross Margin</b>				
	<u>Weight</u>	<u>Price</u>	<u>Gross Revenue</u>	<u>100 Head</u>
Gross Revenue from Sale	678	\$ 0.80	\$ 542.40	\$ 54,240.00
Purchase Price of Cattle	450	\$ 0.90	\$ 405.00	\$ 40,500.00
<b>Gross Margin</b>			<b>\$ 137.40</b>	<b>\$ 13,740.00</b>
<b>Costs</b>				
	<u>Cost/Month</u>	<u># of Months</u>	<u>Total Cost/Head</u>	<u>100 Head</u>
Pasture	\$ 12.00	4	\$ 48.00	\$ 4,800.00
Vet and Medicine			\$ 2.00	\$ 200.00
Transportation Cost			\$ 3.00	\$ 300.00
Tax			\$ 1.00	\$ 100.00
Fuel Cost	\$ 75.00	4	\$ 3.00	\$ 300.00
Death Loss, 1%			\$ 4.05	\$ 405.00
Commission & Yardage (selling) 1.5%			\$ 8.64	\$ 864.00
Pencil Shrink 2%			\$ 11.52	\$ 1,152.00
Interest @ 10%			\$ 15.10	\$ 1,510.00
<b>Total Costs</b>			<b>\$ 96.31</b>	<b>\$ 9,631.00</b>
<b>Profit/Loss</b>			<b>\$ 41.09</b>	<b>\$ 4,109.00</b>
<b>Break Even Selling Price</b>				<b>\$ 0.74</b>
<b>Break Even Purchase Price</b>				<b>\$ 0.99</b>

This budget assumes the cattle are on pasture for 4 months with 2-lbs./day gaining.

### Buy/Sell Price Relationships

Profitability of stocker cattle will be influenced tremendously by the relationship of the purchase price of the cattle and the price at which you sell them. Stocker cattle economics differs from cow/calf economics because the producer is now a margin producer. In other words, you make or lose money based upon selling price, buying price and costs.

$$\theta \text{ Profit for Cow/Calf Producer} = \text{Revenue} - \text{Cost}$$

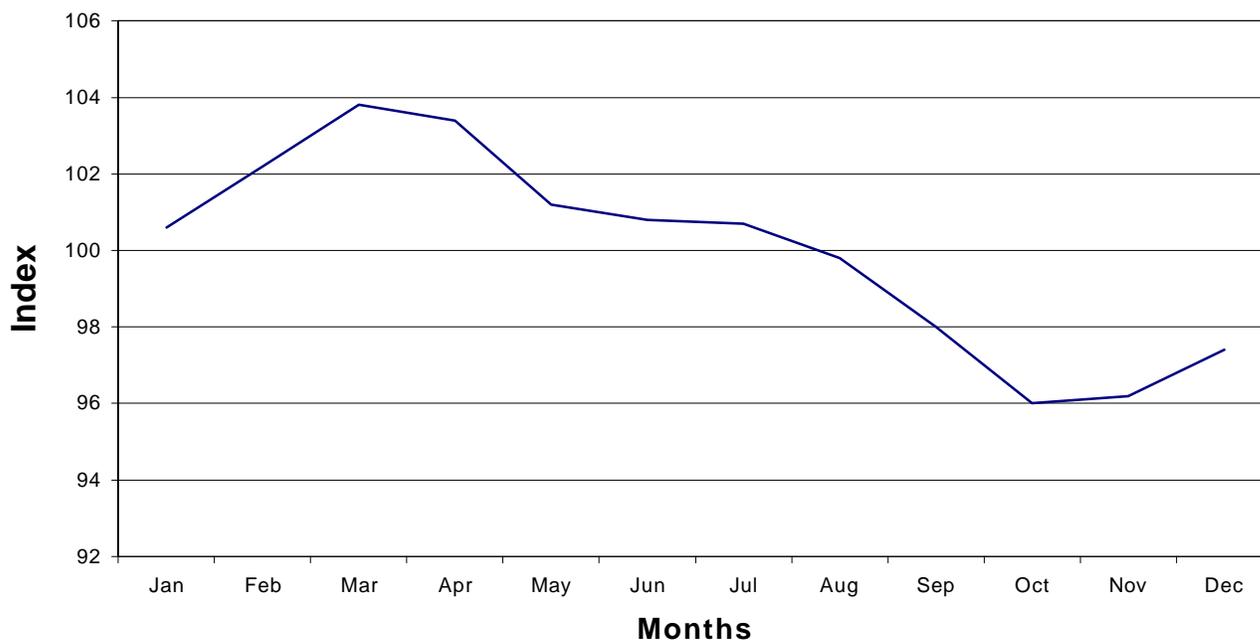
$$\theta \text{ Profit for a Stocker Cattle} = \text{Revenue} - \text{Purchase Cost} - \text{Cost}$$

Stocker cattle producers must consider the price at which they buy the cattle and the prices at which they sell the cattle. The cattle may perform superbly, costs may be low, yet it is possible to lose money due to a negative buy/sell margin.

## Seasonal Price Patterns

Cattle have seasonal price patterns that are similar from year to year. This is mainly a result of 70% of the calves being born in the spring. This causes a somewhat predictable fluctuation in seasonal prices each year. The following graph shows the seasonal price pattern on an index of 100 for 450 lb. calves (stocker cattle).

**Seasonal Calf Prices 1989-1998**

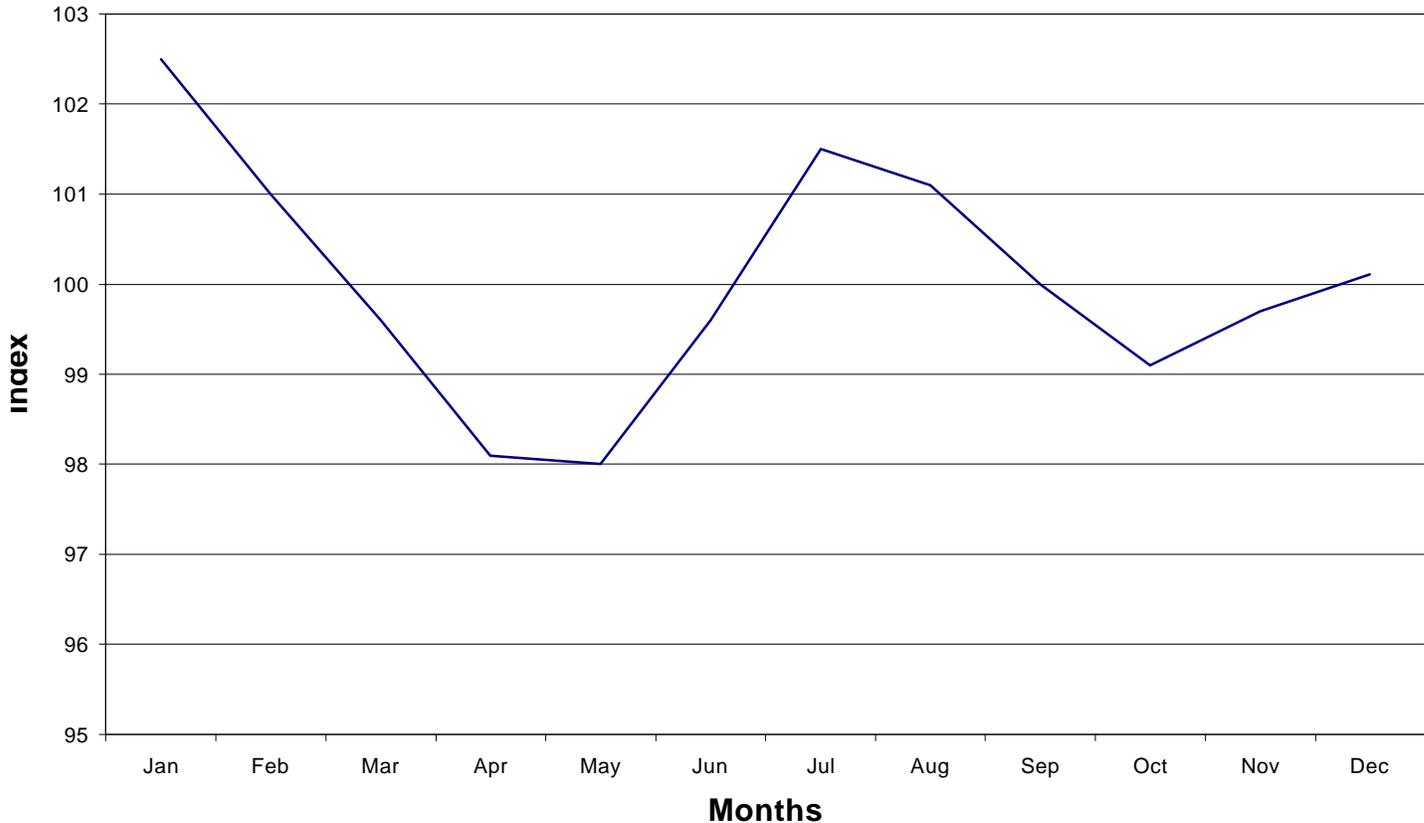


(Source: Cattle Fax 1999)

Note that one-hundred is an average. Numbers above 100 are seasonal highs and numbers below 100 are seasonal lows. As you can see from the graph, prices for stocker cattle tend to be higher in the early part of the year than in the later part of the year. Stocker cattle prices often exhibit "grass fever" (the purchase of cattle when the green grass starts to grow by large numbers of buyers) when the grass (or other forage) starts to grow and trend upwards for a short time period.

The following graph shows the seasonal prices on an index of 100 for a 750-lb. steer from 1989-1998.

### Seasonal Feeder Cattle Prices



(Source: Cattle Fax 1999)

Feeder cattle tend to hit their price lows in May and increase in price in July and August. This is largely a function of the supply of grain and cattle. Grain stocks are low in May, yet feedlots anticipate the harvest in the fall and cheaper grain, and look for cattle that will finish quickly.

Producers may want to consider buying light calves in the fall and wintering them on cheap forages. This may allow producers to take advantage of seasonal price fluctuations as well as "compensatory gain" on green grass. In general, producers should plan to market feeder cattle (600-750 lbs.) in July or August. Seasonal prices tend to drop quickly in the fall.

## Cyclical Cattle Prices

Cattle tend to go through cyclical prices. This can be described as the "Up Cycle" and the "Down Cycle," with transition years in-between. During 1974-1976 the cattle market was in a "Down cycle", 1979 was an "Up Cycle", 1985-1986 was another "Down Cycle," 1990-1991 was another "Up Cycle" and 1996-1998 was a "Down Cycle." During these cycles, different parts of the beef industry profit.

	<u><i>Cow/Calf</i></u>	<u><i>Stocker</i></u>	<u><i>Feedlot</i></u>
<i>Up Cycle</i>	Significant Profits	Moderate Profits	Moderate Profits
<i>Downward Transition</i>	Declining Profitability	Significant Losses	Significant Losses
<i>Down Cycle</i>	Significant Losses	Narrow/Negative Margins	Narrow/Negative Margins
<i>Upward Transition</i>	Improving Profitability	Significant Profits	Significant Profits

(Source: Cattle Fax)

If you own stocker cattle and prices increase significantly, your profit will be high. On the other hand, if prices trend downwards, your profit will be low or negative.

## Buying and Selling on the same Market

If you own the cattle (self financed) and are in the stocker business for the long run, buying and selling cattle on the same market will allow adequate cash flow for the purchase of the next set of cattle. For example, if prices move down while you own stocker cattle, you will have a "paper loss." However, if you buy back on the same low market, the cattle you buy back will cost less than the ones you sold. You still have enough "cash flow" to buy back the next set of cattle. If prices trend upwards when you sell, you will have significant "paper profits." However, your replacement cattle will have increased in cost and income taxes will increase.

## Risk Management

Because stocker cattle are bought and sold, and part of the profit involves the "margin" between buying and selling prices, risk management becomes more important. Producers should consider using forward contracts if their price and profit objectives (loss minimization) are met. Options producers have are forward contracts with:

- θ Cattle buyers
- θ Feedlots
- θ Futures and options
- θ Video sales

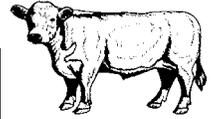
Producers are often leery of forward contracting cattle because everyone wants to get "top dollar." One way to forward price cattle and still take advantage of significant up trends in prices is to buy a put option. If you forward sell your cattle to a buyer and still want to take advantage of upward price trends, you could buy a call option. With both of these alternatives, if prices do trend upwards then you will still reap the rewards. If prices trend downwards, well, you will be glad you had your cattle forward contracted. In both cases you will have to pay the premium for the option.

## Conclusion

Stocker cattle grazing on irrigated pasture can be a profitable enterprise for Nevada producers. However, the producer needs to consider feed resources and quality, stocker cattle gains, buy/sell margins, and costs. Producers should consider implementing risk management strategies before and during ownership.

## Additional References

- Cattle Fax. 1999. *1999 Cattle Industry Reference Guide*. Lakewood Colorado.
- Cattle Fax. 1999. *Retained Ownership, 7<sup>th</sup> Edition*. Lakewood Colorado.
- Cattle Fax. 1999. *Cattle Industry Risk Management*. Lakewood Colorado.
- Riggs, W. and D. Griffith. 1993. *Grassfat, The Economics of Pasturing Stocker Cattle*. Oregon State University, Cooperative Extension, WREP 120. Agriculture Communications, Corvallis, OR.
- Nation, A. 1998. *Pasture Profit with Stocker Cattle*. Green Park Press. Ridgeland, Mississippi.



## **Chapter 9**

### ***Northeastern Nevada Native Hay Budget***

William W. Riggs, Extension Educator Eureka County  
Roby Kettle, Extension Educator Humboldt County,  
Ron Torell, Area Livestock Specialist

<a href="#">Land</a> .....	1
<a href="#">Labor</a> .....	2
<a href="#">Capital</a> .....	2
<a href="#">Machinery and Equipment</a> .....	2
<a href="#">Operations</a> .....	2
<a href="#">Other</a> .....	2
<a href="#">Economic Costs and Returns</a> .....	3
<a href="#">Reference</a> .....	4

Producing forages in the form of hay products is a practice widely practiced by ranchers throughout the west. Hay is put up in order to provide additional winter forage feed stuffs at a cost beneficial to ranches. This chapter estimates the typical costs and returns of producing native hay in Northeastern Nevada. It should be used as a guide to estimate actual costs and returns associated with producing native hay, and is not representative of any particular ranch. The major assumptions made in constructing this budget are discussed below. Assistance provided by Nevada producers is greatly appreciated.

#### **Land**

This budget is based on 600 acres of hay harvested annually. Land is valued at \$600 per acre. The hay stand is entirely native grass, with no establishment required. The hay typically is harvested once per year, with a yield of 1.5 tons per acre. In addition, there normally is re-growth on the meadows, which is leased as pasture for grazing livestock. No landlord services are provided for aftermath grazing.

## Labor

Almost all the labor is provide by the family and is included as a non-cash cost of \$10 per hour. Labor hired to drive equipment during harvest is included as a cash cost of \$7.90 per hour, which includes social security, FICA, and other payroll expenses.

## Capital

Costs of capital are charged at a rate of 10 percent for current and intermediate capital provided by the owner.

