RANGE RESEARCH CONCISE COMMUNICATIONS 2001-2004

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Management based on ecological concepts will protect the health of rangelands and ensure that this valuable renewable natural resource can continue to provide a multitude of benefits, says a North Dakota State University range scientist.

"Much of the Northern Plains' economic base is dependent on rangelands, which constitute the principal land type for the region's recreation, wildlife, and tourism industries and furnish the majority of the forage base for the livestock industry," states Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center. "When managed according to ecological principles, rangelands can sustain high levels of productivity and contribute substantially to the region's quality of life in perpetuity."

The benefits derived from rangelands are not just economic, Manske observes. Rangeland vegetation serves as habitat for wildlife; stabilizes the soil, protecting it from wind and water erosion; and reduces the levels of carbon dioxide in the air by sequestering a portion of the carbon and releasing oxygen. Rangelands reduce the damaging effects of fast runoff and floods by collecting, filtering and storing water in aquifers and potholes and then releasing it slowly into streams and rivers. Rangelands supply clean water for plants, animals, and humans and are aesthetically appealing open spaces for recreation and sightseeing.

The use of rangelands as grazing lands for domesticated livestock is the premier example of high-value-added sustainable agriculture with low energy input, notes Manske. The vegetation is self perpetuating, and the animals harvest their own forage. Grazing on rangelands converts perennial vegetation, which humans do not consume, into a source of high-quality food and beneficial secondary products such as fibers, medicines, cosmetics, oils, glues, and base compounds. Ensuring the continued ability of rangelands to provide these benefits requires an understanding of the effects environmental forces have on plant growth and of the complex processes within the plants and ecosystems. Rangelands are managed with ecological principles, unlike cropland, which is managed by agronomic principles, explains Manske.

Sound rangeland management places priority on the plants. The performance levels of the plant component of a rangeland ecosystem regulate the performance levels of all the other components of the ecosystem, stresses Manske. Plants are the primary producers, converting light energy into chemical energy during photosynthesis. This captured solar energy is the primary force driving all ecosystem functions and the foundation for all uses of rangelands.

To maintain adequate activity of biological processes, healthy range plants require properly timed annual defoliation by grazing, says Manske. "Management that focuses on a single use of rangelands and does not include annual defoliation at the appropriate plant growth stages cannot sustain a healthy ecosystem over time," he emphasizes.

"Management that places the biological requirements of the plants as the highest priority and facilitates the operation of ecosystem functions at potential levels will sustain healthy, productive rangelands that will continue to supply forage for livestock; habitat for wildlife; clean air and water; open spaces for recreation and sightseeing; and food, fiber, and energy for people," states Manske. "The greatest attribute of rangelands is that when properly managed, they can provide all these benefits at the same time."

Manage Forage for Nutrients Not for Dry Matter Production

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Implementing pasture-forage management strategies designed for efficient capture of forage nutrients can improve profit margins for Northern Plains beef producers, says a North Dakota State University range scientist.

"The genetic make-up of the North American beef herd has been transformed over the past 40 to 50 years, and we now have high-performance, fast-growing meat animals. However, the improved profit margins anticipated from this new type of livestock have not materialized. The fundamental cause of this problem is that traditional pasture-forage management practices are inefficient at capturing nutrients from the land. The beef production industry as a whole has not moved toward implementing an improved, efficient pasture-forage management system paradigm," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

The basic components of the traditional pasture-forage management system have not changed in decades, Manske contends. Forage dry matter quantities are still used as the measure when producers make major pasture and harvested-forage management decisions. Pasture stocking rates are determined from estimates of herbage dry matter production. Harvested forages are cut at the time when the greatest dry matter weight can be captured and hay is traded on the dry matter weight basis per bale or ton.

"Forage dry matter does not have a real economic value because it is not incorporated into the beef weight produced," Manske says. "The dry matter is simply the carrier of the nutrients it contains. The nutrients, mainly crude protein and energy (TDN), are the valuable products produced by forage plants on the land."

The renewable forage nutrients are the primary unit of production in a beef operation, and they are the source of new wealth from agricultural use of grazingland and hayland resources of the Northern Plains, Manske says. A biologically effective pasture-forage management system based on increasing production of nutrients per acre, improving the efficiency of capturing produced nutrients, and improving the conversion of nutrients into a saleable commodity like calf weight will improve profit margins by reducing costs per pound of nutrient, cow-calf pasture-forage costs, and the cost of accumulated calf weight.

A comparison of the traditional and the biologically effective pasture-forage management systems can be illustrated by a story of two gold bullion producers.

Gold bullion producer A and gold bullion producer B have the same type of mill equipment and the same size dump truck. Each mill has the capacity to process one truckload of gold-bearing rock per day. A local mine supplies the ore, which is priced by the ton of matrix rock.

Producer A places priority on managing for efficient capture of gold. He samples the ore coming from various locations at the mine and loads only ore with high gold concentrations into his dump truck for use at the mill. He hauls and stores extra loads of ore when the mine is extracting rock from areas that have a high gold concentration. He has these stored loads delivered to the mill when the mine is extracting rock from areas of low gold concentrations. This producer operates his mill at potential outputs all year, one half the year with high-quality ore delivered directly from the mine and the other half with high-quality ore hauled from storage.

Gold producer B uses traditional practices and tries to provide adequate quantities of matrix rock that meet mill input needs. He plays golf for $1 a hole to supplement his income, and he hauls ore from the mine at times that do not interfere with his golf schedule. Loading his truck with mine run ore during the entire year is more convenient, requires less time away from his golf games, and does not require the additional costs of labor and equipment needed to handle stored rock. However, producer B is able to operate his mill at potential outputs for only a quarter of the year; for the other three quarters of the year, output from his mill is below potential.

The matrix rock that producer A selects and hauls to his mill has higher gold content during three-quarters of the year than the rock producer B hauls to his mill. The strategy of producer A permits him to capture greater quantities of gold from his mill each year than producer B captures. The cost per ton of matrix rock is the same for both producers, but because the gold concentration in his matrix rock is greater, producer A has a lower cost per pound for gold delivered to his mill. This reduction in cost for the input gold amounts to a far greater savings than the costs hauling some of the loads from storage add.

Producer A's effective management, which provides ore with a greater concentration of gold, results in improved mill operation efficiency and a lower cost per pound for the output gold produced. Producer A receives greater profits than producer B when both producers sell their entire annual production at the same time to the same distributor at the same rate per pound of gold. Producer B is a better-than-average golfer, but his expenses often exceed his winnings.

