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EC92-124 Nebraska Handbook of Range Management

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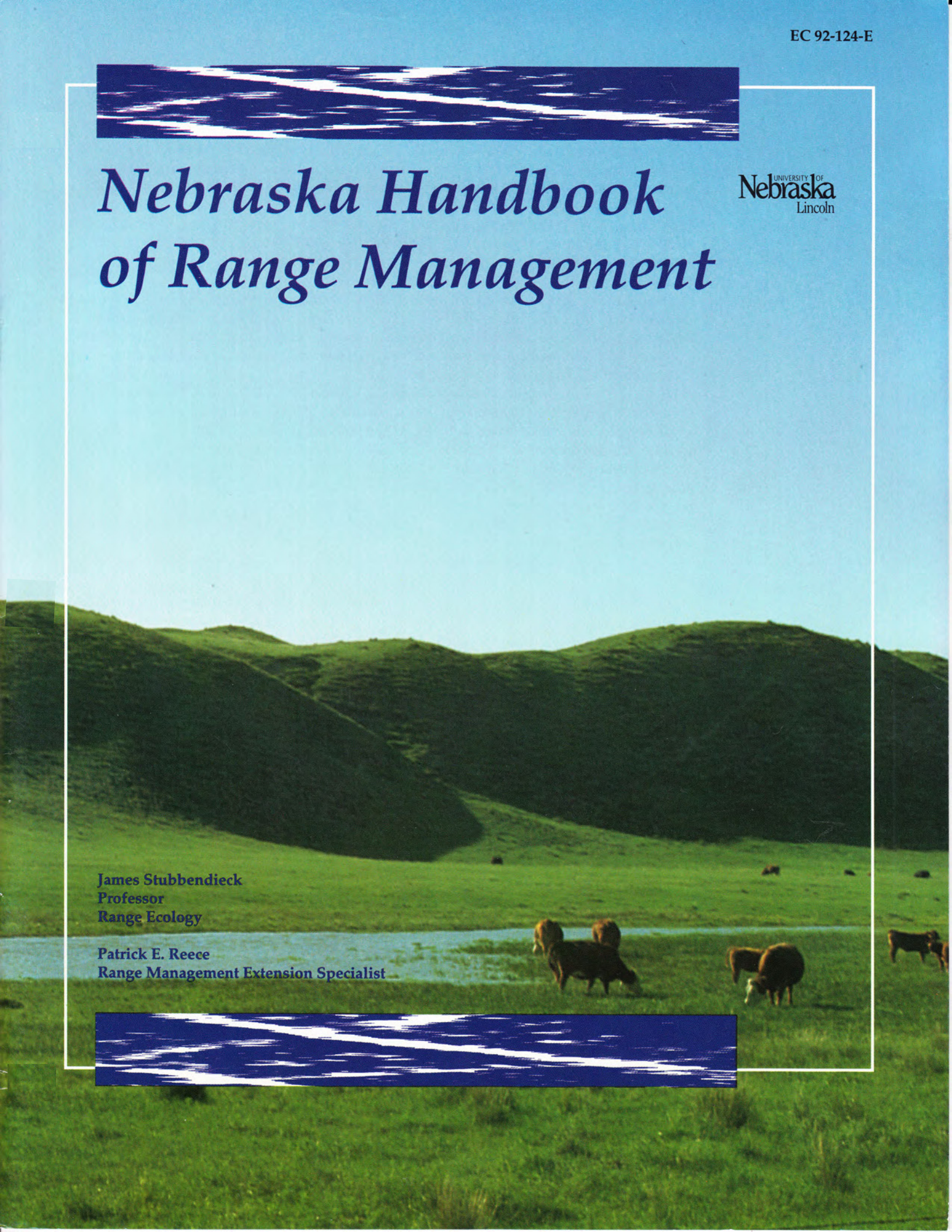

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FOREWORD

The Society for Range Management (1839 York Street, Denver, CO 80206) was created in 1947 to advance the science and art of managing grazing lands. Under the direction of its Committee for Cooperation with Youth Organizations, a basic manual, "Range, Its Nature and Use", was developed in 1957. Material taken from "Range, Its Nature and Use" and used in this manual is gratefully acknowledged. This manual was extensively modified to meet the basic needs of the range industry in Nebraska by Donald F. Burzlaff in 1960. John F. Vallentine and Donald F. Burzlaff prepared the second edition in 1968. L. J. Perry, Jr. and James Stubbendieck prepared the third edition in 1976.

As with the previous editions, this handbook concentrates on the management of livestock on rangeland. But rangeland is used for more than livestock production, and this edition addresses the multiple use concept. This handbook was written primarily for 8th to 10th grade youth of Nebraska, but it should find use also as a reference for entry level range managers and others interested in natural resources.

James T. Nichols, Bruce E. Anderson, Lowell E. Moser, and Steven S. Waller, Department of Agronomy, University of Nebraska are acknowledged for their contributions to this handbook. Rob Ravenscroft, rancher and practitioner of Holistic Resource Management; Kenneth L. Hladek, State Range Conservationist, Soil Conservation Service; and Daryl Cisney, Field Representative, Board of Educational Lands and Funds; were instrumental in the final revisions. Each carefully read the handbook and made valuable suggestions for changes and additional information that substantially improved the quality of this publication. The authors express special thanks to Sue Peterson for typing the manuscript and making numerous helpful suggestions.

PUBLICATIONS

Additional reading in the form of University of Nebraska Cooperative Extension publications are given throughout this handbook. These publications are available from local extension agents or by ordering them directly from the University of Nebraska. A list of publications of interest to range managers and ordering information is located at the end of this handbook.

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INTRODUCTION

Every Nebraskan should be interested in rangeland. The plants, soil, and water are the foundation of Nebraska's economy and quality of life. Rangeland is one of Nebraska's most important and valuable natural resources because it:

—produces forage for livestock and wild game;

—provides a varied habitat for many wildlife species;

—protects the soil from wind and water erosion;

—preserves a "germplasm bank" for many plant species that may become important for yet unknown uses;

—purifies and enhances the environment by cleansing the air, filtering the runoff to streams, increasing the intake of precipitation, and aiding groundwater recharge;

—perseveres in adversity and renews itself when the opportunity is provided by those who use and sometimes abuse it; and

—pleases those who have learned to appreciate the beauty and aesthetic qualities of rangeland.

These are called the "Seven P's of Rangeland[1]. Range plants must be the right kind and kept productive for best use of this resource. Most people enjoy wildlife, hunting, camping, clean water, fishing, and eating beef. Range supplies us with those items, so we must manage it wisely.

1 James T. Nichols. 1986. The "7-P's of Rangeland". Rangelands 8:35.

CHAPTER 1

RANGELAND— TO HAVE AND TO USE

Rangeland is land on which the native vegetation is mainly grasses, grasslike plants, forbs, or shrubs. It includes lands naturally or artificially revegetated when routine management of that vegetation is accomplished mainly through manipulation of grazing.

Rangeland is the primary resource of a ranching operation. Range plants, the rancher's crop, are converted into a salable product through the grazing animal. Rangeland also is the habitat of many species of wild game.

Besides sale of livestock or their products, rangeland may be used for other things at the same time. This is called *multiple use* and is particularly important on public lands (lands owned by the state or federal government). A range can be grazed by livestock to harvest forage while simultaneously yielding water, purifying and enhancing the environment, producing game animals, producing tree products, and providing recreation. However, these uses sometime compete with one another. The rancher and other users of the rangeland must work and plan together for optimum multiple use.

Range management is a discipline founded on ecological principles. It deals with use of rangeland and range resources for various purposes. It includes the science and art of planning and directing rangeland use for optimum long-term animal production, as well as other uses such as wildlife habitat, recreation, controlling erosion, watersheds, and aesthetics. Since rangeland is a natural resource, it requires sound management to be sustained. Rangeland management is planned to produce a range forage crop for use by livestock and wildlife. Rangeland must be carefully used so the forage plants remain vigorous and productive, and so that soil does not erode.

Management of grazing animals is the first responsibility of the range manager. Controlled removal of forage from the rangeland is a natural process necessary to maintain the quality and productivity of the resource.

Four key principles of management of rangelands are:

1. Balance the number of animals with the forage supply.
2. Graze during the proper season or combination of seasons of the year.
3. Obtain proper livestock distribution over the range.
4. Graze the kind or class of livestock to meet management goals.

It is important to understand that the controlled removal of forage (defoliation) is necessary, at least occasionally, to either maintain or improve the resource. Therefore, proper grazing management maintains or improves the resource so it can provide the multiple uses desired today.

CHAPTER 2

HOW THE RANGE LIVESTOCK INDUSTRY BEGAN

Before immigrants came to this country, rangeland was grazed only by native animals such as bison, deer, elk, big-horn sheep, and pronghorn. These animals were used for food and clothing by the Native Americans and later by trappers and settlers. Today this same rangeland produces beef, lamb, and wool for this country and other parts of the world through international export markets.

The range story is not complete without a review of the range livestock industry. The first cattle were brought into the United States by the Spanish explorer Coronado in 1540. As missionaries and Spanish explorers moved north from Mexico, they took livestock with them. Cattlemen were often only second to the fur trappers in occupying new areas. Livestock production on rangeland rapidly became important in what are now the states of Texas and California.

During the Civil War, numbers of cattle greatly increased in Texas. When soldiers returned from the war, cattle were literally running wild on Texas rangeland. A large demand for beef existed in the eastern U.S., but there were no railroads in Texas to ship the cattle to these new markets. Northern railroads offered outlets for cattle.

Cattle were rounded up, and large trail drives began heading north from Texas to the railheads in about 1866. Cattle on trail drives traveled an average of 15 to 20 miles per day, but gained weight from eating the abundant forage along the trail. Some of the most famous routes were the Chisholm, Shawnee, Ft. Griffin, Dodge City, Sedalia, and Goodnight trails (Figure 1).

Nebraska contributed its share to the early history of the range livestock industry. The Ft. Griffin and Dodge City trails ended at Ogallala. Ogallala was one of the roughest towns on the trail. During this period, its reputation was more widespread than that of Dodge City. Cattle moved from Ogallala by rail to markets in the eastern U.S. Some of the cattle were kept in Nebraska or trailed on to the Montana and the Dakota territories. Smaller numbers of cattle were brought to Nebraska from the East by settlers.

Stockmen coming to Nebraska first settled on grasslands in the east and along the Platte River. However, they soon learned that the Nebraska Sandhills could be an important area for cattle production. Livestock that were lost or left in the Sandhills over winter were often in good condition the following spring. Trail herds held over for shipment at a later date gained well on the plants of the rolling Sandhills. Settlement of the area by cattlemen began, and Nebraska rangeland was quickly filled with cattle.

Barbed wire was perfected in the 1870s. It was relatively inexpensive and allowed ranchers to control their animals and fence out their neighboring livestock. Without fences, proper livestock distribution was difficult. On the other hand, in the absence of proper management barbed wire fences led to overgrazing when animals were restricted to one area, often on a

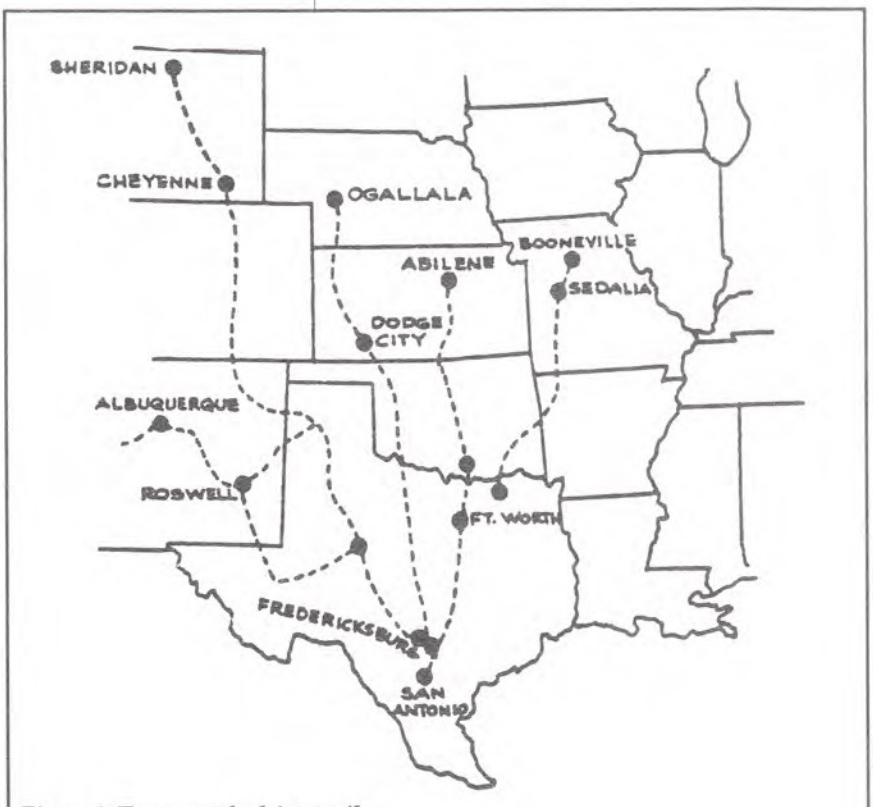


Figure 1. Texas cattle drive trails.

year-around basis. If stocking rates were excessive and cattle could not move to other areas because of fences, plants could not recover. Grassland vegetation had developed under short-term, intensive grazing by bison and other wild game. After utilizing the forage, these animals moved elsewhere allowing the plants time to recover.

Trouble was ahead for the cattlemen. During the severe winter of 1885-86, tens of thousands of cattle died from exposure and starvation. The next year was extremely dry, again reducing cattle numbers. This was followed by one of the severest winters yet recorded. High winds, snow, and bitter cold combined to nearly wipe out many cattle herds.

Other factors besides severe weather caused heavy cattle losses in the 1880s. For example, many ranges had been carelessly overstocked, and ranches were poorly managed. No rangeland was saved for winter grazing, and no preparation was made to insure that cattle had forage and water during winter emergencies. Little use was made of cross fencing, salting, and additional stock watering places to distribute livestock more evenly.

Only ranchers with a true regard for their cattle survived the environmental and financial hardships of the 1880s. These were the pioneers of the present cattle industry in Nebraska. They saw the need for following better grazing practices, providing for their stock in the winter, and improving their business by starting permanent ranches.

Although hard times reduced cattle numbers in the 1880s, the sheep industry grew rapidly in some areas. Sheep are more adept at using winter snow for their water needs than are cattle. Sheep were commonly grazed during the winter in northwestern Nebraska in areas where summer water was not available. The presence of the sheepmen was resented by cattlemen because they thought that sheep grazed the plants too closely, ruining the resources. However, it has been shown that properly managed sheep do not adversely affect most range plants.

Settlers were encouraged by several government land settlement laws. The first Homestead Act was passed in 1862. This law gave land in 160-acre tracts to settlers after they had lived five years on the land and made specific improvements including building a house. Many of these first houses were made of sod because other building materials were not available. Most of the productive land was in private ownership by 1870.

It was soon learned that the 160 acres allowed by the Homestead Act was not enough to support a family in the drier areas of the state, but it took nearly 50 years before the law was changed to allow more land to be claimed. The Enlarged Homestead Act was passed in 1909 giving 320 acres to settlers, but this was still not enough land for a ranch. Also, the homesteader had to live on the land only three years to "prove up".

The Stock-Raising Homestead Act of 1916, commonly known as the "Kinkaid Act," was designed for settlement of lands not suited to farming. Stockmen were given 640 acres of land under this act. This square mile, or "section", was supposed to furnish enough forage to carry 50 head of cattle. This proved to be too small for a ranch, and less than half the people stayed long enough to own their own land. None of the land settlement acts allowed families to homestead enough land for a ranch. In many cases, land suitable only for grazing was plowed up. Many settlers went broke.

Land resources of Nebraska ranches of today came from several sources. Most commonly, the land came from buying out other homesteaders and by purchasing railroad lands. Railroads were given land by the government as an incentive to expand their rail systems. Often they were given alternating sections (640 acres) of land for up to 20 miles away from either side of the tracks. The railroads sold this land to pay for their expenses and to make a profit. Sections 1 and 36 out of each township (6 miles by 6 miles or 36 square miles) were set aside when the land was surveyed to support education. These "common school lands" became important resources for range

managers. Some of the school lands were sold to private owners, but 1.5 million acres of land are still owned by the Nebraska School Trust and managed by the Board of Educational Lands and Funds. About 1.25 million of these acres are rangeland. These lands may be leased to ranchers for grazing. The Federal Government also owns rangeland in Nebraska. These public lands are managed primarily by the U.S. Forest Service and U.S. Fish and Wildlife Service. These public holdings are small compared to those in the 11 western states, but they are an important resource in Nebraska.

Although improper grazing and serious erosion still occur on some Nebraska rangelands today, range management has improved. Most ranchers know the importance of and are practicing careful range management. Much of the rundown rangeland is being restored to high levels of production by proper stocking and improved grazing practices. Development of complementary forage and feed resources has helped many ranchers to improve grazing management on rangeland and to stabilize their livestock operations.

The concept of multiple use is relatively new compared to a singular emphasis on grazing rangeland with livestock. Even with primary emphasis on range livestock production, other consumptive and nonconsumptive uses can occur. When priority is given to other uses, it may be necessary to alter livestock grazing. For example, when a high priority is placed on wildlife, cattle may have to be reduced to leave abundant cover for wildlife habitat. Multiple use makes it very important for ranchers and other individuals interested in natural resources to work together. Valuable input can be obtained from personnel with the University of Nebraska, Soil Conservation Service, U. S. Forest Service, U. S. Fish and Wildlife Service, Board of Educational Lands and Funds, Natural Resources Districts, and private consultants.

CHAPTER 3

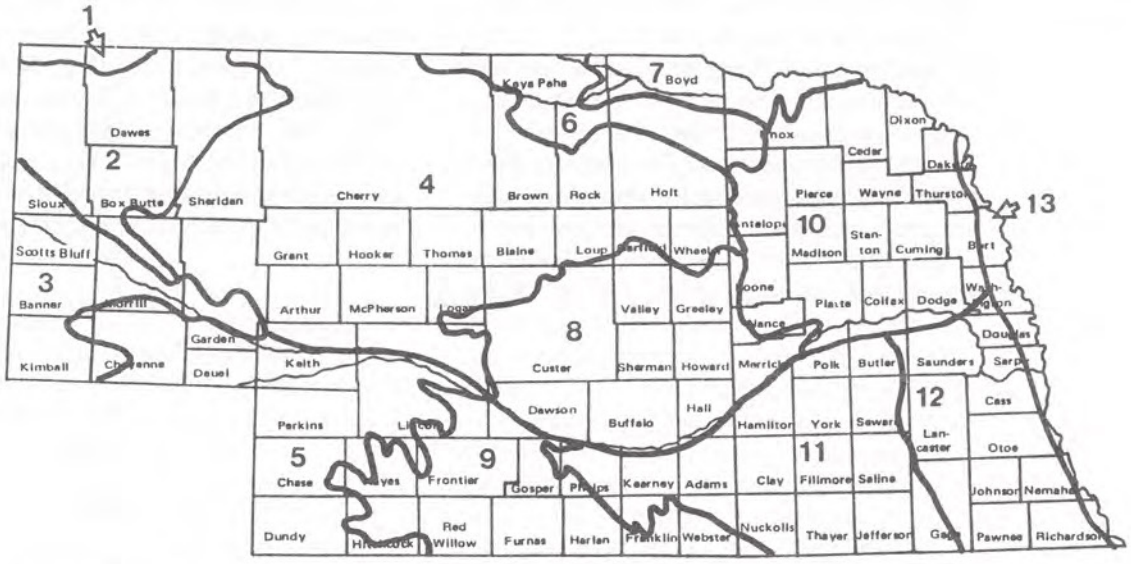
NEBRASKA—A RANGE STATE

The United States contains nearly one billion acres of rangeland. Most is in the 17 western states, including Nebraska. This western range area contains more than 700 million acres making it important simply because of the large amount of land.

Nebraska now contains about 23 million acres of natural grasslands devoted primarily to forage production for grazing animals. Nebraska's multibillion dollar beef cattle industry depends upon forage produced on rangelands. Haylands and introduced grass pastures occupy over 4 million acres, and about 1 million acres was seeded to permanent grass cover as part of the Conservation Reserve Program in the late 1980s and early 1990s. Thus, about 57 percent of Nebraska land is grassland. Rangeland occurs in nearly every county, but the largest blocks lie in the north central and western parts of the state.

The Sandhills of north central Nebraska represent one of the largest continuous expanses of grassland in the United States (Figure 2). It is the largest area of stabilized sand dunes in the Western Hemisphere. About one-half of all grassland in Nebraska is in the Sandhills. Because the sandy soil is easily eroded, the Sandhills are better suited for grazing than for crop production, even though rainfall is high enough to produce some field crops.

The Sandhills are known for their abundance of mid- and tall-grasses and for high quality beef cattle. Many of the larger beef breeding herds in Nebraska are in this area. Cherry County, in the Nebraska Sandhills, has more grazing cattle and calves than any other county



1 **Pierre Shale Plains and Badlands**
2 **Mixed Sandy and Silty Tableland**
3 **Central High Plains**
4 **Nebraska Sandhills**
5 **Central High Tableland**
6 **Dakota-Nebraska Eroded Tableland**
7 **Southern Rolling Pierre Shale Plains**
8 **Central Nebraska Loess Hills**
9 **Rolling Plains and Breaks**
10 **Loess Uplands and Till Plains**
11 **Central Loess Plains**
12 **Nebraska and Kansas Loess Drift Hills**
13 **Iowa and Missouri Deep Loess Hills**

Figure 2. Major land resource areas of Nebraska.

in the U.S. At various times in the past, Cherry County has contained more cattle than many of the individual western range states. Cattle are generally marketed as calves and yearlings and most go to feedlots for finishing.

Prairie hay is cut on about 12 percent of the Sandhills rangeland, particularly from the highly productive wetland and subirrigated meadows. Many Sandhills ranchers winter cattle by feeding hay and grazing regrowth on the hay meadows. Other ranchers winter cattle on rangeland (uncut forage) and feed protein supplements. These ranchers feed hay only in stormy weather. The use of alfalfa hay as a protein supplement is important. Alfalfa is grown on about 1.3 million acres in Nebraska.