## Machinery and Equipment

Two tractors are used in the operation, a 50 hp and a 95-hp tractor equipped with farmhand loader. The 50-hp tractor is used to drag meadows, clean ditches, and rake hay. The 95-hp tractor is used to swath, bale and haul hay. Cutting is done with a 12' pull-type swather. A round baler is used for baling. Hay is hauled from the field to stack lots using reconditioned hay trailers.

Spring 1999 replacement values for machinery are used. To represent the mix of new and used equipment the budget assumes all the machinery is half depreciated in the production year

## Operations

The meadows are harrowed/dragged in April. Irrigation ditches are checked, cleaned, and maintained at this time. A custom cost of \$500 per year, or \$1.67 per acre, has been included for ditch cleaning and maintenance. Irrigation water costs \$5 per acre which represents a positive return on the investment of the water right.

## Other

The economic costs and returns of native hay production are summarized for each operation. Harvest-related variable costs account for \$36.00 per acre, or \$24.00 per ton.

The cash fixed costs of \$1.98 per acre include machinery and equipment insurance. Non-cash fixed costs include depreciation and interest on machinery and equipment, and opportunity cost of land ownership.

To calculate break-even prices, or the hay price that will exactly cover costs, the aftermath income is included as a negative cost. The resulting break-even price over total variable cost is \$33.03 per ton, and the break-even price over total cost (variable and fixed) is \$65.60 per ton.

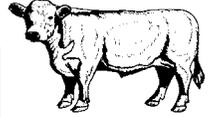
## Economic Costs and Returns

### Northern Nevada Native Hay Native Hay, 600 acres (\$/acre)

<u>GROSS INCOME Description</u>	<u>Quantity</u>	<u>Unit</u>	<u>\$/Unit</u>	Total/acre	<u>Your Returns</u>
Aftermath Pasture	1.00	Aum	11.00	11.00	_____
Native Hay	1.50	Ton	50.00	<u>75.00</u>	_____
Total GROSS Income				86.00	_____
<u>VARIABLE COST Description</u>				<u>Total</u>	<u>Your Cost</u>
Rodent Control				2.00	_____
Farm Pickup				2.14	_____
ATV				.50	_____
Drag Meadows				1.74	_____
Ditch Maintenance/cleaning				1.67	_____
Water cost				5.00	_____
Misc. dams, shovels, boots, etc.				.50	_____
Sub Total				<u>13.55</u>	_____
<u>HARVEST</u>					
Swath				6.10	_____
Rake				3.27	_____
Bale				12.10	_____
Haul & Stack				14.53	_____
SubTotal HARVEST				36.00	_____
Operating Capital Interest				0.50	_____
Total VARIABLE COST				<u>49.55</u>	_____
GROSS INCOME minus VARIABLE COST				<u>36.45</u>	_____
<u>FIXED COST Description</u>				<u>Unit</u>	<u>Total</u> <u>Your Cost</u>
CASH Cost				Acre	
Machinery & Equipment Insurance				1.98	_____
Taxes on Land				3.00	_____
Total CASH Cost				<u>4.98</u>	_____
NONCASH Cost					
Family Labor Non Harvest		Acre		4.00	_____
Machinery & Equipment Interest & Depreciation		Acre		24.88	_____
Land Interest		Acre		<u>15.00</u>	_____
Total NONCASH Cost				43.88	_____
Total FIXED Cost				<u>48.86</u>	_____
Total of All Cost				98.41	_____
NET PROJECTED RETURNS				<u>(-12.41)</u>	_____
Break-even Price, Total Variable Cost				\$33.03 per ton	_____
Break-even Price, Total Cost				\$65.60 per ton	_____

## Reference

- Myer, Gordon L., Torell Rodney C., and Bruce Ben. 1995. *Cost and Returns for a Cow Calf Enterprise in Elko County, Nevada*. University of Nevada Reno Cooperative Extension. Fact Sheet 95-34.
- Turner Brenda et.al. (1997). *Enterprise Budget Native Hay, High Desert Area*. Oregon State University Extension Service. EM 8652.
- Blank Steven C. et.al. *Acquiring Alfalfa Hay Harvest Equipment: A Financial Analysis of Alternatives*. Agricultural Economics Department, University of California, Davis. Authors office copy.



## Chapter 10

### *Parasite Prevention And Control Under Intensive Grazing Management*

Dr. Bill Kvasnicka, Extension Veterinarian  
Dr. Ben Bruce, State Livestock Specialist  
Ron Torell, Area Livestock Specialist

<a href="#">Introduction</a> .....	1
<a href="#">Stomach and Intestinal Worms</a> .....	1
<a href="#">Lung Worms</a> .....	2
<a href="#">Liver Flukes</a> .....	2
<a href="#">Coccidia</a> .....	2
<a href="#">Prevention of Internal Parasites</a> .....	2
<a href="#">Strategic Deworming</a> .....	3
<a href="#">Available Dewormers</a> .....	3
<a href="#">Effective Use of Dewormers</a> .....	4
<a href="#">Parasites Problems Under Intensive Grazing</a> .....	4
<a href="#">Should Beef Cows Be Dewormed?</a> .....	5
<a href="#">Control of Lungworms, Flukes, and Coccidia</a> .....	5
<a href="#">External Parasites</a> .....	6
<a href="#">Summary</a> .....	7
<a href="#">Table 1</a> .....	8
<a href="#">Figure 1</a> .....	9
<a href="#">Citations</a> .....	9

#### Introduction

With proper prevention and treatment methods cattle producers can control most common internal and external parasite problems. Prevention and control of parasites is critical when cattle are managed intensively. Basic parasite prevention and treatment programs are formulated with an understanding of the parasites that challenge livestock, how and when parasites infect cattle, and the damage resulting from the challenge.

#### Stomach and Intestinal Worms

Infected cows, calves, and stocker cattle shed the eggs of gastrointestinal nematodes (GI nematodes) on the pasture or range. The eggs survive cold weather and drought, subsequently hatching into infective larvae when warm moist conditions exist. Infective larvae also survive cold weather. Cattle are infected, or re-infected, with GI nematodes by ingestion of the infective larva. The ingested infective larva develop into adult worms in four to six weeks and the female worms begin shedding additional eggs onto the pasture. Thus cattle grazing pastures or rangelands contaminated with parasite eggs and

infective larvae are infected and continue to shed eggs during the grazing season. Pasture contamination levels increase during the grazing season exposing livestock to increasing levels of infection. The result is sub-clinical parasitism and in some cases clinical parasitism.

Parasitic infections due to GI nematodes are often more obvious in younger animals than in older animals. However, older animals can be damaged, especially during stress periods such as lactation, breeding, or during times of the year when nutrition is inadequate. In addition, older animals serve as a source of infection for the younger more susceptible animals. Sub-clinical production losses are manifested by lower weaning weights, conception rates, and weight gains, especially for stocker cattle and replacement heifers.

### Lung Worms

Lungworms cause a lung disease in cattle with clinical signs similar to those caused by viruses, bacteria, and allergies. Transmission and control is similar to that for GI nematodes. Lungworm disease typically occurs in previously unexposed cattle, such as calves or yearlings, but can also occur in mature animals.

### Liver Flukes

Cattle living in wet areas with alkaline soils may develop liver fluke infections. Liver flukes are transmitted when infected cattle pass larvae in manure and drop the manure in water. The larvae undergo further development in snails. An infective form emerges from the snail that migrates onto the grass. Cattle ingest the infective cysts that are on the grass. The cysts penetrate from the intestines into the abdominal cavity and migrate to the liver. They invade the liver and migrate through the liver to the bile duct. The migrating immature flukes damage the liver. When the immature flukes reach the bile duct the mature fluke forms and the female flukes lay eggs that re-contaminate the pastures.

### Coccidia

Coccidia cause an intestinal disease of young cattle, usually 3 weeks to 6-months old, but they can also affect cattle up to 2-years old. They are transmitted when infected cattle pass cysts in manure onto the ground. Rain or irrigation water washes the cysts from the manure. Contaminated creeks and water sites are also a common source of coccidia infection. The cysts develop under moist and moderate temperature conditions and cattle swallow cysts from the moist ground.

### Prevention of Internal Parasites

A basic beef cattle production program should be designed to prevent diseases by strategic administration of vaccines and medications. Internal parasitism can be prevented by timely administration of modern

---

***The key to preventing internal parasites in cattle is to prevent pasture contamination.***

---

dewormers.

The key to preventing internal parasites in cattle is to prevent pasture contamination. See (Figure 1)

1. Deworm cattle in late fall or before grazing commences with a dewormer that effectively kills the adult worms and the developing larvae.
2. The cattle will become re-infected by ingestion of larvae hatching from the eggs that contaminated the pasture during the previous season. As previously mentioned, within four to six weeks of grazing, cattle start shedding eggs and re-contaminate the pasture.
3. Deworming stocker cattle four weeks after grazing commences prevents secondary pasture contamination. Deworm beef cows and calves six weeks after grazing is initiated. Some newer dewormers claim persistent activity for several GI nematodes and lung worms. This persistent activity has not been verified in the field. If the claim is accurate, timing for the second deworming could be extended. Read the label and consult with an animal health advisor to determine the proper timing.

Because it requires gathering and handling the herd, producers have been hesitant to administer a second deworming. An effective dewormer, formulated in free choice mineral or in a block, is available that can be self fed. The second treatment can be administered without gathering the cattle.

### Strategic Deworming (see Figure 1)

The term in common use for preventing losses due to GI nematodes in pastured cattle by stopping pasture contamination is strategic deworming. A strategic deworming program must be outlined specifically for each ranch and for each cattle management plan. To design a plan a rancher or consultant should consider the following questions.

- When does the grazing season (grass growth) start and end?
- Will pasture rotation occur or will the cattle be moved from private land to a grazing allotment?
- What is the stocking rate?
- Are the pastures or meadows irrigated?
- What class of cattle will be grazing the pasture or range?
- What type of dewormer will be used and when should it be administered?
- What is the efficacy of the dewormer against the common GI nematodes and flukes?
- What is the dose, method of administration, and duration of action of the dewormer chosen?
- What is the cost of the dewormer and the cost of administering the medication?

### Available Dewormers

Dewormers are commercially available in the following formulations: pour-on, injectable, drench, paste, bolus, block, feed for top dressing, mineral mix, and as feed additives for mixing in feed or mineral (Table 1).

## Effective Use of Dewormers

Type I dewormers are effective only on adult parasites. Type II dewormers control adults and the developing larva. In addition, Type II dewormers also control the inhibited stages of internal parasites. If a Type II dewormer is strategically applied harmful levels of GI nematodes will be prevented. When GI nematode parasitism has been reduced to a safe level producers need not be concerned about treating for inhibited forms.

Timing of treatment is critical if a strategic deworming program is to be successful. Review the *Prevention of pasture contamination* section of this paper to determine when the cows, calves, or stocker cattle should be treated.

---

***“Timing of treatments is critical if a deworming program is to be successful.”***

---

If all animals grazing a pasture are free of worms at the start of grass growth (either through fall or winter deworming), they will not need to be dewormed again until the developing larva have matured into egg laying female worms. The life cycle takes three weeks in calves, four weeks in yearling cattle, and six weeks in adult cattle. The number of mid-summer treatments depends on the length of the grazing season and the duration of action claimed by the manufacturer of the dewormer being used.

The ability of a specific Class II dewormer to rapidly stop egg shedding varies. In addition, the eggs shed after use of some dewormers are still alive. If a dewormer is selected that does not abruptly kill the adult GI nematodes and stop egg shedding the cattle should be held in a dry-lot pen for at least five days before grazing. (Table 1)

## Parasites Problems Under Intensive Grazing

GI nematode parasite problems usually intensify over time when intensive grazing systems are used. Three important factors account for this statement.

1. Intensive pasture management involves rotational grazing. When the feed base in a pasture has been utilized the livestock are moved to a pasture with new growth forage. The cattle will rotate back to the vacated pasture when the forage base has recovered. Rotation intervals will vary according to the size of the pasture and can occur weekly or daily. Stocking rates can be dramatically increased when rotational intensive grazing is practiced.
2. Irrigation is usually required to utilize intensive grazing in semi-arid regions.
3. The more intensively a livestock producer manages pastures, the need for a class of cattle that has the capability of superior growth is desirable. More pounds of cattle can be gained per acre on high quality forages with stocker or weaned cattle than with cow/calf pairs. High quality forages are utilized more profitably with stocker cattle, or livestock with high production capabilities, while lower quality forages are more profitably utilized with cow/calf pairs.

Under intensive grazing management systems higher stocking rates contributes to an increased level of GI nematode pasture contamination. Irrigation provides the moisture needed for worm development, survival, and transmission. Consequently, the challenge imposed is increased. The class of cattle recommended for efficient utilization of forage is younger and do not possess immunity to parasites. Therefore, the resistance is lowered. When the challenge is increased and the resistance is lowered parasitic disease occurs.

### Should Beef Cows Be Dewormed?

Healthy adult cows usually harbor small numbers of worm parasites. They develop a partial immunity which prevents a heavy parasite infection level. Cows may not appear to be infested, but in most trials, cows treated with dewormers will wean heavier calves than untreated cows.

---

***“...cows treated with dewormers will wean heavier calves than untreated cows.”***

---

Beef cattle producers should deworm their cowherd. Prevalence studies show that most cows in the Western United States harbor GI nematodes. Visual appraisal would indicate that the cows did not need treatment, but calf-weaning weights indicate otherwise. Cows produce large quantities of worm egg laden manure resulting in pasture contamination. Failure to treat the cows means that the calves pick up and harbor production-limiting levels of nematodes. This accounts for the differences in weaning weights. Split pasture trials attest to the cost benefit of deworming beef cows in the Western United States.

### Control of Lungworms, Flukes, and Coccidia

Strategic deworming may control lungworms. Producers grazing wet areas and irrigated pastures need to be vigilant concerning lungworm outbreaks. Deworming cattle before turning out onto the grazing area can prevent pasture contamination. Producers should always treat cattle of unknown source for lungworms to prevent infestation of a pasture that does not harbor lungworms. Some dewormers kill lungworms rapidly and the cattle can be turned out as they are treated. Some dewormers kill lungworms slowly and the cattle should not be turned onto the pasture for at least five days.

Prevention of liver flukes is difficult. Only one of the approved medications to treat flukes will kill the immature flukes. The others only kill the mature fluke after it enters the bile duct (after the damage to the liver caused by the migrating immature flukes has occurred). Treating cattle thought to be infected in the spring before turnout can reduce pasture contamination. The immature flukes will be mature by spring and any of the approved products will be effective. Cattle grazing fluke infected pastures should be treated after the grazing season with a product that will kill the immature and adult flukes. Egg shedding will then cease following treatment and the pastures will not be further contaminated.

Dewormers are not effective against coccidia. Nearly all cattle shed coccidia. Pastures and lots are usually contaminated. To prevent coccidiosis start feeding decoquinate (Deccox®), lasalocid (Bovatect®), or monensin (Rumensin®), at the beginning of the grazing season. These medications can be administered in mineral, blocks, lick tanks, or in feed. Effective medications to treat coccidiosis are amprolium (Amprol®, Corid®), and sulfonamides. Prevention of coccidia is advised, especially for young cattle that are intensively managed.