"Managing for capture of the greatest quantity of the primary unit of production, whether gold in matrix rock or nutrients in forage, is critical to improved profit margins," Manske says.

The cow-calf operation that bases management on efficient pasture-forage practices that produce and capture the greatest quantities of nutrients per acre could have 130 percent more saleable product per year than a similar operation run by traditional practices. Pasture and forage costs for the operation managed with efficient pasture-forage practices could be only 70 percent of the traditional operation's costs, and the profit of the operation managed with efficient practices could be 92 percent greater than that of the operation managed with traditional practices.

According to Manske, biologically effective pasture-forage management systems that improve the efficiency of feeding modern beef cows have three characteristics. These effective systems

- increase forage nutrient production per acre by coordinating defoliation periods with plant growth stages so that the biological needs of the plants are met;

- improve nutrient capture efficiency by using various forage types during the periods when the amount of nutrient weight captured per acre is a high proportion of the nutrients produced; and

- increase nutrient conversion efficiency by providing adequate nutrients throughout the cows' 12-month production cycle.

A biologically effective pasture-forage management strategy for beef cows with calves born before mid April is to graze fertilized crested wheatgrass (50 lbs N/acre on the first week of April) from early May to early June; graze native rangeland managed by a 3- or 4-pasture twice-over rotation system from early June to mid October; graze Altai wildrye from mid October to mid November; graze spring-seeded winter cereal, like winter rye, from mid November to mid December; and feed early harvested annual cereal hay, like forage barley cut at the milk stage, from mid December to late April.

"Until the livestock industry implements such improved biologically effective pasture-forage management strategies designed to produce and harvest nutrients and efficiently meet the demands of the modern beef animal, profit margins from beef production will not meet their potential," Manske says.

Nutrients Produced by Forage Plants Are the Primary Unit of Production in Beef Operations

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Beef producers who manage land resources to achieve efficient capture of plant nutrients and their efficient conversion into a saleable commodity from modern livestock can increase the wealth generated from pastures and haylands, says a North Dakota State University range scientist.

"The improved genetic potential of the modern, high-performance beef cow has increased the nutrient demands of the animal, but the industry continues to use traditional pasture-forage management technology developed for the old-style, low-performance cow," says Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "These traditional systems inhibit the modern beef animal from performing at its genetic capability, and the result is profit margins below potential. To address this situation, the beef industry could implement biologically effective twelve-month pasture-forage management systems designed to efficiently meet the nutritional needs of the improved animal."

Modern, high-performance cattle are larger and heavier, gain weight more rapidly, produce more milk and deposit less fat on their bodies than old-style cattle. The greater size of modern animals increases their nutrient demand, and their higher production levels increase the demand further so that the additional quantities of required nutrients are not simply proportionate to the animals' greater size.

A high-performance cow that has medium milk production and is 20 percent larger than an old-style animal requires 24 percent more energy and 34 percent more crude protein per year than the old-style animal. A high-performance cow requires 20 percent more energy and 24 percent more crude protein during the period from mid November to late April. She also requires 27 percent more energy and 41 percent more crude protein per day during the lactation period from early May to mid November. A high-performance cow that has high milk production requires 44 percent more energy and 74 percent more crude protein per day during the lactation period than the old-style cow.

High-performance livestock do not have the fat reserves that old-style animals produced and could draw on when forage quality was insufficient, so modern cattle perform at greater efficiency when their nutritional demands are met in each production period. Periods with nutrient deficiency limit modern beef animals' production.

The greater nutrient demands of the modern cow, along with the increasing value of land, make efficient production and capture of nutrients, mainly crude protein and energy (TDN), critical to the economic well-being of the modern beef operation. The potential amount of new wealth generated from the land resource is limited by the biological capacity of the plants to produce herbage and nutrients from soil, sunlight, water and carbon dioxide, and by the effectiveness of management treatments in efficiently capturing the plant nutrients produced on the land and efficiently converting them into a saleable commodity like calf weight.

Because traditional management systems focus on capturing the greatest herbage dry-matter weight rather than the greatest nutrient weight, they are inefficient at nutrient capture. As a result, traditional systems lead to unnecessarily high pasture-forage costs while still failing to meet the nutritional demands of the modern animal during 30 to 75 percent of the days in a year. Animal performance falls below potential and profit margins decline.

Biologically effective pasture-forage management systems with improved efficiency can increase production on the land, capture greater economic value from the land resource, and convert captured nutrients into a saleable commodity at lower costs per pound of accumulated calf weight than traditional systems do. Biologically effective pasture-forage management systems have three characteristics that improve the efficiency of feeding modern beef cows.

First, effective management systems increase forage nutrient production per acre by coordinating defoliation periods with plant growth stages so that the biological requirements of the plants are met. This timed defoliation promotes vegetative reproduction by tiller development from axillary buds, stimulates beneficial activity of rhizosphere organisms and facilitates the functioning of ecosystem processes at higher levels. For native rangeland, this stimulation period occurs between the third new leaf stage and the flowering stage (June 1 to July 15).

Second, effective management systems improve nutrient capture efficiency by using various forage types so that each can be harvested during the periods when the amount of nutrient weight captured per acre is a high proportion of the nutrients produced. The optimum plant growth stage for harvest by grazing or haying is the plant stage when the herbage production curve and the nutrient quality curve for a specific forage type cross. For perennial grasses, this period occurs at the flowering stage.

Third, effective management systems increase nutrient conversion efficiency by providing adequate nutrients throughout the cows' 12-month production cycle. Producers can match forage nutrient supply to livestock nutrient demand by selecting appropriate combinations of pasture and harvested-forage types and by timing livestock use of those forages so that herbage production curves and nutrient quality curves of plants match the dietary quality and quantity requirement curves of cow production periods.

A biologically effective pasture-forage management strategy for beef cows with calves born before mid April is to graze fertilized crested wheatgrass (50 lbs. N per acre on the first week of April) from early May to early June; graze native rangeland managed by a 3- or 4-pasture twice-over rotation system from early June to mid October; graze Altai wildrye from mid October to mid November; graze spring-seeded winter cereal, like winter rye, from mid November to mid December and feed early harvested annual cereal hay, like forage barley cut at the milk stage, from mid December to late April. This pasture-forage management system efficiently produces and captures forage nutrients and efficiently converts them into calf weight by meeting beef cow nutritional requirements economically during each production period.

