Managing Kansas Grazinglands

for Multiple Benefits

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

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Introduction

Livestock grazing, like all enterprises, has the potential to produce waste materials that can pollute water. This can be controlled by proper management. The exact effect grazinglands have on water quality is not well documented. The general goal is to reduce the potential for movement of sediment, plant nutrients, pesticides, and animal wastes into Kansas streams, rivers, lakes, and ponds.

Two overall management goals will address these concerns: (1) Optimizing plant growth will provide, within the limitations of a watershed and property ownership, vegetative cover that intercepts raindrops, provides plant densities that impede runoff, and ensures a root mass that binds soil particles together on the soil surface (Figure 1). (2) Reducing the potential for surface movement offsite or leaching of nutrients, animal wastes, and pesticides.

Reducing the contribution of potentially polluting materials from grazingland will contribute to the protection of downstream water quality. Improved on-site water quality also benefits the livestock production enterprise. Microorganisms and chemicals, such as nitrate, in the water supply can cause disease or weaken the animals' immune systems. This can result in a reduction in weight gains, reproduction, and milk production. Ponds with high nutrient concentrations also may contain high populations of algae, which may be toxic to animals drinking the water.

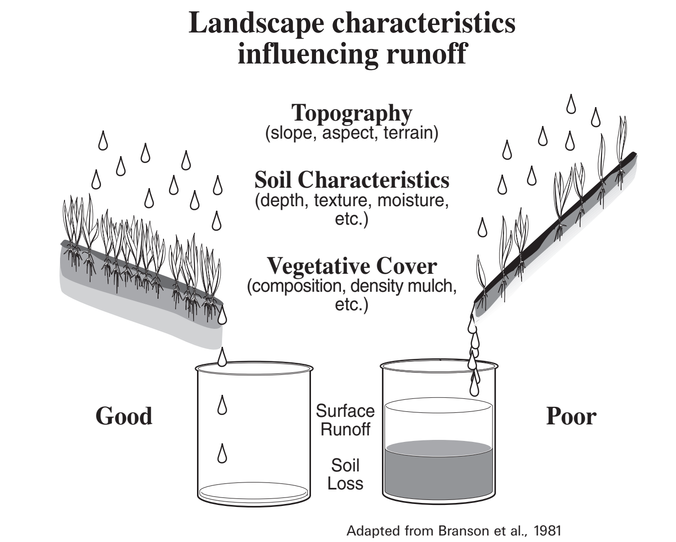

Figure 1. *Topography, soil, and vegetative characteristics influence runoff rates.*

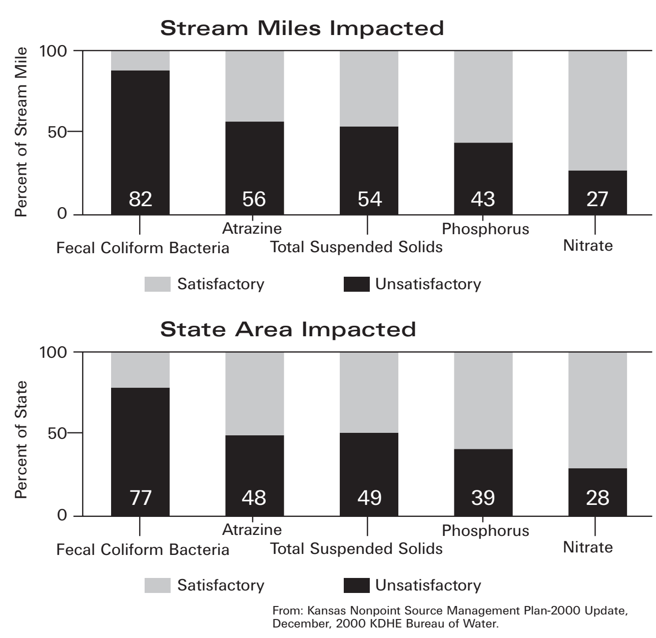

Figure 2. *Common pollutants in Kansas waters.*

Current Status of Kansas Water Resources

Water quality is considered impaired when normal use of the water downstream (including, but not limited to, domestic water supply, fishing, and swimming) is severely limited or prevented. The majority of Kansas streams suffer some type of water quality impairment. The Kansas Nonpoint Source Management Plan 2000 Update reported stream miles impacted and the area of the state affected by pollutants (Figure 2). The assessment reported that fecal coliform bacteria was the primary pollutant of Kansas streams. Fewer than half had unacceptable levels of phosphorus and nitrate.

Sources of Water Quality Impairment

Water quality from grazinglands is impaired when suspended solids (soil particles and organic matter particles), nutrients (nitrogen and phosphorus), bacteria, and pesticides exceed standards for specific uses. Pollutants enter streams and rivers through surface flow (runoff) or through internal soil drainage (subsurface flow) either as suspended material or dissolved in water. Internal soil drainage carries both dissolved and suspended material. Surface flow also carries both suspended and dissolved materials and is the major pollution transport mechanism for Kansas grazinglands. Fecal coliform bacteria, which can originate from human, livestock or wildlife sources, frequently exceed water quality standards in Kansas. Though fecal bacteria is a major concern statewide, an interpretation of the literature by the Kansas Department of Health and Environment suggests that fecal coliform concentrations in typical grazingland streams tend to be lower than those for other land uses. Although the source(s) of coliforms and other pollutants is often difficult to determine, the application of sound grazing management principles will help maintain concentrations at acceptable levels.

Both grazinglands and croplands can, at times, contribute to water quality problems. An earlier Kansas study (Holland, 1971) found that sediment accumulation in small watersheds originated more from cropland than rangeland in eastern Kansas (Figure 3).

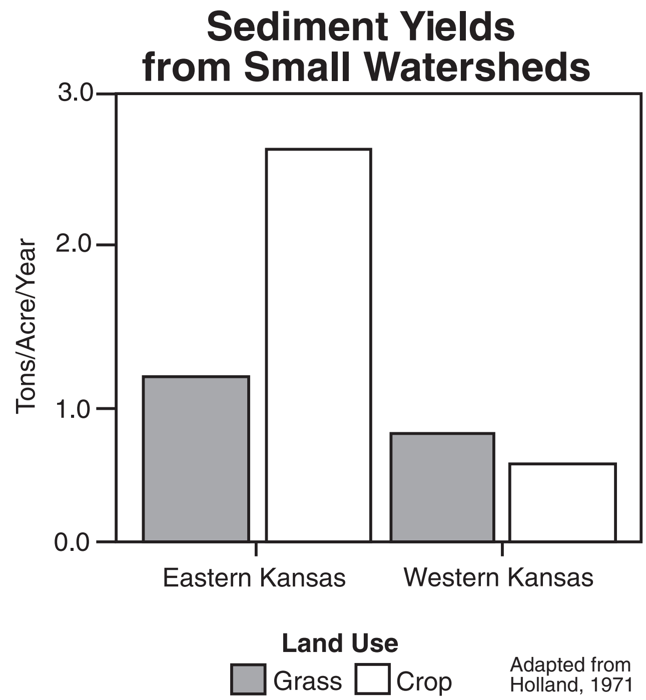

Figure 3. *Sediment yields vary according to land use and climate.*

In western Kansas, more sediment originated from rangeland than cropland, because rangeland has less cover than cropland. The sediment loss from both types of land use areas was small, less than 1 ton per acre per year.

When a stream, river, lake, or aquifer is polluted, but the pollution does not come from a single source or event, the water body is said to be suffering from nonpoint source pollution. Any additional activity that produces wastewater or contaminated storm water runoff, but is not required to hold a National Pollutant Discharge Elimination System permit, is a nonpoint pollutant source.