## External Parasites

Horn flies reproduce in fresh cattle manure from early spring to late fall. Horn fly populations usually peak in late spring and again in late summer or early fall. Hot, dry conditions may naturally reduce horn fly numbers during mid-summer. Thousands of flies may infest a single animal, causing extreme nervousness and energy loss. Horn flies suck blood, irritate and annoy, reduce weight gains, and cause weight losses. The annoyance and irritation interfere with cattle's feeding and resting.

Treatment is economically justified when horn fly populations reach 250 per head. To control them satisfactorily throughout the season, use self-treatment insecticides or routinely apply spray, pour-on formulations, spot-on, or dust chemicals.

Used properly, self-treatment devices are more effective than hand application in controlling horn flies and lice. Such devices include oil back rubbers, dust bags and tubes, liquid wicks and impregnated ear tags. Insecticide impregnated ear tags control horn flies well for 2 to 5 months if they are properly attached to the ear and if pyrethroid resistance is not a factor. Currently labeled ear tags contain a pyrethroid, an organophosphate or a pyrethroid organophosphate synergist mixture. It is also recommended to wait until fly numbers reach about 200 per head to apply ear tags and to use a body spray or pour on when the tags are being applied.

---

***“Used properly, self-treatment devices are more effective than hand application...”***

---

Attacking larvae in the manure can also control horn flies. Insecticides, insect growth regulators, and chitin inhibitors are available in feed, mineral blocks, mineral mix, or sustained release boluses. These products are excreted in the manure and kill or interfere with the development of larvae. The continual influx of flies from neighboring pastures results in reinfestation of treated cattle. This reinfestation is often misinterpreted as treatment failure.

Pyrethroid ear tags (permethrin, fenvalerate) have induced widespread horn fly resistance. Vary the types of ear tag insecticides rather than using the same kind year after year. Remove tags as soon as possible once they have lost their effectiveness in killing horn flies. Tags used 4 to 5 months emit too little insecticide to control fly populations adequately. Tags emitting reduced doses seem to add to the resistance problem by prolonging fly exposure, thus making the surviving population more resistant to the insecticide.

Lice are winter active parasites and treatment and control is not necessary during the spring and summer grazing seasons.

Grub treatment is recommend at the end of the heel fly season and could be effectively applied at the completion of the grazing season.

## Summary

The objective of a parasite control program under an intensive grazing management system is to stop pasture contamination. This will effectively lower the parasite challenge by limiting parasite numbers on the pasture and inside the animal. Prevention, rather than treatment, should be the rancher's goal.

---

***Prevention, rather than treatment, should be the rancher's goal.***

---

Table 1

**Cattle Parasticides**

<b>Products Class Trade Name</b>	<b>Parasites <i>Read label to determine withdrawal time</i></b>	<b>Methods</b>	<b>Kill Rate (Miller)</b>	<b>Eggs Alive (Bliss)</b>	<b>Cost</b>
Albendazole Class II Valbazen®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , mature liver flukes, tapeworms	Drench, paste	Rapid	No	\$\$
Clorsulon Curatrem®	Immature and mature liver flukes	Drench	NA	NA	\$\$
Doramectin Class II Dectomax®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , grubs, sucking lice, biting lice <sup>3</sup> , mites	Injection <sup>4</sup> , pour-on <sup>6</sup>	Slow	Yes	\$\$\$\$
Eprinomectin ClassII Eprinex®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , grubs, sucking lice, biting lice, mites, horn flies	Pour-on <sup>6</sup>	Inter-mediate	Yes	\$\$\$\$
Ivermectin Class II Ivomec®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , grubs, sucking lice, biting lice <sup>3</sup> , mites, horn flies	Injection, pour-on <sup>6</sup>	Slow	Yes	\$\$\$
Invermectin Class II Clorsulon® Ivomec Plus®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , grubs, sucking lice, mature liver flukes	Injection <sup>4</sup>	Slow	Yes	\$\$\$
Ivermectin Ivomec® SR Bolus	Parasite control for 135 days. For 275-660 # grazing cattle	Sustained release bolus	60 days to stop shedding	Yes	\$\$\$\$ \$\$
Fenbendazole ClassII Safe-Guard® Panacur®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , tapeworms	Drench, paste, oral feed, block, mineral	Rapid	No	\$\$
Levamisole ClassI Levasole®, Tramisol®, Totalon®	Adult stomach worms, lung worms <sup>1</sup>	Drench, Injection <sup>4</sup> , pour-on <sup>6</sup> , bolus, feed, block	Rapid	No	\$
Moxidectin ClassII Cydectin®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , grubs, sucking lice, biting lice, mites, horn flies	Pour-on <sup>6</sup>	Slow	Yes	\$\$\$\$
Oxfendazole ClassII Synanthic®	Stomach worms <sup>2</sup> , lung worms <sup>1</sup> , tapeworms	Drench, paste, injection <sup>5</sup>	Rapid	No	\$\$

<sup>1</sup>Adults, developing larvae; <sup>2</sup>Adults, developing larvae, inhibited larvae; <sup>3</sup>Pour-on; <sup>4</sup>Subcutaneous; <sup>5</sup>Intraruminal, <sup>6</sup>Pour-on products are reported to deliver only 1/3 of the active ingredients to the blood stream compared to the injectable products. Thus the classification of these products as a Class II dewormer is questionable. (Bliss)

Cost: estimated cost per 500 pounds of body weight excluding the cost of external parasite treatments for products that do not control externals.

\$ -- \$0.60 to \$1.05

\$\$- \$1.05 to \$1.25

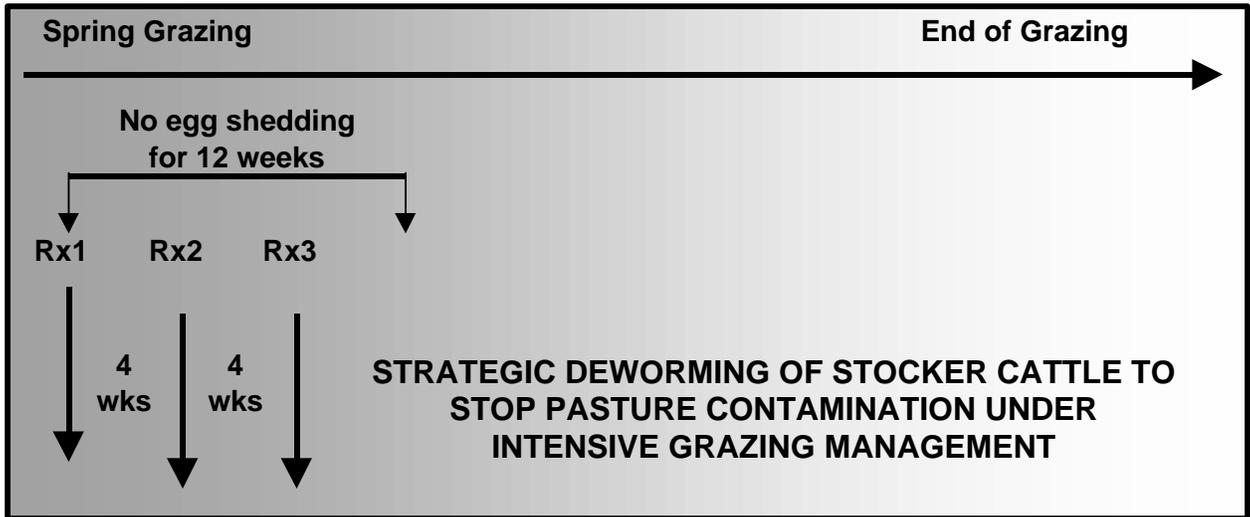
\$\$\$ \$1.25 to \$1.87

\$\$\$\$ \$1.87 to \$2.50

\$\$\$\$\$ \$2.50 to 3.25

\$\$\$\$\$\$ \$10.00 or more

Figure 1



**Rx**

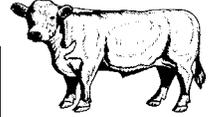
**Step 1: Rx before turnout in spring.**

**Step 2: Rx in 4 weeks (0-4 timing for <90 days grazing)**

**Step 3: Rx in 4 weeks (0-4-8 timing for >90 days grazing)**

**Citations**

- Blagburn BL: Efficacy of fenbendazole medicated feed blocks against gastrointestinal nematode infections in calves. *Am J Vet Res* 48:1017, 1987.
- Bliss D: Strength and weakness of the Avermectins. *Proceedings of the Interstate Veterinary Conference*, Sioux City, IA, 1998.
- Faries FC: Common cattle parasites. Texas Ag Ext Service, L-233 6-98, 1998
- Herd RP: Cattle practitioner: Viral role in worm contrl. *Compend Contin Educ Pract Vet* 13(5):879-886, 1991.
- Kvasnicka WG, Krysl LJ, Torell RC, Bliss DH: Fenbendazole in a strategic deworming program. *The Compendium of Continuing Education, Food Animal Supplement* April, S113, 1996.
- Myers GH: Strategies to control internal parasites in cattle and swine. *J Anim Sci* 66(6):1555, 1988.
- Michel JF, Lancaste MB: Experiments on the control of parasitic gastroenteritis in calves. *J Helminthol* 44:107, 1970.
- Mers GH: Strategies to control internal parasites in cattle and swine. *J Anim Sci* 66(6):1555, 1988.
- Miller JE: Evaluation of the impact of the Ivermectin sustained release (SR) bolus on weight gain and parasite controls in heifers. *Proceeding American Association of Bovine Practitioners* 1993.



## **Chapter 11**

### ***Improving Grass Hay Quality Through Fertilizer and Irrigation Management***

Ron Torell, Northeast Area Livestock Specialist  
Jason Davison, Central Area Plants and Soil Specialist

<a href="#">Introduction</a> .....	1
<a href="#">Irrigation</a> .....	1
<a href="#">Fertilizer</a> .....	2
<a href="#">Hay Quality</a> .....	2
<a href="#">Hay Yields</a> .....	3
<a href="#">Summary</a> .....	4
<a href="#">Table 1. Quality of Hay</a> .....	4
<a href="#">Table 2. Nutrient Value</a> .....	4
<a href="#">Works Cited</a> .....	4

#### **Introduction**

Grass and grass-clover hay is produced on more than 250,000 acres in Nevada. Hay quality is dependent on factors that include: the type of plants in the field; the time of harvest; fertilization practices; and irrigation management.

This chapter will focus on how irrigation and fertilizer management determine which plants will grow in a hay field. The type of plants growing in the field will directly impact the quality of the harvested hay. Proper management can increase the number of desirable plant species and improve their quality.

#### **Irrigation**

Most meadow haylands in Nevada are irrigated under a system of continuous irrigation. Meadows are saturated during the growing season and dry during late summer, encouraging the growth of sedges and rushes, both low-quality plants.

Applying water for a prescribed period every other week is often called intermittent irrigation. The soil type will dictate the amount of water and how long it will remain on the field. This type of irrigation promotes warmer soil temperatures and more soil oxygen. Both of these factors favor the more desirable grass species that improve hay quality.

## Fertilizer

Fertilizer applications are even more important in changing the plant species composition in a meadow. However, when determining which meadows will respond to fertilizer, the presence of sedges and rushes can be misleading. If fertilizer has not been used previously, and small amounts of desirable grass species are present, fertilizer applications can change the composition to predominantly grasses. This conversion may take from three to five years. Applying higher rates of fertilizer will speed up the process. If the use of fertilizer is discontinued, sedges and rushes will once again become the dominant plants in the field.

Nitrogen is the most important fertilizer element to apply. The quantity is more important than the type of nitrogen applied. As a rule of thumb, 80 to 100 units or pounds of actual nitrogen should be applied on each acre of meadow. Higher rates will speed up the conversion, but may not be economical. These high rates of nitrogen will also increase production of hay on most meadows if they are irrigated properly.

Nitrogen should be applied in the fall unless the fields are wet throughout the winter because of a high water table or flooding. If the fields are grazed in the spring, fertilizer should be applied after livestock are removed. Nitrogen concentrates in leaves. If livestock remove the leaves, nitrogen is lost.

Phosphate fertilizer applications are also often beneficial on Nevada hay meadows. The soils are usually shallow and have a high pH. Both factors limit the amount of phosphorous available to plants. When phosphorous is needed, producers should apply three parts nitrogen to one part phosphorous (i.e. 30-10-0). Other macro and micronutrients required for plant growth are normally not deficient in northeastern Nevada, however, a soil test can identify any deficiencies.

## Hay Quality

Percent crude protein and total digestible nutrients (TDN) are often used as indicators of hay quality. As the percentages of crude protein and TDN increase, hay quality also rises. The crude protein percentages represent nitrogen compounds in forage and are lumped together when computing rations for livestock. TDN is a calculated figure representing the sum of all the digestible organic nutrients in the feed and is an estimate of the energetic value of the animal.

Forage test results obtained over the past 40 years in Nevada demonstrate the value of fertilizing hay to improve quality. These results are supported by research data in Colorado, Oregon, and Idaho. In all instances, crude protein levels were increased by the application of nitrogen.

Some words of caution are in order. Nitrogen rates less than 80 pounds per acre may actually reduce protein levels. Small amounts of nitrogen will increase early plant growth, but the nitrogen is soon depleted. The plants continue to grow, the amount of nitrogen in the leaves is diluted, and reduced protein levels result.

More than 300 hay samples were obtained in northeastern Nevada from 1946 through 1987. Chemical analysis of these samples indicate that crude protein levels can be increased by an average of 2.6 percent with the addition of fertilizers. Hay cut early (before July 15) and fertilized, averaged 5.0 percent higher in crude protein than non-fertilized, late cut (after July 15) hay.

Table 1 summarizes the average chemical analysis obtained from samples. Samples were divided into fertilized and non-fertilized hay. The fertilized hays received varying amounts and types of nutrients. The figures shown in Table 1 represent a combination of hays cut early and late.

The quality differences are readily apparent when compared to the nutrient requirements of a pregnant, 1000-pound cow. Table 2 shows the nutrient requirements of a 1000-pound cow during the middle and last two-thirds of pregnancy (October-March). It also details how each hay does or does not meet the requirements of that cow. Table 2 clearly shows that non-fertilized hay does not meet a cow's requirements in any category except calcium. Table 2 also shows that fertilized hay is adequate in every category.

## Hay Yields

Hay yields are usually expressed as tons of hay harvested per acre. However, a measurement such as pounds of crude protein harvested per acre may be more meaningful when determining production. Fertilized hay produces an average of 2.6 percent more crude protein per ton than non-fertilized hay. This means fertilized hay will produce 52 more pounds of crude protein per ton than non-fertilized hay. The fertilizer will also produce significantly more total forage from the same acreage.

Several factors determine the economic returns from a fertilization program. Typically, fields with favorable soils and abundant, manageable water will produce the greatest economic returns. However, lower quality fields can also produce positive economic returns if fertilizer prices are not too high. Producers are advised to follow recommended irrigation practices and then try fertilization on a small scale. Production increases should then be compared with the cost of the fertilizer. Producers should remember that changing plant species with fertilizer and water management takes time. A two to three-year trial may be necessary.

## Summary

Grass hay producers in Nevada can produce high quality hay with a proper management program. That program should include intermittent irrigation, application of fertilizers, and cutting at the proper stage. Each individual practice is helpful, but by applying all three techniques, the highest quality hay is produced at the lowest price.