Ranch operations that implement such biologically effective management practices to produce calf weight from the modern beef animal will see reduced pasture-forage costs, stronger cow-calf performance, and increased profit margins.

Increasing Value Captured from Grassland and Forages Boosts Beef Production Profit Margins

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Increasing the value captured from grassland pastures and harvested forages is the key to improving profit margins for the beef production industry, says a North Dakota State University range scientist.

"Some production costs for the beef industry in the Northern Plains are unnecessarily high because livestock producers tend to rely on traditional pasture-forage management practices that inefficiently capture the nutrients produced on a land base," notes Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center. "These practices result in higher costs for the nutrients ingested by the animals, increased annual production costs per animal, and low profit margins. Just as the value added to a commodity at each stage of production provides economic benefit, increasing the value captured from the land base reduces costs and strengthens profit margins."

Livestock production enterprises such as backgrounding, retained ownership, regional feedlots, and regional packing plants add value to beef commodities and should improve the economic status of the entrepreneur and the region. Historically, raw commodities like wheat and weaned calves have been shipped from the Northern Plains to other regions, which gained the economic benefit of the market value added to the commodities at the successive stages of production. The value added to raw commodities from the Northern Plains built much of Minneapolis and Chicago, Manske says.

Agricultural producers and the Northern Plains region can gain economic benefit by adding value to regionally produced raw commodities through the development and operation of enterprises that continue the progression of production stages. Beef producers and the region can also benefit economically from an increase in the value captured from the land resource, Manske observes.

Value captured is the market value of a resource's potential that would otherwise be lost, but instead is developed and converted into a saleable commodity. The improved efficiency of biologically effective pasture-forage management strategies results in increased value captured from resources on a land base, Manske states. Traditional pasture-forage management practices make the conversion inefficiently. The quantity of forage nutrients produced but lost because they are not converted into a saleable commodity raises livestock production costs.

Implementation of biologically effective pasture-forage management strategies increases the quantity of forage nutrients produced and improves the efficiency of forage nutrient capture and conversion of forage nutrients into saleable commodities, Manske explains. An increased quantity of forage nutrients produced and captured as a commodity reduces livestock production costs and improves profit margins.

"Pasture-forage management strategies that increase value captured place the biological requirements of the plants and the ecosystem processes as the highest priority," Manske says. "Those systems coordinate grazing and harvest periods with plant growth stages. The grazing and harvest periods are timed to remove greater amounts of nutrients rather than greater amounts of dry matter and to provide adequate nutrients throughout the cows' 12-month production cycle. The most successful systems combine pasture and forage types in a 12-month sequence so that the herbage production and nutritional quality curves are coordinated with the 12-month dietary quantity and quality requirement curves of cow production periods," Manske states.

Beef production is the last meat industry to increase the efficiency of feed management systems, Manske notes. He emphasizes that the future profitability of the beef industry depends on its ability to reduce production costs by implementing improved, efficient 12-month pasture-forage management strategies that increase the value captured from the land base.

Biology of
Grass Plant Growth

Well-Timed Grazing Can Stimulate Grass Growth and Tiller Development

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Coordinating grazing periods with appropriate grass growth stages can enhance plant growth and reproduction by tillering, says a North Dakota State University range scientist.

"Carefully timed grazing can stimulate beneficial activity of soil organisms and vegetative reproduction of grasses," explains Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Stimulation of these biological responses can improve the health of grassland ecosystems and increase herbage production."

Grass plants evolved 20 million years ago with early herbivores that are now extinct. During this time, grasses developed biological processes that help the plants withstand and recover from defoliation, Manske explains. This complex of processes, called defoliation resistance mechanisms, accelerates both the growth rate of the grazed plant and its development of foliage and roots. Two biological processes of primary concern to grassland managers are the increased beneficial activity of soil organisms and the stimulation of vegetative reproduction by secondary tiller development from axillary buds.

Plant response to defoliation depends on the amount of material removed and the growth stage of the plant, Manske emphasizes. Removing too much leaf area or grazing too early or too late in the seasonal development of the plant diminishes the plant's ability to recover. Grazing that removes a small amount of leaf area from the grass plant between the third-leaf stage and flowering stage can trigger the beneficial responses.

There is a mutually beneficial relationship between the grass plant's root system and soil organisms, Manske explains. Properly timed grazing can enhance that relationship.

The narrow zone of soil around the roots of perennial grassland plants, the rhizosphere, contains bacteria, protozoa, nematodes, mites, springtails, and mycorrhizal fungi. The grass plant's roots release carbon compounds, including sugars, to these organisms, and the organisms release mineral nitrogen that the plant's roots absorb. The mycorrhizal fungi also provide phosphorus, other mineral nutrients, and water that the plant needs for growth. Activity of the soil microorganisms increases with the availability of carbon compounds in the rhizosphere, and the elevated microorganism activity results in an increase in nitrogen available to the grass plant.

Grazing lead tillers between the third-leaf stage and the flowering stage can increase the amount of carbon compounds the defoliated plant releases into the rhizosphere, Manske explains. The increase in nitrogen produced by elevated rates of microorganism activity allows the plant to accelerate growth and recover more quickly from defoliation. This beneficial activity does not seem to occur when grazing is conducted during the middle and late growth stages of the grass plant.

Grazing that removes a small amount of young tissue from the aboveground portion of lead tillers after the three-leaf stage and before the flowering stage reduces the amount of the hormone that tissue produces to control the growth of axillary buds on the plant crown. With that growth-controlling hormone reduced, vegetative reproduction is stimulated and secondary tillers develop from the previous year's axillary buds.

If no defoliation occurs, the lead tiller inhibits tiller development through a process called lead tiller dominance until inhibitory hormone production declines around the flowering stage. Usually only one secondary tiller develops from the potential six to eight axillary buds because this secondary tiller asserts dominance by producing inhibitory hormones.

All grass species in the Northern Plains have strong lead tiller dominance except Kentucky bluegrass and meadow bromegrass, which have low levels of inhibitory hormones and relatively higher levels of tiller development. Plants with these growth characteristics have greater demands for water than do grasses with strong lead tillers, which produce one set of lead tillers and one set of secondary tillers. Lead tillers of cool-season grasses begin growth during fall, overwinter, and resume growth the following spring. Proper grazing management can increase the number of secondary tillers that develop, but the growing season length does not permit the development of a third set of tillers, Manske states.