The EPA's most recent 305(b) report identifies agricultural production (confined animal feeding operations, cropping practices, and pasturing) as a major nonpoint pollutant source. Nonpoint source pollution involves the movement of plant nutrients (nitrogen and phosphorus), livestock manure (containing nitrogen, phosphorus, bacteria, and oxygen-demanding substances), soil particles, and pesticides from the land surface into surface water or groundwater. This movement can occur through runoff, infiltration of rain and snow melt, or the activities of animals directly in a water body.

There are many ways pollutants from grazinglands can enter water. For example, nutrients and pesticides can enter water through improper practices, such as application to frozen or saturated soil, drift, or excessive use. Bacteria can enter water through direct deposit of animal wastes into streams and ponds. Suspended solids and minerals can pollute water as a result of livestock damaging ponds and stream banks, long-term trailing down slopes, and long-term overgrazing. The potential causes of pollution from grazinglands can be controlled through management similar to that required for long-term economic livestock production.

The quality of water leaving grazinglands is primarily a function of interrelationships between precipitation (interval, duration, and intensity), landscape characteristics, and livestock use. Precipitation events normally determine the maximum amount of runoff possible, while landscape characteristics dictate how much runoff, if any, will occur. Landscape characteristics influencing runoff include: topography (slope, aspect, and terrain), soil characteristics (depth, texture, moisture capacity, etc.), and vegetative cover (species composition, basal density, canopy cover, and mulch) (Figure 4). Infiltration and vegetative cover reduce runoff and subsequent pollutant loading to water courses. Livestock may affect water quality through direct deposition of waste (manure/urine) in water resources or by effects associated with animal concentration (manure concentration, trampling, trailing), overgrazing, and/or untimely devegetation (relative to precipitation events). Management can enhance water quality by manipulating vegetative cover (forage resources) and by managing livestock to minimize negative effects associated with livestock use in a pasture.

A review of relevant literature, pasture inventories, and communication with managers provides an improved understanding of the interrelationship between livestock behavior and water quality. Water quality associated with grazingland is influenced by livestock distribution. Landscape characteristics that may influence livestock distribution include: livestock water (kind, location, quantity, and quality), shade (presence or absence, location, and canopy characteristics), topography, landscape temperature differentials, prevailing winds, and facilities (feeders, rubs, fences, gates, etc.) locations. Relationships between landscape characteristics, pasture conditions, and facilities determine where livestock will likely graze and congregate and thus the location and relative degree of defoliation and waste deposition.

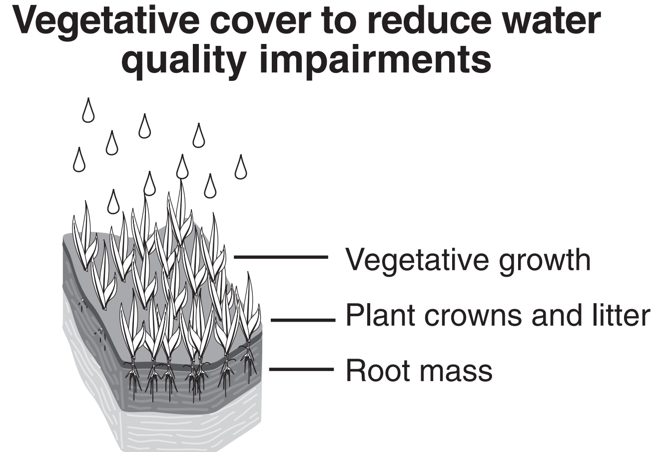

Figure 4. *Runoff and sediment are reduced as vegetation height, density, and root mass increase.*

Benefits of Protecting Riparian and Wetland Areas

Riparian areas, the natural vegetation types and sites along water courses, are considered critical areas for protecting water quality. These riparian areas, together with wetlands, can minimize the effect of pollutants on water resources.

Riparian areas have unique vegetation due to the presence of water for varying lengths of time during the year. In addition, soils in these areas have hydric characteristics (resulting from the presence of water) and may be capable of supporting wetland vegetation. Riparian and wetland areas play an important role in water quality protection by trapping, transforming, or otherwise neutralizing such pollutants as suspended solids, nutrients, and certain pesticides.

Overgrazing along streambanks, channels and in feeding areas can damage or destroy vegetative cover. Vegetation in riparian areas is especially prone to overgrazing because it is usually the first vegetation to green up in the spring and is highly palatable.

For additional information:

Stocking Rate and Grazing Management (MF-1118)

K-State Research and Extension

Water quality impairments can occur in riparian areas, and in downstream areas such as a lake, through any or all of the following pathways.

Direct entry

Animals can deposit manure and urine directly into the water, causing impairments by pathogens, nitrates, and phosphates.

Runoff and leaching

Pollutants from manure and urine can enter surface water through runoff and leaching.

Soil erosion

Where plant cover on streambanks has been damaged or lost, silt and other sediments can pollute the water through soil erosion. Areas that are overgrazed are prone to erosion and pose a higher risk of causing nonpoint source pollution problems. Maintaining the long-term viability of riparian and wetland areas will help assure stable streambanks and the desired on-site and off-site water quality conditions.

The Kansas Grazingland Resource

Kansas has a large and valuable grazingland resource. Based on the Natural Resource Inventory conducted by the USDA Natural Resources Conservation Service (formerly the Soil Conservation Service), rangeland occupies 17.1 million acres and tame pasture 2.2 million acres. Rangeland is grassland dominated by native grasses. Tame pasture normally consists of introduced grasses, including smooth brome, tall fescue, and bermudagrass, which require added nutrients to be fully productive. Management of each forage is based on the growth and development of the plants involved.

The 19.3 million acres in permanent vegetation cover are made up of perennial plants, primarily grasses. Beef cattle production is the major enterprise on these lands. Sheep and goat production are minor uses. Wildlife, fish, and recreational uses are increasing. The economic benefit derived in Kansas from all uses exceeds $4 billion annually.

Management Principles

Several principles of grazingland management are used to maintain and improve the productivity of the resource. Understanding these principles is the key to developing a system of management practices that can sustain profitability and reduce runoff potential. Specific management practices will often be unique to each situation, but practices are always based on the same principles, which apply to all grazing types.

Grazing management strives to develop a vigorous vegetative cover that helps protect the soil and reduce potential water quality impairments. This is achieved in three ways:

1. Vegetative growth provides cover to intercept raindrops;
2. Plant crowns provide barriers to the movement of water and solid pollutants; and
3. Root mass in the upper soil profile holds soil particles in place.

Forage production for livestock consumption and for the replenishment of root reserves is a primary factor in the efficient and economical operation of any grazing enterprise. Adjustments in management and/or facility location can be used to increase plant cover, production, and density. Management should strive to ensure an adequate separation (distance and cover) between livestock waste (manure and urine) and drainages. In developing management strategies to improve vegetative cover, the grazingland manager is guided by six grazing management principles:

- Stocking rate
- Uniform utilization/grazing distribution
- Degree of utilization/degree of use
- Season of use
- Kind and class of livestock
- Systematic rest

The first five are used together. In the management decision process, stocking rate is the most critical principle, while the next four represent modifications of stocking rate. Systematic rest is a specialized form of grazing management requiring higher levels of management inputs.

For additional information:

Grazing Distribution (MF-515)

K-State Research and Extension

Stocking Rate

Stocking rate can be defined as the land area allocated to each grazing animal for the grazable period. Three factors are included: the animal, the forage being grazed, and the length of time animals will be on the land. Stocking rate influences how well perennial plants will recover from grazing during the growing season, how well the plant will continue to produce in following years, the quality of the available forage, and the animals' performance.