Table 1. Quality of Hay

Average quality of fertilized and non-fertilized northeastern Nevada grass hay 1946-1987.

Treatment	% Crude Protein	% Phosphorus	% Calcium	% Crude Fiber	% TDN*
Fertilized	10.10	0.21	0.45	30.90	55.10
Non-fertilized	7.51	0.17	0.54	31.20	51.30
Difference	-2.59	-0.04	0.09	0.3	-3.80
% Change	-25.60	19.70	20.00	0.10	-6.90

\*TDN = Crude Protein x 1.454 + 40.385

Table 2. Nutrient Value

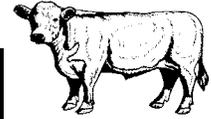
Nutrient requirements of a 1000-pound cow during the last two-thirds of pregnancy compared to the nutritive value of fertilized and non-fertilized northeastern Nevada hays.

	Nutrient Requirements Middle 3rd	Nutrient Requirements Last 3 <sup>rd</sup>	Nutrient Value Fertilized	Nutrient Value Non-Fertilized
Crude protein %	7.00	7.90	10.10	(7.50)*
TDN %	48.80	53.60	55.10	(51.30)
Calcium %	.18	.26	.45	.54
Phosphorus %	.18	.20	.21	(.17)

\*Figures in parenthesis do not meet the nutrient requirements of a 1000-pound pregnant cow.

## Works Cited

- Hasslen, D.A. 1986. *1985-86 Nevada Agricultural Statistics*. Nevada Agricultural Statistics Service. Reno, Nevada P. 15
- Hackett, E.I. 1984. Planning a Fertilizer Program—Nevada Suggestions. In: Second Intermountain Meadow Symposium Proceedings. Colorado State University Special Series #34 pp 81-90.
- Seimer, E.G. and Rumburg, C.B. 1975. Management Practices Determine Plant Species in Meadows. Colorado State University Experiment Station Bulletin 564-S.
- Seimer, E.G. 1984. Generalities About Meadow Fertilization. In: Second Intermountain Meadow Symposium Proceedings. Colorado State University Special Series #34 pp. 91-101.
- Willhite, F.M., Hayden, K.R., and Seimer, Eugene G. 1956. Improving Colorado Mountain Meadows. Colorado Agricultural Experiment Station. General series paper #64 10 pp.
- Yungen, J.A., Jackson, T.L., and W.S. McGuire. 1977. Seasonal Responses of Perennial Forage Grasses to Nitrogen Applications. Oregon State Agricultural Experiment Station Bulletin #626. 11 pp.
- Painter, C.G., Samson, R.S., and Slinkard, A.E. 1968. Fertilizing Irrigated Pastures. University of Idaho Agricultural Extension Service Bulletin #452. 5 pp.
- 1984 Nutrient Requirements of Beef Cattle Sixth Revised Edition, National Academy Press, Washington, D.C. pp 84-85.



## Chapter 12

### *Matching Hay Quality to Cow Needs*

Ron Torell, Northeast Area Livestock Specialist  
Jason C. Davison, Central Area Plants and Soils Specialist

<a href="#">Introduction</a> .....	1
<a href="#">Critical Months for Nutrition</a> .....	1
<a href="#">Matching Hay Quality</a> .....	2
<a href="#">Middle Third of Pregnancy</a> .....	2
<a href="#">Last Third of Pregnancy</a> .....	2
<a href="#">First Three Months After Calving</a> .....	2
<a href="#">Minimize Costly Supplements</a> .....	2
<a href="#">Importance of Forage Quantity</a> .....	3
<a href="#">Purchasing Hay</a> .....	3
<a href="#">Table 1.</a> .....	3
<a href="#">Table 2.</a> .....	3
<a href="#">Table 3.</a> .....	4
<a href="#">Table 4.</a> .....	4
<a href="#">Table 5.</a> .....	4
<a href="#">Works Cited</a> .....	4

#### Introduction

Feeding range cattle through the winter is the most costly aspect of many livestock operations in Nevada. However, if hay quality is matched to the nutritional demands of cattle, the purchase of supplements can be reduced and herd production can be increased. This can be accomplished by simply planning the sequence of hay feeding.

Improving hay quality through fertilization, water management, species composition and time of harvest may also reduce the cost of winter feeding. A nutritional analysis of 302 grass hay samples harvested from 70 northeastern Nevada ranches between 1946 and 1987 supports the above statements.

#### Critical Months for Nutrition

In northern Nevada, January, February and March are nutritionally critical months for the cows that will calve at the beginning of April. Nutritional demands are approximately 10 percent greater during the last third of pregnancy. Allowing cows to lose excessive condition prior to calving will delay birth the following year. This is due to delayed estrous<sup>5</sup>.

Inadequate nutrition during the three months after calving (April, May and June) is also detrimental to reproduction the following year. During these three months, nutritional

demands are 20 percent higher than pre-calving requirements for cows and 25 percent higher for first-calf heifers. If the nutritional demands of the cows are not met during these critical six months (January through June), conception rates can be greatly reduced or delayed<sup>5,6</sup>. The same effect has been demonstrated with bred yearling heifers<sup>1,2</sup>.

## Matching Hay Quality

A feeding plan based on the nutritional demands of cattle and quality of feed on hand can easily be developed for hay listed in Table 1. Table 1 allows comparison of the nutritional values of the hay to the nutritional needs of the 1,000-pound cow for nine months (from the middle of pregnancy to three months after calving.) For the purpose of discussion it is assumed that there is an adequate supply of each hay listed.

### Middle Third of Pregnancy

The poorest quality hay of the four listed is the late cut, non-fertilized hay (Table 2). Producers should feed this hay during the middle third of pregnancy when the cow's nutritional demands are low. Late cut hay falls just short of meeting requirements for protein and phosphorous, but meets or exceeds requirements for energy and calcium during the middle term of pregnancy.

### Last Third of Pregnancy

The early cut non-fertilized hay (Table 3) and the late cut, fertilized hay (Table 4) exceed the requirements for a cow in the middle third of pregnancy. The increased nutritional value of these hays will supply adequate nutrition for cows in the last three months of pregnancy when a phosphorous supplement is added. An energy-based supplement may be necessary under conditions of cold stress because the total digestible nutrient (TDN) values for these hays come close to meeting the cow's minimum energy requirements.

### First Three Months After Calving

The early cut, fertilized hay (Table 5) is the only feed listed that meet all the cow's requirements following calving. Nutritional demands are the highest during this time because of lactation.

## Minimize Costly Supplements

By efficiently managing the winter feeding program it is possible to meet nutritional demands of the cow herd and minimize supplementation. Hay quality statistics listed in this publication are averages for hays produced on Nevada ranches during the past 40 years. An average figure can only be used as a guide because nutritional value varies from field to field and from one year to the next. Because of this, testing is essential in order to minimize supplement feed costs. The costs of forage testing are minimal compared to the costs of most protein and/or energy supplements.

## Importance of Forage Quantity

Cattle require quantities of nutrients not percentages of nutrients. The percentage of nutrients needed to balance the rations discussed in this chapter will be incorrect when the amount of hay fed is less or more than the quantity required (depending on the weight and physiological condition of the animal). Cattle can suffer from “hollow belly” when insufficient forage is fed no matter what the forage nutrient density. Generally, an animal’s dry matter intake ranges from 1 to 3 percent of its body weight depending on the forage quality. The higher the forage quality the greater the intake. Also, it is important to remember that environmental conditions often create the need for additional forage intake during winter months.

## Purchasing Hay

Purchasing additional feed based on the quality and quantity of feed on hand can save money. Northern Nevada livestock producers have access to alfalfa hay markets in southern Idaho and northern Nevada. Hay that does not meet dairy industry specifications can be purchased cheaper than processed supplements on the basis of actual protein per pound. A combination of homegrown hay, purchased alfalfa hay and a phosphorous supplement will usually balance the nutritional needs of the cow herd during critical periods of the year.

The best way to purchase feed, and balance a ration with feed on hand, is through nutritional chemical analysis and least cost ration formulation.

**Table 1.**

Average Quality of Northeastern Nevada Grass Hay 1946-1987\*

Treatment No. Samples	Crude Protein		Crude Fiber	Calcium	Phosphorus	TDN**
	Average	Range				
Early cut, before 7/15						
Fertilized 50	11.6	6.7-17.8	30.1	.42	.23	56.3
Nonfertilized 77	8.9	6.2-11.6	29.7	.61	.18	53.2
Late cut, after 7/15						
Fertilized 36	7.9	2.5-11.3	32.2	.48	.18	52.4
Nonfertilized 139	6.7	3.3-9.9	32.6	.50	.17	51.3

\*100 percent dry matter basis.

\*\*Total Digestible Nutrients, these values were estimated based on species composition of grass hays. TDN values were calculated from information provided by (3).

**Table 2.**

Nutrient Requirements of 1000-pound Cow in Middle and Last Third of Pregnancy and Postpartum Compared to Nutritive Value of Northeastern Nevada Hays Cut Late After 7/15; Nonfertilized

	% CP	Diff.	% TDN	Diff	% Calcium	Diff	% Phosphorus	Diff
Nutritive value of hays late cut, nonfertilized	6.7		51.3		0.50		0.17	
Nutrient requirements of cows:								
Middle third of pregnancy	7.0	-.30	48.8	+2.5	0.18	+0.32	0.18	-.01
Last third of pregnancy	7.9	-1.12	53.6	-2.3	0.26	+.24	0.21	-.04
1-3 months postpartum	9.6	-2.9	56.6	-5.3	0.28	+0.22	0.22	-.05

**Table 3.**

Nutrient Requirements of 1000-pound Cow in Middle and Last Third of Pregnancy and Postpartum Compared to Nutritive Value of Northeastern Nevada Hays Cut Early Before 7/15; Nonfertilized

	% CP	Diff.	% TDN	Diff.	% Calcium	Diff.	% Phosph	Diff.
Nutritive value of hays early cut, nonfertilized	8.9		53.2		0.61		0.18	
Nutrient requirements of cows:								
Middle third of pregnancy	7.0	+1.9	48.8	+4.4	0.18	+0.43	0.18	0
Last third of pregnancy	7.9	+1.0	53.6	-0.4	0.26	+0.35	0.21	-.03
1-3 months postpartum	9.6	-0.7	56.6	-3.4	0.28	+0.33	0.22	-.04

**Table 4.**

Nutrient Requirements of 1000-pound Cow in Middle and Last Third of Pregnancy and Postpartum Compared to Nutritive Value of Northeastern Nevada Hays Cut Late After 7/15; Fertilized

	% CP	Diff.	% TDN	Diff.	% Calcium	Diff.	% Phosphorus	Difference
Nutritive value of hays late cut, fertilized	7.9		52.4		0.48		0.18	
Nutrient requirements of cows:								
Middle third of pregnancy	7.0	+0.9	48.8	+3.6	0.18	+0.30	0.18	0
Last third of pregnancy	7.9	+0.0	53.6	-1.2	0.26	+0.22	0.21	-.03
1-3 months postpartum	9.6	-1.7	56.6	-4.2	0.28	+0.20	0.22	-.04

**Table 5.**

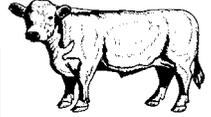
Nutrient Requirements of 1000-pound Cow in Middle and Last Third of Pregnancy and Postpartum Compared to Nutritive Value of Northeastern Nevada Hays Cut Early Before 7/15; Fertilized

	% CP	Diff.	% TDN	Diff.	% Calcium	Diff.	% Phosphorus	Difference
Nutritive value of hays early cut, nonfertilized	11.6		56.3		0.42		0.23	
Nutrient requirements of cows:								
Middle third of pregnancy	7.0	+4.6	48.8	+7.5	0.18	+0.24	0.18	+0.05
Last third of pregnancy	7.9	+3.7	53.6	+2.7	0.26	+0.16	0.21	+0.02
1-3 months postpartum	9.6	+2.0	56.6	+0.3	0.28	+0.14	0.22	+0.01

Nutrient Requirement of Domestic Animals: Sixth revised edition, 1984. These requirement values assume that dry matter intake of forage is 18 pounds for 1000 pounds in middle third of pregnancy, 19.5 pounds for last third of pregnancy and 21.8 1-3 months postpartum. Dry matter consumption should vary depending on the energy concentration of the diet and environmental conditions.

### Works Cited

- <sup>1</sup>Bellows, R.W. and R.E. Short. 1978. Effects of precalving feeding level on birth weight, calving difficulty and subsequent fertility. *Journal of Animal Science* 46:1522.
- <sup>2</sup>Clanton, D.C. and D.R. Zimmerman. 1970. Symposium on pasture methods for maximum production in beef cattle. Protein and energy requirements for female beef cattle. *Journal of Animal Science* 30:122.
- <sup>3</sup>Fonesbeck, P.V. and H. Lloyd. 1984. IFI Tables of feed consumption. International Feed Stuffs Institute. Utah State University, Logan, Utah.
- <sup>4</sup>NRC. 1984. Nutrient Requirements of Beef Cattle. National Research Council, National Academic Press, Washington, D.C.
- <sup>5</sup>Wiltbank, J.N., W.W. Rowden, J.E. Ingalls, K.E. Gregory and R.M. Koch. 1962. Effects of energy level on reproductive phenomena of mature Hereford cows. *Journal of Animal Science* 21:219.
- <sup>6</sup>Wiltbank, J.N., W.W. Rowden, R.E. Ingalls and D.R. Zimmerman. 1964. Influence of postpartum energy levels on reproductive performance of Hereford cows restricted in energy intake prior to calving. *Journal of Animal Science* 23:1049



## **Chapter 13**

### ***How Cutting Dates Relate to Grass Hay Quality in Northeastern Nevada***

Jason Davison, Central Area Plant and Soils Specialist  
Ron Torell, Northeast Area Livestock Specialist

<a href="#">Introduction</a> .....	1
<a href="#">Management Strategies</a> .....	2
<a href="#">Summary</a> .....	3
<a href="#">Table 1</a> .....	3
<a href="#">Table 2</a> .....	3
<a href="#">Works Cited</a> .....	3

#### **Introduction**

Agricultural producers in northeastern Nevada harvest grass or grass-clover hay from more than 200,000 acres. The majority of the hay harvested is composed of grasses, sedges and rushes. Typically, hay is cut once. Average yields are slightly more than 1.3 tons/per acre. The re-growth is utilized as fall pasture.

Quantity and quality of the harvested hay are the primary considerations in a hayland management scheme. Quantity and quality are controlled by management factors that include: irrigation, fertilization, species present and plant growth stage when harvested. The growth or phenological stage of the plant when it is cut plays a key role in determining the quantity and quality of the hay. Proper harvest timing is one of the easiest management techniques to implement with the potential of returning large dividends.

---

***Proper harvest timing is one of the easiest management techniques to implement with the potential of returning large dividends.***

---

Percent crude protein and total digestible nutrients (TDN) are often used as indicators of hay quality. As the percentages of crude protein and TDN increase, hay quality also rises. Crude protein percentages represent nitrogen compounds in the forage and are lumped together when computing rations for livestock. TDN is a calculated figure representing the sum of all the digestible organic nutrients in the feed. It provides information on the energy value of each feed.