The number of sets of tillers determines the number of times each pasture in a rotation system can be grazed, Manske explains. Two sets of tillers permit two rotation grazing periods. Rotation systems that graze each pasture more than two times are not coordinated with grass plant growth and do not meet grass plants' biological requirements. Rotating cattle in an arbitrary sequence that is not coordinated with grass plant developmental stages and that does not meet the biological requirements of grassland plants does not produce satisfactory results, Manske stresses.

Compared to six-month seasonlong grazing systems, rotation strategies coordinated with plant growth requirements show 23 percent greater calf average daily gain and 148 percent greater calf gain per acre. Net return per cow-calf pair over pasture costs is increased by 630 percent and net return per acre over pasture costs is increased by 1872 percent.

Compared to grazing strategies with arbitrary rotation periods, rotation strategies coordinated with plant growth requirements show 4 percent greater calf average daily gain and 11 percent greater calf gain per acre. Net return per cow-calf pair over pasture costs is increased by 11 percent and net return per acre over pasture costs is increased by 19 percent.

Manske emphasizes that grassland managers can increase beneficial activity of soil organisms in the rhizosphere and activate secondary tiller development from axillary buds by implementing grazing management strategies that start after the third-leaf stage, have two grazing periods in each of three to six pastures, and coordinate grazing periods with grass growth stages.

Manipulating Grass Plant Growth Can Enhance Forage Production

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Understanding grass development and grass plant response to grazing can help producers implement effective grazing management strategies, according to a North Dakota State University range scientist.

"Grasses have developed specialized growth characteristics and biological processes in response to a long history of grazing," says Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Producers can manipulate these processes to enhance grass herbage production and reduce pasture and forage costs."

Unlike plants such as trees, shrubs, and forbs, which grow with the youngest cells at the shoot tips, grass plants have the oldest cells at the leaf tip. Therefore, grazing animals can remove portions of a grass leaf without stopping the growth of the shoot. Leaves may continue to grow from existing buds and from new leaf buds developed in the shoot's apical meristem, or growing point. The apical meristem remains close to the ground and below the reach of the grazing animal when the shoot is in the vegetative, or non-flowering, phase. This growth structure makes grasses well adapted to grazing, Manske notes.

Grass plants consist of tillers, which have shoots and roots. Each shoot is made up of units with four parts:

- a leaf, consisting of a blade and sheath, with a collar separating the two structures;
- a node, the point of leaf attachment to the stem;
- an internode, the length of stem between two nodes; and
- an axillary bud, the area of tissue that can develop into a new shoot.

The crown of a grass plant is the lower portion of a shoot and has at least two nodes that can produce roots. Before flower development, the shoot consists of several closely spaced nodes. The node at the top, or apex, of the stem is the location of the shoot's apical meristem, an area of new cell formation. The cells in this area can develop into either leaf buds or flower buds, depending on the stage of the shoot. Leaves form on alternating sides of the shoot so that the oldest leaf is outermost and each new leaf grows upward, protected by the surrounding sheaths of the lower leaves. The leaf grows as the cells' size and weight increase, beginning with cells at the tip of the blade.

Even with this specialized form, grass plants can be damaged if too much material is removed by grazing or if grazing occurs too early or too late in the season. Grazing that deprives the shoot of sufficient leaf area to support itself or that removes leaf buds or the apical meristem has the potential to stop the growth of the shoot and limit herbage production for the season, Manske emphasizes.

He also stresses that the grass shoot's production of three to three and a half new leaves during the growing season is important. When the shoot reaches the third-leaf stage, the apical meristem begins to produce flower buds rather than leaf buds, although formed leaf buds continue to grow and develop. Defoliation of leaf material before the shoot has reached this stage can disrupt the formation of leaf buds and leaves for the shoot, weaken the plant and diminish the plant's ability to produce herbage, Manske stresses.

Most native cool-season grasses reach the third-leaf stage around early June, and most native warm-season grasses follow in about two weeks. On strategies that begin grazing before the third-leaf stage, such as early spring grazing started in mid May, 45 to 60 percent of the potential herbage biomass will not be produced.

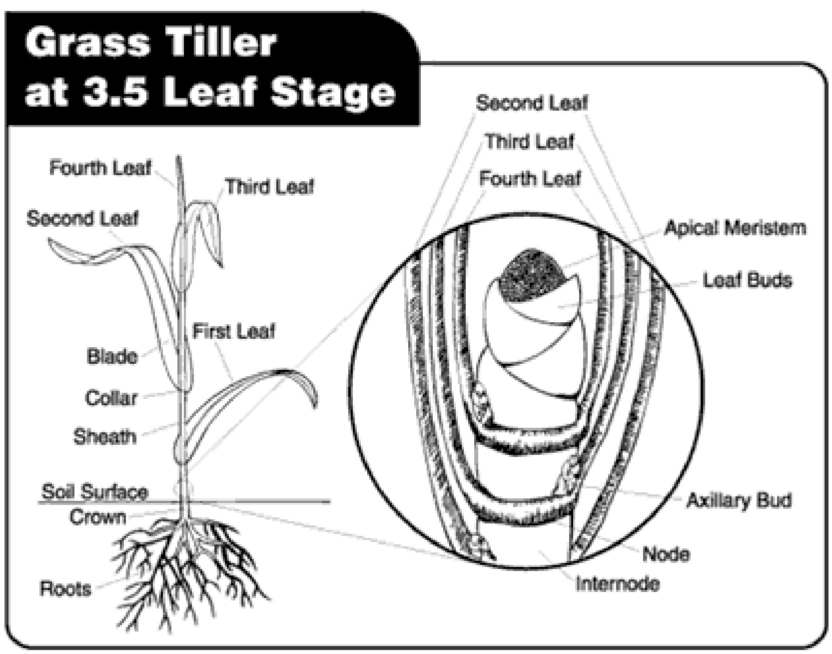
Defoliation of the shoot that has reached the third-leaf stage can stimulate the natural biological processes grass plants have developed in response to grazing. These processes include stimulation of vegetative reproduction, the growth of new tillers from the grazed shoot's axillary buds. Properly timed grazing that removes only a small portion of the leaf activates beneficial processes that can result in a 30 to 45 percent increase in herbage production, Manske says.