Range livestock production is the main agricultural industry in the Pierre Shale Plains, Badlands, Mixed Sandy and Silty Tableland. Short grasses such as buffalograss and blue grama and a few taller wheatgrasses provide a major part of the range forage. A few flocks of sheep are maintained in these areas. In other sections of the Nebraska Panhandle, range livestock are produced on roughlands and in river breaks. Only on the wheatlands in central Box Butte County and on the Central High Tableland and in irrigated sections along the Platte and White Rivers is cash grain production more important than range livestock production.

About one-half of the land is grassland in the Rolling Plains and Breaks in the area of the Republican River in southern Nebraska, and in the Central Nebraska Loess Hills along the forks of the Loup River in central Nebraska. Two-thirds of the land is grassland in the Dakota-Nebraska Eroded Tableland and Southern Rolling Pierre Shale Plains. Rangeland in these areas is mixed with cultivated lands. Cattle commonly graze this resource in the summer and are wintered on hay, silage, or crop residues. Poor grassland management is more common under these conditions than in the primary ranching areas.

Rangeland is usually less important than crop production in eastern Nebraska, but the potential production per acre of rangeland is much higher than in western Nebraska. Therefore, about 40 percent of the beef cows are located in the eastern one-half of the state. Small, scattered pastures are found in most counties. A few large areas of grasslands are present in the Loess Uplands and Till Plains of northeastern Nebraska.

RANGE PLANTS

It is vitally important for ranchers to know how range plants grow to plan grazing programs that will maintain or improve range condition and productivity. A good range manager should know many plants by name and recognize their value as forage plants. Ranchers can then better use modern technology and sound business management techniques to increase ranch profits as well as improve and safeguard range resources.

Kinds and amounts of plants suggest the kind of rangeland and determine its productivity. Range plants also are vitally important for holding soil to prevent serious erosion. The presence or absence of certain plants can show how the rangeland has been used and what should be done to improve or maintain it. Several hundred kinds of plants are found on Nebraska rangelands. Each is a different species, like western wheatgrass and blue grama. It isn't necessary to know all of them, but range managers should be familiar with plants that furnish the most forage for livestock as well as those that are pests or even poisonous. As a general rule, about 12-15 species of primary importance will be growing on any one range area. Since there are many different kinds of plants that grow on rangeland, it helps to group them by their appearance and growth habit. The five main kinds of range plants are grasses, grass-like plants, forbs, shrubs, and succulents (Figure 3).

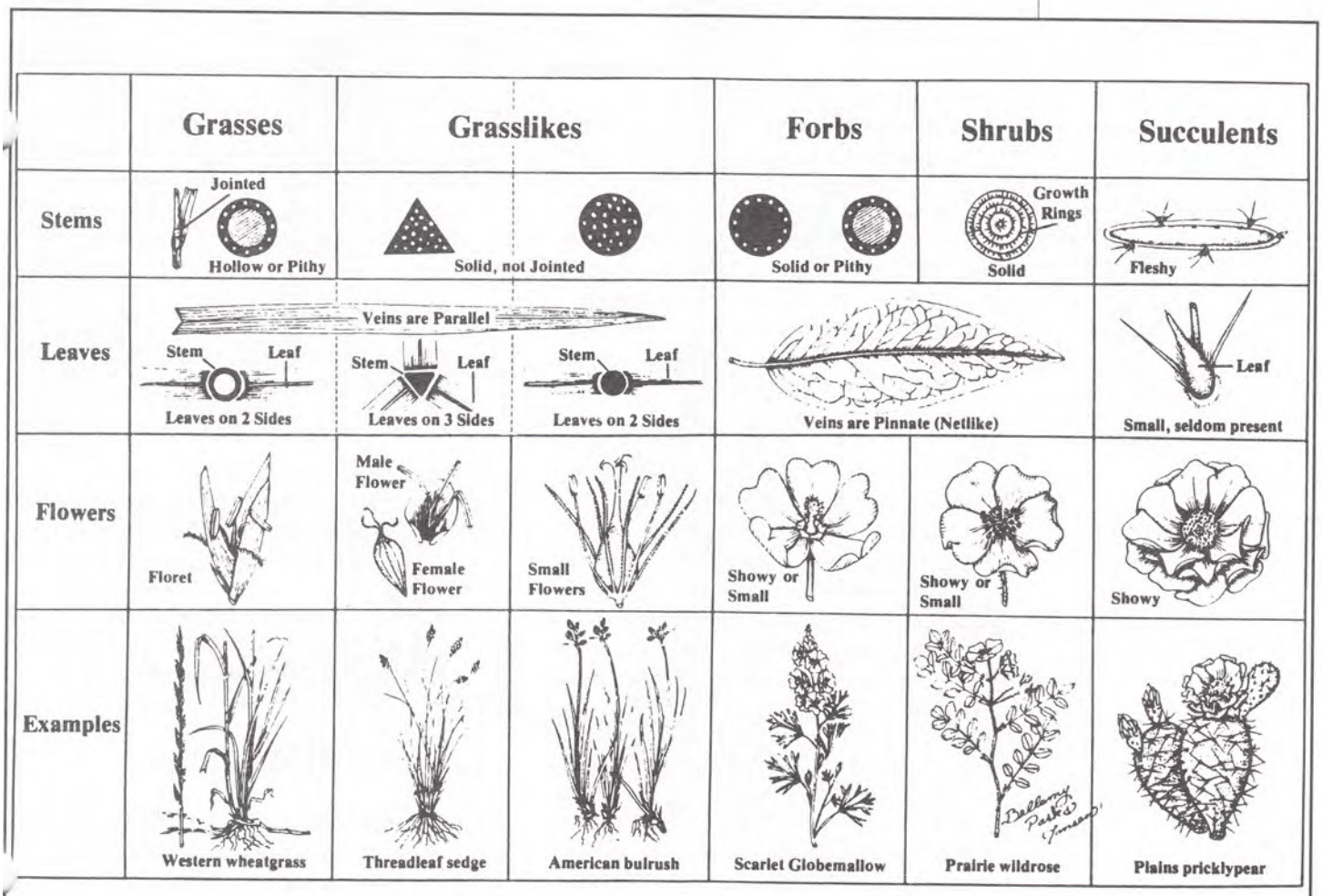


Figure 3. Comparison of plant groups.

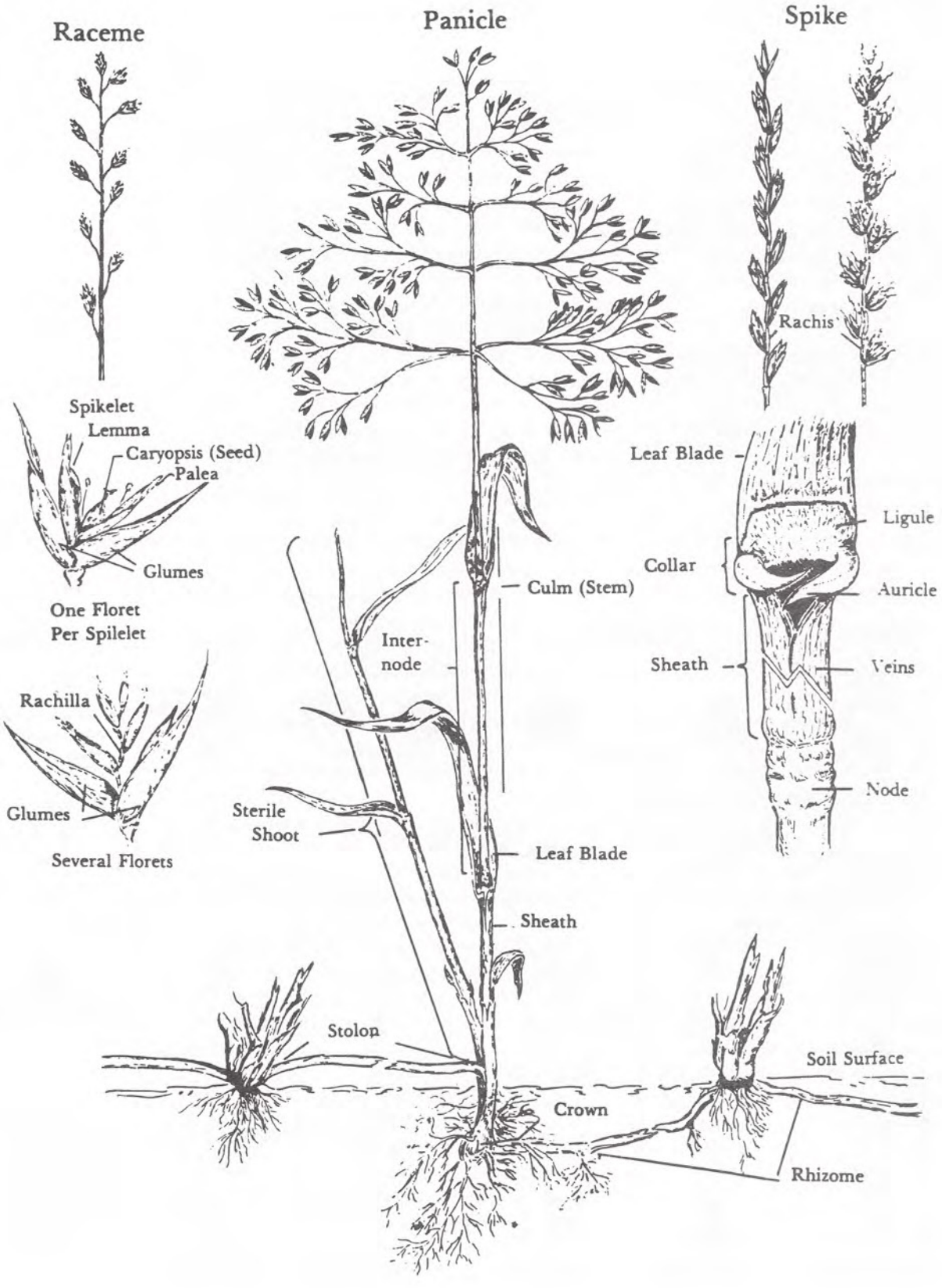


Figure 4. Parts of a grass plant.

Grasses

Grasses are plants with jointed stems (Figure 4). The stems are often hollow between the joints. Leaves are in two rows on the stem. Veins in the leaves are parallel. Examples are: western wheatgrass, downy brome, sand bluestem, and blue grama.

Grass-like Plants

Grass-like plants include the sedges and rushes. Some species are abundant in wet meadows while other species are found on uplands. These look like grasses but have solid (not hollow) stems. Stems of sedges are triangular, while stems of rushes are round. The stems have no nodes. However, the veins are parallel as in the true grasses. Examples are: threadleaf sedge and baltic rush.

Forbs

Forbs (wildflowers and weeds) have net-like veins in the leaves, and the leaves have various shapes (Figure 5). The growth above ground dies back every winter. The word "forb" is better than "weed" because weeds are usually thought of as pests. Many range forbs are not pests because they are attractive wildflowers and are excellent forage. Examples are: purple prairieclover, dotted gayfeather, stiff sunflower, and prairie coneflower.

Shrubs

These are plants with persistent woody stems which remain alive from one year to the next (Figure 5). New growth starts each spring from points above ground along the stem. Many shrubs do not have trunks like trees have but branch out from near the base of the plant. The portion of shrubs that animals may consume is called browse. Examples are: sand sagebrush, small soapweed, leadplant, and smooth sumac.

Succulents

Only a few species of succulents occur on Nebraska rangeland. The majority of these plants are cacti which remain alive above ground from year to year. The green portions of the plants are stems. Leaves are small and remain on the plants for only a few days. Sharp spines are modified leaves and cover the plants. Examples are: plains pricklypear, brittle cactus, and ball cactus.

In addition to being classified on the basis of their life form or growth habits, plants are also grouped in other ways:

Life Span

Annual plants live only one season. They do not grow a second year from roots or crowns but must start from seeds each year. Summer annuals germinate in the spring and complete growth and seed production by summer or fall. Examples are: annual sunflowers and sixweeks fescue. Winter annuals germinate in the fall and over-winter as seedlings before completing growth and seed production in the spring. Examples are: downy brome and woolly plantain.

Biennial plants live two years and flower only during the second growing season. Examples are: common eveningprimrose, musk thistle, and sweetclover.

Perennial plants live from year to year and produce leaves and stems for more than two years from the same plant. Examples are: sand bluestem, leadplant, leafy spurge, and threadleaf sedge.

Origin

Native plants are part of the original vegetation of North America. Examples are: big bluestem, stiff sunflower, and leadplant. *Introduced plants* are those which have been brought in from outside North America. Examples are: smooth bromegrass, alfalfa, and crested wheatgrass.

Growth Season

Cool-season plants make their principal growth during the cool conditions in spring and fall. Inflorescences appear in late spring or early summer. Examples are: prairie junegrass, needleandthread, Kentucky bluegrass, and western wheatgrass.

Warm-season plants generally make their principal growth during the frost free period and develop seed in the late summer or early fall. Examples are: prairie sandreed, sand bluestem, indiangrass, and blue grama.

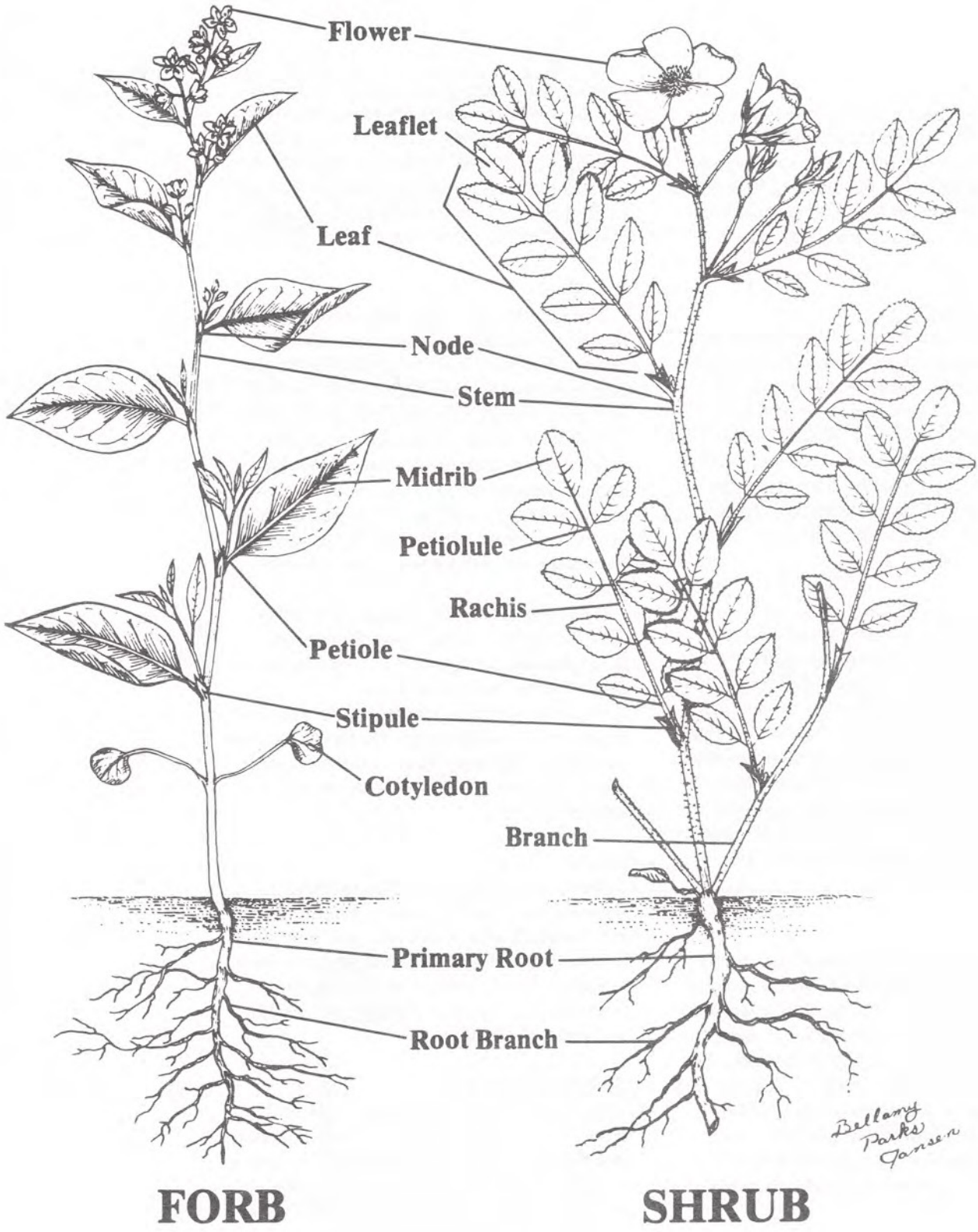


Figure 5. Parts of a forb and shrub.

Adaptation

Adapted plants are those which can successfully become established, grow, and reproduce under certain environmental conditions (rainfall, temperature, soil, etc.). Some plants can be adapted in one part of Nebraska and not adapted in another part of the state. Indiangrass is adapted to certain areas in central and eastern Nebraska which receive moderate amounts of rainfall, but it is not adapted to drier areas in western Nebraska. Plants adapted to a narrow set of environmental conditions are referred to as indicator species. For example, alkali sacaton occurs only in saline soils, and buffalograss only grows in fine-textured soils and not in sandy soils.

Scientific and Common Names

Each plant has two names: its scientific name and its common name. Some plants have several common names. The weedy grass commonly called downy brome in Nebraska is also called cheatgrass, bronco grass, military grass, and wildoats. So it is desirable to choose one common name as the standard name so that everyone will know what plant is being discussed.

The scientific name (sometimes called the botanical or Latin name) always has two parts. The scientific name for downy brome is *Bromus tectorum*. *Bromus* tells what genus the plant belongs to, and *tectorum* identifies the particular species within the genus. Each plant can have only one scientific name which is the same throughout the world.

As you learn more about range management, you may want to learn the scientific names of range plants. The scientific name is harder to learn, but professional rangeland managers everywhere use the scientific name to identify each plant.

Two Nebraska Cooperative Extension publications contain detailed information on range plants. Range and other natural resources managers should obtain Nebraska Range and Pasture Grasses (EC 85-170) and Nebraska Range and Pasture Forbs and Shrubs (EC 89-118) to aid in identification and understanding of range plants.

CHAPTER 5

THE PARTS OF A PLANT

Plants are like animals, because each is an individual. Some may be similar in appearance and some are vastly different. Even those that are similar in appearance have some characteristics by which they can be recognized as individuals. Each plant species has some part or characteristic which makes it different from all others. Each range plant has vegetative parts (stems, leaves, and roots) and flowering or reproductive parts.

Stems and Leaves

Stems serve as the superstructure for plants. They display leaves so they can absorb sunlight and usually terminate in an inflorescence. Stems carry water and nutrients from the roots to the leaves and carry manufactured carbohydrates from the leaves to the roots. Leaves develop from buds on the stems. Photosynthesis occurs in green leaves and stems.

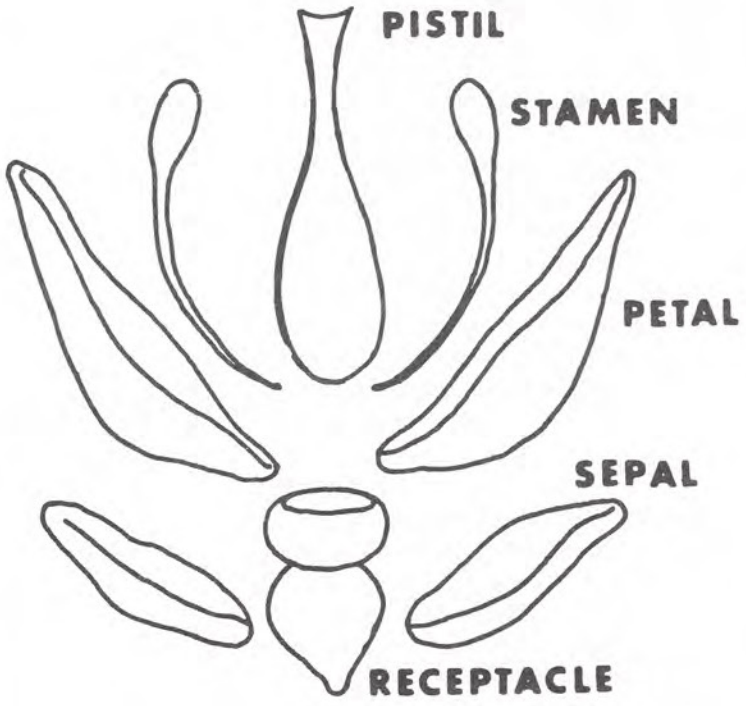


Figure 6. Parts of forb and shrub flowers.

Roots

Unlike stems, roots do not have joints or nodes. Some plants have roots that are highly branched. Others have a large, thick root called a tap root. The root's growing point is at the tip. The main functions of the roots are to absorb water and nutrients from the soil and to store energy. They also anchor the plants in the soil.

Rhizomes

Rhizomes (rye-zoms) actually are creeping underground stems. They have nodes and leaf-like scales and should not be confused with roots. Western wheatgrass, sand bluestem, and prairie sandreed all produce large rhizomes. Rhizomes store energy and can produce new plants.

Stolons

Stolons are similar to rhizomes except that they grow above ground. Buffalograss is a common Nebraska grass that has stolons. Stolons also store energy and can produce new plants.

Flowers of Forbs and Shrubs

The flower of most forbs and shrubs (Figure 6) include five basic parts: receptacle, petals, sepals, stamens (made up of anthers and filament), and pistil(s) (made up of the stigma, style, and ovary).

The *receptacle* is the broadened support or base of the flower. The reproductive organs are the *stamens* (male) which produce the pollen, and the *pistils* (female) which bear the seeds.

The reproductive organs are generally enclosed by two kinds of leaf-like structures (the *petals* and the *sepals*). The petals make up the inner-most and upper-most series of leaf-like structures and are usually brightly colored. They are sometimes irregular in shape, as in alfalfa and larkspur.

The sepals form the lowermost series of leaf-like structures and are generally green and much less conspicuous than the petals. The sepals are generally quite regular in shape.

The Grass Plant

The flowering parts of a grass plant are collectively called an *inflorescence*. The grass head is composed of the axis or "backbone" called the *rachis* (ray-kiss) and specialized units called *spikelets* {consisting of *glumes* and *floret(s)*}. A normal spikelet is composed of two glumes, the *rachilla* (central axis of a spikelet), and one to several florets (flowers or reproductive subunits of the spikelet).