Only the palatable species should be considered in determining stocking rates. Continued overuse of the most palatable species will occur if stocking rates are determined by including unpalatable species as part of the forage available. This will reduce the long-term productivity of the forage resource, resulting in a reduced profitability of the livestock enterprise, increased likelihood of soil erosion, and invasion of undesirable vegetation.

Many livestock operations base their stocking rate on tradition, the rate used by their neighbors, financial pressure, research results, or guesses. For grazed forages to remain productive, grazing pressure must be matched to the pasture's carrying capacity on a pasture-by-pasture basis and adjusted for short-term climatic changes.

When matching grazing pressure with carrying capacity, the goal is to attain the best compromise between maximum gain per animal and maximum gain per acre, rather than to maximize either factor by itself. To protect the soil from eroding, it is important to ensure that the vegetation on the grazingland is maintained or improved during the growing season. Most often, this is achieved with a moderate stocking rate. A manager's goal should be to stock at the average, but be prepared to change stocking rate or to feed during periods of stress, such as drought or flooding.

Uniform Utilization

Grazing animals usually do not graze an area uniformly. When uneven grazing occurs, forage availability and quality may suffer, resulting in reduced animal performance. Uneven grazing patterns can occur for several reasons:

Pasture shape, terrain, and water location

Many pastures have one or more areas that are underused due to the presence of steep slopes, unusually rough terrain, or inaccessible water sources. The shape of a pasture also can affect uniformity of grazing. Encouraging animals to graze underused areas is often difficult and requires changing the grazing animals' habits and grazing patterns. See the following section on grazing distribution practices for information on how to accomplish this.

Grazing preference

The relative palatability of a plant species depends on factors such as the other species present, stage of growth, and soil fertility status. Grazing animals will concentrate in areas where the plants are most palatable or will selectively graze only the most palatable plants throughout the pasture.

Seasonal Nutritional Needs

Forbs often fill nutritional needs during certain periods. This may cause uneven grazing patterns.

Degree of Utilization

Degree of utilization refers to the portion of the current year's forage production consumed or destroyed by grazing animals. Each pasture has an optimal degree of use, depending on plant palatability, season of use, and kind and class of livestock. Generally, no more than 50 percent of the current growth by weight should be removed during the growing season.

Season of Use

The time of year during which plants are grazed influences how much plant material can be removed without reducing the production potential or changing the species that grow. A perennial plant must have enough leaf area during the late summer and early fall to produce food, both for current growth needs and for stored food reserves. Excessive defoliation (removal of more than 50 percent of the plant by weight) during certain periods is harmful to plants. Warm-season plants should not be grazed excessively during reproductive development (mid-July to frost). Cool-season plants are most susceptible during early vegetative growth in late winter to early spring, summer dormancy (July-August), and the vegetative growth in early fall.

Kind and Class of Livestock

The kind and class of the livestock influence grazingland management decisions. Different animals prefer different forage types. Cattle prefer grasses, sheep prefer forbs, and goats and deer prefer browse (the edible portions of woody plants) and forbs. Because of these differences in dietary preference, mixing kinds of livestock under certain conditions to increase carrying capacity and production is possible. Sheep and goats may also help control weeds and brush. However, the forage source must have the necessary diversity and production for the animals to meet their dietary needs.

Total forage demand will depend on the age and reproductive status, or class, of the grazing animals.

For information on the requirements of animal waste management, contact the Livestock Waste Management Section, Kansas Department of Health and Environment.
www.kdhe.state.ks.us/feedlots
(785) 296-6432

Systematic Rest

Planned, periodic rest has become a major factor in the maintenance and improvement of grazed forages. Rest at key periods allows the plants to grow and meet their nutritional requirements. Systematic rest can maintain or improve pastures with little disruption in livestock management.

Grazing management principles must be applied in combination to accomplish multiple goals including profitability assurance, maintaining forage vigor, and addressing water quality issues. Stocking rate, grazing distribution, degree of use, season of use, and kind and class of livestock are the primary principles used to produce a management strategy. Well devised facilities and/or practices such as livestock water, prescribed burning, and fencing are fundamental to a successful strategy. When strategy or practice changes are considered, evaluate their influence on vegetative cover and livestock concentration. An effective evaluation identifies the expected livestock behavioral response to the new combination of management principles, pasture facilities and landscape features. Significant management changes or investments to protect water quality will be selected based not only on expected livestock behavior, but also on economic feasibility.

Management Practices

The following are management practices that can reduce the discharge of pollutants from grazingland, improving and protecting water quality.

The choice of grazing management practices should be based on the basic principles listed below.

- Grazing distribution practices
- Fertility management
- Weed and brush management
- Prescribed burning
- Grazing systems

Grazing Distribution Practices

A uniform distribution of grazing is essential for the effective use of the forage resource. Obtaining uniform use patterns as soon as the animals are introduced is important since livestock establish their grazing habits when they first enter a new pasture.

Modifications of Normal Management

Among the most readily used practices are those that require only modifications of normal management. Examples include the location of salt/mineral feeders; oilers, dust bags, or rubbing posts; and winter feeding areas. Properly used, these normal management practices help maintain adequate vegetative stands, reducing runoff potential.

Moving salt/mineral feeders away from water is one way of improving grazing distribution. The new salt/mineral location should be in undergrazed areas. When placing the salt/mineral feeders in a new location, make sure the livestock follow so they know where the new location is. Move the salt/mineral feeders whenever livestock congregate and begin to trample and damage the vegetation.

Oilers, dust bags, or rubbing posts can be used in the same way as salt and mineral feeders. They do not need to be located with the salt/mineral or left by water. Oilers or rubbing posts should not be placed between water and salt. Salt should not be placed between water and oilers. Distribute these throughout the pasture to gain uniform use of the pasture.

Winter feeding location can influence where animals graze during the growing season. Feeding locations can be temporary or permanent, depending on management considerations and the animals' needs. Use temporary feeding locations to change seasonal grazing patterns. In areas that need to be grazed, feeding on the ground will help by encouraging the animals to trample standing vegetation and graze dead plant material as they pick up feed. Trampling the standing vegetation allows animals access to new growth later in the season.

Pastures set aside for use during the winter months and not grazed during the growing season can be grazed more heavily. In this situation, the plants have a chance to recover during the growing season.

Permanent feeding facilities should be placed where animals will not have access to streambeds and runoff will not enter streams. Winter feeding in the same location every year results in overuse or trampling of the vegetation, especially if the area is also grazed during the growing season. Continual feeding in the same location will, over time, bare the area, opening it to erosion. Permanent winter feeding facilities should be managed according to the guidelines and regulations applicable to confinement feeding operations.

Substantial Changes in Management or Capital Input

Another category of management practices includes those that are more involved, requiring changes in management or capital input. Examples include prescribed burning and construction of drift fences, access routes, livestock watering facilities, and fencing. Each of these can be used to improve the overall vegetative stand and reduce runoff potential.

Prescribed burning can be used to change where and how much animals graze an area. For more information, see the section on prescribed burning on page 8.

Drift fences (short fences or barriers) can prevent livestock from trailing through an area. For example, a drift fence could be used to block a gentle slope where continual trailing of animals is causing gullies. This will force the animals to use different areas. A drift fence parallel to a stream can force livestock to cross at selected locations that will minimize damage to the banks and channel.

Constructing access routes along contours or through barriers in areas of rough or steep terrain will allow livestock and equipment access and improve use of the forage.

Livestock water location is an important factor in determining animal behavior and habits. One way of drawing animals away from streams and drainages is through the use of livestock water developments. Examples include stock ponds (Figure 5), pipelines and troughs, spring developments, and solar-powered pumps. Choosing the kind of water source depends on the terrain, groundwater availability, and cost.