Changes in day length trigger the shoot to begin sexual reproduction, or flowering. The first external sign of flower stalk development is the swelling of the sheath that encloses the flower head. This stage of grass plant development, occasionally referred to as the "boot" stage, marks the shoot’s transition from the vegetative to the reproductive stage. Most cool-season plants enter the reproductive stage before June 21, the longest day of the year, and most warm-season plants enter the reproductive stage after June 21, Manske observes. Flowering, fertilization, and the formation of seed heads soon follow.

Strategies that delay grazing until after seeds have developed are neither biologically nor economically sound, Manske emphasizes. Plants need not produce viable seed each year for a grassland to remain healthy. In North American prairies, the primary form of grass reproduction is vegetative, and defoliation management designed to enhance sexual reproduction through seed production does little to improve the prairie ecosystem and increase herbage production, Manske notes.

Delaying grazing to allow seed production decreases livestock returns. The nutritional quality of the grass diminishes sharply after the flowering stage. On pastures managed to produce grass seed, the growth of secondary tillers has not been stimulated by grazing between the third-leaf and the flowering stage, so the quantity and quality of herbage produced are lower than the quantity and quality of herbage produced on rotation pastures. Manske says that the energy and resources directed toward sexual propagation could be better directed into vegetative tiller production.

Implementing grazing management strategies that start after the third-leaf stage and coordinate rotation grazing periods with grass growth stages can activate beneficial plant processes that result in increased herbage production and in turn reduce pasture and forage costs, Manske emphasizes.



Twice-Over Grazing System Improves Soil Quality

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Grazing native rangeland in rotational periods that are coordinated with grass growth stages stimulates fungus activity that improves soil structure, says a North Dakota State University range scientist.

In a recent study, Lee Manske, of the NDSU Dickinson Research Extension Center, and TheCan Caesar-TonThat, of USDA Agricultural Research Service at Sidney, Montana, discovered a beneficial group of fungi associated with roots of grass plants managed with the twice-over rotation grazing system. A technique developed by Caesar-TonThat detected and quantified the previously unknown organisms.

"The fungi are part of the rhizosphere, the narrow zone of soil surrounding the roots of perennial plants," Manske explains. "The discovery of these organisms is important because they are the only ectomycorrhizal fungi that have been found in association with herbaceous plant roots in the mixed grass prairie. Ectomycorrhizal fungi are fungi that do not invade the tissue of the host plant with which they exist in a mutually beneficial relationship. The action of the ectomycorrhizal fungi improves the quality of the soil, making the organisms extremely beneficial to the grassland ecosystem."

The ability of the fungi to enhance soil quality stems from the organisms' excretion of large amounts of adhesive substances that stabilize soil particles and bind them into water-stable aggregates. An increase in water-stable aggregates increases soil pore size and distribution. Further, because the aggregates do not break down when the soil is wetted, their presence helps prevent pores from becoming blocked by dispersed soil particles. The changes result in increased soil oxygenation, water infiltration, and root distribution and in decreased erodibility. These improvements in soil quality are advantageous for increased herbage production.

The rhizosphere contains organisms whose complex system of interactions developed in conjunction with the coevolution of grasses and grazing mammals, Manske explains. The activity of these rhizosphere organisms in association with grass roots is beneficial to both grass plants and rhizosphere organisms. The activity is also critical for grassland ecosystem functions and for energy and nutrient flow through the ecosystem.

Activity levels of rhizosphere organisms are greater on pastures managed with the twice-over rotation system than on pastures under seasonlong grazing. The factor believed to be responsible for the increase is the twice-over rotation system's coordination of grazing with grass growth stages, which stimulates the active passage of greater quantities of carbon compounds such as simple sugars through the grass plant roots. The carbon compounds exuded into the zone of soil around the grass plant roots accelerate rhizosphere organism activity and the biogeochemical cycles of the grassland ecosystem.

"Grasslands are complex ecosystems whose above- and below-ground components interact by stimulation, response, and feedback processes," Manske says. "When all of the interrelated components are functioning properly, the ecosystem is healthy and productive. The key factor in sustaining grassland ecosystem performance at potential levels is properly timed grazing by large herbivores. This action stimulates ecological processes and produces conditions that meet the biological requirements of the components of the ecosystem."

"The capacity of the twice-over rotation grazing management system to enhance the activity levels of rhizosphere fungi that can improve the soil quality in grasslands is a significant finding," Manske says. "The grazing system's potential for improving and sustaining grassland ecosystem health is of considerable importance for the development of ecologically sound management strategies."

Not All Heavy Grazing Is Overgrazing

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Improved understanding of the biological concept of overgrazing could help reduce controversy over grassland management, says a North Dakota State University range scientist.

"The term overgrazing is often used incorrectly to refer to grazing that exceeds an arbitrary level determined by the eye of the beholder," states Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Technically, overgrazing refers to continued heavy grazing that exceeds the recovery capacity of the plant community and creates a deteriorated range." Under this biological definition, the recovery capacity of the plant community determines both the level at which grazing becomes too great and the difference between tolerable short-term heavy grazing and unacceptable long-term heavy grazing.

Short-term severe defoliation results from practices that remove a high proportion of leaf material within a short period, Manske explains. Such practices include fire, flash grazing, or mowing close to the ground. Healthy, vigorous plants with relatively high levels of stored carbohydrates can tolerate periodic short-term severe defoliation when the interval between events is great enough for the plants to recover fully. The recovery interval is variable: three to four years for tallgrass prairie, five to 10 years for moist mixed grass prairie, and up to 25 years for dry mixed grass prairie.

Long-term severe defoliation is continued heavy defoliation that exceeds the recovery capacity of the plants. Prolonged severe grazing that results in biological damage to plants is correctly called overgrazing, Manske says. Overgrazing significantly reduces the total leaf area and photosynthetic capacity of plants. Herbage biomass and root systems on the affected grassland are greatly diminished, plant growth patterns are distorted, and growth response is delayed. The reduced vigor of plants results in the death of some individual plants and in an unhealthy shift in plant species composition.

Such range deterioration could result from excessively high stocking rates. It could also result from grazing practices that exceed the vegetation's capacity for fully recovering biologically, Manske explains. Overgrazing can result from defoliation that occurs when plants are at or near stressful stages of development; that is too severe and removes too much leaf area, forcing plants to draw on limited stored carbohydrates; or that occurs too frequently to allow plants adequate recovery time.