## Management Strategies

A management strategy that seeks to maximize economically feasible production, while maintaining acceptable hay quality, is the goal of most operations. However, as grass plants mature and production rises, hay quality drops rapidly. For example, a field harvested when the plants are in the vegetative state will produce low amounts of very high quality feed. The same field can produce large amounts of low quality hay if it is harvested after the plants have flowered. As a general rule, hay fields dominated by grasses and grasslike plants should be harvested when the plants are in the flowering stage.

During this stage of growth seed heads protrude from the leaf blades and are open. In northeastern Nevada this growth period generally occurs about early to mid-July. After mid-July, hay quality drops rapidly. This fact is supported by test results obtained over the last 40 years. As early as 1945, researchers at the University of Nevada, Reno conclusively demonstrated the increased value of early cut-hay. Early-cut hay produced steers weighing 150 pounds more than steers that were fed late-cut hay following a 100-day feeding period. This fact is also supported by chemical analysis obtained from more than 200 hay samples in northeastern Nevada. The samples represent hay produced during 1946 through 1987 at locations throughout northeastern Nevada. Table 1 is a summary of the average chemical analysis obtained from these samples. The samples were divided into hays harvested before (early-cut) and after (late-cut) July 15. None of the hay had been fertilized during the year of harvest.

The quality differences are readily apparent when compared to the nutrient requirements of a pregnant 1000-pound cow. Table 2 shows the nutrient requirements of a 1000-pound cow during the middle and last trimesters of pregnancy (October-March). It also details how each hay does or does not meet the requirements of that cow. Table 2 clearly shows that late-cut hay does not meet the cow's crude protein, TDN or phosphorus requirements. The early-cut hay, however, is adequate in every category, except that it is marginally deficient in phosphorous and the percentage of total digestible nutrients.

Hay yields are usually expressed as tons of hay harvested per acre. However, a measurement such as pounds of total digestible nutrients (TDN) or pounds of crude protein (CP) harvested per acre may be more meaningful when determining production. Early-cut hay produces an average of 2.23 percent (Table 1) more crude protein per acre than late-cut hay. Early-cut hay will produce 44 pounds more crude protein in each ton of hay harvested. The higher fiber content of late-cut hay also makes it less palatable and daily consumption levels will generally be lower.

Researchers in Wyoming have reported similar results. Their results indicated that protein values are similar for plants with seed heads just emerging, completely headed and during the flowering stages of growth. After flowering, protein and TDN levels dropped significantly.

## Summary

Northeastern Nevada hay producers should attempt to produce the highest quality hay possible. To do that, grass hays should be cut as near to the flowering growth stage as possible. Forty years of data indicates that mid-July is about the time when hay quality begins to drop in northeastern Nevada.

Table 1

Average Quality of Northeastern Nevada Grass Hay 1946-1987

Treatment	% CP	% Phos	% Calcium	% Mg	% K	CRUDE FIBER%	TDN %
Control: No Fertilizer Early Cut Before 7/15	8.94	0.18	0.61	0.14	1.67	29.7	53.3
Control: No Fertilizer Late Cut After 7/15	6.71	0.17	0.50	0.11	1.35	32.6	50.1
Difference	-2.23	-.01	-.11	-.13	-.32	+2.9	-3.2

Table 2

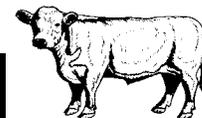
Nutrient Requirements of 1000-pound cow in the Middle and Last Trimester of Pregnancy Compared to the Nutritive Value of Early and Late Cut Northeastern Nevada Hays

	Nutrient Requirements Middle Trimester	Nutrient Requirements Last Trimester	Nutrient Value Early Cut	Nutrient Value Late Cut
Crude Protein %	7.00	7.90	8.90	(6.70)*
TDN %	48.80	53.60	(53.30)	(50.10)
CA %	.18	.26	.61	.50
Phos %	.18	.20	(.18)	(.17)

\*Figures in parenthesis do not meet the nutrient requirements of a 1000-pound pregnant cow.

## Works Cited

- Hasslen, D.A. 1986. 1985-86 Nevada Agricultural Statistics. Nevada Agricultural Statistics Service. Reno, Nevada. P. 15.
- Morrison, F.B. 1959. Feeds and Feeding: A Handbook for the Student and Stockman. Morrison Publishing Company, Clinton, Iowa. P 13-41.
- Waggoner, J.W., Radloff, H.D. and Eberhart, W.L. 1979. Nutrient Content of Forages Harvested in Wyoming. In Management of Intermountain Meadows Proc., Univ. of Wyoming, Ag. Exp. Station, Colorado State University Mtn. Meadow Research Center. Pp 115-131.
- Raleigh, R.S., Rumburg, C.B., and Wallace, J.D. 1964. Digestibility of Native Flood Meadow Hay at Different Stages of Growth. West. Sec. Amer. Soc. Anim. Sci. Proc. 15:LVI-I-LVI-5.
- Shipley, M.A. and Headley, F.B. 1948. Nutritive Value of Wild Meadow Hay as Affected by Time of Cutting. Nev. Agric. Exp. Station Bulletin #181. Pp. 23.



## Chapter 14

### WEED CONTROL IN PASTURES

Robert E. Wilson, Extension Educator, White Pine County  
Kent McAdoo, Northeast Area Rangeland Resources Specialist

<a href="#">Introduction</a> .....	1
<a href="#">Integrated Management</a> .....	1
<a href="#">Weed Control In New and Established Pastures</a> .....	2
<a href="#">Management Conditions</a> .....	3
<a href="#">Herbicide Selection</a> .....	3
<a href="#">Conclusion</a> .....	4

#### Introduction

It is estimated that we realize only about 25-50% of the yield potential of our pastures and hay lands in the U.S. With better varieties, fertility practices, weed control, and overall management, we can better cope with increasing costs and low livestock prices by increasing forage yields. Weed control is an important part of management because weeds reduce production, quality, and palatability of pastures. Weeds are defined here as plants growing in places where they are not wanted and interfering with the growth of desired forages. Weed populations can substantially decrease forage production and/or quality. Weeds typically invade sites where ground disturbance has taken place. They will also invade pastures that have declined as the desirable vegetation thins out. Any time forage crops are established, weeds will be present to compete with them unless control measures are applied.

#### Integrated Management

Weed control should not be considered a single practice, but rather a combination of wise management strategies. Such practices as planting certified weed-free seed, good nutrient management, clipping, irrigation water management, prescribed grazing, and timely forage harvest management all combine to help keep weed populations to a minimum. Any management practice that encourages a vigorous forage stand and maintains a full canopy helps keep weeds suppressed. However, even the best pasture management practices will not entirely eliminate the need for chemical weed control.

---

***Weed control should not be considered a single practice, but rather a combination of wise management strategies.***

---

Insect and disease outbreaks, drought, extreme winter weather, human error, and other environmental factors that provide open spaces for weeds often override good management efforts.

In agriculture, herbicides are an integral part of most pasture and cropping system weed management programs, but should be used in conjunction with other tools such as cultural controls and sanitation. The better we use all of the tools, the better chance we have of producing high quality, clean hay or forages.

Before herbicides are applied, the grower first needs to know the weed species that are causing problems. Numerous weed identification guides are available to help identify weeds. Weed species will differ from one area to the next. The weeds in one pasture may even differ from those in a neighbor's field because of differences in management practices such as crop rotations, past weed control efforts, etc. Keeping good records of where weed species occur in a field helps determine appropriate control. The newer precision farming techniques are making record-keeping much easier for growers through such tools as remote sensing, computerized mapping, etc., but that technology has not yet been widely adopted in Nevada, especially for low input crops such as pastures and hay fields.

## Weed Control In New and Established Pastures

Weed control prior to planting and during the first season of establishment is the key to cost-effective weed management for the life of the stand. Herbicide treatments are only tools for maintaining a highly productive and mostly weed-free stand, rather than a tool to catch up from heavy weed infestations that are more easily controlled without the crop present, especially broadleaf plants such as alfalfa or clovers. With this approach, the strong competitive influence of a vigorous, uniform stand is utilized to its full potential in preventing or slowing the invasion of weeds.

In established pastures, weed control should ideally start long before the pasture stand thins out. The herbicides currently available can effectively control most weeds in established alfalfa without harming the crop, but removing weeds from a heavily infested, poor stand of grass, alfalfa, or alfalfa/grass pasture is more difficult and will probably be disappointing to the grower. The result is often a thin pasture with a total forage yield that is less than before the treatment.

---

***In established pastures, weed control should ideally start long before the pasture stand thins out.***

---

One option—if enough desirable forage remains on the site—is to suppress growth by grazing close for several weeks prior to planting. Alternatively, suppression can also be accomplished by using a “burndown” herbicide, one that burns back the green growth of desirable perennials, but does not kill the crown or roots. Herbicide application can be either broadcast or banded. The latter treatment can be done to leave alternate strips of green and burned back vegetation, allowing an early return to grazing when spring no-till

seeding of legumes into a grass pasture is desired. This method also requires less herbicide, yet produces greater weed suppression. However, if present pasture condition consists of dominantly weeds and/or low quality forages, the existing stand may need to be killed. Ideally, this should be done toward the end of the previous year's growing season to prepare for an early seeding the following year.

## Management Conditions

Overgrazing, low fertility, and poor drainage will all contribute to weed problems. Water standing in low areas kills desirable grasses and encourages growth of water-loving weeds such as plantain and curly dock. Thistles and other weeds that thrive on drier sites can flourish on high spots where grasses grow poorly.

---

***Overgrazing, low fertility, and poor drainage will all contribute to weed problems.***

---

Clipping and a combination of spring and/or fall weed control are the best approach to effective weed management. Clipping newly seeded stands is quite effective against annual and biennial weed species when done just prior to seed development. Spring herbicide applications are the most effective way to control susceptible annual broadleaf species. Fall herbicide applications will work more effectively on winter annual, biennial, and perennial broadleaf species. Regular use of each tool will result in eradication or substantial reduction of nearly all weeds.

Proper timing of fertilizer application and grazing can stimulate a longer period of vegetation growth. All of this helps to make desirable pasture vegetation more competitive with weed species.

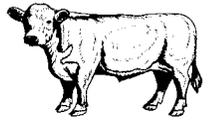
## Herbicide Selection

The desired plants seeded into a pasture determine the herbicides that can be used. For grass pastures, broadleaf herbicides such as 2,4-D, dicamba, MCPA, or picloram are all available for weed control. For more troublesome weeds like tall whitetop, new herbicides are available. When alfalfa or clovers are included in the seed mixture, the selection of an acceptable herbicide becomes more limited. Either the selected herbicide must not also kill the desired vegetation, or the herbicide must be applied specifically and selectively to the weeds targeted for control. Because of continuing developments in available herbicides, no specific attempt will be made here to list the most effective herbicides for various weed species. Rather, the authors refer readers to annual updates of the Pacific Northwest Weed Control Handbook. For weed identification, Weeds of the West, by Whitson et al, (1992), and Invasive Plants in Nevada: an Identification Handbook, by Staddard et al (1996) are excellent references.

To avoid building resistance to a particularly effective herbicide, an herbicide management strategy should be adopted. This can be done by rotating herbicides, rather than by cutting back or increasing application rates. Care should be taken not to rotate another herbicide with the same mode of action. By choosing products from different herbicide groups in subsequent years, the problems of weeds becoming resistant to a particular product can be minimized or eliminated. There is also a trade-off between repeated application of conventional herbicides and use of the more persistent (and more expensive) chemicals.

## Conclusion

The response of weeds to any of the available herbicide products may be altered by growing conditions, weed populations, type of irrigation, genetic variations of weeds, soil type, pH, organic matter, time of application, and application rate. The need for weed control generally decreases as the growing season continues.



## Chapter 15

### ***Water Quality and Public Policy***

Dr. Susan Donaldson, Area Specialist  
Dr. Sherman Swanson, State Range Specialist

<a href="#">Introduction: Issues of Water Quality and Public Policy</a> .....	1
<a href="#">Water Quality Laws Affecting Production Agriculture</a> .....	1
<a href="#">Monitoring</a> .....	4
<a href="#">References</a> .....	4

#### Introduction: Issues of Water Quality and Public Policy Are Important to Producers

Ever-increasing attention is focusing on the role of agriculture in water quality protection. While issues of water supply and vested water rights remain important, federal policies mandate and regulate the maintenance or improvement of water quality. By understanding these public policy issues and laws, producers can focus on those management practices that will ensure not only sufficient water, but water of reliable, usable quality.

#### Water Quality Laws Affecting Production Agriculture

Since the passage of the Federal Water Pollution Control Act of 1972, known as the Clean Water Act, all fifty states have established statutes regulating the protection of water quality, whether on rangeland, pasture, or feedlots. In addition to the Clean Water Act, another piece of federal legislation called the Safe Drinking Water Act also governs water quality.

Water quality has several different meanings. The Federal Clean Water Act (CWA) focuses on the water in our rivers, lakes and streams with the general goal of making them “fishable and swimmable.” The CWA also sets specific water quality standards based on the intended use of the water. In Nevada, the water in water bodies like the Truckee and Carson Rivers is used and reused. It must therefore meet standards for such “beneficial uses” as municipal and industrial supplies, agricultural irrigation and habitat for fish and wildlife.

The CWA also divides water pollution broadly into two main categories. Contaminants that enter water bodies from the discharge pipe of a factory or a wastewater treatment plant are called point sources. Since these discharges are easy to see and monitor, they have been regulated by the U.S. Environmental Protection Agency (U.S. EPA) for over twenty years.

The other broad category of contaminants is known as nonpoint source (NPS) pollution because it doesn’t come from an easily identifiable point such as a discharge pipe. Instead, it comes from everywhere else - from streets, parking lots, construction sites,

agricultural fields, pastures, spills, illegal dumping, improperly maintained septic tank systems and any form of disturbance that can accelerate soil erosion. After spending tens of millions of dollars cleaning up point sources, many of the nation's water bodies still remain too polluted for fish and various human uses. Nonpoint source pollution is now America's largest water quality problem.

---

***After spending tens of millions of dollars cleaning up...many of the nation's water bodies still remain too polluted for fish and human use.***

---

Each state must provide a report to the U.S. EPA every two years detailing the quality of their assessed surface waters, the sources of any water quality impairments, and the documented contaminants (per Section 305(b) of CWA). Additionally, Section 303(d) is now used to identify waters of special concern that may require action through the establishment of Total Maximum Daily Loads (TMDL) of specific pollutants, and to determine methods by which the standards may be met. States thus have water quality programs and laws designed to decrease water pollution and meet the goals of the CWA.