Strategic fencing is a possibility where it allows vegetation to be manipulated. But strategic fencing should be considered only after other practical means of manipulating grazing distribution, including water development, have been exhausted. Fencing usually has a high investment cost and is at least semi-permanent once it is installed. Electric fencing can be an economical means of controlling animals when all other means are inadequate.

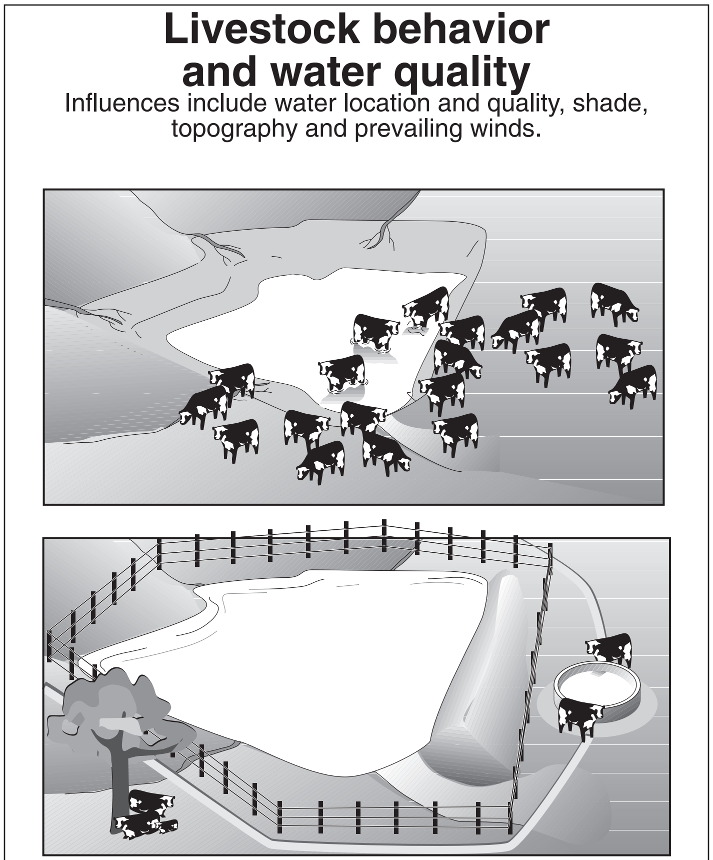

Figure 5. *Location and kind of livestock water source can change animal behavior.*

Fertility Management

Fertility management involves the selection of rate, timing, and method of nutrient applications. Proper use of nutrients can reduce the potential for movement into surface or groundwater. There are three primary sources of supplemental nutrient applications to grazinglands: commercial fertilizers, manure, and lagoon water. Each has unique management guidelines for their use. Nutrient applications are a necessary production practice on tame pastures and on rangeland in some areas. The following are management guidelines common to all nutrient sources:

- Soil test to determine existing nutrient levels.
- Determine amount of supplemental nutrients needed to meet the forage production goal.
- Apply nutrients when they will most likely be used by the plants.
- Do not apply fertilizers, manures, or lagoon water to frozen or saturated soil, or under conditions where runoff is likely (such as immediately before heavy rains, on moderate to steep slopes, or next to streams or other water).

For additional information:

Rangeland Weed Management (MF–1020)

Rangeland Brush Management (MF-1021)

K-State Research and Extension

Additionally, commercial fertilizer should be applied in split applications according to plant growth and moisture availability whenever possible.

Manure may be applied fresh (from the lot or stockpile) or composted. The following guidelines should be followed:

- Determine nutrient content of each lot of manure.
- Apply manure to supply the amount of nutrient needed in smallest quantity, usually phosphorus. Applying manure to meet nitrogen needs usually results in a rapid buildup of soil phosphorus levels.
- Monitor salt content in manure and soil to prevent the development of saline, sodic, or saline/sodic soil conditions.
- Be sure to follow any waste management plan and permit requirements if the confined animal feeding facility is permitted.
- Lagoon (animal manure or nutrient management) water should be applied by the same guidelines as manure.

Weed and Brush Management

Weeds and brush can restrict or prevent livestock from grazing a pasture uniformly. They replace grazable forage and can create physical barriers to livestock movement and grazing, and limit access to parts of a pasture. This can lead to stand reduction and possibly overgrazing of certain areas, which could increase the potential for erosion. Base a management strategy for reducing weed and brush problems on an understanding of the role of competition for root space in the soil and on what plants will be present.

Plant roots compete for space from which they can extract water and nutrients. If the roots of one species totally occupy a portion of the soil profile, invasion of other species is difficult or impossible. In a successful management program, the roots of desirable species will occupy the soil profile, assuring dominance by those species.

Controlling unwanted plants can be expensive and difficult. Strategically planning brush areas for wildlife or erosion control may be more economically feasible than trying to reclaim the land for grazing. Poisonous, noxious, and invading weeds that are not compatible with forage should be targeted for control. Many "weeds" are actually beneficial to livestock and wildlife, and the consequences of their removal should be considered before a control program begins.

Forage production decreases as weed and brush encroachment increases. At some level, weed and brush populations become high enough to warrant control. To be justified, control of undesirable species must increase forage production or availability for livestock. Reducing unwanted plants to a tolerable level generally is more economical than attempting to eliminate them. Cost effectiveness increases when weeds are controlled on sites with high production potential, such as lowlands and meadows. Because species respond differently to control attempts, accurate identification of the undesirable plant is important for successful management.

Weed management is sometimes necessary because of overgrazing and/or drought. Two or more successive years of drought will encourage invasion of both undesirable grasses and broadleaf weeds. Annual weeds also may occur in pastures under certain weather conditions. The first step is to develop a long-term management program that encourages the growth of desirable vegetation, particularly perennial grasses.

Mechanical, chemical, and biological control methods, along with prescribed burning, can be used when weeds get too large or widespread. Integrating control methods with the ongoing management program will be a key part of the process.

A long-term brush management program may also be needed to deal with existing trees and brush that are impairing the effectiveness of other management practices, and any new invasions of trees and brush. Mechanical, chemical, and biological measures, along with prescribed burning, should be used in combination to manage existing woody plants and prevent their invasion. Management programs should begin by targeting open areas where brush is scattered, followed by areas where brush is more dense. The most cost-effective and timely methods appropriate for the situation should receive priority. When using biological measures, be sure to consider all potential grazing animals, including cattle, sheep, goats, and so forth.

Note: Before destroying any hardwoods that may have potential economic value, such as walnut and oak, an assessment by a forester may be desirable. **When using pesticides, always read and follow label cautions, instructions, and directions.**

For additional information:

Prescribed Burning: A Management Tool (L-815)

Prescribed Burning: Planning and Conducting (L-664)

Prescribed Burning: Safety (L-565)

Prescribed Burning: Equipment (L-876)

K-State Research and Extension

Prescribed Burning

Fire, grazing, and drought were natural factors in the development of native grazinglands. As settlement progressed, improvements such as roads, fields, and fencing limited the occurrence and size of wildfires. Over time, vegetation changed in subtle ways. Prescribed burning strives to reintroduce fire as a safe and effective management practice. The first consideration in prescribed burning is safety, including adherence to any applicable state regulations. Properly timed fires can be conducted with minimal runoff and soil loss. Prescribed burning has been used more on rangeland than cool-season pastures. Properly used, it can increase vegetative growth and reduce weed and brush problems. This reduces the potential for erosion and runoff.