The stocking rate that a particular land area can safely support varies with grazing system, so stocking rates cannot be properly determined for parcels of land or regions of the country without consideration of the grazing system used, Manske emphasizes. Grazing systems that are based on plant requirements and that coordinate grazing periods with plant growth stages can be properly stocked at levels that would cause biological damage on a given parcel of land managed with another type of grazing system. As a result, changing the grazing system on biologically damaged range may simultaneously permit continued stocking at the previous rate and lead to improved rangeland health.

Grazing Fall Green-Up in Pastures May Take a Bite Out of Next Year's Production

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Treating young fall tillers of grasses as a source of bonus late-season forage for grazing livestock can be costly to producers, says a North Dakota State University range scientist.

"The fall tillers, which grow from the crowns of perennial grass species between mid August and the end of the active growing season, remain viable over the winter. They continue growth as lead tillers the following spring, producing a high proportion of that season's herbage," explains Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center. "Although it's commonly accepted as an innocuous practice, fall grazing has the potential to degrade grassland ecosystems because it can remove or damage fall growth and other leaf material that the grass plant depends on to survive the winter and resume growth the next spring."

Understanding grass growth cycles allows livestock producers to coordinate management strategies with the biological requirements of grass plants in order to promote vigorous growth of the plants and efficient capture of the herbage dry matter and nutrients produced on grasslands, Manske emphasizes.

Perennial grasses are perpetuated primarily through vegetative reproduction by tillering rather than through sexual reproduction, which is the process of seed production and the uncertain growth of a seedling. Sexual reproduction is the only method by which annual grasses are perpetuated.

Perennial grasses start growth of next year's plants in late summer or early fall during winter hardening -- the plants' process of preparing for winter. Warm-season grasses produce a relatively large bud but suspend additional growth until the next spring. Cool-season grasses produce tillers with one and a half to four leaves.

Very few perennial grasses grow from seed in established grasslands. Almost all young plants are tillers that have grown from axillary buds on the crowns of established plants, Manske explains. The tiller is the basic unit of the grass plant. The lead tillers are most conspicuous during the early and mid portions of the growing season as the tillers progress through typical growth stages. After the lead tillers have flowered, secondary tillers can grow from axillary buds.

Secondary tiller growth can be suppressed or stimulated by the timing of grazing periods. Most secondary tillers do not complete their growth cycle during one growing season. Those that have not entered the sexually reproductive stage can overwinter and complete their growth stages the following year as lead tillers. Under some environmental conditions, like prolonged drought, lead tillers can overwinter and resume growth the following year. Lead tillers that have overwintered progress through their growth stages at abnormal times.

During the later portion of the growing season, the grass plant population consists of mature lead tillers, secondary tillers, and fall tillers. Mature lead tillers that are near the completion of their life cycle and secondary tillers that have developed seed heads will not overwinter but will progress through a natural aging process called senescence, Manske explains. During this aging process, the cell components of the aboveground structures are translocated to belowground structures. The translocation of cell contents reduces the nutritional quality and the weight of the herbage. The nutritional quality of mature herbage during fall is about 4.8 percent crude protein. The weight of the herbage is about 40 percent to 60 percent of the herbage weight during mid summer.

Secondary tillers and fall tillers that will overwinter have active leaf material until the end of the growing season when the chlorophyll fades and the leaves lose their green color, appearing brown like the lead tillers that have completed their growth cycle.

Perennial grasses remain alive and maintain physiological processes throughout the year, even during the winter, Manske observes. Winter dormancy for perennial grasses is not a period of total inactivity but a period of reduced biological activity. The crown, some portions of the root system, and some leaf tissue remain active by using stored carbohydrates. Survival and spring regrowth of secondary tillers and fall tillers depend on the plant's having adequate carbohydrate reserves.

The quantity of carbohydrates stored during the winter hardening process is closely related to the amount of active leaf material on each tiller. Tillers with abundant leaf area during late summer and early fall can store adequate quantities of carbohydrates to survive the winter and produce robust leaves the following spring, Manske emphasizes. "Generally, the greater the number of active leaves on a tiller during the fall, the more robust the plants will be the following spring."

Heavy grazing of grasslands during August to mid October removes sufficient leaf material from secondary and fall tillers that quantities of carbohydrates stored will be low. Tillers with low carbohydrate reserves may not survive until spring. Manske says researchers suspect that fall tillers with fewer than one and a half leaves may be unable to store adequate carbohydrate reserves to survive the winter. Plants that have low carbohydrate reserves and survive the dormancy period produce tillers with reduced height and weight.

The rate at which plants respire, or use, stored carbohydrates during the winter is affected by the amount of insulation standing plant material and snow provide from the cold winter air temperatures. "The greater the amount of insulation, the more slowly the plant draws on its carbohydrate reserves," Manske notes. When the standing herbage on a grassland is grazed short and most of the snow is blown off, very rapid respiration can occur and deplete carbohydrate reserves before spring, causing plant death called "winter kill."

On tillers that have overwintered, the leaf portions with intact cell walls can regreen early in the spring. The leaf portions with ruptured cell walls remain brown. The surviving leaves, with their brown tops and green bases, are most obvious soon after the snow melts. When the current year's early leaf growth has been exposed for several hours to air temperatures below 28°F, it may have large dry portions and appear similar to overwintering leaves.

"The green portion of the overwintered leaves provides nourishment from photosynthesis that, in combination with remaining stored carbohydrates, supports the development and growth of new leaves and roots. The robustness of spring growth in plants that overwinter is dependent on the amount of surviving leaf area," Manske says.

"Removal of the leaf area of the overwintering tillers by grazing during fall or winter deprives developing tillers of a major source of nutrients, increases the demand on low levels of carbohydrate reserves, and results in reduced leaf production," he says. Reductions in leaf height for the major grasses during the succeeding growing season range from 17 percent to 43 percent, and the contribution of herbage weight to the ecosystem biomass is greatly reduced.

"The common assumption that grazing perennial grasses after they turn brown following a hard frost will not harm grass plants guides numerous fall grazing practices. This popular belief is not consistent with the biology of grass growth and should not be used as a foundation for grazing management decisions because of the resulting reductions in grass production and increases in pasture-forage costs the following year," Manske stresses. "Implementing biologically effective grazing strategies results in considerable reductions in pasture-forage costs for cows and calves."

Time of Harvest Is Critical in Minimizing Hay Cost

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Beef producers can reduce the cost of livestock feed from harvested forages by cutting plants at the optimum growth stage, says a North Dakota State University range scientist.