Three general types of grass inflorescences are the spike, the raceme, and the panicle. In a *spike*, the spikelets attach directly to the rachis. In the *raceme*, each spikelet grows on the end of a short, slender branch. Spikelets in a *panicle* are connected to the plant by a branch which is branched two or more times.

Two glumes are the chaffy or leaf-like bracts at the base of the spikelet. The rachilla (ray-kill-ah) is the shortened axis of the spikelet upon which are borne the florets. The floret is the grass flower. Each grass flower has one pistil and usually three stamens.

Each fertile floret at maturity produces a seed. The seed is enclosed by two chaffy, leaf-like bracts known as the *lemma* and *palea* (pay-lee-ah). The bare seed without the lemma and palea is called the *caryopsis*. In many grasses (like oats and wheatgrasses), the lemma and palea remain with the seed after they ripen and fall. Others (like wheat and sand lovegrass) "shell out" and drop their caryopses without the chaffy lemma and palea.

The range manager and others interested in natural resources should know the vegetative as well as the floral parts of a grass plant. To learn these parts, look at the diagram on grass plant parts (Figure 4). Then learn to recognize these parts on living grass plants. Notice how these parts differ among grasses.

The grass stem is made up of *nodes* (joints) and *internodes* (the area between the nodes), and is usually hollow except at the nodes. It is usually called a *culm*.

The grass leaf is made up of two main parts: the *sheath* which fits closely around the stem and the broad, expanded portion known as the *blade*. The region where the sheath and blade join is called the *collar*. Often on the inside of the collar, and sticking up above the sheath, is a thin lining called the *ligule*. The ligule may also appear as a ring of hairs or may be entirely absent. Two earlike tips which often protrude from each side of the collar in some grasses are called *auricles*. The wheatgrasses are examples of grasses with auricles.

Identifying Range Plants

The first step in identification is to group plants into grasses, grass-like plants, forbs, shrubs, and succulents. Determine a plant's name by comparing the plant you have collected with word descriptions, drawings, and photographs. Such things as flower color, shape of the plant, and leaf peculiarities may be described in reference books and compared to an unknown specimen.

If the different parts of a plant are well-known, an identification key can be used. A key is an organized list of plants arranged according to their structure. Identify your local plants if possible. Help can be obtained from Cooperative Extension or Soil Conservation Service personnel, vocational agriculture teachers, or 4-H club leaders. Two University of Nebraska Extension Circulars valuable for identification of range plants are Nebraska Range and Pasture Grasses (EC 85-170) and Nebraska Range and Pasture Forbs and Shrubs (EC 89-118).

CHAPTER 6

RANGE PLANT FORAGE VALUES

All range plants are not of equal value. In addition to plant names, range managers must also know the relative value of plants. Many plants are valuable for livestock production, wildlife habitat, or soil stabilization. Some plants are not palatable or may be even highly poisonous. Threeawns, inland saltgrass, and stinkgrass are nearly worthless for grazing. Examples of grasses good for soil stabilization of blowouts are blowoutgrass and sandhill muhly. Some shrubs, such as western sandcherry and leadplant, are valuable for livestock and wildlife production.

Livestock usually prefer range plants when they are green, tender, and growing rapidly. They are the most nutritious at this growth stage. However, grasses such as blue grama and buffalograss cure well while standing and are desirable for winter grazing. Most annual plants are not desirable on rangeland in Nebraska because they mature quickly and are not readily eaten by livestock when mature. While they may be valuable for a short period, they may not appear at all in dry years when forage is needed the most.

Forage and Nutrient Value of Range Plants

Range livestock selectively graze different plants and plant parts. The *palatability* (or forage preference) of a particular range plant can be defined as how well it is liked by livestock. How readily animals eat a given plant also depends upon what other plants are available. Cattle normally graze only small amounts of sand sagebrush, but will consume more of it if other forage is not available. This is termed *relative palatability* (relative to what else is present).

The forage value of different plants is classed as good, fair, or poor. To determine forage value in Nebraska, first consideration was given to the palatability of the plant to cattle during the plant's growing season. The forage value of important range plants is commonly given in range plant handbooks such as Nebraska Range and Pasture Grasses (EC 85-170) and Nebraska Range and Pasture Forbs and Shrubs (EC 89-118).

When fed nothing else, cattle and sheep will gain weight far more rapidly eating alfalfa than eating the same amount of straw, because straw lacks certain nutrients that animals need. A diet of only winter range forage will not supply all essential nutrients regardless of how much the animals eat. However, these range plants may be used satisfactorily when the diet is supplemented with relatively small amounts of protein. The rate at which forage passes through the digestive system of animals increases as forage quality increases. Proper protein supplementation will increase the digestibility and rate of passage of winter range forage and allow animals to obtain the needed nutrients.

Livestock Nutrient Requirements

Cattle, sheep, and goats, as well as deer and elk, are ruminants. Their stomachs are divided into four major compartments. This special construction allows ruminants to use coarse feeds such as hay, range grasses, browse, and silage. However, ruminants are not able to digest the coarse materials by themselves. Bacteria and other microorganisms living in the digestive system help break down the forage. Horses do not have a rumen, but instead have a large pouch or caecum (see-kum) in the intestines where millions of bacteria break down the forage. Humans have only simple stomachs with one compartment.

A nutrient is any feed substance needed to support life. Range livestock need five classes of nutrients:

1. protein,
2. energy,
3. minerals,
4. vitamins, and
5. water.

Each of these nutrients supplies a special need in the animal's body. While one nutrient will seldom substitute for another, supplemental protein can improve the digestibility of energy sources by increasing the number of beneficial microorganisms in the digestive system of livestock. Livestock must consume enough protein and energy to meet the needs of both the microorgan-

isms and their own body requirements. Animal nutrient requirements depend upon stage of growth and reproduction. Protein and energy requirements nearly double when cows begin to produce milk at calving. Young animals require higher percentages of protein in their diets than older animals. Nutrient Requirements of Beef Cattle (EC 85-258) and Nutrient Requirements of Breeding Beef Cattle (G 78-389) should be obtained for a more detailed discussion.

Protein

Proteins are critical in the development of muscles, internal organs, hair, wool, and horns. Proteins are also of major importance in blood, other body fluids, and for reproduction. When the body has enough protein, any surplus protein can be used for energy, but this is inefficient when compared to digestion of other energy sources.

Energy

Much of the energy an animal needs comes from carbohydrates and fats. Carbohydrates make up about 75 percent of the dry matter of range plants. Sugars, starches, and cellulose are carbohydrates. Fats furnish about 2.25 times as much energy per pound as carbohydrates. Although fat content is generally low in most range forage, it may be quite high in supplemental feeds such as cottonseed meal or soybean oil meal.

Minerals

Minerals are important in all animal tissues. Calcium and phosphorus make up the major portion of bones and teeth and are needed in nearly equal amounts. Minerals needed in very small or trace amounts include iron, copper, iodine, cobalt, and others. These are generally available in adequate amounts in range forage. Salt provides needed sodium and chlorine. More information may be found in Mineral Nutrition of Range Beef Cattle (G 77-350).

Vitamins

Although vitamins are needed in very small amounts, they must be present for animals to live and grow. Vitamin A is important in keeping body membranes healthy, in fighting diseases, and for reproduction and growth. Vitamin A appears in forages as carotene, which is converted in the animal's body to Vitamin A. Vitamin D is required in bone formation and for proper use of calcium and phosphorus. Vitamins needed by ruminants are generally sufficient in green range forage or can be manufactured by bacteria in the rumen. More information may be found in Vitamin Requirements of Beef Cattle (G 77-363).

Water

Water is an important substance, because about 75 percent of both animal and growing plant tissue is composed of water. Water is used to transport nutrients from one part to another in plants and animals. Water is also important for digestion, controlling body temperature, and eliminating waste products. Additional information may be found in Water Requirements for Beef Cattle (G 77-372).

Seasonal Changes in Forage Quality

The amount and digestibility of nutrients in range forage changes dramatically over seasons (Figure 7). Range forage is high in digestible nutrients during rapid spring growth. Grazing animals generally need no supplemental feed at this time. As the plants begin to mature and dry, the amount and digestibility of many important nutrients decline, and supplemental feeding is often needed. Therefore, the amount of supplementation depends upon nutrient availability and the specific needs of the livestock.

Protein, phosphorus, and carotene (Vitamin A) content of range grasses follow similar patterns throughout the year. All three are high in rapidly growing grasses, but low in mature grasses. Fiber content increases as plants mature. Rainfall in the fall may wash out many soluble nutrients.

Differences in nutrient content also may be found among plants. Cool-season grasses, such as wheatgrasses, grow early in the spring and again in the fall if soil moisture is adequate. During these growth periods, they are higher in protein, phosphorus, and carotene than warm-season grasses, such as

the bluestems. The nutrient content of warm-season plants is highest during June, July, and August. Shrubs generally maintain higher levels of protein, carotene, and phosphorus than grasses during the winter.

Weather conditions affect the nutrient content of range plants. Livestock will often perform better on rangeland during years of low rainfall, providing ample forage is available, than during wet years. Soil fertility also affects the nutritive content of range and pasture forage. For example, when soils are low in phosphorus, phosphorus content of plants may also be low.

Supplementing the Diet

How does one know what supplements to feed to range livestock during the winter? Supplements should be based on the kind and amount of nutrients livestock obtain from range forage relative to their needs. Remember, supplementation means to supply nutrients that are missing or low in range forage. These supplements are fed to correct a deficiency in the range forage rather than to replace it.

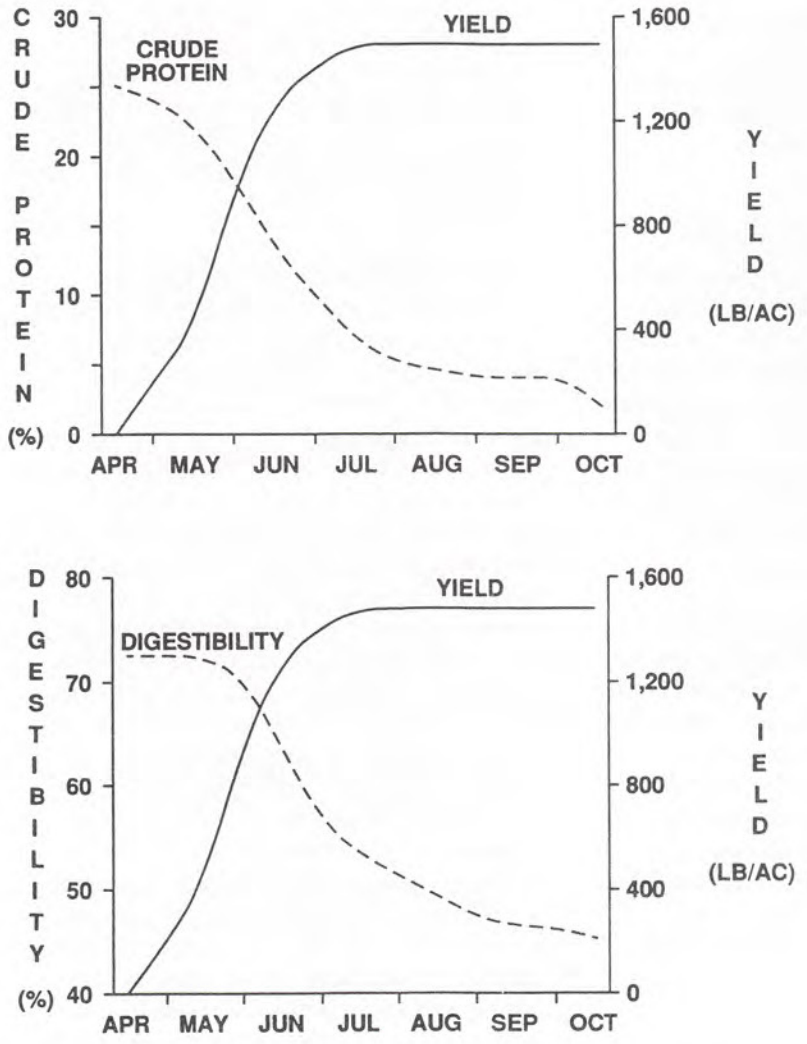


Figure 7. Seasonal patterns in crude protein, digestibility, and yield of western wheatgrass from April to October.

The following is a guide for supplementing range livestock:

1. Supplement deficiencies in the diet. It is seldom a good practice to supply nutrients for which a dietary need has not been proven or for which a deficiency would not be expected in range forage.

2. Feed supplements that are economical. Supplements may increase weaning weights and calving percentages, but not necessarily enough to be profitable.

3. Feed supplements so that each animal gets its share.

4. The method of feeding supplements must keep range animals moving and well distributed over the range.

Four nutrients which may be low in range forage on winter range are protein, phosphorus, Vitamin A, and energy. Do not forget that water and common salt are nutrients also. Fresh water and salt should be supplied to range livestock throughout the year. Cattle may drink 8-15 gallons of water each day.

Diets high in mature grass may include ample energy but are usually low in protein, phosphorus, and carotene (Vitamin A). If a moderate part of the diet consists of browse, less protein and phosphorus may be needed from supplemental feeds. Diets containing larger amounts of browse often have enough Vitamin A but may be low in energy.

Cattle can store enough Vitamin A in the liver to last three to six months. However, this may not last until spring when grasses start growth.

Supplemental feeds commonly fed to range cattle that are high in phosphorus include alfalfa, bone meal, dicalcium phosphate, cottonseed meal, and soybean meal. Protein supplements commonly fed include alfalfa, cottonseed meal, and soybean meal. Supplemental feeds high in energy include corn, sorghum, oats, and various milling by-products. All fresh, green, leafy forages are high in carotene.

CHAPTER 7

POISONOUS PLANT PROBLEMS

Some livestock are lost each year in Nebraska from plants such as lupines, larkspurs, locoweeds, groundsels, water hemlock, and milkweeds (Figure 8). Livestock losses from poisonous plants tend to be less statewide for Nebraska than for states to the west. However, serious localized losses do occasionally occur in western Nebraska.

Figure 8. Common poisonous plants.

Toxic or poisonous plants cause biochemical or physiological changes in livestock following consumption. Toxic compounds are present in over 200 range plants native to the grazing lands of the United States. Toxic compounds may be produced in plants or absorbed from the soil by plants. Death is the loss most often associated with poisonous plants. Some poisonous plants, however, do not kill the animal but reduce production from the animal and/or its offspring. Nonlethal losses include lower weaning weights, reduced percent calf or lamb crops, reduced longevity of the breeding herd, and unmarketable animals due to birth deformities.

Whenever sick animals are examined by a veterinarian and the diagnosis is not specific, the possibility of poisoning by plants should be investigated. If the producer or veterinarian is uncertain of the species in their area, an individual with training in plant identification should be contacted.

A clear diagnosis of plant poisoning is usually based upon evidence of grazing poisonous plants, type of animals affected, clinical signs of toxic reactions, season of the year, and the circumstances under which losses occur. Once it is determined that a problem exists, either through identification of the plant or actual livestock losses, specific management programs can be implemented to correct the problem.

Grazing management practices are important in reducing livestock losses from poisonous plants. As the desirable forage plants decrease with declining range condition, grazing animals may consume proportionately larger amounts of toxic plants. Animals in poor physical condition from grazing depleted rangelands also tend to be more susceptible to plant poisoning. Maintaining rangelands in high condition reduces, but does not eliminate, the potential of losses from poisonous plants. Groundsels, larkspurs, lupines, locoweeds, water hemlock, and milkweeds are often present on rangelands in good to excellent condition. While they may compose a small percentage of the plant populations, unusual climatic conditions, such as drought or late snowfall, can cause a substantial increase in the potential hazard.

Ranchers who can recognize poisonous plants and are aware of the potential affect of climatic variability can modify their livestock management to reduce the hazard. Specific actions and concepts include:

1. If any livestock show symptoms of poisoning, all animals should be removed from the pasture immediately.

2. Stock turned out too early in the spring, before grass has adequate growth, may consume early developing poisonous plants.

3. With few exceptions, the known dangerous plants are not palatable to stock and must be consumed in relatively large quantities to be toxic. Only a few poisonous plants, such as larkspurs, are relatively palatable to livestock; and even fewer are addictive, such as locoweeds.

4. Use caution when handling livestock in areas known to have poisonous plant problems. Hungry livestock may fill themselves on the first green forage they find, regardless of the palatability or forage value.

5. Cattle transported in from other areas are generally more susceptible to poisonous plants than are local cattle.

6. All animals do not exhibit the same forage preference or susceptibility to poisonous plants. Stock the kind of animals least likely to be poisoned or graze during the season with the lowest potential for poisoning. For example, sheep are seldom susceptible to larkspur poisoning. Cattle can usually graze areas with larkspur with little trouble after the seeds have fallen from the larkspur plants.

7. Adequate water should always be provided for livestock because of the impact of thirst on consumption. Feed intake of thirsty animals is reduced until their thirst has been quenched. Once that thirst is quenched, they often eat large quantities of any plant that is available.

8. Lack of salt or minerals may be associated with livestock grazing poisonous plants. Livestock with inadequate minerals may develop a deprived appetite and eat abnormally. Locoweed poisoning is an exception because feeding protein and mineral supplements have not reduced losses.

9. Areas within or adjacent to heavy infestations of poisonous plants should be avoided when establishing salt and supplement stations.

10. Spraying poisonous plants with herbicides may increase both their toxicity and palatability. Avoid herbicide drift on poisonous plants in adjacent pastures where livestock are grazing. Grazing should be deferred until plants have dried or other vegetation has grown to provide a substantial forage source. This generally takes a minimum of three weeks.

For more information, obtain a copy of "Plants Poisonous to Livestock in the Western States", USDA Agriculture Information Bulletin 415, which contains photographs of the most common poisonous plants in Nebraska and the University of Nebraska Extension publication Nebraska Poisonous Range Plants (EC 85-198). Both can be obtained from your local extension office.

CHAPTER 8

HOW RANGELAND DEVELOPS

Soils and plants on rangeland developed together over a long period of time. Range plants respond to the development of soils, but they also affect development by adding organic matter and reducing erosion.

Soil is made up of mineral matter, organic matter, air, and water. It is a product of the action of climate and vegetation upon rock material. Each stage of soil development from bare rock to a loamy soil is able to support a particular group of plants and accompanying insect and animal populations.

Plant Succession

Lichens and mosses are able to grow on solid rock. They help the weather factors (wind, rain, freezing, and thawing, etc.) to gradually break down solid rock into smaller particles. They also add organic matter. After many years, this makes it possible for annual forbs and grasses to establish. As the soil continues to develop, a few perennial grasses and forbs are able to grow.

It takes thousands of years for productive rangeland to develop. This process is termed *primary succession*. Finally, the plants on the rangeland are in balance with the climate, many organisms, and soils. This is referred to as the *climax* stage. Climax vegetation is a mixture of plant species which make the best use of the available soil nutrients, soil moisture, and energy from the sun. It is the highest type of vegetation that can exist under current conditions. As conditions change, such as during drought, the vegetation may change, but it progresses towards climax as weather conditions return to normal.

The range manager has little control over primary succession because it may take thousands or even millions of years to occur. *Secondary succession* is the process of change in plant and animal communities on land that has been occupied by climax vegetation destroyed by cultivation or degraded by improper grazing (Figure 10). The soil has already developed beyond what is necessary to support the current vegetation. The range manager is manipulating secondary succession with attempts to improve the vegetation.

Water and Mineral Cycles

To keep range soils productive, nutrients have to be returned to the soil. At the end of the grazing season, some vegetation should remain on the rangeland. This remaining vegetation is not wasted. Leaves and stems dry, drop to the ground, and become mulch or litter.

Litter protects the soil against erosion caused by wind and water. Plant materials break up, decay, and become a part of the soil. Roots of plants also die and contribute organic matter to the soil. Millions of small living plants and animals called *soil microorganisms* occupy the soil. These organisms are constantly breaking the organic matter into nutrients that can be used by the range plants.

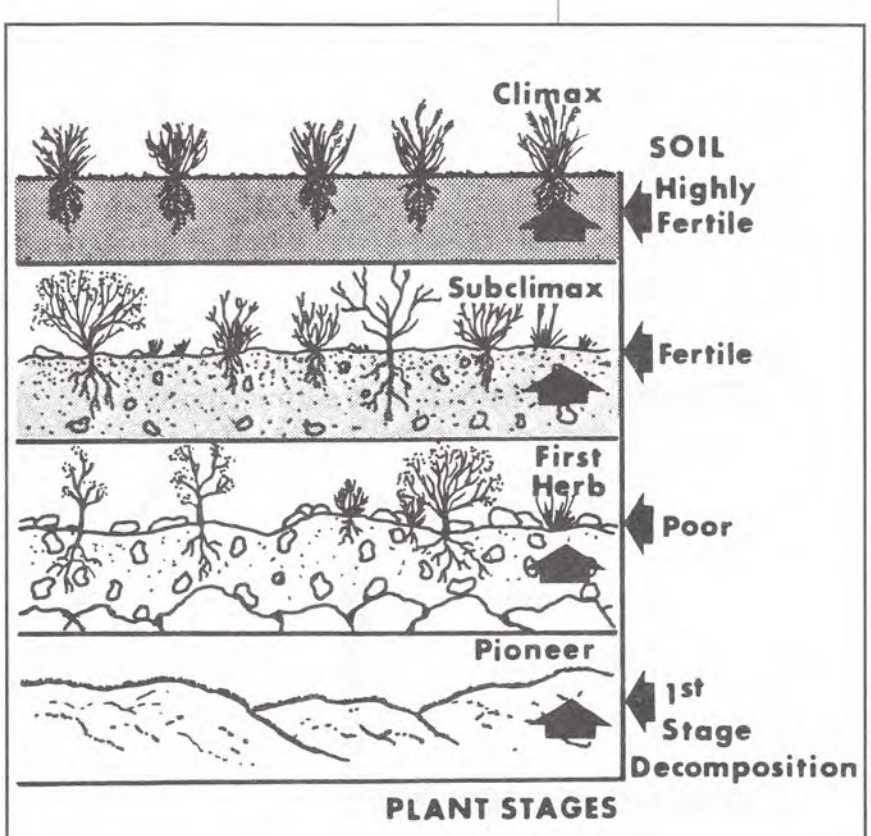


Figure 9. Stages of rangeland development.