Nonpoint sources on range and pasturelands include watershed disturbances such as grazing, roads, facilities, construction activities, and natural processes. Natural processes as well as each of the other activities can either contribute pollution or contribute to cleaning up pollution. The six pollution categories you should be aware of include:

- **Sediment:** This results from erosion of soil from uplands or streambanks into water bodies. Sediment ranks first in quantity among pollutants contributed by agriculture to receiving waters. Maintaining healthy plant cover on pastures and restricting traffic on streambanks helps to decrease sediment inputs. Sediment in water damages fish habitat, may clog fish gills, adds phosphorus which may over-stimulate algae, and decreases light penetration.
- **Heat:** Increased temperatures stress cold water fisheries and may result in fish deaths, especially of species such as trout that require cool water. Increased temperatures may result from inflow of warmer irrigation waters. Thermal pollution may also result from reduced streamside vegetation, thus increasing the width or decreasing the shading of the water surface. In winter, wide shallow channels without the protection of riparian vegetation become colder. They may freeze too deep and kill fish or other life.
- **Nutrients:** Nutrients enter waterways as part of a natural aging process. When increased amounts of nutrients enter waterways, they become pollutants fueling the growth of algae. Nutrients, especially nitrogen and phosphorus, can originate from animal manure and fertilizer use. Flushes of nutrients into the water may occur during irrigation events if excess water is applied, or during rainfall events.
- **Pathogens:** A variety of pathogens, or disease-causing organisms, are carried in animal manure. Bacteria from the intestinal tract of warm-blooded animals called coliforms are used as indicators of fecal contamination and the possible presence of microbial pathogens. Studies have shown that livestock grazing increases fecal coliform counts over normal background levels generally present, and numbers may

remain high even after cattle are removed, impairing water quality. However, this may or may not be a problem. Some fecal coliform bacteria and pathogens exist naturally. The key is to focus on improving those management practices that are responsible for increased bacterial counts, especially in waters where human contact may be a concern.

- Pesticides: These chemicals are used to control pests of all kinds. In irrigated pastures, the most common pesticides are herbicides, or chemicals that kill plants (or weeds). Pesticides must be applied carefully to minimize runoff or drift into water bodies, where unintended toxicity may have negative effects. Pesticide labels help applicators avoid such problems. They must be followed very carefully.
- Salts and other chemicals: Salts and many other chemicals dissolve in water, sometimes called the “universal solvent”. Although many of these chemicals are harmless or even needed for life, some become toxic in too high a concentration. Irrigation practices that leach salts from soil may concentrate them in drain water. Spills and water removal may create toxic conditions where too much of a chemical or too little water creates too high a concentration for plants or animals to live.

Your main focus may be upon ensuring that adequate supplies of usable ground and surface water are available for both irrigation and stock watering. By learning about issues important to water quality, you will be better able to protect and enhance

---

***...currently feedlots and other confined animal feeding operations are under scrutiny...***

---

your water resources. Find out what laws and ordinances are being used in your area that relate to water quality and watershed management. Are there any upcoming requirements for water quality or management approaches that could impact your livestock and irrigation operations? For example, currently feedlots and other confined animal feeding operations are under scrutiny because of potential surface and groundwater degradation, and other factors such as odors, wildlife impacts, and nuisance complaints. Feedlots in excess of 300-head that are discharging into a stream are considered point sources of pollution and must obtain permits under the federal National Pollution Discharge Elimination System (NPDES) or state-equivalent permits to continue to operate.

Your choices in land management are crucial to future actions. Nonpoint source (NPS) pollution control continues to be addressed primarily by voluntary implementation of best management practices (BMPs) designed to reduce or eliminate pollution. If voluntary measures can be shown to be effective, there will be less driving force to enact further regulations governing NPS pollution. Management practices involving fertilizer, pesticide and water application, planned grazing, and riparian buffer establishment and management may go a long way toward decreasing NPS and thus avoiding new regulations that place strict limits on pollutants. Your actions to improve water quality while you improve irrigated forages are important steps in safeguarding your future and your neighbors' water quality.

## Monitoring

Because of the public concern and growing personal concern by many farmers and ranchers for water quality, monitoring programs are becoming more common. In general, monitoring is necessary for achieving management goals. However, there are far many more things that could be monitored about a pasture and livestock operation than a producer can afford to monitor. Producers therefore need to focus on key questions and efficient monitoring methods. The first step is to list the key questions, those that would cause a manager to change practices based on monitoring information if intentionally collected, organized and kept. Critics might also ask key questions based on law and water quality standards. For each key question, determine the data or other information that will be needed for an answer that promotes real understanding.

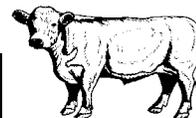
Certainly it will be important to know the timing and type of management practices. This includes beginning or ending of various management actions such as grazing in a pasture, irrigating, and fertilizing, as well as how, how many, how much, what kind etc. A producer will also want to have records of big events such as floods, droughts, insect or disease outbreaks, etc.

Beyond implementation, one should monitor the effect or results of specific management choices. Such annual factors as production, gain, distribution, and utilization or stubble height, provide information useful for understanding long-term results such as whether specific areas meet management objectives. Along with written records, perhaps the most useful and cheapest single monitoring tool is labeled and dated photographs. Often pictures tell a story that could not be told, understood correctly, or appreciated without them.

Along with whatever monitoring information you record, you also will be interested in the monitoring data collected by others. The State Department of Environmental Protection Water Quality Bureau regularly monitors the quality of certain streams and rivers at standard locations using standard methods. These data are available to citizens who may be interested in whether the stream or river meets water quality standards. Learning what water quality problems occur up and downstream from your irrigated pasture can help you use your other monitoring information to evaluate your management opportunities.

## References

- Clawson, James W., G. Gough., L. Hickam and L. Britt. 1998. Cattleman's Information Guide to Water Quality. National Cattlemen's Beef Association, Washington, D.C.
- Clean Water Deskbook. 1991. Environmental Law Institute, Washington, D.C.
- Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams. Idaho Water Resources Research Institute, Moscow, Idaho. EPA 910/R-93-017.



## Chapter 16

### *Managing Irrigated Pastures for Water Quality*

Dr. Susan Donaldson, Area Specialist  
Dr. Sherman Swanson, State Range Specialist

<a href="#">Introduction: Good Water Quality is Good Economics</a> .....	1
<a href="#">Linkages Between Pasture Management and Water Quality</a> .....	1
<a href="#">Irrigation</a> .....	1
<a href="#">Water Diversion</a> .....	2
<a href="#">Livestock Management</a> .....	3
<a href="#">Manure Management</a> .....	4
<a href="#">Fertilizer Management</a> .....	5
<a href="#">Pesticide Management</a> .....	6
<a href="#">Reference</a> .....	8

#### Introduction: Good Water Quality is Good Economics

Most farmers and ranchers don't set out to improve water quality until they see that it makes good business sense. However, most pasture management measures that improve water quality also make good business sense. Usually, water quality problems indicate economic leaks or unwise shortcuts and practices that don't work with the natural tendencies of the land. Virtually all water quality problems represent wasted assets (soil, water, fertilizer, pesticide, vegetation functions, animal health, land value, etc.) or plant materials that are not adapted to site conditions. Because our society values good quality fishable and swimmable water, producers that don't follow best management practices (BMPs) will likely suffer increased scrutiny. Because this chapter provides information about pasture management for water quality, it also provides sound economic advice.

#### Linkages Between Pasture Management and Water Quality

##### Irrigation

The most important variable in pasture production is water. The goal for water application is the optimum production of plants to produce value. Each plant species and time of year represents specific water requirements that wise application of water can help meet. Plant growth and even plant success depends on sufficient water availability.

Both too little and too much water will decrease success. Too little water keeps small plants from covering soil, and bare soil is exposed to raindrop splash and runoff erosion. Soils disturbed by cultivation and left bare are even more vulnerable to wind and water erosion, resulting in loss of topsoil, decreased productivity, and potential water quality problems.

Waterlogged soils help riparian or wetland vegetation thrive. These plants provide important functions along streams and in other wetlands. However, most improved pasture plants suffer when soil oxygen is lacking. Excess irrigation results in decreased productivity and often leads to surface runoff that carries pollutants such as manure or excess nutrients away from the pasture and into the stream. Too much water can thus decrease plant productivity or success and lead to water quality problems.

On the other hand, some demonstration projects have shown that pasture and wet meadow irrigation and even over-irrigation can help clean up dirty water. When water laden with fine sediment and nutrients soaks into soil, the sediment becomes part of the soil and the nutrients add fertilizer. This approach works well in soils such as organic loam that capture and store excess nutrients. The practice doesn't work as well on sands that don't effectively capture nutrients, or on clayey soils with low infiltration rates and high runoff potentials. Any soil that has recently been fertilized could become a source of nutrients when excessively irrigated. Any pasture that is not well vegetated could become the source of sediment from erosion during overland flow.

Perhaps the most difficult water quality problem is salt. Many plants don't thrive in saline soils. Irrigation that supplies just the amount of water needed by pasture vegetation often allows salts to accumulate at the soil surface as evaporation brings up saline water and leaves the salts in a crust at

---

***Irrigation that supplies just the amount of water needed by pasture vegetation often allows salts to accumulate at the soil surface...***

---

the surface. While leaching salts into the deeper saline shallow aquifer may be necessary for continued plant growth, it is not necessary to use fresh water for the leaching cycle. Generally, in saline soils the quantity of salt in the soil profile is huge, while the salt in drain or tail water is small. Thus, somewhat saline drain water can effectively leach salt deeper into the soil or simply become part of the irrigation water supply. This is another example of how irrigation can help clean up low quality water. Using low quality water for irrigation purposes also leaves high quality water in a stream or other water body, providing multiple benefits.

## Water Diversion

Over-irrigation with surface water takes extra water away from the stream or other water body. In a stream, river, or lake, water quality is closely tied to water quantity. This principle has led to much discussion about in-stream flows, maintenance flows, minimum flows and minimum pools. One of the solutions to pollution is dilution, or the addition of good quality water to decrease concentrations of pollutants. For fish, decreased flows also mean reduced area or volume of habitat. In low water situations, the remaining fish and concentrated nutrients can quickly lead to low oxygen concentrations and other poisonous effects. In Nevada, water law has changed through the years to require that some water be left for wildlife at springs and to allow water rights for fish and wildlife.

Riparian and wetland vegetation that provides or maintains important and productive fish and wildlife habitat depends on sufficient water at the right time in the right locations and at

appropriate depths. In the Truckee River, excess water has been used in recent years to gradually decrease water flows after spring snowmelt runoff so that riparian cottonwood tree seedlings could keep their growing roots within the wetted soil zone just above the river-dependent water table. Elsewhere, maintenance flows are designed to not only sustain riparian vegetation but also to transport appropriate amounts and sizes of sediment and scour spawning gravels. Much of the expense of dealing with erosion and sediment could be avoided if the combination of water, channel form, and riparian vegetation were managed to maintain natural stability or to recreate naturally stable forms and conditions.

## Livestock Management

Within irrigated pastures, livestock management is second only to water management for economic gain and water quality. The economic goal is optimal animal gain and plant growth for future gain (See Chapter 3 for management-intensive grazing and livestock performance considerations). Protection of soil cover is also the goal for water quality improvement. Plant cover protects against soil erosion and helps keep plant nutrients on-site. This is most critical near areas with concentrated flows where greater depths and increased water speed can erode soil and move manure or nutrients.

Unfortunately, livestock concentrate into small areas within pastures. Thus, their manure is not scattered evenly for recycling nutrients. Furthermore, some plants become stressed before livestock graze others, especially in larger pastures and with longer grazing seasons. Using a pasture for supplemental or winter feeding creates additional concerns because manure concentrates in the areas where animals spend a lot of time. While keeping nutrients on-site by feeding on the pasture that provided the hay makes good sense, it creates problems when feeding occurs repeatedly in localized spots. Therefore, an inventory of pasture management problems or opportunities ought to focus on distribution of livestock, manure, plant cover and impacts such as erosion. If these concentrated use zones occur near a stream, solving problems should involve management to redistribute livestock.

If the concentrated use occurs away from a stream, riparian buffer strips help filter dirty water before it can enter the stream. A buffer is an area of undisturbed, or at least well-managed, vegetation between the grazed area and the stream or lake. To avoid water quality problems, protect or carefully manage riparian buffer strips next to fields where runoff is likely to move nutrients or microorganisms from accumulated manure. Feedlots or corrals where animal impact will likely remove vegetation cover should be isolated from streams.

Grazing distribution problems frequently occur where animals go the stream for water or to cross. Numerous water diversion methods such as solar or nose pumps and hydro rams complement traditional plumbing for developing off-stream water. Where streams must provide the water for livestock in feeding areas or where livestock must be allowed to

---

***Where streams must provide the water for livestock in feeding areas...there should be a minimal area of access that is thoroughly rock-lined to armor the stream against erosion.***

---

cross the stream, there should be a minimal area of access that is thoroughly rock-lined to armor the stream against erosion. Providing an easy access, rock-lined crossing avoids this impact

because cattle walk up to a half a mile to cross on firm footing, and the rock lining prevents erosion. Adjacent areas along the stream receive extra protection from good riparian vegetation management if animals choose to use the armored access. Where animals don't select an armored spot for watering and crossing, fencing can create one or more water gaps surrounded by fenced riparian buffers.

In addition to improving animal performance, management-intensive grazing improves distribution while it helps plants recover from grazing. Livestock will use a pasture differently depending on the season of use, length of grazing and rest periods, number of animals, kind and class of animals, and a variety of other management measures such as salting, watering, herding, and other training practices. Optimal forage production, forage harvest and water quality results from artful management of all these factors and keen observations of management effects.

### Manure Management

Manure can be a valuable source of soil organic matter and slow-release nutrients in pastures. Proper handling of wastes will decrease the chances that nutrients, salts, or bacteria will leach into the groundwater, or flow into local streams and ponds. If nutrients from animal wastes enter surface water bodies, they may stimulate algae and aquatic plant growth. At excessive levels, aquatic plant growth may decrease dissolved oxygen during nighttime respiration. This may harm fish and impair other beneficial uses. Warmer water also carries less dissolved oxygen, so levels may become critically low in warm, nutrient-rich waters. The risk of nutrient enrichment increases in irrigated pastures, since the opportunity for leaching and runoff increases. Organic matter may color the water, increase turbidity, and affect the oxygen demand.

Ammonia, which can come from animal wastes, can be very toxic to fish depending on stream pH, water temperature, and oxygen content. In the higher pH waters that are common in Nevada, very small amounts of ammonia may kill fish. The higher the temperature of the water, the smaller the amount of ammonia needed to kill fish.

Animal wastes are also high in microorganisms, including pathogens, organic matter, and salts. Runoff can carry sediment and organic matter, plant nutrients, and pesticides that are either bound to the sediment or dissolved in the water. Although not all soils and not all irrigation practices or rates produce runoff, many do. Because pathogenic organisms generally do not thrive in the soil, vegetation can serve as a filter by discouraging transport in runoff and encouraging infiltration. It is important to adequately separate the potential pollutant and the water source. On level ground, a minimum buffer distance of 10 feet of vegetated ground is generally needed. When ground is frozen or runoff to the stream is increased by clay layers or other factors, 60 feet of vegetated ground may be needed. As slopes increase, buffer widths also should increase.

#### **Characteristics of the Ideal Buffer Zone**

- Dense vegetation is maintained at all times.
- Flow spreads out and soaks into the soil, and is not channeled through the buffer zone.
- Infiltration of runoff is high.
- The buffer is protected from destructive disturbances.
- Annual inspections and frequent monitoring are used to maintain the buffer in good working order.

When a riparian buffer is working properly, it will spread runoff in the form of shallow, uniform flow through the buffer vegetation. This provides an opportunity for water to soak into the ground, and for sediments to deposit within the buffer area. Because the pollutants are kept onsite, water quality is improved. Your local Conservation District or Natural Resources Conservation Service can help you design and install an appropriate buffer.