"Cutting forages at the growth stage when the greatest amount of nutrients can be captured per acre reduces the costs of nutrients and in turn the costs of livestock feed," states Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Traditionally, domesticated perennial grass hays are cut late, after the seed heads have developed and plants have reached maximum height. Cutting domesticated grass hay at a mature plant stage yields about the year's potential production of forage dry matter per acre at a moderately low cost per ton, but the low yield in weight of nutrients per acre causes high nutrient costs."

Mature domesticated grass hay like crested wheatgrass and smooth bromegrass is expensive livestock feed because the costs per pound of crude protein are high, at 28 cents. The land costs, production costs, equipment costs, and labor costs per acre are lower for domesticated grass hay cut late than for annual cereal hays like forage barley or oat forage and for annual legume hays like forage lentils or pea forage. However, during the cows' third trimester production period mature domesticated grass forage has daily livestock feed costs of 85 cents per cow, which are considerably greater than the daily feed costs of 38 cents per cow for annual cereal forages and 44 cents per cow for annual legume forages.

Livestock feed costs are determined primarily by the cost per unit of weight of the nutrients contained in the forage, not the cost per unit of weight of dry matter, Manske says. The amounts of dry matter needed to meet the nutrient requirements of livestock are variable with the amount of nutrients contained in the forage. Forages with lower nutrient costs per unit of weight have lower feed costs per day. The nutrient cost per unit of weight is determined by the weight of the nutrients harvested per acre prorated against the land costs, production costs, equipment costs, and labor costs per acre.

The weight of nutrients harvested per acre is related to the percent nutrient content and the weight of the forage dry matter at the time of cutting. The percent crude protein content and dry matter weight of the forage first increase and then decrease as the growing season progresses and plants mature. These changes are reflected in the quantity curves for the two factors. The percent crude protein content and dry matter weight curves for a single forage type differ from each other throughout the growing season, and the curves of various forage types have different shapes.

The greatest percent crude protein occurs during early plant growth stages and then the quality level declines as the plants develop. The weight of the forage dry matter per acre increases during the early growth stages until plants reach their maximum height, and then the dry matter weight decreases as the plants dry during senescence, Manske explains. The rate of growth to peak dry matter weight is greater in grasses than legumes, and percent crude protein content declines at a greater rate in grasses than in legumes. The greatest amount of crude protein per acre is present not when the percent crude protein curve or dry matter weight per acre curve reaches its peak but at the plant growth stage when the curves for percent crude protein content and weight of forage dry matter cross.

The two curves cross at the flowering growth stage for grass plants, including perennial grasses and annual cereal grasses. The cost per pound of crude protein is lower for perennial grasses and annual cereal forages when plants are cut early, between the boot stage and the early milk stage. Cost per pound of crude protein for crested wheatgrass hay cut at the boot stage is 14 cents, half the cost per pound of crude protein for hay cut at a mature plant growth stage. Costs per pound of crude protein for forage barley and oat forage hay cut early, at the milk stage, are

11 cents and 13 cents. Costs per pound of crude protein for the respective annual forage types cut later, at the hard dough stage, are higher, at 15 cents and 17 cents.

The two curves for legumes cross at a later growth stage, when the plants are at full growth but before the leaves start drying from senescence. Costs per pound of crude protein are 13 cents for forage lentil and for pea forage hay cut once at a late full-growth stage. Costs per pound of crude protein are 17 cents and 15 cents, respectively, for the same legume forage types cut at earlier plant growth stages.

“This evaluation of harvested forages based on costs per unit of weight of the nutrients shows that not all harvested forages are expensive livestock feed,” Manske says. “Harvested forages cut at the growth stage that yields the greatest amount of nutrients per acre have lower costs per unit of weight of nutrients and provide lower-cost livestock feed.”

Grazing Management
Based on
Grass Biological Requirements

Healthy Grasslands Will Produce Healthy Profits for Beef Ranchers

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Grazing management that maintains healthy plants on grasslands will produce strong animal performance and improve returns for beef ranchers, says a North Dakota State University range scientist.

"Healthy grassland ecosystems produce greater herbage weight and more pounds of calf per acre than grasslands in average condition. The key to improving grassland ecosystem health is implementing grazing management practices that meet the biological requirements of the plants and coordinate grazing periods with grass growth stages to stimulate beneficial processes within grass plants and the ecosystem," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

Plants are the primary producers in the grassland ecosystem, Manske explains. The solar energy they convert into chemical energy during photosynthesis is the primary source of energy driving all ecosystem processes, so the performance levels of the plants regulate the performance levels of the other grassland ecosystem components, including livestock weight gains.

"Effective management practices meet the biological requirements of the plants and help the ecosystem processes function at their full potential. These management practices improve the performance levels of all grassland ecosystem components, elevate plant health status, and increase productivity of grassland ecosystems. The result is sustained high performance levels," Manske says.

The twice-over rotation system, a biologically effective grazing management strategy developed for use in the Northern Plains, was designed to manipulate processes that result in beneficial changes to plant growth, soil organisms, and biogeochemical cycles in the ecosystem. The twice-over rotation system on native rangeland with complementary domesticated grass spring and fall pastures coordinates defoliation with grass growth stages to enhance vegetation and animal performance.

The twice-over rotation system begins grazing in May, on a spring pasture of crested wheatgrass or other early growing domesticated cool-season grass that has reached the third-leaf stage. This is the earliest plant growth stage at which grasses can be grazed without damage, Manske explains.

Native grasses begin seasonal development more slowly, and the use of domesticated grass pastures in May protects native pastures by delaying grazing on them until the plants have reached the third-leaf stage.

A 3- to 6-pasture native range rotation system is used from early June until mid October, with each pasture grazed for two periods. Each native range pasture is grazed for 7 to 17 days during the first period, the 45-day interval from 1 June to 15 July. The length of the first period on each pasture is the same percentage of 45 days as the percentage of the total season's grazeable forage each pasture contributes.

During the first period, grasses are between the third-leaf and flowering stages, the stages of plant development at which grazing produces beneficial effects. Two of these effects are of particular importance to beef producers: tillering from axillary buds, which is the method by which grasses reproduce vegetatively, and enhanced activity of rhizosphere organisms that live in the narrow zone of soil surrounding the roots of perennial grasses and provide nutrients for plant growth.

Tillering contributes to the production of greater herbage weight, and the increased activity of the soil organisms supplies the plants with greater quantities of nutrients to support additional growth.