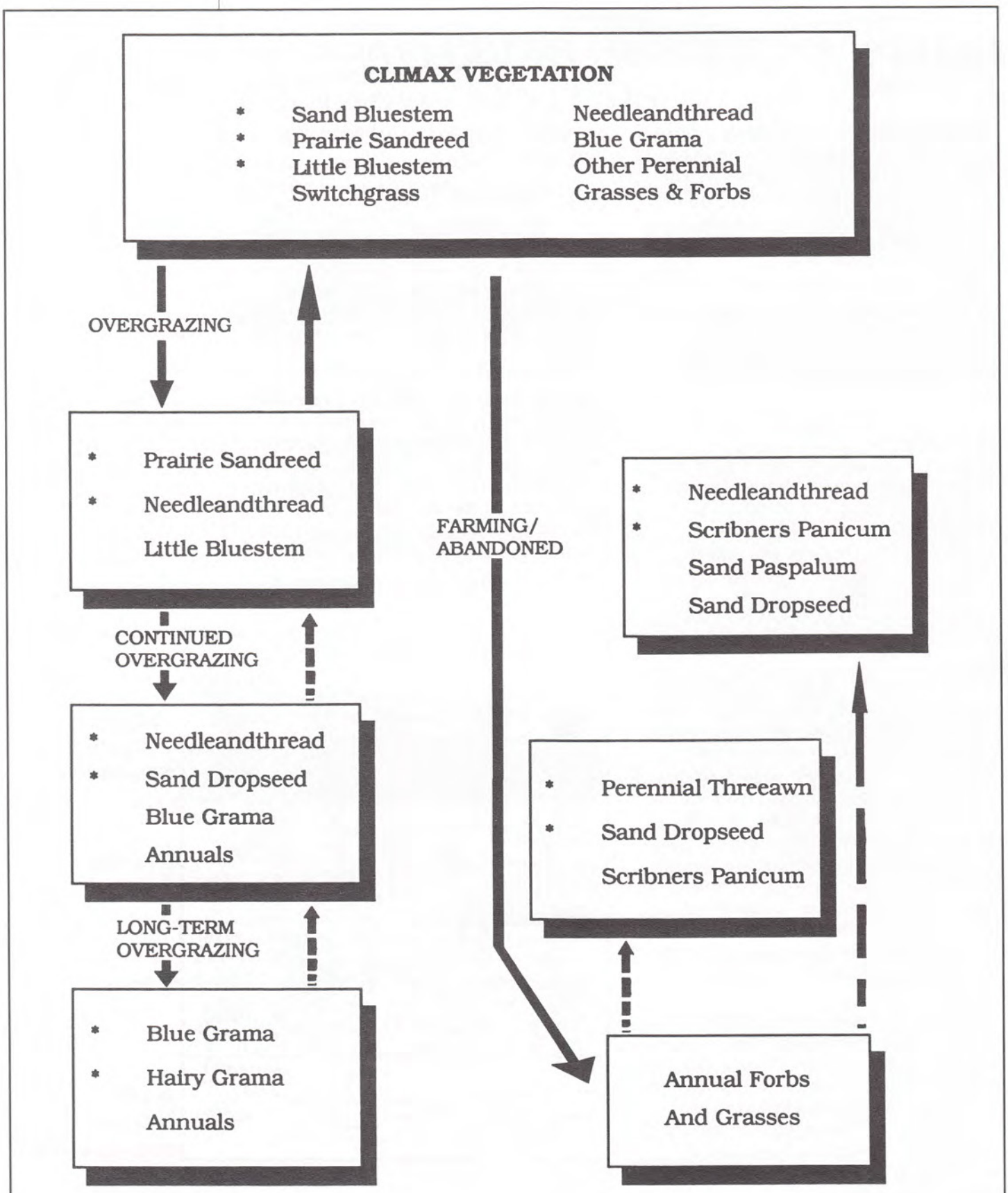


Figure 10. Plant communities associated with overgrazing or abandoned farmland on sandy range sites in Vegetation Zone II. Asterisks (*) indicate dominant species. Dotted lines represent slow rates of recovery.

The wise range manager looks for ways to reduce surface runoff of water, because water is generally the major limiting factor to plant productivity on rangeland in Nebraska. One of the best methods is to maintain a cover of vigorous range plants. Perennial grasses are best, but all plants help reduce surface runoff. The vegetation protects the soil from the erosive force of falling raindrops. Plants and litter slow the movement of water over the soil surface, permitting more water to soak into the soil. Proper management should allow nearly all of the soil moisture to cycle back out of the soil through the growing plants rather than be lost through evaporation or deep percolation (Figure 11). In addition, a good cover of plants and litter reduces moisture losses due to evaporation from the soil surface.

Water lost by surface runoff may be of great concern to the range manager. If water runs off quickly after a rain rather than seeping into the soil, less water is available for plant growth. Not only is this water lost to the plants, but it may also carry away valuable top soil. Soil and water losses may slow or reverse the process of soil development.

Minerals, such as nitrogen, are added and removed from the ecosystem on a cyclic basis (Figure 12). For example, nitrogen is added when microorganisms change

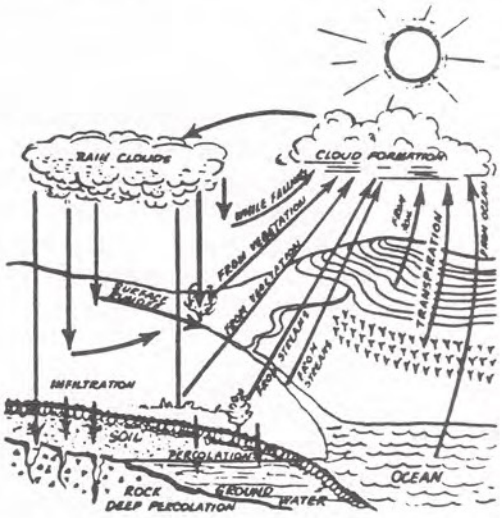


Figure 11. Water cycle.

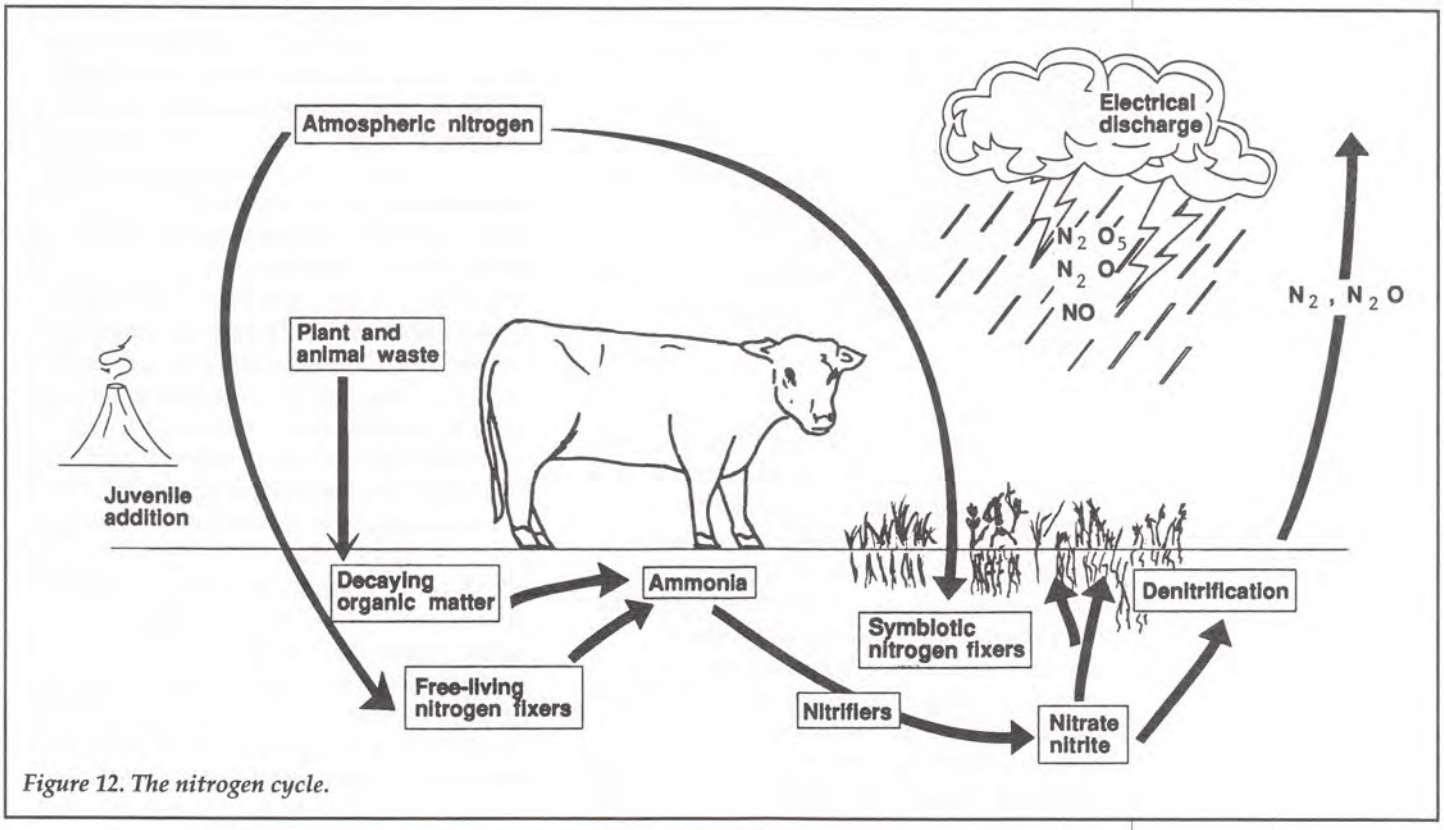


Figure 12. The nitrogen cycle.

atmospheric nitrogen into forms that plants can use. Precipitation during electrical storms adds nitrogen to the soil. They are continually being used and reused by organisms varying in size from cattle and horses down to microorganisms. Plants are continually moving minerals from the soil to their tissues. Fire and erosion may remove minerals. Plants are consumed by the animals, and the animals deposit manure and urine back onto the land. Animals also trample plants placing them in contact with soil microorganisms. The microorganisms complete the cycle by making the minerals available for plant uptake. An active mineral cycle is necessary for optimum sustained production from rangeland.

Energy Flow

The range ecosystem is characterized by a continual flow of energy through the system. Unlike water and minerals, energy does not cycle. The energy comes from the sun and an efficient range ecosystem will "capture" that energy through the process of photosynthesis. Carbon, from the gas carbon dioxide, is converted into numerous carbon compounds which are the main components of plant tissue. When plants are consumed some of the energy is lost to heat. That is why fewer pounds of beef than hay are produced on the same amount of land. The amount of energy captured and its flow through the system will be greater on well managed rangeland near climax vegetation than on poorly managed, overgrazed rangeland.

Range Sites

Before ranchers can decide if their rangeland is producing its maximum amount of forage, they must first determine what it is capable of producing. Different areas of rangeland have different soil types and growing conditions for plants. Rangelands with similar soils and climate support similar vegetation. These are called *range sites*. Each range site produces similar kinds and amounts of plants under natural or climax conditions. Different range sites often require different management. The potential climax vegetation of each range site is the standard against which present condition of a range is judged. A discussion of range sites and examples are given in the Range Judging Handbook for Nebraska (EC 84-109). A more detailed description is found in the Soil Conservation Service Field Office Technical Guide: Nebraska Range Site Descriptions and Guide for Determining Range Condition and Suggested Initial Stocking Rates (August, 1981) available at local SCS offices. Some of the factors that determine the kinds and amounts of plants rangeland can produce are climate, slope, soil characteristics, and depth to water table.

Climate. Amount of precipitation greatly affects rangeland productivity. Average annual rainfall on Nebraska rangelands varies from more than 36 inches in eastern Nebraska to less than 13 inches along the Wyoming border. Length of growing season (frost free period) varies from 120 days in extreme western Nebraska to more than 160 days in the eastern part of the state. Even under ideal moisture conditions, extreme temperatures (high or low) will normally decrease forage production.

Slope. Forage production on a steep slope is much less than on a gentle slope. Water runoff from a steep slope is usually high, unless the soil is sandy, causing the soil to be drier. Soils on steep slopes are shallower and less developed than on gentle slopes, and erosion is often greater. Adjacent soils on overflow bottomlands may be deep and fertile. Areas with deep, fertile soils are able to produce much more forage than areas where little soil has developed. Grazing steeper slopes is more difficult, and care must be taken that grazing does not cause steep slopes to erode.

The direction of slope also is important. The kinds and amounts of plants on the north side of a hill differ from those on the south. Slopes facing south receive the most sunshine. As a result, south-facing slopes are not only warmer and drier but also usually have shallower, less developed soil and are less productive. A steep slope makes a southern exposure even more dry.

Soil Texture. Soil texture refers to the size of the soil particles. Soil texture is determined by the percentage of sand, silt, and

clay particles in the soil mixture. Sand is the largest sized particle and clay the smallest. Soils are a mixture of different sized soil particles.

Loamy soils (soils of intermediate texture) are the most suited for forage production, because they take water easily and have good moisture holding capacity. Moisture penetration in clay soils is slow, and runoff may be high. Sands allow water to penetrate quickly but have a low water holding capacity and lower fertility.

The name given to a soil is based on the size of particles that are most abundant (Figure 13). For example, a very fine sandy loam means that the texture was mostly silt and clay with a considerable amount of very fine sand. A loamy fine sand would be a soil consisting mostly of fine sand with some silt and clay.

Soil Structure. Soil structure refers to the arrangement of the soil particles, whether they clump (aggregate) together or remain single. The most productive soils are those in which the soil particles clump together. This allows water, air, and roots to readily move through the soil and gives the soil good water and nutrient-holding capacities. Well aggregated soils are less susceptible to wind and water erosion.

Root Zone Depth. The depth to which roots can grow before reaching a layer they cannot penetrate affects plant productivity. Restrictive layers may be rock, shale, or gravel. Cultivated soils may have a hard pan due to compaction, but this is generally not a problem on rangeland. A large amount of top growth results from a large amount of roots. A deep soil allows maximum growth of roots. Most of the soils in Nebraska are relatively deep.

Water Table. Range sites with a water table within several feet of the surface produce a different kind and amount of vegetation than do sites with deep water tables. Water tables in many low places in the Nebraska Sandhills are a few inches to a few feet below ground level. A high water table increases forage production from two to four times and increases the proportion of tall grasses, sedges, and rushes resulting in a high organic matter content of the soil. Land continually covered with water with emerged vegetation is referred to as marsh and is not considered to be rangeland.

Alkalinity and Salinity. Alkaline soils contain relatively large amounts of sodium salts, and saline soils contain relatively large amounts of nonsodium salts, such as calcium and magnesium. Soil with poor drainage and high water tables often becomes salty. On these sites, evaporation of the water leaves the salts on the ground surface. If the salt accumulation is slight, the amount of total forage produced may be high even though salt tolerant plants predominate. If the salt accumulation is high, no vegetation may be able to grow and the ground may be bare. Most of these sites are located in river valleys.

The Soil Conservation Service office can provide a copy of the soil survey for your county. The soil survey contains maps and text that will show the kinds of soils that occur on your rangeland and will explain their properties.

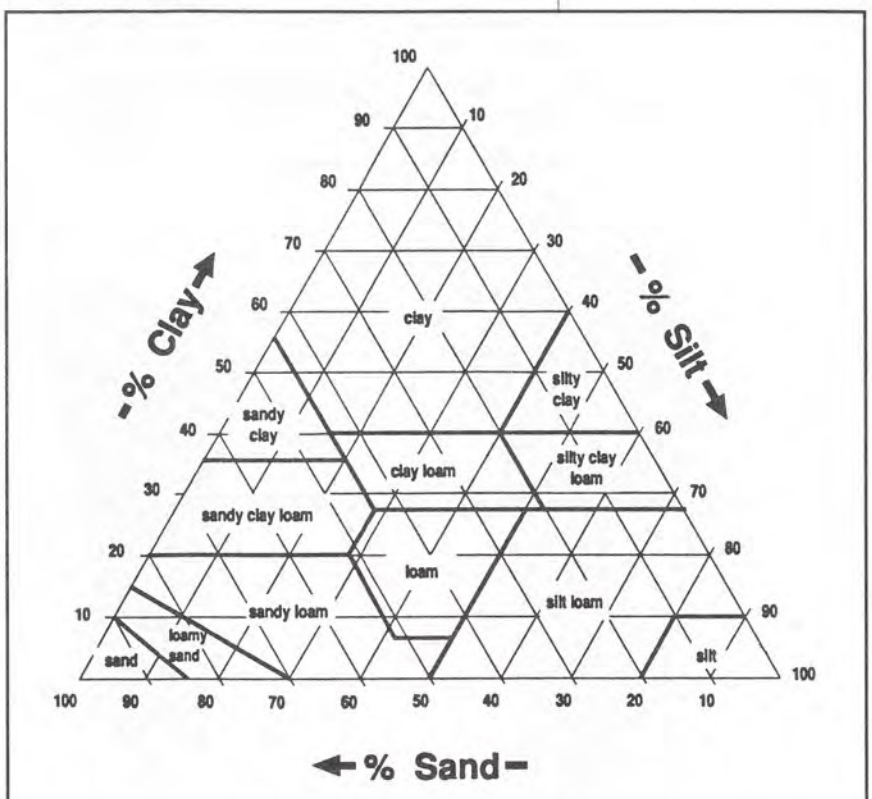


Figure 13. Percentages of clay (below 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.5 to 2.0 mm) in the basic soil textural classes.

CHAPTER 9

HOW GRAZING AFFECTS PLANTS

Effects on Individual Plants

Range plants on highly productive sites tend to loose vigor and their productive ability if an adequate amount of foliage is not removed. But, enough vegetation must be left throughout the growing season so that plants can convert energy from sunlight into carbohydrates to build up energy reserves in roots and crowns.

The phrase *"take half and leave half"* of the annual forage production from the good and fair forage plants has been used by range managers. More than one-half may be taken if the plants are vigorous, if soil erosion will not result, and if the rangeland is in a planned grazing system. If erosion is not a problem, 60 to 65 percent of the current year forage crop may be removed if grazing is limited to the winter. However, using one-half or more of the current year's production may be too much in times of severe drought. Season and duration of grazing use are just as important as the amount of forage removed. If environmental conditions are favorable for plant growth, slightly more than one-half can be removed when a pasture is grazed for a relatively short time (a few days to a few weeks) as opposed to continuous use through the summer grazing period.

Range plants produce enough foliage to support grazing without permanent harm to the plant. Only when too much of the plant is removed does the plant suffer. If forage plants are grazed and then allowed to make adequate top growth for root recovery, they won't be seriously affected. Plants are more likely to be harmed as the amount and frequency of grazing on the same plants increase.

When vegetation is closely grazed, the roots are reduced also (Figure 14). A deep root system helps range plants to be productive and compete for limited soil moisture in most years and survive when drought occurs. Since heavy grazing (repeated severe defoliation with inadequate recovery time between defoliations) greatly reduces root development, defoliated plants are more readily and severely injured by drought. Continued heavy grazing can kill plants and also reduce the number of young plants available to replace normal death losses of the older plants. On the other hand, research indicates that properly grazed plants are as productive as ungrazed plants.

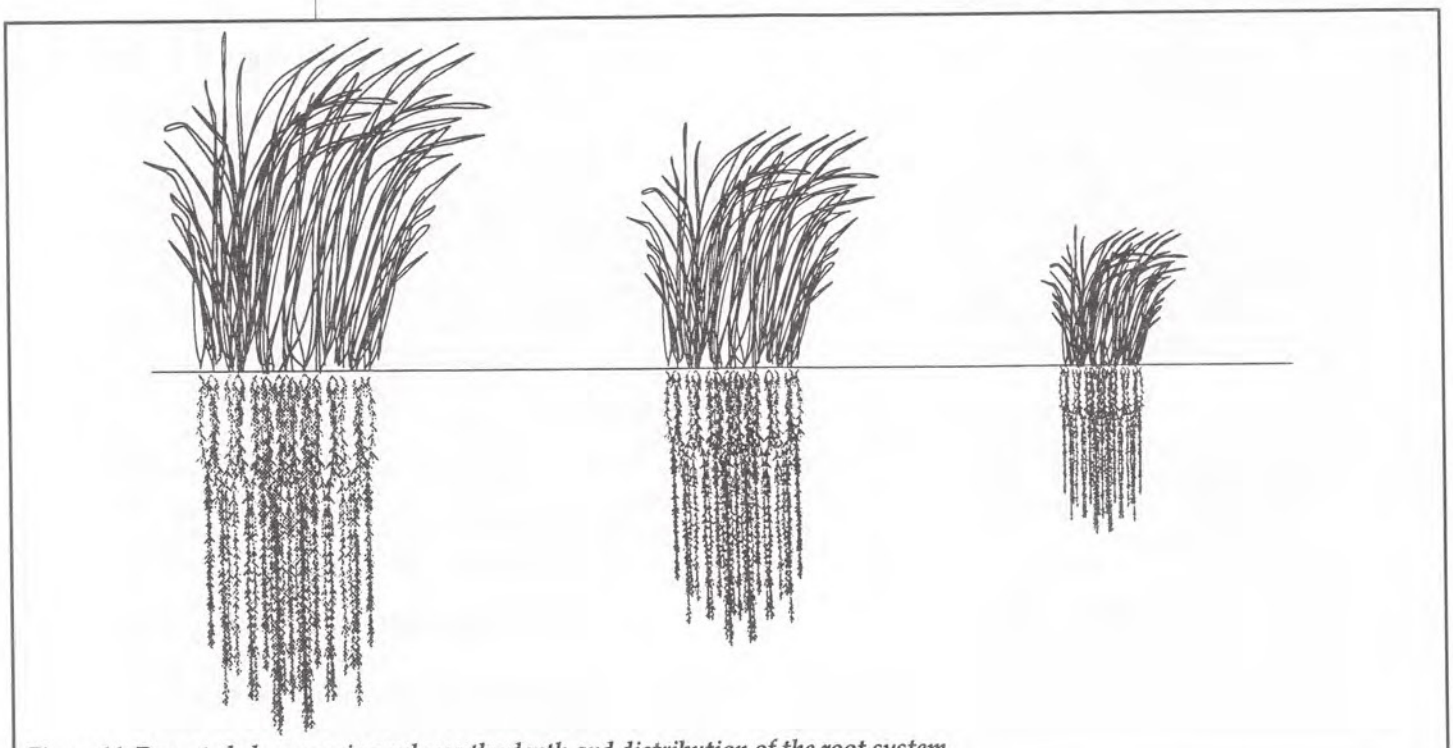


Figure 14. Repeated close grazing reduces the depth and distribution of the root system.