A riparian buffer also protects ditches, ponds and especially streams from excessive erosion. The energy of flowing water and wave action can easily erode many stream or pond banks if they lack protection from plant roots that bind soil in place. The tops of plants slow water flow or movement and prevent the high velocities that detach soil particles. Slowing water allows sediment to settle out and become new stream bank or floodplain. Adding floodplain width and floodplain accessibility slows future water velocity and reduces erosion. Snags and woody debris also provide these water-slowng and water quality-improving benefits.

### Fertilizer Management

Fertilization can effectively increase productivity of irrigated pastures. However, fertilizer misapplication can add to NPS pollution. Soils vary considerably in their ability to absorb and supply essential nutrients for plant growth. To use fertilizers appropriately and efficiently, you need a soil test to know which nutrients are needed, and which are not. There is no other way to get accurate information about the current amounts of nutrients present in the soil, and the amounts recommended for the addition. Applying advertised or standard rates sometimes leads to over-fertilization, which wastes money and can pollute water supplies.

Be cautious when using nitrogen fertilizers. Nitrate dissolves readily in water and is easily washed away or leached below the plant's root zone by over-irrigation, which may pollute groundwater. Leaching of nitrate-nitrogen out of the root zone can elevate nitrate concentrations in underlying groundwater to levels unacceptable for drinking water quality.

Irrigating properly following fertilizer application is as important as using the right fertilizer at the right time in the right amount. Over-watering fertilized areas can cause nutrients to leave the site by way of surface runoff or subsurface leaching. Over-watering wastes money and pollutes water, including drinking water supplies. Be careful to apply

#### **Tips for Protecting Water Quality When Fertilizing**

- Avoid using fertilizers near streams, shorelines or on saturated soils.
- Get a soil test - use only the specific amounts of nutrients necessary.
- More is not better with fertilizers – do not waste money by over fertilizing.
- Do not put fertilizers over snow – plants don't need fertilizer during the winter, and when the snow melts, the fertilizer may simply wash away. When fertilizing during winter months, apply only to bare ground.
- After a soil test, fertilize in spring and early fall when plants are actively growing.
- Do not over-water after fertilization, or nutrients will be lost in surface runoff and leaching.
- An appropriate fertilization program promotes healthy plants that resist insects and diseases. However, improper use of fertilizers can damage or weaken plants and pollute lakes and streams.

water slowly and in the right amount so it soaks into the soil and wets only the area of the soil occupied by plant roots.

## Pesticide Management

Pesticides represent one of the many tools for integrated pest management. When used carefully and appropriately, they may provide the management option you need. On the other hand, pesticides have been found in surface water and shallow groundwater in both urban and rural areas of Nevada. While concentrations are presently very low, if they increase, we run the risk of increasing toxicity and losing the flexibility of using certain pesticides.

The effect of a pesticide on a water body depends on the properties of the pesticide, the amount, method, and timing of application, and the amount of water applied to the pasture after pesticide application, whether from rainfall or an irrigation event. The longer a pesticide remains active in the environment and the more water soluble and toxic it is, the greater the threat.

Whenever possible, alter your pasture management to increase the health and vigor of desirable species, allowing them to compete more effectively against unwanted invaders. Use pest-resistant crop cultivars, and verify the identity of the pest before deciding on a control strategy. Choose the most pest specific, least persistent, and least leachable alternative.

There are many important licensing and training requirements for using pesticides. Environmental and safety concerns make it critically important to follow all label and site directions. For example, herbicide injury to non-target plants is a common side effect of herbicide application by untrained individuals as a result of spray and vapor drift or inappropriate applications. Risk of spray drift increases with increasing wind, higher temperatures, lower humidity, certain nozzle types, etc. Whenever possible, spray early in the morning, or consider the use of rope wicks or wipe applicators. Common symptoms of herbicide injury include yellowing and/or bleaching, root stunting, distorted growth, and death.

Contamination of surface and groundwater supplies results from inappropriate use of chemicals. Risks are greatest in areas with shallow water tables. Mix chemicals and clean containers in areas away from water bodies, preferably on impervious surfaces, and read labels carefully to decrease chances of personal injury. Pesticides are poisonous and must be used with caution at all times.

### **Risks from Using Pesticides**

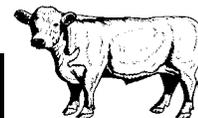
- Each time you use a spray or powder, you are exposed to the potential for inhalation or absorption of the toxin.
- Pesticides can contaminate surface and groundwater supplies. If pesticides percolate down to the water table, your personal water supply—and your livestock’s—may be jeopardized.
- Continuous use of pesticides may induce tolerance and resistance in pests.
- Some pesticides break down slowly and can remain in the environment for years.
- Pesticides may kill or harm beneficial insects, such as ladybugs, which feed on other small, harmful insects, larvae or eggs.

### **Follow the Safety Checklist Below Whenever Using Pesticides:**

- 1. Read the label carefully and take notice of personal safety and environmental precautions.** The label information isn't advertising -- it's based on solid science and the law. It includes the proper rate of pesticide use for various conditions, the relative toxicity of the product, directions for safe mixing and application, and any environmental precautions. It lists the product manufacturer's name and address, required protective clothing, and warnings about groundwater contamination and hazards to wildlife.
- 2. Wear appropriate personal safety equipment when handling pesticides.** Start by wearing a wide-brim hat, long-sleeved shirt, long pants and chemical-resistant gloves. You should also wear sturdy work shoes or rubber boots, not sneakers or sandals. Depending on the product you are using, it may be necessary for you to wear goggles, face shield or a respirator.
- 3. When mixing and loading chemicals, prevent spills that might contaminate water supplies.** To prevent tank overflow, never leaving a sprayer unattended during filling.
- 4. While filling sprayers, avoid back siphoning by keeping the discharge end of the fill hose above the tank's water level.** If you put the end of the hose down into the pesticide liquid in the tank, you run the very real risk that the hose will suck water and chemicals back into the hose, and possibly into your well or home, when you turn off the water. All wells should be equipped with antibacksiphon devices to prevent groundwater contamination.
- 5. Calibrate your sprayer before application and never exceed labeled chemical rates.** After you've read the label and chosen the right product to apply at the prescribed rates, its important to make sure your sprayer is delivering the right amount of product. Follow the directions on the sprayer carefully.
- 6. Prevent pesticide leftovers by mixing only needed quantities.** If you follow label instructions for rates and mix carefully, your tank should be empty as you complete application.
- 7. Never rinse equipment near wellheads, ditches, streams or other water sources.** If needed, install a longer rinse water hose to move the cleaning operations a safe distance from a well or other water source. Spray the rinse water in the spray tank out over the target area, following label directions.
- 8. Always triple rinse or pressure rinse chemical containers before disposal or recycling.** If it's been properly rinsed and label instructions have been followed, the pesticide container is ordinary trash, but the best place for it is a pesticide container collection and recycling facility.

## Reference

- Cobourn, J. and S. Donaldson. 1995. Small Ranch Manual: A Guide to Management for Green Pastures and Clean Water, University of Nevada Cooperative Extension, EB-95-02.
- Godwin, D.C. and J. R. Miner. 1997. Appropriate Livestock Management Facilities Protect Water Quality in Suburban Watersheds. Pp. 417-422 in: River Quality: Dynamics and Restoration, eds; A. Laenen and D.A. Dunnette. Lewis Publishers, New York.
- Prichard, D., H. Barrett, J. Cagney, R. Clark, J. Fogg, K. Gebhardt, P. Hanson, B. Mitchell, and D. Tippy. 1993. Riparian Area Management: Process for Assessing Proper Functioning Condition. TR 1737-9 Bureau of Land Management, BLM/SC/ST-93/003+1737, Service Center, CO. 60 pp.
- Schepers, J.S. and D.D. Francis. 1982. Chemical water quality of runoff from grazing land in Nebraska: Influence of grazing livestock. *J. Environ. Qual.* 11:351-354.



## Chapter 17

### *Managing Water Supplies for Water Quality*

Dr. Sherman Swanson, State Range Specialist

Dr. Susan Donaldson, Area Specialist

<a href="#">Introduction: Water Comes Through a Watershed</a> .....	1
<a href="#">Water Supply and Storage</a> .....	2
<a href="#">Management Tools</a> .....	2
<a href="#">Riparian Vegetation Management</a> .....	3
<a href="#">Streams Naturally Vary</a> .....	4
<a href="#">Maintaining Good Quality Groundwater Supplies</a> .....	4
<a href="#">Summary</a> .....	5
<a href="#">Reference:</a> .....	6

#### Introduction: Water Comes Through a Watershed

We irrigate pastures in a cold desert because precipitation comes infrequently and usually when it is too cold for plants to grow. The water for irrigation fell somewhere else and then flowed through the soil, groundwater aquifer, stream, river, canal and/or pipe before watering the pasture. Pasture irrigation, therefore, may depend on a watershed located many miles away.

A watershed is the area of land that supplies water to some place like your pasture. What we call a watershed, some people call a water catchment. The job of a watershed is to capture, store and safely release the water from precipitation. People with irrigated pastures need to recognize that land management in that watershed directly affects their water supply including its timing, quantity, and quality. Even irrigation systems with a reservoir depend on watershed capture, storage and safe release of water because of factors such as sedimentation, evaporation and economic realities.

For irrigation, off-site management, whether downstream, upstream, or up in the watershed, may cause many on-site problems such as excess sediment or stream channels that are too deep for efficient diversion. Furthermore, one person's management problems can add expense for other people. Farms that own or manage more of the land within their own watershed find more opportunities to apply best management practices so that their watershed captures, stores and safely releases the water from precipitation. They will also have the best opportunity to balance downstream and upstream benefits. Keeping water upstream to grow harvestable forage that also covers the watershed, helps it capture water, and stabilizes soil, offsets any incentive to send water downstream too quickly for irrigation.

## Water Supply and Storage

Runoff water that flows past the irrigated pasture before the growing season, or in a flood so big that only a part of it is useful for irrigation, provides an irrigator with little or no direct benefit. Captured water that is slowly released in mid- or late-summer from a watershed aquifer is far more valuable. In an irrigated valley with limited reservoir storage, the groundwater stored for late season irrigation downstream may be the water that was applied earlier to upstream pastures.

Throughout the watershed, vegetation is the best tool for breaking the energy of falling water and the best protection against the hazards of excess soil erosion. When raindrops fall, their impact can dislodge soil particles unless the drops hit plants or plant litter first. Water on the land surface is free to run off until it soaks into the soil. By slowing the movement of surface water with small dams, leaves, sticks, etc, it has more time to soak in. Soil pores that capture water quickly also increase infiltration. Plant roots help form soil pores. Also, by adding organic matter, plants help keep many pores open. The more organic matter in soil, the better is the soil sponge. Plants are therefore the best tool for keeping water on the land longer and water in the stream later in the season.

The more water that runs off, the more water there is for causing erosion across the soil surface in rills or in gullies. Any water that enters the soil profile becomes available for either plant growth or recharging an underground aquifer. Slowing the flow of water within a pasture or watershed allows time for more infiltration, soil storage and then vegetation growth.

While plants working with soils are always the key resources, not all vegetation provides the same water detaining and soil-holding functions. Furthermore, there is no single type of vegetation that is ideal in all situations. Plants also use water to grow. In any watershed, the goal is to keep the soil in place so that it can capture and hold water that in turn supplies the plants that hold the soil. Although the value of water alone will probably not pay for the expense of watershed-scale vegetation conversions, many vegetation management practices also benefit other resources.

## Management Tools

Whenever considering vegetation management, livestock management becomes a vital tool, especially in upper watersheds. Additional tools include prescribed fire, herbicidal and mechanical manipulation, and revegetation. In all cases, the objectives for vegetation management come from understanding the options presented by the land. By considering the importance of various plant communities to watershed and other functions, and the utility of various vegetation management tools, watershed managers make better choices.

---

***Vegetation and livestock management close to the stream is most likely to influence water flow and water quality.***

---

Rangeland managers first determine the plant communities that could live on the soils within a watershed. They will choose from only those that adequately protect the soil and promote rangeland health. Among these, the people most interested in that land will select the plant communities that provide the best benefits. In general, the goal is to establish or maintain a

vegetation cover that fits the environment of the site and sustains the land while providing useful products such as forage, wildlife habitat, and water. Usually the first concerns are preventing too hot or too frequent fires, preventing exotic weed invasions, and managing livestock grazing so that streams and the watershed vegetation continue to function properly. Vegetation and livestock management close to the stream is most likely to influence water flow and water quality.

### Riparian Vegetation Management

Perhaps the most stream-available water-storage aquifer is under the floodplain or under riparian vegetation. Much of this aquifer is composed of sediment captured by riparian vegetation as it slowed water velocity. The roots and roughness provided by the vegetation and its dead wood also provide the erosion resistance needed to keep the soil and aquifer in place. By keeping channel materials in place, floodwaters can continue to spread over a larger area with more surface area and more time for water to soak in.

After years of cleaning streams and fighting willows to control floods, we've learned that faster water leads to more erosion and other problems. When erosion cuts streams bigger and deeper, the deep water that can no longer spread over a floodplain flows downstream rapidly in a deep torrent. After spring runoff, such streams often dry up earlier than they used to, and don't support the kinds of vegetation that have strong roots needed to hold banks.

---

***After years of cleaning streams and fighting willows to control floods, we've learned that faster water leads to more erosion and other problems.***

---

Much of the sediment in many streams comes from streambank erosion. Increased bank erosion after channels begin cutting causes riparian vegetation and channel form to change away from naturally stable conditions. On streams or rivers with large watersheds, farmers then lose large areas of their fields. Erosion often becomes dramatic on small streams too.

Unfortunately, efforts to protect unnaturally high banks from erosion often direct high-velocity water to other locations. As a result, the farmer, a neighbor, or the community slips into the process called "serial engineering". In serial engineering, flood control or bank armoring results in the need for more and bigger projects. Such efforts stand in the way of natural recovery. Without bank armoring, streams and rivers form a new floodplain at a lower level. As the new floodplain forms, it absorbs more flood energy and more water with increased size and the help of lush vegetation. Working with nature and riparian vegetation recreates a naturally stable form that slows water velocity and increases water storage through infiltration. It also makes the best economic sense.

The riparian restoration approach also pays large dividends for water quality because the wide floodplain and lowered stress during floods allows the active or low-flow channel to narrow. This narrower channel with a wide vegetated floodplain stays cooler. Less stream surface is exposed to sunlight and warm air. Increased shade from riparian vegetation reaches over more of the channel and keeps the air and water cooler in summer and warmer in winter. Furthermore, cool water from floodplain storage dilutes the warm water exposed to sunlight and summer air. This approach to higher quality water pays off economically by decreasing the costs of flood

fighting, increasing land values for people interested in wildlife and beauty, and may bring in cash from a fishing, hunting, or other recreation businesses.

### Streams Naturally Vary

As valuable as riparian vegetation is for water capture and floodplain aquifer storage, not all streams have much of this floodplain storage, and some don't have much of an opportunity to create it. Watersheds and stream zones differ dramatically in climate, geology, size, and in other ways that affect their ability to capture, store and safely release water. In some watersheds, riparian vegetation is primarily a factor in fish and wildlife habitat and water quality. Areas where riparian vegetation doesn't have much opportunity to positively affect water supply or storage are generally steep, bedrock controlled, and in narrow canyons where riparian vegetation consumes more water than it causes to be stored.