Rangeland. Prescribed burning on rangeland can provide many benefits. It is an aid in grazing distribution, weed control, brush control, wildlife habitat improvement, and grazingland improvement. Annual burning, where it is possible, together with previously mentioned practices can change the grazing distribution. Livestock prefer forage on burned areas.

A management program that includes timely spring burning for 2 successive years will greatly reduce most weed and brush species. Combining prescribed burning with other control practices can keep weeds and brush at a minimum.

Cool-Season Grasses. Cool-season grasses such as smooth bromegrass and tall fescue, do not respond to prescribed burning like native grasses. However, prescribed burning can be used to remove excess mulch and standing dead material that inhibits grass growth and to control woody invasion.

Grazing Systems

Grazing systems are specialized grazing management programs developed as a means of providing systematic rest to the forage plants. A grazing system involves recurring periods of grazing and rest for the forage. If a certain system can improve long-term vegetative health, this reduces the potential for erosion.

A grazing system is more than just a plan to randomly move livestock from one pasture to another. It must be designed to accomplish specific goals and objectives within the resources available (land, labor, capital). When designing a system, producers must first work out the mechanics of moving the animals. Animal and financial management, along with marketing ability, should also be considered. Above all, the attitude, understanding, and ability of the operator is important.

Three major concerns must be addressed: water, fencing, and animal nutrition. Clean, high-quality water for the grazing animals must be in adequate supply. There must also be a reserve in case the primary water source fails.

Fencing should be designed so that livestock can be moved as simply as possible with the least amount of fence material. Fencing must be adequate to confine the animals.

Nutrition directly affects animal performance. One concern is the varying level of nutrition resulting from the movement of animals from grazed to ungrazed forages. Moving animals before nonselective grazing becomes excessive will help even out this variation in nutrition.

Designing a System

A grazing system should be designed to maintain or enhance forage potential of a pasture. A properly designed system should improve plant vigor and production by favoring desirable plants. Maintaining or improving plant vigor, dry matter production, and good vegetative cover will result in the best forage production. It also will provide environmental benefits by reducing erosion potential. Degradation of species composition and/or reduction in forage production will occur in systems that do not allow desirable perennial plants time to replenish their food reserves.

A well-designed grazing system should integrate management of the vegetation, soil, and animals. It should consider the effect annual differences will have on management strategy. Plant production and animal performance are highly influenced by stocking rate. Individual animal performance should not be sacrificed for high livestock production per acre. The type of livestock operation and the level of managerial ability are important considerations.

Kinds of Systems

There are many different kinds of grazing systems. Each system has advantages, disadvantages, and limitations. The following are several categories of grazing systems in use today. As the complexity of the system increases, the level or intensity of management also must increase. Many systems substitute management skills for labor. A system may be designed to benefit the plant, the animal, or both. Those that benefit the plant will have the most benefit for environmental quality.

Sequential or complementary forage grazing systems (using two or more forages during the grazing season) strive to provide green, high-quality forage as long as possible. Normally, producers design such a system so each forage is grazed at its highest quality. Properly designed and managed, these systems benefit both the plant and the animal.

Sequential forage systems are those in which two or more forages are grazed in a sequence. To properly design a sequential forage grazing system, forages must have different growing seasons and be fenced separately. Each forage is used during its vegetative growth period. Regrowth may be stockpiled for dormant-season use.

Complementary forage systems are those that use two or more forages together. The second forage is used to supplement the primary forage. Generally, the second forage is a summer annual such as sudan. The second forage is grazed at the same time as the primary forage to add quality to the animals' diet.

Partial-season grazing systems use a forage for only a short period during the growing season. Intensive early stocking, used only on rangeland, is an example. Intensive early stocking (doubling the number of stockers during the first half of the grazing season and removing them by July 15) can benefit both forage and livestock production. Once grazed during the early part of the season, the pasture must not be grazed again until after the plants are dormant.

Deferred grazing is the practice of delaying grazing in a pasture normally reserved for use during the dormant season. Deferred grazing also may be used to provide a rest period for restoring plant vigor, reproduction, or new seedling establishment. The deferred pasture is not necessarily part of a systematic rotation. A deferred pasture can be used during the dormant season for backgrounding yearling cattle or for calving. When used for dormant season pasture, supplementation of the animals may be necessary. Pastures used during the dormant season and rested through the growing season are usually in the best condition.

Two to four pastures/one herd systems, often called "rotation grazing," require livestock to be moved from pasture to pasture, with each pasture being grazed only once each year. The next year, grazing begins in a different pasture. Forage potential is usually improved by these systems, but animal performance may be reduced unless their nutritional needs are carefully managed. To maintain nutritional quality, moves must be made so animals are not facing major palatability or nutritional changes.

This system is not as intensive as cell grazing, and may be more consistent with water quality protection from eroded sediments. It allows time for recovery of vegetation and soil stabilization.

Management intensive, cell, or time-controlled grazing is an intensification of the rotation system. Grazing periods and move dates are made based on degree of use rather than a preset number of days. Generally, there are more than six pastures involved. The goal is to use the best parts of all the plants, not just the most palatable plants. Relatively long rest periods follow the grazing period. Research and experience indicate both the plant and animal can benefit, but **only** if the system is carefully designed, used, and managed.

Physical Improvements

Physical improvements include:

- Strategic fencing
- Livestock water developments
- Working facilities

These improvements allow for efficient management and enhance forage production and grazing. By enhancing forage production, these improvements can help reduce the potential for erosion and runoff.

Strategic Fencing

Adequate fencing type and design is required to effectively control grazing to benefit forage use. Without adequate control, livestock will graze the most palatable plants first, leaving less palatable plants until later in the season or ignoring them altogether.

One of the most effective management changes is cross-fencing large pastures to separate vegetation types, topographic areas, or water sources. To determine fence placement, consider 1) current grazing patterns; 2) barriers to livestock movement (such as vegetation types, topography, and water locations); and 3) how easily the resulting pastures could be managed. Fencing also may be used to protect water resources.

Cross-fencing can be done using conventional barbed wire fences (3-wire), woven wire, or high-voltage/low-impedance electric fencing (Australian-New Zealand type). The latter is the most cost effective and is considered semi-permanent.

Livestock Water Development

Water is a nutrient for livestock and a management tool for the producer. The lack of water, poor-quality water, or poorly placed watering facilities are some of the most commonly encountered problems. Water can be the most important, but often the most overlooked, nutrient or management practice. It is a major consideration in most intensive grazing management systems.

If a new water location is to be developed, the producer should consider three criteria:

1) protection of existing and future water sources;
2) amount of water available; and
3) location of watering facilities within the pasture.

If a new water source is developed in a pasture with an existing source, the grazing distribution pattern may be altered. The quality of the new source may be much higher. If the new water supply can be controlled, livestock can be moved from one watering source to another.

Water developments include ponds, springs, dugouts, windmills, water wells, and pipelines. Solar-powered pumps are also available.

If a new pond is constructed, lay a water line under the dam and develop a trough below the dam (Figure 6). Consider setting the troughs on some kind of gravel or concrete pad to reduce erosion potential. Fencing the entire pond will improve the quality of the water, protect the investment in the pond, and increase the lifespan of the storage capacity. (There are no data on how long these benefits will last or the period over which the investment should be amortized, however.) Fencing also will prevent livestock from walking on ice during the winter and from bogging down in silt during periods of low water.

For large pastures, locate water sources so livestock do not have to travel more than ½ to ¾ mile in rough terrain and no more than 1 to 1½ miles on level terrain. The distance between water sources must be taken into account to ensure that animals can readily travel to all parts of the pasture.