Grasses not only tolerate grazing, but may be stimulated to produce additional forage by grazing. The terminal bud, or growing point, of the grass plant is close to the surface of the ground until stems begin to elongate. If the terminal bud of the grass plant is removed and environmental conditions are favorable for plant growth, other buds at the base of the stem will develop new shoots to take the place of the original stem.

The location of growing points of the grass leaf also provides tolerance to grazing. They are located at the base of the blade near the collar and at the base of the sheath. If a grass leaf tip is grazed before it is fully developed, it will continue to grow from the base of the blade or sheath. The ends of grass blades remain blunt after grazing even though the blade is still growing. If a grass leaf is grazed when fully developed, it will not grow any more.

Effects on Plant Communities

Plants are grouped in natural communities. Although plants live together in a community, they compete with each other for moisture, sunlight, and minerals. Taller plants and those with the most extensive root systems have a competitive advantage until grazing becomes excessive.

All range plants are not affected the same when rangeland is grazed. Plants that animals like best are grazed first, while the less palatable plants often go ungrazed. If the palatable plants are defoliated repeatedly with inadequate recovery time between defoliations, their ability to compete for moisture and nutrients with the unpalatable, ungrazed plants around them will be reduced. Some species of range plants can withstand heavier grazing than others. These include species that are short, have many vegetative shoots as compared to reproductive shoots, and/or rapidly reproduce vegetatively.

Range plants in Nebraska are sometimes grouped by how they respond to heavy, continuous, summer grazing by livestock. The concept of grouping plants into these categories may be less important to managers using short duration and other advanced grazing practices. The three groups are decreasers, increasers, and invaders.

Decreasers are native, perennial range plants that decrease in number under heavy grazing, because they are highly palatable to livestock.

Increasers are range plants which increase in number as the decreaser plants are weakened and die. While they are perennial plants, they are usually less palatable than the decreasers. In some cases, as with the short grasses such as blue grama and buffalograss, the plants act as increasers because they have a greater grazing toler-

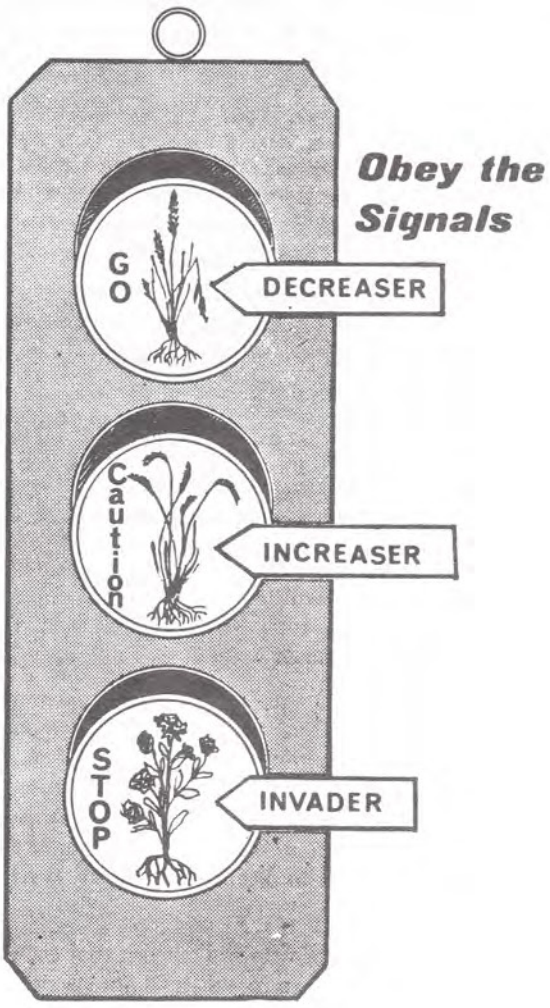


Figure 15. Management decisions are heavily based on the plants present.

ance rather than being less palatable than taller plants.

Invaders are undesirable range plants that invade and take over a range when the vigor or number of decreasers and increasers has been reduced. Plants in this group are usually annuals, not present in climax vegetation, or are there only in small amounts (2.5% or less).

Most people think of the same thing when they see the different colors of traffic signals. Each has its own meaning. Green means go. Yellow means caution. Red means danger, stop! These same colors and their meanings can be applied to range plants. We might call the decreaser plants the "green group plants", the increaser plants the "yellow group plants", and the invader plants the "red group plants". An ample supply of decreasers (green group) on the rangeland indicates your grazing program is going well. Increasers (yellow group) are the ones to watch with caution. If the amount of forage production by increaser species is getting larger each year at the expense of the decreasers, a change in management may be necessary. The invaders (red group) clearly mean "DANGER" on the rangeland in terms of site stability and forage production.

The number of different kinds of desirable plant species is an important characteristic of rangeland. This is called species diversity. High species diversity of desirable plants increases management alternatives and often site stability. Combinations of growth seasons provide assurance of forage production with differences in precipitation patterns between years. Diversity also provides an opportunity for animals to graze different species at the season progresses. This tends to reduce the frequency of grazing on an individual species and provides a high quality diet for the grazing animals over more of the growing season. High species diversity also benefits many wildlife species. Many wildlife species depend more heavily on forbs and shrubs than do cattle. For example, it takes over 100 pronghorn antelope to eat as much grass as a single cow. Due to little diet overlap, wildlife and livestock may compete little for forage.

Eliminating the cause of range deterioration may restore the vegetation in a few years. The cause of deterioration in most cases is improper grazing management. Prolonged drought, extreme temperatures, insect attacks, or fires at the wrong time of the year also may play a part. Management practices that enhance plant vigor during and following drought are discussed in Drought Management on Range and Pastureland (EC 91-123). If no desirable plants remain, artificial seeding may be desirable if economically feasible. If soil erosion occurred along with the deterioration of the vegetation, permanent damage may have occurred to the rangeland.

CHAPTER 10

RANGE CONDITION

Range condition indicates how close a range site is to producing its potential. It is a measure of the current species composition and production as compared to what the range site is naturally capable of producing. In effect, it is nature's recorded history of a range. It helps describe to the range manager the effects of past use of the range and the result of management practices. Range condition can serve as a guide to how much improvement is possible. Experience in range judging helps the range manager determine range condition.

Standard classes for range condition are excellent, good, fair, and poor. A range in excellent condition has maximum grazing capacity and produces a higher percentage of highly palatable forage species than lower condition range and shows evidence of efficient mineral and water cycles and energy flow. The vegetation is diverse and is at or near climax. Maximum sustained production of livestock products will generally occur on these sites.

Excellent range condition also has greater water absorption by the soil and is less susceptible to erosion. Rangeland in excellent condition supports a greater diversity of animals, birds, insects, and microorganisms.

Determining Range Condition

Range should be judged on the basis of how closely it resembles the climax situation for the range site. The farther a range departs from the ideal, the lower it is placed in range condition. The methods used to determine condition are explained in the Range Judging Handbook for Nebraska (EC 84-109).

Trend in Range Condition

It is important that any definite change in range condition be recognized. The pattern in range condition over time is called trend. It indicates whether the range is improving, deteriorating, or remaining about the same. Trend is more difficult to evaluate than range condition. A single visit to a range can only serve as an estimate of range trend. Several visits over several years are needed to evaluate trend accurately. Relative vigor of decreasers and increasers, relative abundance of invaders, and soil movement are the best characteristics to use in evaluating range trend. Upward trend on improving rangeland will be shown by vigorous decreasers and healing erosion scars. Downward trend will be shown by decreasers in low vigor, common occurrence of less desirable plants, and possibly active erosion.

Rangeland cannot be managed efficiently without understanding condition and trend. Range condition and trend are valuable tools for determining stocking rates, developing and modifying management strategies, and for placing range improvements in the proper order of priority.

CHAPTER 11

DETERMINING THE BEST INITIAL STOCKING RATE

When calculating stocking rates, two terms, *animal units (AU)* and *animal unit months (AUM)*, must be understood. An animal unit is a 1,000-pound mature cow, with a calf less than three months old, or its equivalent. Animal weight variations require adjustments in AU equal to 1/10th AU for every 100 pounds of live weight that the animal differs from the defined weight for its classification. Therefore, a 1,200-pound cow would equal 1.2 AU. An animal unit month (AUM) is the forage or feed necessary to carry an animal unit for one month, about 780 pounds.

The carrying capacity of rangeland should be compared with the forage and feed requirements of range livestock by working with AUM's. Examples of "animal equivalents" are shown in Table 1.

Using Stocking Rate Tables

A good method to follow in setting up initial stocking rates is to use established stocking rate tables. Stocking rate tables give the AUM's of grazing per acre during an average year. This means the approximate length of time (in months) that one mature, dry cow or her equivalent can graze on one acre of range each year.

Table 2 is used in setting an initial stocking rate. The table gives suggested initial stocking rates for the four vegetative zones (Figure 16) and various range sites in excellent (100-76%), good (75-51%), fair (50-26%), and poor (25-0%) range condition. Note how grazing capacity increases from zones of lower to higher precipitation (vegetative zones I through IV) and from shallow and thin loess to subirrigated and wetland range sites. A detailed description of setting initial stocking rates may be found in the Soil Conservation Service Field Office Technical Guide: Nebraska Range Site Descriptions and Guide for Determining Range Condition and Suggested Initial Stock Rates (August, 1981), available at local SCS offices.

Three things must be known in order to obtain an initial stocking rate from Table 2. These are: 1) range site, 2) vegetative zone, and 3) range condition. As an example, let's take a sands range site in vegetative zone II

Class of livestock	No. of animal units*
Cows (1,000 pounds)	1.00
Cow and calf pairs (calves over 3 months in age)	1.30
Replacement heifers (over 24 months)	0.90
Two-year-old steers	0.90
Yearling cattle (18-24 months)	0.80**
Yearling cattle (12-17 months)	0.70
Weaned calves (under 12 months)	0.50
Young bulls (over 24 months)	1.20
Bulls (mature)	1.50
Saddle horses (mature)	1.25
Sheep (mature)	0.20
Lamb	0.15

* Adjust according to the weight of the animals.
** Yearling cattle gaining at a high rate (1.5-2.0 pounds per day) may equal 0.90-1.00.

Table 1. Animal units of different classes of livestock.

that is in good range condition. Table 2 shows that the suggested initial stocking rate would be 0.53 AUM per acre.

Determining Animals Per Pasture

After determining the suggested initial stocking rates, the next step is to determine the number of usable acres in the pasture. Do this by subtracting heavily timbered, very steep, barren, or rocky areas from the total acreage. Ponds and streams must be subtracted as should all areas not open to grazing. Determine the number of usable acres for each range site and each range condition. Ignore different range condition classes or range sites less than 40 acres in size, except on wetland and subirrigated sites. To determine the number of animal unit months the pasture will provide, multiply the usable acres by animal unit months of grazing per acre. Do this for each range site and condition. Add AUMs for all sites and conditions to get the total for the entire pasture.

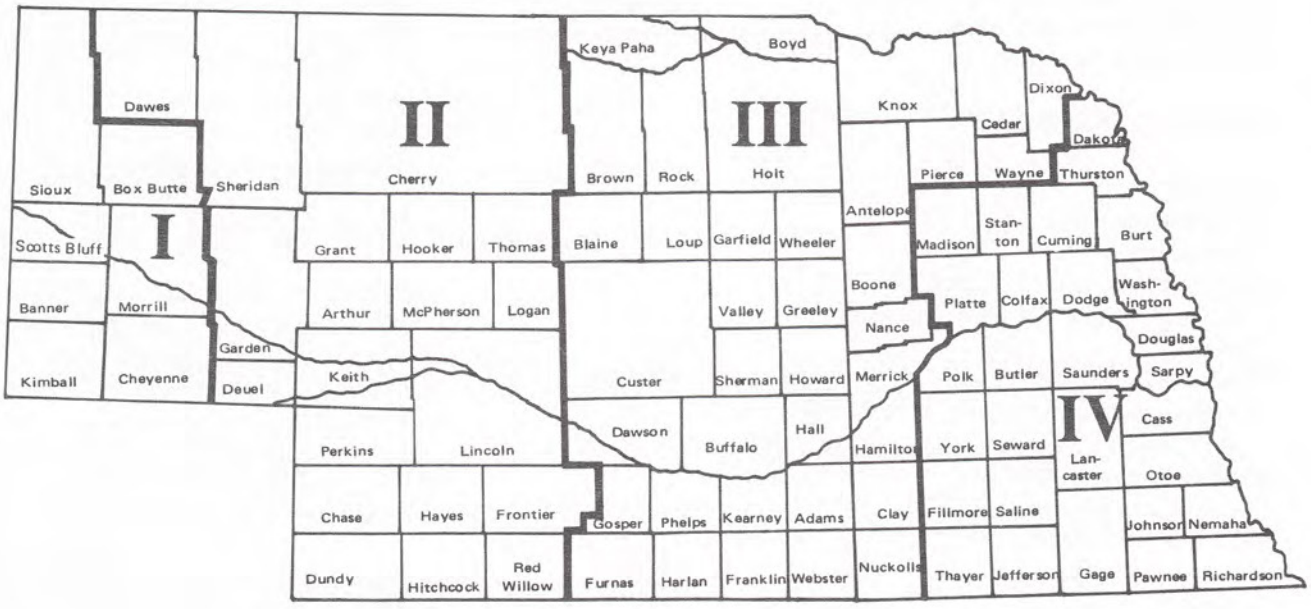


Figure 16. Nebraska vegetative zone map used for determining range conditions.

Table 2. Suggested initial stocking rates (in AUM's per acre annually).

Range Sites	Range Conditions - AUM's/acre Excellent	Good	Fair	Poor
VEGETATIVE ZONE I				
Wet land	1.8	1.35	0.90	0.45
Wet subirrigated	1.7	1.28	0.85	0.43
Subirrigated	1.5	1.13	0.75	0.38
Saline subirrigated, silty overflow, sandy lowland, silty lowland	0.8	0.60	0.40	0.20
Saline lowland, sandy, sands, silty	0.5	0.38	0.25	0.13
Clayey, choppy sands, limy upland	0.4	0.30	0.20	0.10
Shallow clay, shallow limy, shallow to gravel, savannah	0.3	0.23	0.15	0.08
Saline upland, panspots	0.2	0.15	0.10	0.05
VEGETATIVE ZONE II				
Wet land	2.0	1.50	1.00	0.50
Wet subirrigated	1.8	1.35	0.90	0.45
Subirrigated	1.6	1.20	0.80	0.40
Saline subirrigated, silty overflow, sandy lowland, silty lowland	0.9	0.68	0.45	0.23
Saline lowland, sandy, sands, silty	0.7	0.53	0.35	0.18
Clayey, choppy sands, limy upland	0.6	0.45	0.30	0.15
Shallow clay, shallow limy, savannah	0.5	0.38	0.25	0.13
Shallow to gravel, thin loess	0.4	0.30	0.20	0.10
Saline upland, panspots	0.3	0.23	0.15	0.08
VEGETATIVE ZONE III				
Wet land	2.1	1.58	1.05	0.53
Wet subirrigated	1.9	1.43	0.95	0.48
Subirrigated	1.7	1.28	0.85	0.43
Saline subirrigated, silty overflow, clayey overflow, sandy lowland, silty lowland	1.0	0.75	0.50	0.25
Saline lowland, sandy, sands, clayey	0.9	0.68	0.45	0.23
Choppy sands, limy upland, shallow clay, shallow limy	0.7	0.53	0.35	0.18
Shallow to gravel, thin loess, savannah	0.6	0.45	0.30	0.15
VEGETATIVE ZONE IV				
Wet land	2.2	1.65	1.10	0.55
Wet subirrigated	2.0	1.50	1.00	0.50
Subirrigated	1.8	1.35	0.90	0.45
Saline subirrigated, silty overflow, clayey overflow, sandy lowland, silty lowland	1.2	0.90	0.60	0.30
Sandy, sands, silty, clayey	1.0	0.75	0.50	0.25
Limy upland, dense clay	0.9	0.68	0.45	0.23
Shallow limy, shallow sandy, shallow to gravel, thin loess	0.8	0.60	0.40	0.20

To determine animal units the pasture can support for the grazing season, divide the total number of AUMs by the number of months in the grazing season. For example, a pasture with 653 AUM's of grazing capacity is to be used for a 5-month grazing season. Divide 653 by 5 which equals 131. A total of 131 animal units can be grazed for 5 months in the pasture. In the final step, divide 131 by the animal unit equivalent of the livestock that will be grazed. For example, the pasture would carry about 187 yearlings (131 divided by 0.7) or 100 cow-calf pairs (131 divided by 1.3) for 5 months.

Mechanical Measurement of Range Forage Yield

A second method of estimating an initial stocking rate uses a direct measurement of forage yield. This is determined at the end of the growing season, otherwise forage production will be underestimated. This method is seldom used since range condition is not considered. A detailed discussion of this technique is presented in A Guide for Planning and Analyzing a Year-Round Forage Program (EC 86-113).

When using this method, mark off a circle with a 21-inch piece of string attached to a large nail at the center of the circle (Figure 17). All current year forage in the plot produced by decreaser and increaser plants should be clipped at ground level. Put the forage in an open paper bag and place it in a warm location to become air-dry. After several days, weigh the sample in grams (454 grams equals one pound) and subtract the weight of the empty bag. Multiply the number of grams by 10 to get pounds per acre. For example, if you clip 90 grams of air-dry forage from the plot, there are 900 pounds of forage per acre (90 times 10 = 900).

The average forage production of several plots on each site should be used. Since forage production on different sites varies, clip a new set of plots for each range site in the range unit.

Only 25 percent of the forage can be used for calculating stocking rates, because about one-half of the forage removed during the grazing season (25% of total production) will be associated with wildlife, insects, and trampling. This practice will leave about 50 percent of current year plant foliage for cover. To estimate the initial stocking rate for a range site producing 900 pounds of forage per acre, multiply the 900 pounds by 0.25 (900 pounds times 0.25 = 225 pounds). Next, multiply 225 pounds per acre by 0.88 to determine *available* dry matter, because air-dry forage contains about 12 percent moisture (225 pounds per acre times 0.88 = 198 pounds of available dry matter per acre). Since a mature, 1,000-pound cow eats about 26 pounds of forage (dry matter) each day, one AUM would be equivalent to about 780 pounds of forage (26 pounds times 30 days = 780 pounds per month). Then divide 198 pounds of available dry matter per acre by 780 pounds/AUM to calculate stocking rate (198 divided by 780 = 0.25 AUM per acre).

The estimate of stocking rate using this method may vary considerably over years. Thus, for this method to be accurate, forage production may need to be determined over several years. Then use the average production in determining an initial stocking rate.

Local Experience

Local experience will help set an initial stocking rate. Check with several ranchers who have rangeland similar to yours. If they have kept good stocking records over many years, this advice will be most helpful. However, remember that a hasty guess may be very misleading.

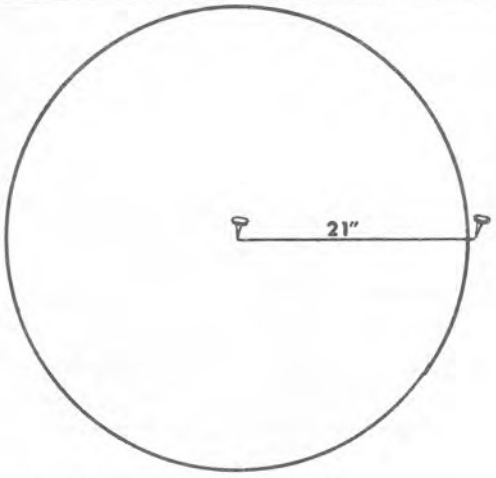


Figure 17. Plot used to determine yield of range forage.

CHAPTER 12

ADJUSTING THE STOCKING RATE

Basis for Adjustments

Adjustments in stocking rates should be based on range condition and trend. After stocking is made at the initial rate, check the effect this has on key areas in succeeding years. Decreaser and increaser plants should be observed to see how they react. Further changes in stocking rates and time of grazing may be needed as the grazing season progresses or in following years. Detailed grazing records should be kept for each pasture that include number and class of livestock and date of entry and exit for all livestock. If range trend declines, stocking rates must be reduced and/or grazing management strategies must be modified. Resolution of the cause of downward trend may include range improvements.

A range in fair condition with a distinct upward trend may cause no concern, but care should be given so that the condition improves at least to good condition in succeeding years. Either poor condition or downward trend should serve as a red flag of warning.

Carrying capacity varies from year to year and even from month to month on the same rangeland. No range has a single permanent, unvarying carrying capacity. Rainfall alone causes wide variations in forage production. It is not uncommon in the Great Plains for forage production on native rangeland to be three times as great in a good year as in a dry year. Rainfall also varies from month to month. This causes actual carrying capacity of a range to vary rather than being fixed.

A flexible system of stocking is necessary to meet variations in forage production resulting from drought, late spring seasons, and insect damage. One operating practice is to maintain a cow herd of a size the range can carry in low forage years. Excess forage in average and good years can be used by keeping some calves and selling them later, buying yearlings, or by leasing grazing to others.