Watershed areas where water storage under the influence of riparian vegetation outweighs water consumption by riparian vegetation have wider valley bottoms. Here, there is more opportunity to spread floodwater over a floodplain surface above an aquifer that can be recharged during annual high flows. Unfortunately, because of a variety of causes, many of these wide valleys have lost or drained their shallow aquifer through the process of channel incision (deepening) and erosion. What were once mountain meadows with steady outflow have too often become sagebrush flats producing mud during floods and little water in late summer.

Fortunately, many of these valleys can recover some or even much of their water storage, water quality, and habitat values. Here too, vegetation management is generally the most economic tool. One stream in sagebrush country recovered its water storage capacity from ½ million gallons of water per mile to over 4 million gallons of water storage per mile. Furthermore, this improvement came with continued grazing. By changing the timing of grazing to fit the needs of the stream, allowing spring grazing rather than season-long grazing, the pasture steadily improved while forage harvests increased by more than four times.

### Maintaining Good Quality Groundwater Supplies

If you depend upon groundwater supplies for drinking water, whether human or animal, be aware that many human activities and pollutants have contaminated our aquifers. Agricultural and industrial chemicals, fuels, nutrients from animal wastes or septic systems, and fertilizers are examples of pollutants that can reach groundwater. Pollutants can percolate downward by themselves or be dissolved in water, making the groundwater unusable by plants, animals and humans. Once contaminated, groundwater can be expensive and difficult, if not impossible, to clean up.

Fortunately, you have an opportunity to improve groundwater quality by your irrigation and livestock management practices. Applying irrigation water high in nutrients to actively-growing forage may result in nutrient uptake and pollutant filtering, decreasing the likelihood of groundwater contamination and decreasing existing surface water problems. Likewise, avoiding over-irrigating will decrease the chance of leaching of pollutants. You can also protect groundwater supplies by establishing a wellhead protection area.

Wellhead protection is a basic strategy to protect groundwater. Many groundwater aquifers become polluted when surface water carried problem chemicals right down the well. These

problems could have been avoided by proper wellhead protection. Private well owners should designate a Wellhead Protection Area (WHPA) with a minimum radius of 100 feet around the wellhead. For larger public supply or agricultural wells, where groundwater flow patterns are known, the WHPA comprises the zone of contribution, which is the surface area contributing recharge to the well.

### **Protecting Groundwater Within the Wellhead Protection Area**

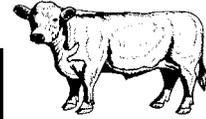
- Avoid spilling or disposing of animal wastes, fuels, pesticides, or fertilizers within the WHPA or within the WHPA of adjacent properties.
- When applying manure, be sure to credit your nitrogen budget for the nutrients contained in the manure.
- Seal the well with a 50-foot deep concrete collar around the well casing to prevent contaminants from directly entering the aquifer. In addition, the top of the well casing must be capped, and must be at least 12 inches above finished grade. If the well is within 1/4 mile of a stream or major irrigation ditch, it must be sealed to a 100 feet depth. For other construction details consult the office of the Nevada State Engineer, Division of Water Resources, Carson City, at (775) 687-4380.
- Site the well outside areas of potential contamination. Wells should not be located in corrals, pastures without wellhead enclosures, feedlots or drainage ways from such facilities. Locate livestock pens at least 100 feet away from the wellhead, and increase distances in sandy, high-permeability soils. Livestock traffic may damage the wellhead, and leachate from manure may travel directly down outside of the well pipe.
- Check to make sure antibacksiphon devices are in place and functioning correctly to prevent the direct injection of pesticides or other pollutants into your water supply.
- Cap and seal abandoned wells since they provide a direct conduit to the aquifer, the wellhead protection area around them should be maintained.
- Inventory all potential sources of contamination on your property and adjacent properties, and protect the well against contamination by any sources that cannot be eliminated.
- Test well water at least once a year for coliform bacteria and at least every 3 years for basic water chemistry.

### **Summary**

Careful management of your watershed and pastureland will pay many dividends, both in terms of improved water storage, increases in late season water, increases in forage yield, and improved water quality.

## Reference:

- Prichard, D., J. Anderson, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian Area Management: A Users Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. TR 1737-15 Bureau of Land Management, USDA Forest Service and Natural Resources Conservation Service. BLM/RS/ST-98/001+1737, Service Center, CO. 126 pp.
- Swanson, S. 1996 Reading a Stream's Need for Management. Pages 23-36 In: George, M. R. (Tech. Coord.) Livestock Management in Grazed Watersheds -- A Review of Practices that Protect Water Quality. Univ. Of Calif. Davis Animal Agriculture Research Center and Univ. Of Calif Agricultural Issues Center Publication 3381.75 pp.
- Walker, M. and W. Johnson. 1998. Protecting Nevada's Water. University of Nevada Cooperative Extension Special Publication SP-98-03.



## Chapter 18

### *Irrigation Diversion Structures For Sustained Pasture and Meadow Production*

By Dr. Sherman Swanson, State Range Specialist  
Dr. Susan Donaldson, Area Specialist

<a href="#">Introduction:</a> .....	1
<a href="#">Most land was shaped by moving water</a> .....	1
<a href="#">Locate diversion structures to avoid problems</a> .....	2
<a href="#">Design and manage structures to move sediment without causing erosion</a> .....	3
<a href="#">Where channels are changing, anticipate the changes</a> .....	4
<a href="#">To design a structure get the help on an engineer and other professionals</a> .....	4
<a href="#">After construction, monitor to answer important site-specific questions</a> .....	5
<a href="#">Summary</a> .....	5

#### Introduction:

In the West, many mountain meadows or other pastures receive irrigation water diverted with a headgate or other structure from a stream or river. Some diversion structures remain in place and the stream or river and water supply remains stable for many decades. Others structures seem to need repair every year. To reduce the need for repair and to keep from causing erosion that could undermine a pasture, match the location, design and management of the structure to the natural tendencies of the channel and the land.

#### Most land was shaped by moving water

Moving water has the power to erode and move sediments. More water, a steeper slope, less friction or channel roughness and a more pipe-like shape increase the power. Where sediment is readily available, more power means that more dirt, sand, gravel, etc. gets picked up, bounced or rolled. In sediment-laden water, a structure that interferes with stream power causes sediment to drop out and deposit. On the other hand, if a structure causes water to speed up on erodible materials, erosion can increase and also change a channel dramatically. Depositing coarse sediment deeply over a field, and eroding a channel so that it drains the water table costs money. More than a few producers have lost their farm or ranch after they could no longer irrigate a field or sustain forage production due to a lowered water table or sediment dump.

The land on most ranches varies from places that erode slowly (or rapidly in harsh climates, erodible rock types, or poor conditions) to ones that collect soil. Usually steep mountain watersheds deposit the coarse sediment at the mouth of the canyon where water can first spread out during a flood. The coarse soil at such locations generally makes a poor place for irrigation or unlined canals. Much of the water doesn't go very far before sinking below roots. Further

away from the mountain or in wider valleys, soil tends to be finer, more fertile and deeper. Here water spread into a thin layer and deposits fine sediment during floods, building up the soil.

Fertile soil is also deposited where a meandering channel slowly moves back and forth across the valley. These flat surfaces form by deposition of soil over the gravel bars that follow the meanders as the channel moves across the valley. These soils are often easier to irrigate and more productive because a high water table has kept vegetation strong and the collected soil is very fertile.

However, fast water can easily erode these soils. Removing dense vegetation, increasing water depth or increasing water speed increases the risk of erosion. The area of the stream channel where water is deepest and fastest is at the greatest risk from a change in water velocity. Relatively flat channel slope and roughness caused by turns, drops and riparian vegetation or woody debris are stream and floodplain characteristics important for channel stability. So too is the ability to spread high water out into a thin flow across a wide floodplain during big floods. While too many of these energy-dissipating factors could be too much of a good thing, many streams have developed a pipe-shaped active channel with an easily flooded floodplain. Such streams successfully transport most sediment without excess deposition or erosion. Riparian vegetation helps move sediment through the channel by resisting erosion that would otherwise widen the channel and allow too much sediment to deposit.

### Locate diversion structures to avoid problems

The goal for any irrigator is good forage production with low maintenance and long life. The diversion of water is permitted through established water rights that often specify the point of diversion, although this can often be changed legally. The method of diversion is not specified in the water right.

The ability to change the point of diversion varies. Because canals or ditches must be engineered on specific slopes to transport their water and sediment without eroding the on-site soil, a specific field might have only one logical location for a diversion. Some fields have water rights for only enough water for part of the available acreage and the irrigated part of the field could be relocated to find the best fit among soils, water loss, and structure maintenance. Elsewhere irrigation structures could be relocated if ditches were lined or if several structures were consolidated to allow an investment in one really good one.

Each structure should be located in a setting that resists erosion even with the changes to water flow that the structure will cause. While bedrock controlled sites present few risks, they are rare near fertile soils. Therefore, irrigators often look for other erosion resistance factors. In ideal areas floodwaters spread out just enough, appropriate riparian vegetation provides erosion resistance, and the channel form transports sediment.

Where the stream slope or gradient is moderate (2-4%) the accessible floodable area may not be very flat, but even the gently sloping banks are important for spreading water and absorbing energy. Roads in the bottom of canyons or valley bottoms create problems if their construction put fill onto the floodable area near the stream or if the stream has captured the road. Adding a structure in such a location, or in an eroded or narrow valley bottom, may increase erosion on the

side of the canyon. Steep canyon walls may even collapse in a landslide if erosion undercuts the toe slope of the side hill.

Low-gradient streams (less than 2%) generally form a flatter floodplain and are more stable where the stream has room to meander and flood over a wide area. Wide flat floodplains are often ten or more times the width of the channel. Low-gradient streams remain stable by keeping their form but gradually adjusting their location. Although the bed of such channels is made of erodible material, it often stays in place except in big events when more of the same size material comes in to replace what moves on downstream. Fortunately such streams can be very stable. Channel movement is gradual as long as the movement of the bed of the channel isn't triggered by a disturbance such as from a dozer or backhoe.

If the natural surface armor of these gravel-bed channels gets disturbed, then erosion can take place when no new gravel comes to replace what erodes. Locating a big fixed structure on such a moving channel causes problems. However, this may be less problematic than the channel cutting caused by frequent disturbance to bed armor as smaller push-up structures have to be rebuilt often. Structure design and maintenance is tricky on channels that depend on a combination of channel and floodplain form with the right hydrology for riparian vegetation, constant gradual motion for dynamic stability, and sediment transport with neither excess erosion nor excess deposition.

Unfortunately, most of these channels have already been disturbed enough so that floodwaters no longer spread over a wide floodplain. Even if big floods occasionally spread across the wide valley bottom, frequent high flows don't spread as they did before channel down cutting. The frequently recurring power of fast water in an over-big channel speeds erosion and channel change. Similarly, many narrow channels have become wide and they now move lots of sediment in bank-eroding bursts during peak flows. They used to move sediment regularly with pipe-shaped but shallower flows that spread excess runoff across a floodplain.

### Design and manage structures to move sediment without causing erosion

In any situation, the sediment delivered to the structure during at least the high flows must be transported through a structure or problems will develop at and/or downstream of the structure. Deposition of sediments at the structure can interfere with diverted water flow, in-channel water flow, or flow of floodwater onto the floodplain. More importantly, many streams balance some erosion with input of new sediment from upstream. If sediment supplies are cut off at a diversion, channel areas downstream often cut down and then cut rapidly into their banks. The opposite problem can also occur where too little un-diverted water remains in the channel to transport the sediment coming through the structure.

Structures often flatten the channel slope and cause sediment deposition above the structure. Because of the need to pass sediment during high flows, most diversion structures are designed to be opened or closed, allowing water (and sediment) to flow into the lower channel or into the ditch at will. This requires manual opening and closing of the gates at the correct times. Proper timing may be easier where flows are seasonal and predictable because of snowmelt than where high sediment-transporting flows come sporadically because of thunderstorms.

Other structures are designed to split the water and split the sediment, passing whatever comes and sending it in both directions (both downstream and into the ditch or canal). While this is useful on a channel with a natural slope and form, it may mean that the low-gradient engineered canal needs periodic clean out. If the combined sediment transport capacity of the split waters is too little for the total load, both the canal and the downstream channel may need periodic appropriate cleaning.

### Where channels are changing, anticipate the changes

After channels cut into their bed or lose the stability that comes with floodplain access and riparian vegetation, they often change predictably, widening measurably from year to year. Their sequence of changing channel forms can make management difficult. Furthermore, problems increase when the changes are not predicted. Any structure that crosses such a channel must be keyed into the bank a long way or the water will simply cut around it.

Both down-cut and widened unstable channels present problems for designing diversion structures. Fast water tumbling over a structure can churn with turbulence that causes further erosion where bank stability has been reduced. It is tempting on a deeply eroded channel to build a large structure that fills the gully with water and therefore fills ditches by gravity. After all, this was the floodplain that used to flood naturally, and with great stability. However, such structures concentrate the power of flowing water onto a small area. Because of the added stress and erosion, many high structures have blown out. This sometimes results from eddy currents on either side of a spillway lacking bank armoring, especially if the structure has not been extensively keyed into the unstable banks. At a minimum, banks must be armored, and excess energy dissipated over hardened and rough surfaces or in deep water.

The diverted water may also create problems. The depth of incision represents a fall of diverted water off the old high floodplain and into the incised channel. Areas of concentrated free-falling flow then become headcuts that may simply cut around the structure, even if they occur some distance away from the structure. Although it's best to avoid the expenses caused by incision, once it happens, the best alternative is often to pump water from the channel rather than use an unnatural structure in a dynamic setting.

### To design a structure get the help on an engineer and other professionals

The USDA Natural Resources Conservation Service (NRCS) and many private firms have the engineering expertise to design structures that accomplish objectives based on factors included in the discussion above. However, you may want to engage them in an interdisciplinary discussion with a hydrologist, soils scientist or geomorphologist, and riparian biologist about the specific objectives that fit the local setting. Avoid standard designs purported to fit any situation. Too many streams and too many producers have suffered the consequences of standard solutions designed by single disciplines where the setting called for many kinds of knowledge to consider interrelated factors. Streams are far too variable and complicated for single discipline thinking.

### After construction, monitor to answer important site-specific questions

If a particular setting presents significant irrigation problems, regular monitoring may be needed forever. Monitoring should focus on the form of the channel. Measuring or keeping photographs that track channel changes such as erosion and deposition teaches about slow but important changes that may not otherwise be noticed. Channel incision or cutting is a concern on many channels because it changes so many of the relationships upon which irrigation depends. Sediment deposition presents similar problems. Where riparian or other vegetation is needed to prevent excess erosion, then grazing management and monitoring are an important part of pasture, irrigation, stream, and watershed management.

### Summary

Keeping and putting water onto land is an art form that is backed by many sciences. Because water comes in bursts with high energy and sediment or the power to erode, how we manage water with diversion structures is critical to the long-term success of irrigated agriculture. When and where possible, irrigators should understand and work with natural processes and consider the nature of their streams and the riparian vegetation. Vegetation is as much a part of channel form as the water slope and floodplain access. Matching diversion structures to the land may be as important to success as matching the crop to soil type.