Small ponds, pit ponds, and spring developments should be used whenever possible instead of large ponds, windmills, or water wells, due to cost and feasibility considerations. A new option for shallow wells and wet areas where spring developments are not possible is the solar-powered pump. Keep in mind the protection of the well from outside pollutants.

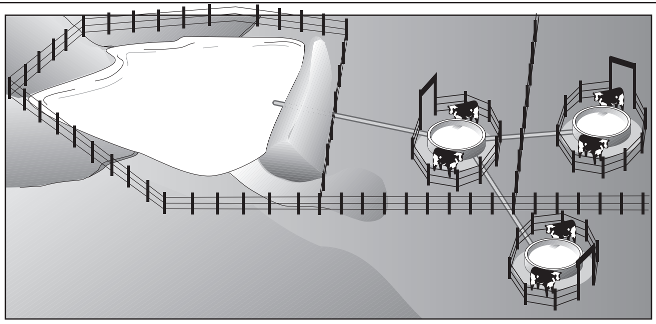

Figure 6. *A single water source can be used to supply several pastures through the use of a pipeline and troughs.*

In areas where water is difficult to obtain, storage facilities and pipelines can be used to transport water over long distances very efficiently.

Water locations preferred by livestock strongly influence where livestock graze and congregate because thirst is a primary physiological demand. Loafing and social behavior tend to prolong livestock concentration around watering points. Loafing may be prompted by the need to rest, ruminate, or take advantage of evaporative cooling or shade. Social interactions that tend to be concentrated around watering points include pecking order establishment, suckling, and breeding.

Livestock preference between similar watering facilities in the same pasture is usually determined by prevailing wind direction, proximity to shade, location of salt/mineral supplements, feed, or other factors that satisfy physiological needs. Current research suggests that livestock prefer watering at troughs over other sites (Miner et. al, 1992). Project experience suggests that, all other factors being equal, livestock prefer water facilities in the following order: 1) trough (from well or spring), 2) pond, 3) pool in stream, and 4) flowing point on stream.

In general, livestock seem to prefer watering from a trough and generally avoid watering from flowing points on streams. The cause of this behavior is unclear; temperature, taste, and fear may contribute to these preferences. Research (Willms et. al, 2000) and experience suggest palatability and water temperature significantly influence water consumption. A variety of safety concerns may also exist in or near watering facilities. Ice, mud, or collapsing stream banks may cause injury or even death. It is also reasonable to assume that livestock may instinctively prefer watering at locations having good visibility to avoid predation.

Pasture inventories have identified problems associated with watering location, particularly pond siting. Water in the south part of a pasture is frequently associated with more extreme cases of livestock concentration and poor vegetative cover. Water sited in topography that limits livestock access tends to be used less, resulting in overuse of other water sources or reduced intake by livestock (reducing animal performance). Properly placed water facilities have the potential to enhance grazing distribution and allow safe and easy access to palatable water. Troughs, supplied by pipelines from wells or springs, can be strategically located to provide a water source in a desirable portion of the pasture and in topography that allows easy access. If ponds can be located similarly, they too may enhance water quality.

Past placement of watering facilities (typically ponds) was to a great degree limited by topography. Decisions regarding location and type of facility also were limited by the tradition, economics, technology, and public energy and/or water distribution infrastructure at the time of installation. Management decisions made today offer a different set of opportunities and limitations but are still driven by a basic understanding of natural systems, economic cycles, and technology. Water facility location is a major water-quality concern due to the level of activity associated with preferred watering points, yet it is only one of several factors to be evaluated when addressing water quality concerns. Preferred shade and management facilities placed for convenience, such as feeding areas located in drainages, are examples of additional concentration areas of potential concern.

Working Facilities

Good facilities for handling livestock and storing feed and hay are important in managing and operating efficiently. Day-to-day operations will be more efficient and timely when livestock can be checked or handled whenever required with minimal stress to the animals. It also helps operation efficiency to store feed in a way that makes handling easy and prevents losses. Facilities do not have to be new, but should be in good repair, reliable, and accessible.

Permanent winter feeding facilities should be located in nearly level, well-drained areas with good vehicle access even during wet weather. If birthing areas are included with feeding areas, they should have good drainage, protection from winds, and should be free of muddy areas and standing water. Reserving a pasture for birthing by not grazing it during the growing season is a possibility.

To protect water resources, the following practices are suggested: 1) divert runoff around feeding and handling areas; 2) clean lots regularly and store, apply, or dispose of manure properly; and 3) discharge contaminated runoff to a natural vegetative filter area. Other, less feasible, but effective, options include using covered and guttered discharge areas, or discharging contaminated runoff into a settling pond or a designed filter system. These options may involve high costs for materials, labor, and design.

Summary

Grazingland can be a source of water pollutants. Fortunately, management of grazingland for sustained yield of forage and livestock also achieves optimum water pollution control. The management practices used should be based on fundamental principles used to balance grazing defoliation with adequate long-term plant growth. Maintaining sufficient plant growth to protect the soil and allow for maximum infiltration of precipitation is a key consideration.

The most important water-quality-protection measures are also some of the most important practices for the long-term viability of the grazingland resource. These are:

- Overgrazing should be avoided.
- Apply nutrients according to plants' needs.
- Use a planned strategy to manage pests, including management, cultural, and biological controls.
- When using pesticides, have a planned management strategy to get maximum effectiveness and handle according to label directions.
- Manage use of riparian areas to maintain productivity and promote stable stream characteristics.
- Provide alternative watering sites to promote grazing distribution.
- Provide alternative loafing areas to allow for maintenance of vegetation.

Introducing WQFARE

The Water Quality Financial Analysis and Resource Evaluation (WQFARE) is a five-step process to help managers of private grazingland identify risks and develop site-specific management measures to benefit water quality. WQFARE provides agricultural producers with a means to first identify potential management alternatives to improve water quality from grazinglands and then evaluate their economic feasibility. The first three steps comprise an inventory and evaluation phase, and the last two steps make up the planning phase of WQFARE.(Figure 7.)

Step 1 - Physical Inventory

Locate and describe the following for each pasture of the management system:

- Water resources (streams, ponds, wetlands, springs, troughs, etc.)
- Management influences on livestock (watering points, mineral, feeding areas, etc.)
- Landscape influences on livestock (shade, wind, terrain, vegetation types, etc.)
- Potential problem sites (concentration areas, heavily grazed areas, erosion, etc.)

The major factor influencing livestock activity, and consequently potential problem sites, is the location of preferred watering points. Watering preference is influenced by facility type, water quality, water quantity, and the proximity of the facilities to other areas that attract livestock such as preferred shade and preferred grazing areas. Prevailing wind direction and topography also play an important role in attracting or discouraging the use of grazing areas, trees or watering facilities with similar qualities.

Step 2 - Evaluating the Current Management System

Step 2 consists of two phases:

- Determining problem sources and the potential for correcting them.
- Reviewing managerial characteristics of the enterprise, including goals and management information.

Determining Problem Sources and their Correction Potential

The source of potential problems can be explained by studying how livestock respond to landscape and management features. Problem sources are determined by identifying the feature(s) and/or livestock behavior causing sites to have exposed soil and/or poor vegetative cover in close proximity to water resources. Vegetation density helps indicate whether management measures are needed for specific sites because the presence of vegetation helps slow runoff and protect the soil from erosion. The potential risk a site poses to water quality also depends on the size and slope of the area, as well its proximity to water resources. Adequate separation (influenced by cover, slope and distance) between problem sites and water resources is needed to reduce contaminant transport by runoff to streams, ponds, lakes, and springs. Sites with more extreme conditions may require a larger area of separation to protect water resources.