With a straight cow-calf operation, conservative numbers of livestock (often set at 75% of average forage production) must

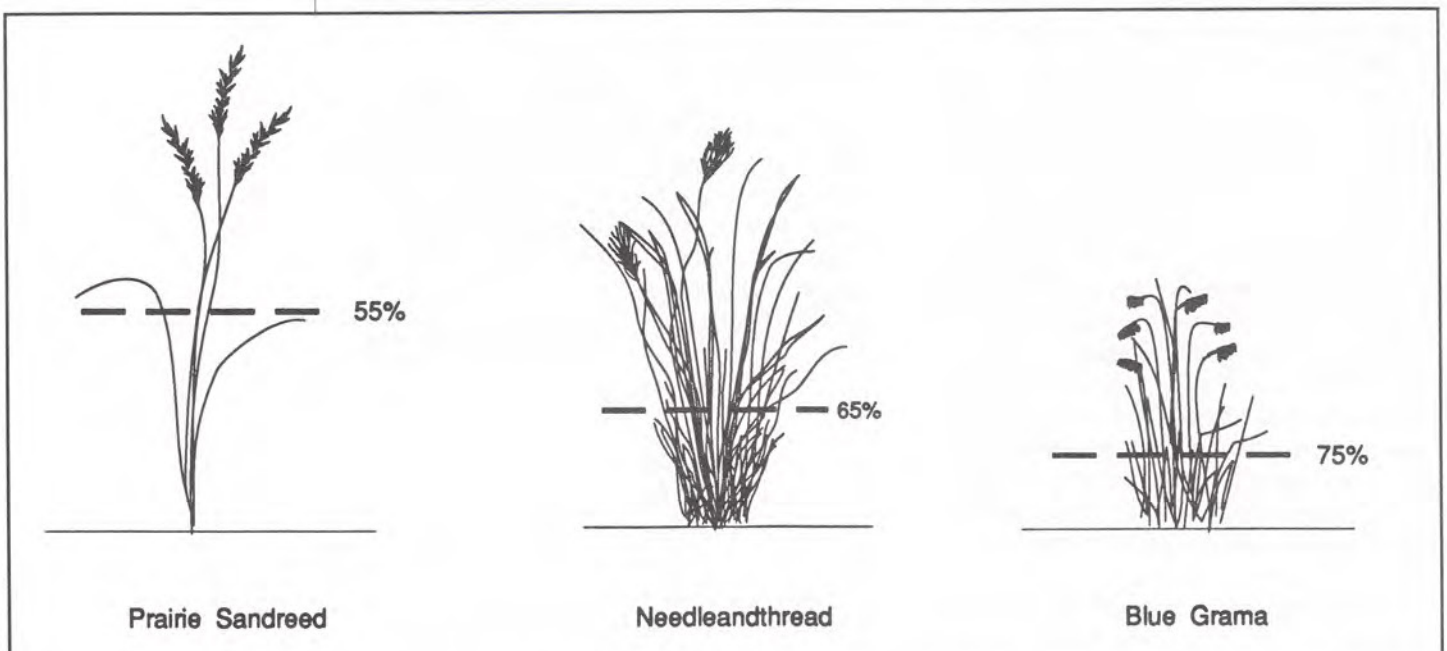


Figure 18. Proper levels of utilization are critical for efficient use of forage resources and maintaining healthy plants. The percent of total plant height removed at 50% utilization is greater for shortgrass than tallgrass species.

be used to prevent excessive grazing during low-producing years. Hay production on ranches may also give added flexibility.

Carrying capacity of rangeland is influenced by many management decisions. Kind and class of livestock and time and season of grazing affect carrying capacity. Good livestock distribution throughout each pasture will allow the full carrying capacity to be realized.

Degree of Use Check

Grazing distribution and level of utilization should be checked frequently as the grazing season progresses. The purpose is to determine how closely the primary or *key* forage plants have been grazed during the current grazing season. These checks will give a better idea of how much more grazing can be done before proper use is reached and help to maintain the long-time range condition at a high level.

Proper use of forage may differ among pastures depending upon management objectives for individual pastures. Those objectives may involve animal performance, vegetation recovery, soil erosion control, weed control, or prescribed burning. The optimum date and length of grazing period and percent utilization of plant species will depend on the desired response. The relationship between utilization based upon weight of current year foliage and plant height can be estimated in the field prior to grazing. Clip the current year growth of several samples of key or target species at the ground level and tie each bundle with string. By balancing each bundle on your finger, the height at which 50 percent of the foliage weight would be removed (point of balance) can be determined (Figure 18). Cut the bundle at that point and balance the top portion to determine the height at which 25 percent utilization would occur. Balance the bottom portion to determine the height at which 75 percent utilization would occur. Not all plants of the same species will be grazed. Grazed plants often have different levels of utilization. Use the height to weight relationship determined in the field to estimate the average level of utilization for grazed plants within species.

Grazing too close, when combined with inadequate recovery time, produces an increasingly less desirable plant cover which is often less dense, less productive, and shorter lived. Close grazing may force animals to eat stemmy plant parts low in nutritive value. Healthy animals and optimal production cannot be expected from improperly grazed rangeland.

CHAPTER 13

GRAZING MANAGEMENT AND GRAZING SYSTEMS

Reasonable goals should be developed to provide a focus for grazing management. Domestic and wild grazing animals can be manipulated in many ways to accomplish vegetation and/or animal production objectives. Often several ways exist to accomplish any objective. The actual methods used should be based upon ecological and economical efficiency. For example, vigor of key plant species can be improved by one or more of the following:

1. change the season of grazing,
2. reduce the length of the summer grazing period from months to weeks or days,
3. delay livestock turn-out dates,
4. improve livestock distribution, and/or
5. change kind or class of livestock.

Progress toward objectives will depend upon environmental conditions that influence plant and animal growth as well as management decisions. Functional management records and an understanding of plant and animal growth processes and requirements are needed to fine tune grazing strategies.

Plant Growth Cycles

An understanding of the rhythm of plant growth will help range managers maintain healthy range ecosystems. Growing points constitute a very small part of total plant biomass but give rise to and regulate all plant growth. Shoot apices (terminal buds), leaf bases, dormant buds, and root tips are examples of growing points.

The growth pattern of grasses is best explained on the basis of tiller development. A *tiller* is composed of an apical meristem (growing point at the stem apex which may become the inflorescence or seed head if not aborted), a stem, leaves, roots, and inactive lateral buds that may become new tillers. Growth in the grass shoot begins in the leaf blade and is followed by growth in leaf sheaths. After several leaf blades have developed, the stem begins to grow on some tillers, elevating the growing point as internodes elongate. Bottom leaves located on the outside of the tiller were the first to grow.

The Growing Point

When the growing point is removed from the tiller, growth of that shoot stops. It may remain green as long as soil moisture is adequate. Removal of the growing point from the shoot will allow lateral buds to develop. If adequate soil moisture is present and favorable temperatures occur, new tiller growth will take place. New tillers can develop rapidly from lateral buds when maturity of parent tillers is limited before the growing point is removed. Lateral bud development is slow if parent tillers are advanced in maturity before grazing. Grazing can stimulate the growth of existing tillers if old leaves are removed and the growing point is not removed. Grazing early developing plants, such as cool-season grasses, may increase the amount of soil moisture available for warm-season grasses while utilizing cool-season plants while they are high in quality. Heavy continuous grazing of the primary grasses in a pasture will reduce the total amount of growth during the year, because the leaf area cannot be replaced before soil moisture shortages or changes in air temperature restrict plant growth.

Carbohydrate Reserves

Plant regrowth depends upon the supply of available carbohydrates. Carbohydrates are produced by photosynthesis and used as building blocks in the growth process. Carbohydrates are produced only in the light and only in green plant cells. Initial growth of leaves after winter or summer dormancy is totally dependent upon carbohydrates stored from the previous or first part of the growing season. As tillers mature, movement of carbohydrates (energy reserves) into storage areas increases. Storage occurs in crowns, roots, rhizomes,

stolons, seeds, and stem bases. Energy reserves are reduced when plants are heavily grazed without adequate time for recovery because stored carbohydrates are used to replace the lost leaf area. If energy reserves are not replenished after grazing, plants may not survive winter or summer dormancy. Plants can recover if soil moisture and air temperatures are favorable for growth and heavy grazing does not occur repeatedly. A single season of heavy grazing with inadequate recovery may require several years of sound management for full recovery. Plants will remain vigorous and productive if an adequate amount of leaf area remains following grazing, and if an adequate amount of time is allowed for recovery.

Root Growth

The greatest influence of grazing is on root growth and activity. Removing more than one-half of the foliage causes all root growth to stop and nutrient absorption to decrease. Most roots continue to grow when less than one-half of the foliage is removed. Root growth will stop immediately and may not begin again for one to two weeks when grasses are severely defoliated. Plants quickly lose their competitive advantage when their root systems are impaired. Less desirable plant species use soil moisture and nutrients when the depth and extent of desirable plant root systems is reduced by heavy grazing.

Importance of Livestock Distribution

Grazing should be uniform over all parts of the range. Ranges which appear to be overstocked in certain areas often can be improved by more uniform grazing without reducing livestock numbers.

Even on properly stocked range there can be small areas where forage is wasted because of the great distance from water, difficulty of livestock access or other factors. Local areas will be grazed heavily close to water sources, main trails, and corrals. These "sacrifice area" must be kept small.

Cattle tend to concentrate on level ground, on meadows, around water sources, and around trees. A stockwater shortage almost always leads to improper livestock distribution. Lack of cross fences or improperly placed fences may also cause distribution problems. Distribution can be improved by:

1. Developing new stockwater facilities in undergrazed areas.
2. Cross fencing large pastures to increase stock density.
3. Fencing along range site lines and around seeded range.
4. Starting planned grazing systems.
5. Feeding winter supplements in underused areas.
6. Placing salt away from water.
7. Mowing old grass in under used areas.
8. Prescribed burning.

For more information on distribution, obtain a copy of Proper Livestock Grazing Distribution (G 80-504).

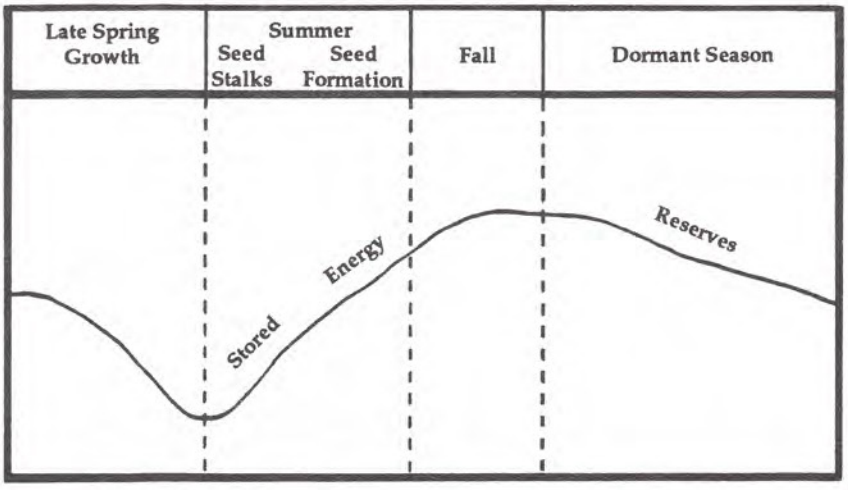


Figure 19. The annual growth and energy storage cycle of warm-season grasses.

Grazing Systems

Most ranchers practice some type of rotation grazing system. Rangeland in Nebraska is rarely grazed year-around. Some ranchers only rotate summer and winter use. Native range on some livestock farms is grazed only in the summer, and cattle are wintered on crop residues and harvested forages. Under this system of production, rangeland should not be grazed until there is enough spring growth to carry the livestock. Best production, however, is accomplished by following a carefully planned grazing system.

A system is, by definition, a method by which facts and principles are used in an orderly form to produce a logical plan. A grazing system is a plan. The efficiency of the plan depends upon management commitment and how well the plan addresses goals and objectives within environmental constraints. The more you understand about interactions of animal, plant, and environmental resources, the more refined and flexible the grazing system may become. As flexibility increases, so do management options. Regardless of the grazing system, stocking rates must be properly balanced with the available supply of forage. No grazing system can compensate for overstocking.

Conventional Planned Grazing Systems

To implement a grazing system it is necessary to divide the range into units. Generally, existing pastures can accommodate a grazing system on a ranch unit. In a conventional-planned grazing system, all livestock are generally placed in one pasture at a time. This provides the manager with a greater opportunity to control the time of grazing and degree of utilization for individual pastures. Concentrating livestock in one pasture often improves grazing distribution and improves harvest efficiency of forage. Consequently, moderate increases in stocking rates over properly stocked continuous grazing can be sustained while maintaining animal performance. When one pasture is being grazed, others are deferred. This allows previously grazed pastures to recover if environmental conditions are favorable for plant growth. It also allows uninterrupted plant growth in pastures not yet grazed. Stocking rates are often different for each pasture because of differences in range sites and range condition. Frequent observation of degree of use is required to avoid excessive grazing when fully stocked and using a grazing system. Daily rates of forage removal are greater than under continuous grazing because cattle are concentrated in one pasture. A good system allows range plants to recover from grazing, regain vigor, and build energy reserves. Greater forage production may be obtained from most range plants by grazing versus complete rest when environmental conditions are favorable for plant growth.

Some Grazing System Examples

A. *Two-pasture System.* This system is primarily adapted for small cow herds.
System Number 1 (graze both pastures early in the season)
First year: Grazing Periods
Pasture A and B: May 1-May 15
Pasture A: May 15-July 15
Pasture B: July 15-October 1
Second year:
Pasture A and B: May 1-May 15
Pasture B: May 15-July 15
Pasture A: July 15-October 1
System Number 2 (graze only one pasture early in the season)
First year: Grazing Periods
Pasture A: May 1-July 15
Pasture B: July 15-October 1
Second year:
Pasture B: May 1-July 15
Pasture A: July 15-October 1

The early use under these two systems, especially System 1, suppresses or capitalizes on cool-season grasses (like Kentucky bluegrass) and cool-season weedy grasses (like downy brome) when desired. The weedy cool-season grasses are most palatable at this time.

Early use of undesirable cool-season grasses allows more available moisture for desirable plants later in the growing season. If a rancher has primarily warm-season grasses and no cool-season components to use, the beginning dates should be 15-25 days later in the season.

The dates listed for all grazing systems are only examples. Length of individual grazing periods may need to be adjusted according to pasture productivity and climatic conditions. Grazing systems should be flexible and adjusted to fit within ranch operations and to accomplish management objectives.

B. *Three-Pasture System.* This sequence is best adapted to ranch units with three available pastures in the growing season. It is simple and easy to follow with a minimum of livestock movement.

First year: Grazing Periods
- Pasture A: May 10-June 15
- Pasture B: June 15-August 10
- Pasture C: August 10-October 1

Second year:
- Pasture B: May 10-June 15
- Pasture C: June 15-August 10
- Pasture A: August 10-October 1

Third year:
- Pasture C: May 10-June 15
- Pasture A: June 15-August 10
- Pasture B: August 10-October 15

Livestock are in the first grazed pasture in the spring for a shorter period than in any other grazed pasture for that growing season. This is because the vegetation is beginning its growth and cannot produce as much forage during the early grazing period as would be produced during the growing season. If a rancher has an operation with both cool- and warm-season grasses or cool-season pasture, the beginning dates could be 10 days earlier compared to warm-season grasses only. Early grazing of all pastures could be used to utilize cool-season forage.

C. *Four-Pasture System:* The four pasture grazing system is common in the Sandhills. Each year pastures are moved up one step from the time they are grazed the previous year. This system is most adaptable to ranching operations with several pastures.

Grazing Periods	Year			
	First	Second	Third	Fourth
May 15-June 10	A	B	C	D
June 10-July 15	B	C	D	A
July 15-August 25	C	D	A	B
August 25-October 1	D	A	B	C

Livestock are in a grazing unit for a shorter time than in the examples described previously. The first grazing period may be particularly short because of lack of adequate forage early in the grazing season. All pastures could be grazed early to use cool-season forage.

Short Duration Grazing

The use of conventional grazing management at conventional stocking rates generally results in an actual harvest of less than 25 percent of all forage produced per acre during the growing season. Animal consumption of the total annual herbage ranges from 30 to 40 percent under short duration grazing. Improved harvest efficiency is accomplished through better grazing distribution and control over the time of grazing, because livestock are more concentrated when rangeland is divided into a larger number of pastures.

Short duration grazing requires a high commitment to frequent observation and management.

Individual pastures may be used several times or only once during the summer grazing season. Single pasture use systems are best suited to operations that retain ownership of livestock. Animal performance is generally lower in single versus multiple use systems because of lower forage quality associated with advanced plant maturity in pastures at the end of the season. Retained ownership allows producers to capitalize on compensatory gain of growing cattle.

With multiple grazing periods and larger numbers of pastures, there are more time sensitive decisions. The potential for mistakes increases. Gradual implementation and initially conservative stocking rates will allow mistakes to be minimized.

The number of grazing periods per pasture on rangeland should be reduced as average precipitation and diversity of desirable perennial plant species decline. Multiple grazing periods can be beneficial in several situations under short duration grazing:

1. Harvest efficiency can be improved on pastures composed of cool- and warm-season grasses. These pastures can be grazed when plants such as prairie junegrass, needleandthread, and porcupine grass have adequate spring growth but have not headed. Pastures could then be grazed later in the season to capitalize on warm-season grasses. When abundant precipitation occurs in the spring or preceding fall, it may be desirable to add a third grazing period to capitalize on early developing winter annuals such as downy brome.

2. If temperatures and soil moisture are favorable for plant growth, pastures can be grazed to remove growing points so that seedhead production is reduced and regrowth will provide high quality forage for a late season grazing period. Moderate grazing should be initiated when primary forage species are in the early to mid-boot state and only when adequate soil moisture is present in the soil.

3. Pastures may be grazed in the summer and winter if utilization of primary forage species is light during the summer.

4. More than two grazing periods can be sustained on subirrigated and wetland sites in all Vegetation Zones and on upland sites in Zones III and IV because of increased availability on soil moisture. Even with increased soil moisture, regrowth after grazing is directly related to the amount of green leaf area at the end of a grazing period. Length of deferment period should be increased as level of defoliation increases or rate of plant growth declines. Heavily grazed pastures should not be grazed again in the same growing season.

Selective Grazing

All grazing animals prefer some plant species more than other plant species. When grazing, animals search for certain kinds and parts of plants. They also prefer new growth more than old plant tissue. Consequently, animals often regraze areas as regrowth occurs before using plants previously ungrazed. If regrazing occurs before roots have recovered, the plants are damaged and

need more time to recover. The selectivity of grazing animals is a continual factor in the grazing process.

Selective grazing cannot be eliminated, but can be controlled by well planned and well managed grazing systems. Cattle will consume more kinds of plants when stocking densities (animals per acre) are relatively high. However, as long as enough forage is available for animals to obtain fill, some selective grazing will occur at any stocking density.

When to Begin and End Grazing

Nebraska ranges may be grazed any month of the year, but they should not be grazed all year long. Plants are most nutritious when they are growing most rapidly before they produce inflorescences. Generally, all livestock nutrient requirements are met during these periods. This is also the time when environmental conditions are most favorable for plant growth. The time to initiate grazing will depend upon management objectives and the kinds of plants. Initial and ending grazing dates can be selected to enhance or damage selected plant species when combined with controlled levels of utilization or defoliation.

Key Points on Management for Short Duration Grazing

A checklist of fundamental concerns should be reviewed when designing or modifying grazing management plants. This practice may be as important as a pre-flight safety check conducted by pilots before take-off. The following items should be included in all pre-graze checklists:

1. Livestock forage requirements and available forage resources must be in balance.

2. Increases in stocking rates should be approached with caution.

3. Grazing systems require a commitment to management. Systems will not run themselves, and delay of livestock movement in a single year may cause measurable reductions in plant vigor or herbage production, as well as livestock performance.

4. The initial starting date of grazing each spring will be a critical management decision. If forage species are set back during the first portion of the growing season, herbage production may be reduced throughout the balance of the current grazing season.

5. Readily available and dependable water supplies are necessary for optimum production and the efficient harvest of forage. Water requirements in individual pastures increase greatly because cattle are concentrated.

6. All herbage resources should not be committed to one specific type of grazing system. Some pastures should be held for flexibility, drought, and special use needs.

7. The potential of livestock losses to poisonous plants will increase as concentration of animals increases. An understanding of seasonal plant toxicity and animal sensitivity will be important in avoiding serious problems.

Other Management Necessities of Grazing Systems

In any grazing system, the same pasture is not grazed or left ungrazed at the same time any two years in a row, except a system specifically designed to graze undesirable components (e.g., weedy grasses) in the spring. By not grazing the same pasture at the same time two years in a row, the plants are not consecutively close cropped by livestock at a critical stage of development.

If additional winter feed is necessary, the early grazed pastures of the previous growing season could provide some forage. Livestock may be moved to the next pasture in the sequence when drought occurs or when existing pasture is smaller than the average. An adequate supply of water and salt must be provided in each pasture for the number of animals that will be grazing there at any one time.

Methods of moving livestock that excite or stress animals can reduce livestock performance. Gates strategically located in fences between pastures where stock will drift through naturally will help. It also is desirable to move small bunches at a time rather than in a general roundup.

Every pasture need not be included in the grazing system. Extra pastures may be needed for emergencies, sick animals, quarantine periods, bulls during non-breeding season, horses, etc. The working of livestock (spraying, branding, weaning, etc.) may be done at the time livestock are moved from one pasture to another.

Grazing systems are flexible and should be designed for each individual situation. The systems presented here are only examples. Many changes and deviations of these exist in Nebraska, but the main principles and advantages of a grazing system remain the same.

CHAPTER 14

SALT PRACTICES, STOCKWATER DEVELOPMENTS, AND RANGE FENCING

Salting Practices

Livestock should have access to salt throughout the year. Feeding a salt supplement to grazing livestock is a standard and rather inexpensive range practice. Grazing animals generally need more salt than they can get from plants. Proper salt location is one of the cheapest and most convenient methods of improving livestock distribution in a pasture.

Salting boxes or blocks should be located away from water and moved as often as necessary. Salt should be moved to areas of the pasture where underuse is noticed. Salting places should not be located on areas that are subject to severe erosion. On sandy soils, it may be necessary to move the salt box each time the salt is put out.

Salt is usually placed in boxes to protect it from adverse weather. Inexpensive salt boxes can be made from old metal barrels or from tires. Salt blocks may be more expensive but they are more convenient to use and generally last longer than loose salt in boxes.

Suggestions for salting:

1. Allow 2 pounds per cow per month or 0.5 pound per head per month for sheep.

2. Place salt systematically over the range, but not less than 0.25 mile from water. Move the salt to areas where forage is getting the least use.

3. Have one salt box or block for each 20-25 head of cattle in a continuously grazed summer pasture. A larger number of cattle can use one salt location when they are concentrated in a grazing system.

4. If range forage is deficient in phosphorus (usually the last one-half of the grazing season), mix equal portions of calcium phosphate or steamed bone meal and salt.

Stockwater Development

On most Nebraska rangelands there are not enough natural water sources for the number of animals the rangeland will carry. Even though there may be plenty of forage, enough stockwater must be present before the range can be properly grazed. Livestock should not have to travel long distances to water. Cattle will graze an area close to water repeatedly rather than move a long distance to ungrazed forage.

Stockwater problems may arise from inadequate yield or storage of water, poor quality water (alkaline or saline), improper location and number of watering places, or stockwater developments that waste water. A combination of permanent water sources such as lakes, streams, springs, pipelines, and wells with temporary supplies such as reservoirs or dugouts may be most practical.

The amount of water needed by livestock differs with the kind of range, amount of salt consumed, climate, season, and kind of stock. Cattle require 8 to 15 gallons of water per day and sheep require about 1 gallon per day. Ranchers should allow for excess storage because daily evaporation losses can be high from large stock tanks and ponds during the summer months. Evaporation should be taken into consideration when determining if adequate supply of water will be available.

Watering places require different spacings in rough or choppy hills than they do on gently rolling or level ranges. Cattle should not have to travel more than 0.25 to 0.50 mile for water on steep, rough ranges. On more level ranges the distance from water to the farthest corner of the pasture should not be greater than one mile.

The range manager should plan for a minimum of one watering place per section (640 acres) for best distribution of grazing livestock under most conditions in Nebraska.

Portable, solar-powered pumping units

can provide reliable sources of water for livestock at more than one location. The economic efficiency of portable units increases when the cost is divided over an increasing number of pumping locations.

Wells and Windmills

The most common type of water development in Nebraska consists of wells and windmills. A well has many advantages as a source of livestock water:

1. Wells can be placed in the most desirable locations.

2. Wells furnish a more dependable water supply in dry seasons and in winter.

3. Water quality is generally high.

4. Wells are safe places for livestock to water in the winter.

Wells should not be on soils subject to erosion. Where erosion can be kept to a minimum, windmills may be put between pastures along fence lines. This is a good practice when the pasture is small or when water development is needed in remote areas of two adjacent pastures. The potential for serious erosion exists around all wells on upland sites in the Sandhills. Livestock watering tanks should have an overflow which will pipe excess water far enough away from the tank to prevent mud holes or ice sheets from forming around the tank.

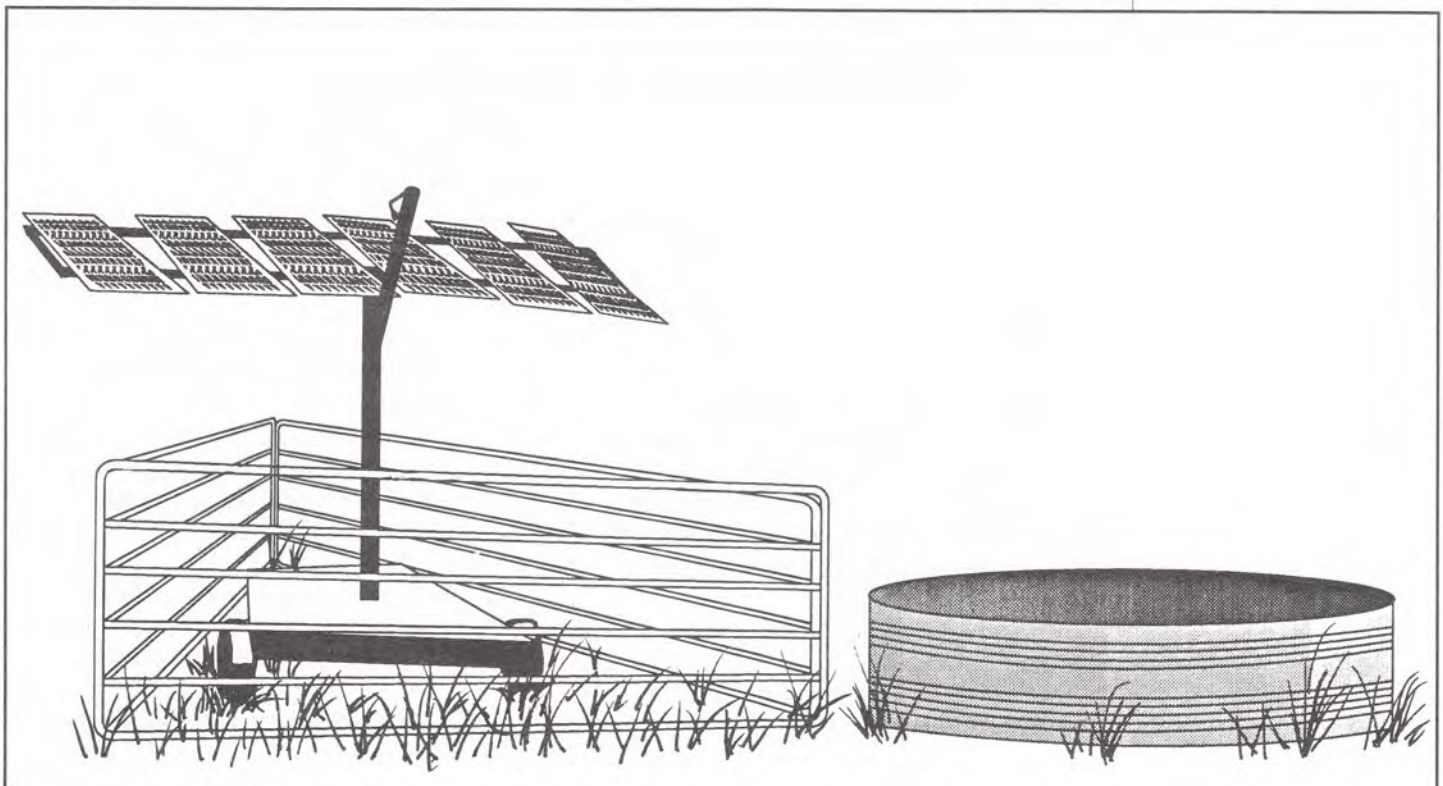


Figure 20. Portable solar powered pumping unit.

The size and erosion of sacrifice areas around stock tanks can be minimized by constructing water pens with one eight-foot gate per pasture. When the area around tanks is reduced to the minimum space required for banking soil against tanks, most cattle will not loaf in the immediate area. Annual cover crops can be established inside water pens during deferment periods in the current or following growing seasons by broadcasting seed several days before livestock are moved to another pasture. Rye or oats can be broadcast in spring or fall and hay millet in early summer. Grazing systems can usually be designed to provide adequate time for cover crop establishment for fence line or dispersed water locations in most years.

Springs and Seeps

A dependable supply of clean water throughout the grazing season may be developed from springs and seeps. Such development may create a good water place away from dangerous bogs and swamps.

To develop a watering place from a spring, soil should be removed down to bedrock or to the source of water. A concrete or masonry box should be built around the source of water, with an outlet pipe several inches from the bottom. The outlet pipe should lead to a tank or trough located a short distance from the collection box. This prevents livestock trampling in the vicinity of the water source. When developing bogs or seeps, it may be necessary to lay a system of tile about the collection box. This will increase its efficiency. The range manager should contact the Soil Conservation Service for proper design and to explore the potential for cost sharing.

Pipelines

Water pipelines have been installed in some areas of Nebraska to supply large quantities of high quality water for both human and livestock consumption. Some individual ranches have pipeline systems, but usually several ranchers form a company and develop a relatively high-producing well. Water is then pumped through buried polyvinyl-chloride (PVC) pipes. Some pipelines in Nebraska are over 100 miles long and may supply water to livestock on more than 50,000 acres of rangeland. The Soil Conservation Service will help design pipeline systems and cost-sharing may be available.

Stockwater Dams or Reservoirs

Stockwater dams and reservoirs are important sources of water in certain areas of Nebraska. Soil texture should be considered before such a structure is built. Heavy clay soils are ideal because of their resistance to seepage losses. Bentonite, a clay mineral, should be used as a sealing agent for the bottoms of reservoirs built on soils that permit seepage losses. Stockwater dams may be only a temporary source of water. The Soil Conservation Service will help design dams and cost-sharing may be available. Other types of man-made stockwater developments include dugouts, catchment basins, and sand tanks.

Range Fencing

Range fencing is used for proper livestock control. The five reasons for good range fences are:

1. Fences help prevent straying or trespassing of livestock.
2. Fences help distribute livestock and provide more uniform grazing of forage.
3. Fences make grazing systems possible and divide winter from summer rangeland.
4. Fences can eliminate grazing or trampling on critical areas, such as blowouts and reseeded areas.
5. Fences make it possible to separate different classes of stock for better management and provide breeding pastures.

Cross fences should be built to follow natural land features or range site boundaries as much as possible (Figure 21). When possible, the range manager should plan

cross fences so that all range units have about the same potential stocking level. When range units are large and contain different range sites, livestock concentrate on the range sites most easily grazed. This results in over use of forage on some portions of the unit and underuse on other areas. Fencing on range site boundaries allows management practices needed for the best production from each site.

The size of pastures on Nebraska ranches is determined, to a large extent, by the convenience of a certain size to the operation of the ranch. Convenience in operations certainly should be considered, but efficient use of forage produced on the range is more important. The larger the pasture, generally, the more inefficient the use of the forage by livestock.

A cross fence could be the most convenient and economical range improvement you could add to your ranch. A mile of 4-strand, barbed-wire fence requires 16, 80-rod spools of wire and 320 posts. Suspension fences are not as expensive as conventional fences because they require fewer materials (Figure 22). Posts in a suspension fence are spaced more widely, and metal or wooden stays are used to keep the wire separated between posts. The wire is not fastened tightly to the line posts allowing the wire to move slightly as animals come in contact with it. Strong double "H" frames are recommended for stretching points (Figure 23). The Soil Conservation Service should be contacted for fencing specifications and potential cost sharing.

Rangeland has been successfully separated into pastures with one-, two-, or three-wire low impedance electric fences. While a single wire cross fence has been effective for cattle that have been previously trained to electric fence, calves will tend to move ahead of cows under a one-wire fence. A minimum of two wires is usually required for an efficient circuit where soils are dry during part of the grazing season. Electric fences and suspension fences have proven to be reliable and economical for separating pastures (Figure 24). Electric fence systems designed in the United States and New Zealand are reliable and may cost 30 to 50 percent less than conventional barbed wire fences (Figure 24). Low impedance electric fences can be charged by a number of sources including solar panels with a 12-volt battery for night time (Figure 25). Efficient systems require good insulation, secure and clean connections, and thorough grounding.

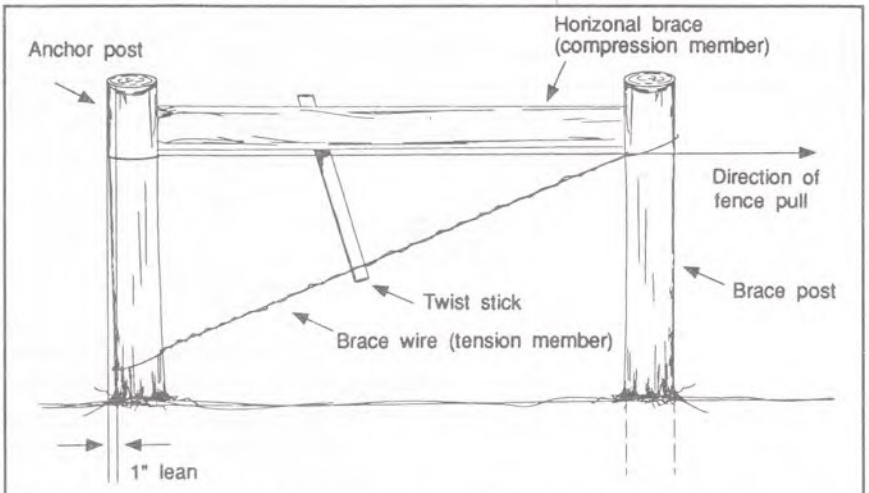


Figure 21. Recommended construction of a "H" frame for barbed-wire or electric cross fences.

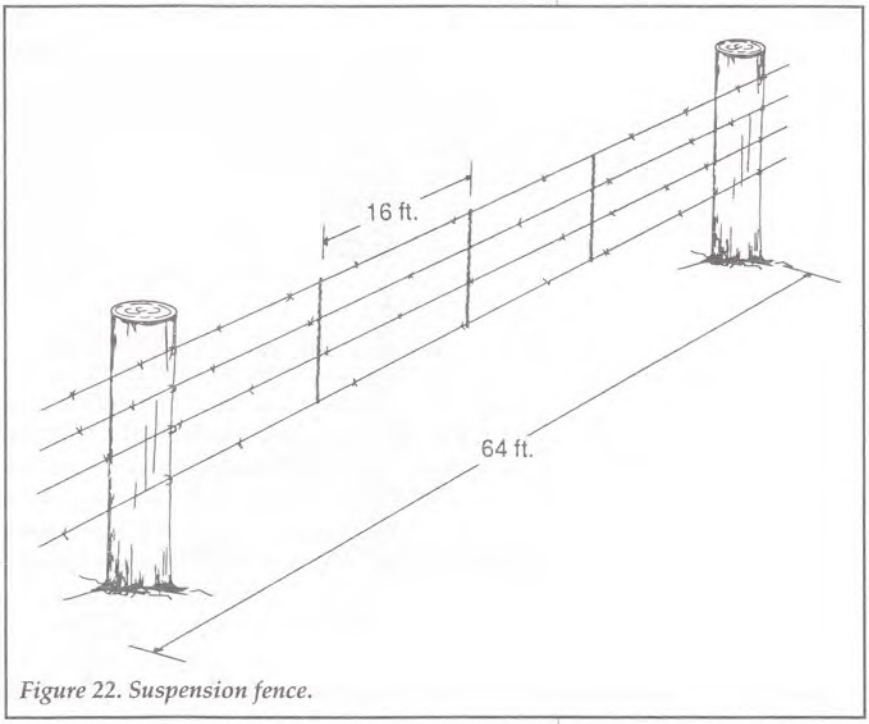


Figure 22. Suspension fence.

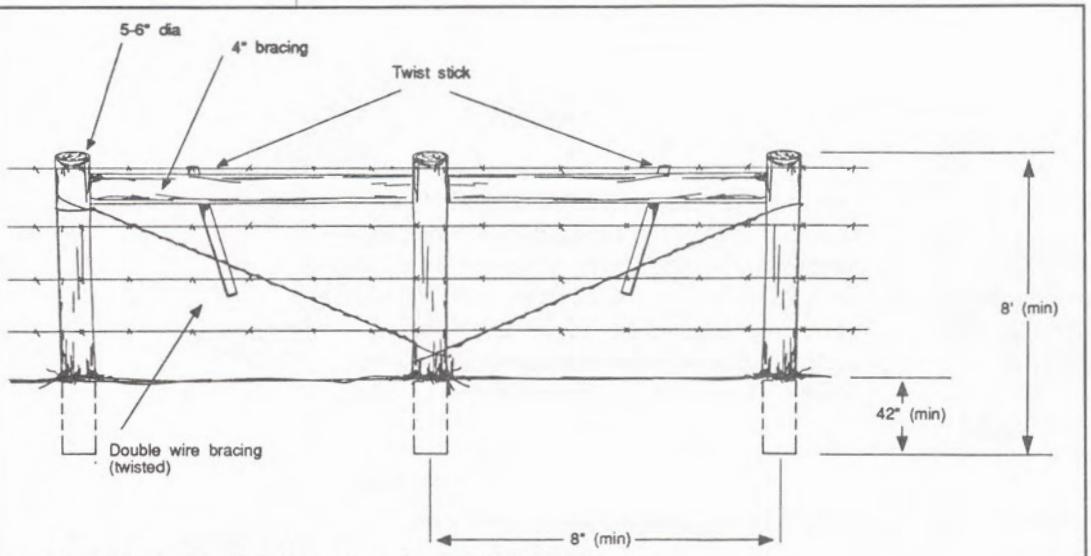


Figure 23. Recommended dimensions for a double "H" frame.

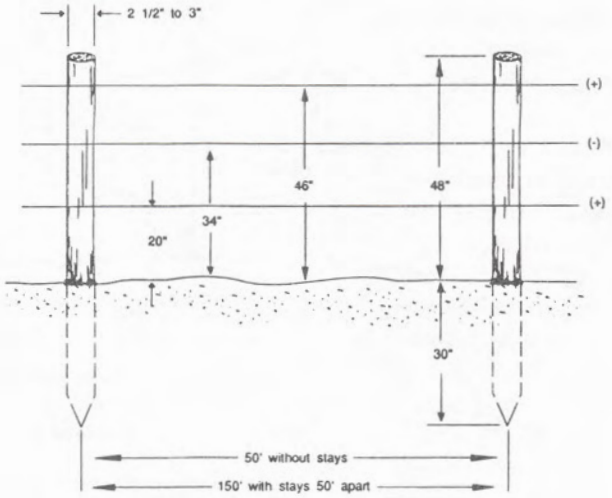


Figure 24. Three-wire low impedance electric fence for cattle or horses.

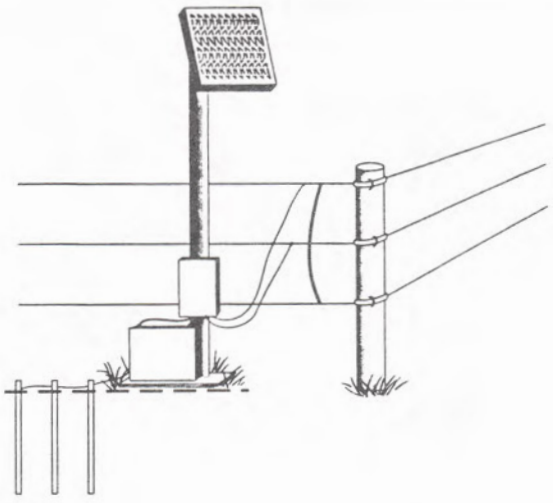


Figure 25. Low impedance electric fence charger with a 12-volt battery and a solar charger.

CHAPTER 15

RANGE SEEDING

Over one million acres of highly erodible land was seeded to a permanent cover of grasses in Nebraska in the late 1980s and early 1990s. Thousands of acres of rangeland in Nebraska could still benefit from seeding. Many of these areas are land that was at one time farmed and then abandoned. It also includes rangeland that has been severely misused. Drought and overgrazing on some ranges often has resulted in destruction of the vegetation and/or a low state of productivity.

Seeding is an expensive range improvement practice and should be done only when it is the best practice to help managers reach their goals. It is recommended only on sites where the native vegetation has been destroyed to the point that it will not respond to improved management practices within an economical time frame. Before planning a seeding, obtain and study copies of Establishing Dryland Forage Grasses (G 81-543) and Certified Perennial Grass Varieties Recommended for Nebraska (EC 90-120). Personnel in local Soil Conservation Service offices can furnish detailed information on standards and specifications for seeding.

Planning

Planning is necessary for successful grass seeding. Plans for the seeding should include:

1. Selection of the grass (including varieties) or mixture of grasses that will fulfill the purpose for which the seeding is to be made.

2. Preparation of a suitable seedbed.

3. Following the best seeding practices.

4. Careful management after seeding.

Selecting Grass or Grass Mixture

Selection of the correct grass species (including variety) or mixture of grasses depends upon several things. The first is the time of year forage will be needed. Select cool-season grasses to provide grazing in late April and early May. They also will extend the period in which green grass is available to livestock in the fall. Warm-season grasses provide high quality forage in midsummer. Small areas within native pastures are generally seeded to mixtures of predominantly warm-season grasses to minimize grazing distribution problems.

Large areas where livestock water systems occur or can be developed should be seeded to warm- or cool-season species, fenced and managed as separate pastures.

Another consideration is the adaptation of grasses to the soil and climate of the area. Crested wheatgrass, for instance, is best suited for the medium and heavy soils of western Nebraska. Switchgrass and little bluestem may be used in mixtures for many range areas of Nebraska. Sand lovegrass is best used in mixtures on the coarse-textured soils of the state.

Whenever possible, plant certified seed of improved and recommended varieties of grass. This assures an adapted seed that will have a better chance of stand establishment and sustained production. Seed should be bought and planted on a pure-live-seed (PLS) basis. The PLS content of grass seed is determined by multiplying the germination percentage times purity percentage. A discussion of PLS may be found in Establishing Dryland Forage Grasses (G 81-543)

Seedbed Preparation

Seedbed preparation is necessary for successful establishment of grass seedlings. Many seedings develop slowly or are even lost because of poor seedbed preparation.

Range seedings in Nebraska are most successful when the seedbed has a stubble cover. The cover will help keep the soil moist, lower the surface temperature of the soil, and prevent unnecessary erosion. Stubble is most often provided by a crop of sudan, sorghum, or millet. The cover crop should be seeded late enough during the year before seeding to eliminate chance for seed production by the cover crop. If it appears that seed will mature on the cover crop, inflorescences should be removed by mowing before they ripen. The grass seeding is made directly into the stubble the following fall, winter, or early spring.

No tillage is necessary before seeding. Tillage destroys the cover and loosens the soils. If weeds are a problem before seeding, they can be suppressed with the proper herbicide.

The seedbed must be firm. If the soil is tilled before seeding, several operations with rollers or treaders are necessary to obtain the desired firmness. Nurse crops generally should not be planted along with range grasses because they compete for moisture and sunlight.

Seeding Practices

The best seeding practices require use of a grass drill with depth bands, double disc furrow openers, and packer wheels. This assures careful placement of seeds at a uniform depth and in close contact with the soil. Depth of seeding for most grasses in Nebraska should not exceed one inch. Some of the very small seeded grasses, such as sand lovegrass, should be planted at a depth of 0.25 to 0.50 inch. Contact the local Soil Conservation Service office or Natural Resource District office for suggestions concerning grassland drills. Many grass seed companies lease grassland drills to their customers.

A range interseeder was commonly used in the past where tillage for seedbed preparation would cause severe erosion hazards. It still may have an application in special situations. This machine seeds grass in the bottom of a shallow lister furrow without disturbing the vegetation between furrows. The range interseeder is best adapted for reseeding abandoned farm land on sandy range sites.

Sod seeding was developed in the 1970s. The process involves suppressing existing grassland vegetation with herbicides, grazing, or mowing and using a special drill to cut grooves in the sod and place seeds directly in the grooves. Advantages of this method include no tillage for seedbed preparation, little disturbance of the soil surface, and greatly reduced erosion potential.

Time of seeding is important. Cool-season grasses should be planted in late summer for fall establishment, if soil moisture conditions are favorable. They also may be planted in early spring. In central and western Nebraska, wheatgrasses may be planted during the late fall and winter (November-March) for early spring germination.

Since warm-season grasses are not frost-resistant in the seedling stage, they should be planted in midspring from early April through May. Slow germinating warm-season grasses such as bluestems, switchgrass, and indiangrass should be planted at the earlier date.

Management

Pay close attention to the management of range after seeding. Generally, seedlings should not be grazed until they are established. Establishment may require from one to three years, and more time is often needed for warm-season, native grasses.