Much of the potential to improve water quality associated with grazingland rests on the ability of the manager to anticipate how livestock will respond to the implementation of management practices. Familiarity with livestock behavior will allow managers to identify practices that will reduce negative impacts associated with livestock concentration and heavily grazed areas.

Some problems may be corrected by simply adjusting basic management principles such as stocking rate, grazing distribution, season of use, kind and class of animal, and systematic rest. It may be desirable to implement a low-input/low-risk strategy first because it could sufficiently

Figure 7. *WQFARE is a two part, five step process to evaluate current management strategies, consider alternatives, and assess their economic feasibility.*

STEP 1	STEP 2	STEP 3	STEP 4	STEP 5
Physical Inventory	Evaluating the Current Management System	Existing Economic Situation Evaluation	Alternative Management Strategy Development	Analysis of Economic Feasibility of Each Proposed Management Strategy
Inventory and Evaluation			Planning	

address concerns about water quality, or at least provide insight into the potential for correcting problems using more costly management measures. A combination of practices coordinated into a management measure will often be necessary to correct the problem site(s) found in a pasture. The availability of practices suitable for implementing a water quality management measure will vary with the unique characteristics of pastures and the management system.

Reviewing Managerial Characteristics

- Enterprise and lifestyle goals
- Management information

Goals: Many grazingland managers have goal statements identifying the type of business and lifestyle for which they strive. Some goals even identify desired recreational and environmental conditions. For operations with defined goals, water quality objectives can be included as a supplement to existing goals. Regardless of the explicit nature of enterprise goals, documentation of efforts to benefit water quality may be of future value as public demand for water resources increases or regulatory controls are implemented.

Management Information: The basic land, capital, and management inputs for each pasture in a management system should be reviewed and cataloged to help identify strengths and weaknesses. Weaknesses found in grazing management systems are often associated with an imbalance in the amount of land suitable for different uses. For example, few year-round grazing enterprises are fortunate enough to have an ideal combination of pastures suitable for winter use, spring/fall grazing, and summer grazing. Managing for water quality enhancement can compound the challenge of achieving a balanced system. Adjustments that better match practices to the resources available may be necessary to accomplish both water quality and production goals. Management should also be flexible to take advantage of new information and/or innovation. When using the compiled management information to develop potential options for correcting problems it is important to look closely at not only the current use, but also the potential use of each pasture. Development of alternative strategies is discussed in Step 4.

Step 3 - Existing Economic Situation Evaluation

An analysis should be conducted to characterize the current economic situation of the entire operation. Farm Financial Standards Council guidelines are recommended to analyze all grazing and associated enterprises. A baseline profitability estimate is derived using balance sheets for each enterprise and an accrual-adjusted income statement. Current enterprise economic analysis provides a baseline profitability estimate to compare the economic projections associated with potential changes.

Standardized performance analysis (SPA) was developed from a cooperative effort by the livestock industry and several universities to provide guidelines for handling complex enterprise analysis issues for livestock producers. SPA is a system of standardized procedures for measuring asset productivity and profitability of livestock enterprises. Procedures allow individual producers to directly measure their productivity against industry benchmarks on a local, regional, and nationwide basis.

A critical component of any detailed enterprise analysis like SPA is collecting accurate financial and production data. Producing valid production and financial data requires detailed record keeping. A valid assessment of the profitability of a pasture should incorporate accrual-adjusted financial statements (beginning balance sheet, balance sheet, and income statement). Accrual adjusted financial statements account for changes in the value of noncash assets such as herd inventory. The primary information needed is herd inventory throughout the year, along with feed and land resources used by the grazing enterprise. Technical assistance in developing enterprise profitability estimates is available through Kansas State University Department of Agricultural Economics. Data collection forms for the appropriate enterprise can be obtained from local K-State Research and Extension offices.

Step 4 - Development of Alternative Management Strategies

An alternative management strategy involves adjustments to basic management principles described earlier and may require capital improvements. The objective of management alternatives for improved water quality is typically to relocate concentration and heavily grazed areas away from water resources. Developing an affordable management strategy generally involves much more than changing how livestock use the pasture. Realistic alternatives must be compatible with the unique combination of management ability, resources (land, labor, and capital) and objectives of each operation. At least one, but preferably several possible alternatives should be developed.

Developing New Management Measures: Developing new practice combinations involves envisioning desired livestock use patterns and management adjustments needed to accomplish them. Alternatives are devised by anticipating the response of livestock to possible management adjustments. Management adjustments and improvement practices considered should generally encourage grazing in underused upland portions of pastures and discourage livestock trampling, manure deposition, and overgrazing areas sensitive to water quality degradation, such as riparian areas. Depending upon specific pasture conditions, management strategies that include one or more of the following adjustments may benefit water quality:

- Changing watering facility type and/or location
- Reducing the stocking rate to a moderate level
- Implementing prescribed burning
- Controlling undesirable trees and brush
- Alternating feeding locations
- Discontinue feeding near streams and in drainages
- Adding and/or removing fences to improve grazing distribution
- Relocating mineral supplements
- Providing wind protection away from water resources
- Promoting use of upland shade
- Resting pasture for a period during the growing season

Developing Economically Viable Management Strategies to Improve Water Quality

Many of the profitability measures commonly used in agriculture can be misleading. Basing management decisions on net farm income, gross margin, returns per acre, or returns per head comparisons often leads to economically inferior management strategies. The Farm Financial Standards Council suggests two primary measures of profitability, rate of return on assets, and rate of return on equity. These measures scale net income to the capital resources required to achieve it. SPA provides the framework for calculating these values.

Economic Analysis of Structural Improvements

The economic feasibility of proposed capital improvements should be evaluated using standard capital budgeting procedures. Capital budgeting refers to the process of planning expenditures on assets whose cash flows are expected to extend beyond one year. Capital budgeting decision rules commonly applied in grazingland situations are net present value (NPV), benefit cost ratio (B/C), and internal rate of return (IRR). Under certain conditions, these common measures can yield conflicting results. When this occurs, NPV is generally considered the superior method of evaluating capital investments or management alternatives.

NPV and B/C are similar. NPV is defined as the difference between the sum of discounted cash inflows and outflows, while B/C is the sum of discounted benefits divided into the sum of discounted costs. IRR is defined as the discount rate that equates NPV to zero.

Capital budgeting decision rules are all discounted cash flow (DCF) procedures. DCF procedures discount future cash flows to account for the time value of money when considering investments or management measures. A basic principle of financial management is that a dollar today is worth more than a dollar tomorrow (Brealey and Myers, 1991). Cash on hand today could be invested to generate future income, or retire debt and reduce interest expenses. To make a fair comparison of cash flows occurring at different time periods, they should be adjusted to a common point in time, typically the present value. Discounting, the mathematical reverse of compounding, is the process of converting future cash flows to their present value.

Capital budgeting criteria favor projects with more immediate benefits. For example, technology that can shorten initial grazing deferments would be more valuable to a livestock operation than extending the life of a seeded stand of grass. Projects or management changes that require a large initial investment, or do not return benefits until several years into the future, rarely generate a positive discounted net return to a livestock producer.

Unfavorable economic evaluations of grazingland improvements are often criticized as short sighted because some would assume that a project that permanently improves pasture condition and productivity will eventually pay for itself. While this rationale is intuitive, it does not recognize the time value of money. At a 7 percent discount rate, the present value of an investment returning $100 per year never exceeds $1,430, even with an infinite time horizon. Capital costs, therefore, impose a limit to the private benefit of improved pasture productivity. Consequently, pasture improvements requiring excessive up-front investment will never pay off, even if benefits continue perpetually. Properly estimated capital budgeting results are considered long-term feasibility estimates.

STEP 5 - Analysis of economic feasibility of each proposed management strategy

An analysis of the economic feasibility of each proposed management strategy is performed in the final step of the WQFARE process. Capital budgeting decision rules are recommended to evaluate potential improvements requiring long-term capital investment. Other management changes will be evaluated using partial budgeting or full enterprise analysis. This process helps determine which alternative management strategies are viable, and help rank expected costs and benefits associated with the alternatives. In some cases, the process helps to determine the amount of "cost share" funding that may be needed to implement a strategy.

Evaluating the economic feasibility of proposed management measures

Step by step instructions for calculating NPV and other capital budgeting measures are presented in several financial management texts and extension publications, with a variety of ways to approach the problem. At a minimum, however, any capital budgeting estimate should contain the following elements:

1) an estimate of the annual net cash flows generated by the improvement;
2) cash flows discounted at an appropriate rate to determine present value; and
3) computation and interpretation of the NPV estimate.

Estimating Annual Net Cash Flows

The initial step in developing a capital-budgeting feasibility estimate is projecting net cash flows generated each year over the life of the improvement. Improvements or management changes generate net cash flows by increasing productive capacity, and/or reducing operating costs. Information needed to estimate annual cash flows generated by range improvement practices includes: 1) physical responses, such as changes in livestock or forage production; 2) the value of physical changes, represented by forage or livestock prices; 3) the costs associated with implementing the changes; and 4) the life of the improvement.

Physical production changes resulting from a range improvement can be valued either in terms of forage production or livestock production. Forage value changes would typically be represented by prevailing grazing lease rates or hay prices. Changes in livestock production values would be represented by added production multiplied by the relevant price. Due to the dynamic and complex nature of livestock prices, valuing changes in livestock production is typically more complicated than valuing changes in forage production. Cash flow estimates require information about the relationship between forage and livestock production. Seasonal impacts related to forage balance within the overall livestock operation also may need to be considered when evaluating major grazingland management changes.

Partial budgeting is a common method used for estimating cash flows. Partial budgeting simplifies the cash flow estimation process by considering only costs and returns impacted by the management change or capital investment. To aid managers estimating cost components, example budgets for various management practices are typically available from K-State Research and Extension and other sources.

SPA analysis evaluates profitability on a enterprise-wide basis. Evaluating the economic impact of management changes or capital improvements requires baseline profitability estimates of the individual pasture under consideration. In this case an enterprise-wide profitability estimate may not be adequate. The baseline profitability estimate may need to be estimated for specific pastures.

Cash flow estimates should be based on incremental changes in costs and/or revenues associated with the investment. The relevant comparison is the difference between cash flows generated by the proposed investment and the next best alternative. For example, the profitability of a new water system should be based on how productivity is impacted relative to productivity without the water system. A common error in feasibility analysis is estimating the profitability of the water system by evaluating the profitability of operating a cattle enterprise. Estimating incremental cash flows requires the analyst to understand which costs change. Average costs calculated from standard accounting procedures include an allocation for overhead and other fixed costs.

Producers considering a substantial capital improvement should understand the difference between cash flow and profitability. A project may be profitable, but may not be feasible for producers unable to meet the cash flow requirements. A project may be profitable in the long run, but not financially feasible if the investment creates liquidity problems. Liquidity refers to whether there is enough cash on hand to pay bills as they come due.

Discounting Cash Flows

To accurately assess the financial impact of capital improvements or management changes, cash flows projected to occur in the future should be discounted to their present value. A simple method of discounting cash flows to their present value is multiplying each projected cash flow by the appropriate discount factor. The appropriate discount factor is determined by the discount rate and the year in which the cash flow occurs. Discount factor tables are available in financial management texts and other sources. Financial calculators and popular spreadsheet software will readily compute present value.

The economic feasibility of range improvements depends largely on the discount rate used in the analysis. The discount rate should reflect the minimum rate of return management is willing to accept on the investment, which in most cases would be the expected rate of return on competing investment alternatives. The appropriate discount rate also depends on the operator cost of capital, prevailing interest rates in the general economy, and the risk associated with the investment. The importance of proper discount rate selection increases as the useful life of the planned improvement increases.

An important issue to consider when developing cash flow and discount rate estimates over a multiyear period is inflation. Inflation refers to the increase in the price level of goods and services in the economy over time. Rising prices influence future income projections through livestock prices and production costs. Cash flows estimated from prices that include inflation are considered "nominal." By contrast, cash flows estimated from prices that have the inflation component removed are considered "real."

Like cash flows, interest rates can be expressed as nominal or real. Nominal interest rates include a premium equal to the expected rate of inflation. Interest rates observed in the capital and money markets are typically nominal rates. To convert the interest rate from a nominal to a real basis, the expected rate of inflation should be subtracted from the nominal interest rate.

Capital budgeting analysis can be done with either real or nominal cash flows. The inflation assumption should be consistent between discount rates and cash flows. If projected cash flows were estimated on a nominal basis, a nominal discount rate should be used.

The risk associated with a particular range improvement will influence the results of a feasibility estimate. The second basic principle of financial management (Brealey and Myers, 1991) states that a safe dollar is worth more than a risky one. Consequently, riskier investments typically require a higher return. Financial markets implicitly add a risk premium to the return on financial assets. Adding a premium to the discount rate, therefore, is a common method of adjusting for risk. However, deriving a risk-adjusted discount rate on a specific physical asset is often difficult. An alternative approach is to use the discount rates typically applied to similar investments. Real discount rates ranging from 4 to 8 percent are commonly used to evaluate rangeland improvements, although recent research suggests that the risk-adjusted real rate of return on most agricultural assets falls between 5 and 9 percent.

Calculating and Interpreting the NPV Estimate

NPV is simply the sum of discounted cash flows, whether negative or positive, over the life of the improvement. A zero NPV is considered the break-even point and implies the project yields a rate of return equivalent to the discount rate. Any project with an expected NPV greater than zero is projected to be economically feasible. When choosing between several alternatives, the project carrying the greatest NPV is the economically preferred choice. Similarly, a benefit cost (B/C) ratio equal to one implies total benefits equal total costs. Any project with a B/C greater than or equal to one, therefore, is projected to be economically feasible.

An alternative method of estimating the economic feasibility of a capital investment is internal rate of return (IRR). IRR is defined as the discount rate that equates NPV to zero. Financial calculators and computer software can quickly calculate IRR, which is expressed as a percent rate of return. The accept/reject decision criteria is whether the IRR exceeds the opportunity cost of capital. This is often more intuitive than interpreting a summed dollar value. IRR should be interpreted carefully, however, because results are sensitive to underlying assumptions regarding the reinvestment of positive cash flows.

Sensitivity Analysis

Any economic evaluation requires an estimate of projected livestock prices, production costs, productivity impact, and other variables. These forecasts cannot be identified with any degree of certainty. Deriving economic impact estimates will inevitably require assumptions regarding these variables using estimates based on the best available information. Sensitivity analysis is a tool used to identify the sensitivity of the results to changes in the underlying assumptions. Some variables may be highly uncertain, but the exact values make little difference to the results. For example, the precise useful life of long term assets such as fences, wells, and storage tanks bears very little impact on the economic estimate. Conducting sensitivity analyses on these variables, therefore, may not be worthwhile. On the other hand, the discount rate and livestock production figures carry a large impact on economic feasibility.

Sources of Technical and/or Financial Assistance

The availability of assistance can depend upon the resource concerns found, the natural and/or political boundaries in which the property is located, and management goals and practices. Below is a list of potential sources of technical and/or financial assistance.

KSU Research and Extension
Kansas Rural Center
Natural Resources Conservation Service (NRCS)
State Conservation Commission
Soil and Water Conservation Districts

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