Competition from weeds is one of the most common reasons for stand failure. Broadleaf weeds in newly seeded grasses can be controlled with herbicides. You should contact your local extension office for herbicide recommendations and to obtain a copy of the latest Herbicide Use in Nebraska. Currently, no herbicide is recommended for control of grassy weeds in new grass seeding. If foxtail barley, bristlegrasses, or sandburs are a problem, the only practical solution is mowing. Care should be used when mowing so that the new seedlings are not cut too close to the soil surface. Mowing should be done at heights of 4 to 5 inches. Grazing may be an alternative to mowing, but it is extremely difficult to apply grazing pressure to only the weedy species.

CHAPTER 16

MISCELLANEOUS RANGE IMPROVEMENTS

Some undesirable plants cause lower productivity of native plants. Some weedy plants use about four times more water than do forage plants. Removal of undesirable plants from range can increase both forage production and stocking rates while improving wildlife habitat and reducing the potential of livestock poisoning.

Nebraska has had a noxious weed law for many years. The word "noxious" is considered to be a legal term used to classify weeds that pose a serious threat to the economic, social, or aesthetic well-being of residents of the state. The Nebraska Noxious Weed Control Act states that it is the duty of landowners to control weeds on their property. When noxious weeds are found by the County Weed Superintendent, the landowner is notified. If the landowner fails to comply with the written notice to control the noxious weeds, the county authority will arrange to have the weeds controlled and will bill the landowner or will subject the owner to a fine.

The current noxious weeds are musk thistle, plumeless thistle, Canada thistle, and leafy spurge. Spotted knapweed, diffuse knapweed and purple loosetrife are currently being evaluated for possible addition to the noxious weed list.

Weed Control

Numerous plants may negatively affect the quantity and quality of range forage, but four greatly different species cause special problems on Nebraska rangeland.

Musk thistle is an introduced, biennial forb that can be controlled by hand digging or with herbicides. It is a problem because it infests large acreages and rapidly spreads by seeds even if only a few plants are not controlled. The publication Musk Thistle...Its Appearance, Spread and Control (EC 87-160) will provide additional information about this weed.

Leafy spurge is an introduced, perennial forb. It has spread rapidly across the Northern Great Plains and has a significant start in Nebraska. Buds located far below the soil surface initiate growth if the tops of the plants are damaged or removed. Repeated applications of herbicides are necessary to just keep the populations from increasing. If leafy spurge is found, an aggressive program of control must be initiated immediately. The publication Leafy Spurge (G 87-834) is a good starting point to learn about this weed and its control.

Eastern redcedar is a native tree and is the third species of concern. Eastern redcedar was confined to ridges and ravines before wildfires were controlled. Birds have spread the seeds from windbreaks across rangeland. Young trees are easy to cut out with a shovel, and they do not resprout. Landowners have not placed a high priority on eastern redcedar control, and now it is a problem on about 250,000 acres in Nebraska. Older trees can be cut with a chain saw or a tractor mounted mechanical shears. Another option is treatment with herbicides, but trees may be too dense to make any of these methods cost effective. The best approach may be a combination of prescribed burning to control the small trees and mechanical and/or herbicide treatment to control the larger trees.

The fourth species is sand sagebrush, this woody species occurs throughout much of western Nebraska, but it becomes a bothersome competator with grasses primarily in sandy soils in the southwestern portion of the state. It spreads slowly, but it is difficult to control. Options for chemical control are discussed in Sagebrush Control (G 80-510).

Most undesirable plants can be controlled with herbicides. Herbicides are not specific for only the weedy species to be controlled. Nontarget species may include important range forbs. Therefore, it is extremely important to know the plants and know which will be affected when evaluating the potential use of an herbicide to control a weed species. For specific recommendations as to time of spraying and rates of chemicals contact the local Extension office to obtain a copy of "Herbicide Use in Nebraska" which is a guide that is revised each year by Nebraska Cooperative Extension.

Although chemicals may be used to eliminate undesirable plants, the range manager must remember that these plants have usually become a problem because of range management practices. Control of the

undesirable plants will not be effective unless the cause of range deterioration is identified and corrected. In many weed control programs, grazing should be deferred during the current growing season. This will give the grasses a chance to increase in vigor and ground cover.

Grazing may be another weed control option. If the weed is palatable to grazing animals, it may be possible to graze the weed during a critical time in its life cycle to prevent reproduction and spread. Excessive grazing pressure must not be placed on a desirable species while trying to control the weedy species. An example is the use of goats and sheep to control leafy spurge.

Insects and pathogens are other forms of biological control. Many plants could become serious weed problems but are kept under control by insects or pathogens. Some of the musk thistle is controlled by insects, and scientists are actively evaluating insects for leafy spurge control.

Prescribed Burning

Prescribed burning is one of the oldest, but least understood, range management tools. Fire applied at the correct time of the year may control undesirable species while improving the quality of forage available to grazing animals. Range and other natural resource managers should obtain Grassland Management with Prescribed Burning (G 88-894) and Conducting a Prescribed Burn (EC 90-121) to see if prescribed burning could be a useful tool on their land. Prescribed burning can be dangerous, and managers must have proper equipment, adequate help, and extensive experience before conducting a burn. A burning permit must be obtained from the local fire authorities before conducting a prescribed burn.

Sand Blowout Control

Drought conditions and over-utilization lead to the development of new blowouts or reactivation of old blowouts. Most blowouts in the Nebraska Sandhills can be controlled. To heal these areas, sand movement must be stopped and a cover of grass must be allowed to develop or be established.

Control of sand blowouts is expensive and requires:

1. Fencing to keep livestock from trampling and grazing new vegetation on the blowout areas.

2. Leveling or shaping sharp edges of the blowout into a gradual slope. Sharp embankments give the wind its swirling action.

3. Fertilizing infertile, sandy soils to hasten the growth of these grasses.

4. Seeding the blowout to a mixture of adapted grasses such as sand bluestem, prairie sandreed, sand lovegrass and switchgrass.

5. Providing a protective cover to stop damage from blowing sand while grasses are becoming established. Old hay may be spread over the surface immediately after seeding and working it into the sand by feeding or supplementing cattle in the area or with a stubble puncher or dull disk. If mature hay, stacked after the seed has ripened, is used for mulching, some grass will grow from the shattered seed. In many cases this is the only seed applied to blowouts. Temporary crops such as rye, sudangrass, millet, and hairy vetch seeded the year before perennial grasses are seeded will help form a good seedbed.

An alternative method of blowout control is implementation of short duration grazing. If properly applied, this grazing management practice may allow blowouts to heal without fencing. It is used much more frequently than the expensive method of shaping, seeding, and mulching.

The only endangered plant species in Nebraska, blowout or Hayden's penstemon, occurs only in active blowouts. Have a representative of the Soil Conservation Service or your local extension agent determine that this species is not present before initiating blowout control. Blowout

penstemon is a rare, spectacular, and valuable species of plant that will not survive control procedures, and we each need to do our part to prevent its extinction. If it is present, your local extension agent or Soil Conservation Service representative can contact the proper authorities for alternatives.

Improving Production of Subirrigated Meadows

Yield and quality of hay produced on many subirrigated meadows can be improved with commercial fertilizers. Valuable publications on the topic are Fertilizing Grass Pastures and Haylands (G 78-406) and Subirrigated Meadow and Range Management Studies (WCC 89-1). Introduction of adapted legumes in conjunction with phosphate fertilizer will increase hay yield and quality. Soil tests should be conducted to better determine the amount of fertilizer needed. Use of fertilizer for improving meadow production includes:

1. A reliable soil test.

2. When legumes are present in subirrigated meadows, production can be increased in western Nebraska (and western Sandhills) by applying 30-60 pounds of nitrogen and 60 pounds of phosphate (P_2O_5) per acre per year. With this type of fertilizer program, soil testing is necessary because phosphorus may accumulate so that it is not needed every year. In eastern and central Sandhills the nitrogen recommendation is 50-75 pounds of nitrogen and 80-100 pounds of phosphate per acre per year.

3. If legumes are not present, nitrogen fertilizer will increase grass production. Where legumes are absent from the stand, 60 pounds of nitrogen is recommended for western Nebraska and 80-100 pounds of nitrogen per acre is recommended for central and eastern Nebraska.

4. If legumes are not present, they can be interseeded in winter or early spring. Legumes may be seeded with any seeder or drill equipped to handle small seed. This is often done with attachments to fertilizer spreaders at the time of phosphorus application. Drilling gives the best results, especially when seeding birdsfoot trefoil. Some ranchers seed legumes such as alsike clover and red clover by feeding mature clover-grass hay on meadows where they wish to establish new stands.

Grazing cattle on subirrigated, but not wetland, meadows is a sound practice under proper management. A subirrigated meadow may be grazed one year and cut for hay two consecutive years. The regrowth following haying may be removed by grazing after frost. Gains of cows and calves grazing meadows have proven equal to those from grazing upland Sandhill ranges during the summer.

Fertilization of Upland Sites

Pastures seeded to cool-season grasses such as smooth brome, intermediate wheatgrass, or crested wheatgrass may require nitrogen fertilization for top production. Suggested nitrogen rates vary from 80 to 100 pounds of nitrogen per acre in eastern Nebraska to 30 to 60 pounds per acre in subirrigated areas of western Nebraska. Fertilization of upland, native range in central and western Nebraska with either nitrogen or phosphorus fertilizer is not recommended. Application of 40 to 80 pounds of nitrogen per acre may be economical on rangeland in central and eastern Nebraska, but it must be applied near the completion of cool-season grass growth to keep the proper balance of warm- and cool-season species. Individuals interested in fertilizing pastures should obtain a copy of Fertilizing Grass Pastures and Haylands (G 78-406).

Range Pitting and Furrowing

Range pitting and furrowing were commonly used on rangeland in the past. Currently, they are seldom used because of costs, but they still may have applications in special situations. Range pitting makes shallow depressions to trap runoff water on soils that do not take water readily. This results in an increased amount of moisture available for plant growth and a smaller amount of surface runoff. Contour furrows and terraces also help reduce surface flow after rains and get more moisture into the ground. Pitting or furrowing is most useful:

1. Where the clay or silt content of the soil is high, and it is difficult for water to penetrate.
2. Where much of the rainfall normally runs off.
3. Where the terrain is rolling to moderately steep.
4. Where less than 20 inches of precipitation is received annually.
5. Where desirable forage plants are present to take advantage of the additional moisture.

Rodent and Insect Control

Rodents, particularly pocket gophers and prairie dogs, may become a serious problem on rangeland. Rodents may become so numerous that they eliminate forage stands. A mechanical burrow-builder for placing poison bait in meadows and hay fields infested with pocket gophers has been effective. The use of the burrow-builder is not practical on most upland ranges. Range seeding in areas with heavy populations of pocket gophers may require some type of control before stands can be successfully established. Poisoning has been used. Your local extension agent can furnish a copy of Plains Pocket Gophers and Their Control (G 76-319) and Prairie Dogs and Their Control (G 80-519) for detailed information.

Insects such as grasshoppers and black wheatgrass bugs also may become serious problems on rangeland in other forage crops. Several insecticides are approved for use in controlling these pests. Local extension agents can give advice on the most practical control measures for your area and furnish copies of Common Forage Legume Insects (EC 86-1545) and Field Crop Insect Management Guide for Nebraska-Alfalfa, Soybeans, Small Grains, Range and Pasture (EC 91-1511).

CHAPTER 17

COMPLEMENTARY FORAGE CROPS

Complementary forage crops add to or enhance the year-round balance of grazing and feed resources in conjunction with rangeland resources. A few examples are irrigated pasture, sudangrass, dryland cool-season pastures, and crop residues that provide forage of higher quantity and/or quality than is available from the primary rangeland resource at certain times of the year. These complimentary forages often improve the distribution of forage availability during the year. Complementary forage crops can be used to develop more efficient livestock production programs. Most Nebraska ranches outside the Sandhills depend on complementary forage crops during some period of the year.

Crop Residues

The most common complementary forage crops are crop residues. After fall weaning, many ranchers turn their beef cows into harvested corn or milo fields. Because nutritional needs of the beef cow are relatively low following weaning, beef cows in good condition will normally obtain their minimum requirements of crude protein and energy from corn or milo residues until inclement weather prevails. Supplementation may be necessary during periods of snow cover and when persisting cold temperatures with wind occur.

Summer Annual Grasses

Other common complementary forage crops include sudangrass, forage sorghums, and hay millets. These are used for late summer grazing or as winter feed. Summer annual forages are often grazed, but can be collected as dry hay, left in windrows, or used as a silage to feed beef cows or yearlings in winter and spring. When used for fall or winter feed, an alternative practice is to windrow the crop in August or September and allow the livestock to graze the swaths of forage one at a time with the aid of an electric fence. Sudangrass, sorghum x sudangrass hybrids and forage sorghums are also used for summer grazing during August and September when pasture production is limited. Summer Annual Forage Grasses (G 74-171) is an important source of information for summer annual forage grasses.

Irrigated Pasture

Irrigated pasture can produce large amounts of high quality forage. Grazing time is potentially from May 1 to November 1. Irrigated pastures are often used in early spring to support cattle until summer pastures are ready for grazing and in late fall after removing cattle from summer pastures. Hay may be harvested from the area during summer months. Publications on irrigated pasture available from the local extension office include Perennial Plants for Irrigated Pasture (G 81-567), Cross Fences for Pastures Under Center Pivot Irrigation (G 81-581), and Grazing Management of Irrigated Pastures (G 81-563). The costs associated with irrigated pasture are high, but they may be offset by advantages over dryland range for beef cows that include:

1. Forage quality meets the beef cow's requirements to a greater degree in early spring and fall.
2. More dependable forage quantity adds stability to the ranching operation.
3. Cows generally will have shorter time intervals from calving to first heat.
4. A higher percent of beef cows will cycle by the start of breeding season.
5. Artificial insemination (AI) is easier.
6. Fewer bulls are needed.
7. Cows will generally have higher conception rates.

8. Calves will normally perform better.

9. Early pasture may reduce hay needs and costs.

Hay and Silage

Hay and/or silage are always important forage resources on ranches where the practice is appropriate. The use of any complementary forage crop demands an intensive management plan from seeding through harvesting. Such factors as soil, site, seeding, fertilization, cultural practices, livestock utilization, etc. must be planned as a group when incorporating a complementary forage crop into a range-livestock operation. Many publications dealing with selection, production, harvest and utilization of hay and silage are included in the list at the end of this circular.

Some ranchers do not have the equipment, facilities or farming experience needed to produce and utilize these crops. Thus, a well prepared management and economic assessment plan are essential.

PUBLICATIONS

These publications may be ordered directly from Communications and Computing Services at the University of Nebraska using the order form provided, or they may be obtained from local extension offices.

Range Management

EC 84-109	Range Judging Handbook for Nebraska ($4.00)
EC 85-198	Nebraska Poisonous Range Plants ($.50)
EC 86-113	A Guide for Planning and Analyzing A Year-round Forage Program ($1.00)
EC 89-118	Nebraska Range and Pasture Forbs and Shrubs ($5.00)
EC 90-121	Conducting a Prescribed Burn ($.50)
EC 91-123	Drought Management on Range and Pastureland ($4.00)
G 79-435	Inoculation of Forage Legumes ($.25)
G 80-504	Proper Livestock Grazing Distribution ($.25)
G 81-543	Establishing Dryland Forage Grasses ($.25)
G 81-563	Grazing Management of Irrigated Grass Pastures ($.25)
G 84-738	Management to Minimize Hay Waste ($.25)
G 86-775	Prussic Acid Poisoning ($.25)
WCC 89-1	Subirrigated Meadow and Range Management Studies

Grasses

EC 85-170	Nebraska Range and Pasture Grasses ($4.00)
EC 89-265	Ammonia Treatment of Low Quality Forages ($.50)
G 88-894	Grassland Management with Prescribed Burning ($.25)

Pastures

EC 90-120	Certified Perennial Grass Varieties Recommended for Nebraska ($.50)
G 81-567	Perennial Plants for Irrigated Pasture ($.25)
G 81-581	Cross Fences for Pastures Under Center Pivot Irrigation ($.25)

Alfalfa

EC 72-195	Producing Alfalfa in Nebraska ($.50)
G 73-2	Fertilizer Management for Alfalfa ($.25)
G 75-220	Weed Control in Alfalfa ($.25)
G 77-357	Selecting Alfalfa Varieties for Nebraska ($.25)
G 80-488	Leaf Spot and Black Stem Diseases of Alfalfa ($.25)
G 83-652	Seeding and Renovating Alfalfa ($.25)
G 88-874	Management Tips for Round Bale Hay Harvesting, Moving, and Storage ($.25)
G 89-900	Phytophthora Root Rot of Alfalfa ($.25)
G 89-912	Alfalfa Crown and Root Rots and Stand Longevity ($.25)
G 89-931	Alfalfa Anthracnose ($.25)

Weeds

EC 87-160	Musk Thistle...Its Appearance, Spread, and Control ($.50)
G 77-384	Common Milkweed ($.25)
G 79-436	Control of Downy Brome in Alfalfa ($.25)
G 80-509	Canada Thistle ($.25)
G 80-510	Sagebrush Control ($.25)
G 86-807	Where Do Weeds Come From? ($.25)
G 87-834	Leafy Spurge ($.25)
G 89-905	Weed Control on CRP Acres ($.25)

Herbicides

EC 91-130	1991 Herbicide Use in Nebraska ($2.00)
G 84-704	Brush and Woody Plant Control ($.25)
G 88-871	Chemical Control of Rangeland Weeds ($.25)

Insects

EC 84-1510	Insect Control Guide for Beef Cattle in Nebraska ($.50)
EC 86-1545	Common Forage Legume Insects ($.50)
EC 89-1550	Nebraska Management Guide for Control of Arthropod Pests of Livestock and Horses ($.50)
EC 91-1511	Field Crop Insect Management Guide for Nebraska—Alfalfa, Soybeans, Small Grains, Range and Pasture ($2.00)
G 73-30	The Alfalfa Weevil ($.25)
G 78-409	Cattle Grub Control in Nebraska ($.25)
G 89-950	Horse Insect Control Guide ($.25)
MP 40	The Economics and Control of Insects Affecting Beef Cattle in Nebraska (Northern Great Plains) ($1.00)

Pesticides

EC 90-2500	Restricted Use Pesticides ($.50)
EC 90-2501	Pesticide Safety Telephone Hotlines ($.25)
G 79-472	Disposal of Pesticide Containers ($.25)
G 79-479	Pesticide Laws and Regulations ($.25)
G 89-937	The Pesticide Label ($.25)
G 90-1001	Spray Drift of Pesticides ($.25)

Fertilizer

EC 73-197	Fertilizer Know How ($.50)
G 74-111	Use Nitrogen More Effectively ($.25)
G 78-406	Fertilizing Grass Pastures and Haylands ($.25)
G 82-601	Using Phosphorus Fertilizers Effectively ($.25)

Soil

G 74-127	Understand Your Soil Test—Phosphorus and Potassium ($.25)
G 74-153	Understand Your Soil Test: pH-Excess Lime-Lime Needs ($.25)
G 82-595	Understanding Nitrogen in Soils ($.25)
G 89-901	Understand Your Soil Test: Sulfur ($.25)
G 91-1000	Guidelines for Soil Sampling ($.25)

Irrigation

G 82-607	Irrigation in the Sandhills—The Rancher's Management Alternatives ($.25)
G 86-826	Irrigating Alfalfa ($.25)

Water Resources Management

G 85-763	Nitrate-Nitrogen in Drinking Water ($.25)
G 89-907	Water Testing Laboratories ($.25)

Beef

EC 85-258	1984 Nutrient Requirements of Beef Cattle ($.50)
EC 90-263	Nebraska Calving Book ($1.00)
G 73-62	Grass Tetany ($.25)
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G 74-170	Nitrates in Livestock Feeding ($.25)
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G 75-232	Cow-Calf Herd Health Program ($.25)
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G 75-269	Calf Scours: Causes, Prevention, and Treatment ($.25)
G 76-307	Bull Selection ($.25)

G 76-325	Sweet Cover Poisoning ($.25)
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G 80-493	Developing Replacement Beef Heifers (Weaning—Breeding) ($.25)
G 80-495	Managing Two-Year-Old Beef Heifers (Calving—Rebreeding) ($.25)
G 80-497	Feeding the Beef Cow Herd—Part II. Managing the Feeding Program ($.25)
G 80-520	Wintering and Backgrounding of Calves ($.25)
G 80-536	Reproductive Tract Anatomy and Physiology of the Bull ($.25)
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G 81-539	Assisting the Beef Cow at Calving Time ($.25)
G 81-574	Reproductive Diseases in Cattle ($.25)
G 82-620	Pinkeye ($.25)
G 83-655	Management of Early Weaned Calves ($.25)
G 83-666	Breeding Soundness Examination of Beef Bulls ($.25)
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G 87-851	Improving Reproductive Performance and Productivity of Beef Herds ($.25)
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G 90-972	Reducing Calf Losses with Top Management ($.25)

Sheep

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Horses

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G 83-679	Equine Vaccination Program ($.25)

Wildlife

G 76-319	Plains Pocket Gophers and Their Control ($.25)
G 80-519	Prairie Dogs and Their Control ($.25)
G 88-882	Assistance With Wildlife Damage Problems in Nebraska ($.25)

Ranch Economics

EC 71-847	Your Balance Sheet ($.50)
EC 71-848	Your Income Statement ($.50)
EC 71-849	Cash Flow Planning With the Aid of Your Record Book and Budgeting ($.50)
EC 71-852	Cash Flow Planning Form ($.25)
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EC 71-854	Income Statement Form ($.25)
G 76-276	How to Figure Depreciation ($.25)
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G 76-311	Incentive Pay for Farm-Ranch Workers ($.25)
G 80-485	Social Security and Income Tax Withholdings on Farm Wages Paid ($.25)

Ranch Management

FM 75-2	Five-Year Continuous Depreciation Schedule and Farm & Ranch Inventory Record ($3.00)
FM 88-S1	Nebraska Farm and Ranch Business Record, Extra Pages of Income and Expense ($2.00)
FM 88-4	Nebraska Farm and Ranch Business Record Book ($5.00)
G 74-141	Harvesting Hay Crops for Silage ($.25)
G 74-142	Preserving Hay-Crop Silage ($.25)
G 74-178	Oven Moisture Test for Grain, Hay, and Silage ($.25)
G 75-205	Estimating Hay in Stacks ($.25)
G 77-331	Obtaining Feed Samples for Analyses ($.25)
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RB 254	Beef Cattle—At What Weight Should They Be Sold? ($1.00)

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