During the second period, after mid July and before mid October, each pasture is grazed for double the number of days it was grazed during the first period. Cows and calves graze a fall pasture of Altai wildrye or other type of wildrye from mid October until weaning in early or mid November. “Removing livestock from native range pastures during the fall allows native grasses to store nutrients that will maintain plant processes over the winter and to retain the fall vegetative growth that will become next season’s lead tillers. This practice ensures healthy plants in the spring and greater herbage production during the growing season,” Manske says.

The twice-over rotation system’s elevation of plant health and stimulation of beneficial ecosystem processes result in increased plant basal cover and aboveground herbage biomass and improved nutritional quality of forage. The twice-over rotation grazing management system with complementary domesticated grass pastures has a grazing season of more than 6.5 months with the available forage above, at, or only slightly below the requirements for a lactating cow for the entire grazing season.

The increase in quantity and quality of herbage on the twice-over rotation system results in improved animal performance. Cow and calf accumulated weight gain, weight gain per acre, and weight gain per day are greater on the twice-over rotation system than on traditionally managed systems, he says.

The greater herbage production per acre permits higher stocking rates on the twice-over rotation system than on traditional management systems. The twice-over rotation system requires fewer than 12 acres per animal unit for the entire 6.5-month grazing season. This is half the land area that a 6.0-month seasonlong grazing system requires when properly stocked at 24 acres per animal unit. The lower acreage required to carry a cow-calf pair for the season reduces pasture-forage costs.

“The benefits of biologically effective grazing practices are both ecological and economic,” Manske says. “By implementing the twice-over rotation grazing management strategy, producers protect rangeland health, increase their profits, and ensure that the grassland will sustain their cow-calf operation for years to come.”

Approach to Reducing Beef Production Costs Challenges Traditional Assumptions

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Reducing costs of beef production in the Northern Plains may require a change in some basic assumptions about effective management practices, says a North Dakota State University range scientist.

"Preliminary results of studies at NDSU's Dickinson Research Extension Center indicate that beef production costs are high in part because traditional pasture-forage management practices implemented in the region are not well-suited to the modern beef animal," says Lee Manske, a range scientist at the Dickinson facility. "Combining old management practices and modern livestock leads to great inefficiencies in the capture of the nutrients produced on a land base and in the conversion of those nutrients into a saleable product. These inefficiencies contribute to high production costs."

Traditional pasture-forage management strategies used in the Northern Plains were developed during the era of low-performance livestock. During the past several decades, the type of livestock in the region has shifted to a fast-growing, high-performance animal, but pasture-forage management strategies have not been adjusted to take full advantage of modern livestock's genetic potential, Manske observes. Attempts to produce high-performance livestock though the use of traditional low-performance management strategies result in calves with weaning weights below potential and in high annual expenses for cow maintenance.

Traditional low-performance pasture-forage management practices focus on providing livestock with adequate dry matter and supplement nutrients only when absolutely necessary, Manske explains. Under these strategies, low-performance cows produced lightweight calves. These practices were successful for low-performance livestock because the animals had low production drain and were able to store nutrients when they were available and draw on nutrient stores during periods when forage quality was low.

High-performance livestock have high production drain and do not produce at potential levels under traditional strategies. These modern animals perform more efficiently when nutrients are provided as they are required during each production period, Manske emphasizes. "Expecting a high-performance cow to produce a large healthy calf when depending on stored body fat and poor-quality feed is like expecting a professional athlete to perform remarkable feats on the diet of a couch potato."

In contrast to traditional practices, effective management strategies for high-performance livestock focus on providing animals with adequate nutrients throughout the year and supplement dry matter when necessary. Producers can match forage nutrient supply to livestock nutrient demand by selecting appropriate combinations of pasture and harvested forage types that grow well in the Northern Plains and by timing livestock use of those forages so that herbage production curves and nutritional quality curves of the plants match the dietary quantity and quality requirement curves of cow production periods, Manske says.

"Coordination of forage quality and quantity with livestock requirements is necessary for efficient beef production," Manske stresses. "This coordination improves individual animal performance, reduces acreage required to carry a cow-calf pair for the season, increases total accumulated weight gain, reduces costs per pound of accumulated calf weight, and increases net return after pasture-forage costs per cow-calf pair and per acre."

Investigations into the effectiveness of beef production practices and their incorporation into 12-month pasture-forage management systems are ongoing at the Dickinson Research Extension Center.

Deferred-Type Grazing Systems Reduce Grass Plant Density and Animal Performance

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Keeping cattle off grass to promote grass seed production decreases livestock and grassland productivity, says a North Dakota State University range scientist.

"Early rangeland managers believed that grass seed production was necessary for grassland health, and they developed deferred rotation grazing strategies specifically to allow grasses to flower and set seed," says Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Grass plants do not need to produce seed for grasslands to remain healthy. Controlled grazing studies have not shown positive vegetation response to deferred strategies in the Northern Plains."

"In fact," Manske says, "research over the past 20 years has demonstrated that effective grazing strategies are those designed to stimulate vegetative reproduction rather than seed production in grass plants."

Very few young grass plants mature from seed in an established grassland, Manske says. He notes that he has found only 12 true seedlings in a six-year period. Almost all young grass plants are formed vegetatively, when axillary buds on the plant crowns develop into tillers that are initially connected to the root systems of parent tillers. This support provides a competitive advantage for tillers over seedlings, which have separate, less developed root systems.

Under the deferred grazing strategy, producers withhold grazing from one or two pastures until the lead tillers of grass plants develop through the vegetative stage and the sexually reproductive stage. During this period, each lead tiller produces hormones that prevent the six to eight axillary buds located on its crown from developing into tillers. At about the flower stage, the lead tiller reduces its production of these inhibitory hormones. This reduction permits the growth of one axillary bud into a secondary tiller, which in turn produces inhibitory hormones to prevent growth of the other axillary buds.

Manske explains that this process allows the plant to focus its energy on seed production rather than vegetative reproduction.

At this stage, cattle are usually permitted to start grazing on the deferred pasture. As the seeds on the lead tiller mature, the leaves age and dry, and their nutritional quality decreases substantially. Because the crude protein content of the forage is below the 9.6 percent required by lactating cows, the animals use body fat for some of their milk production, and their weight decreases, Manske explains. The loss of weight leads to decreased milk production, which in turn results in lower calf average daily gain.

The secondary tillers that began growing at the flowering stage of the lead tiller have good nutritional quality but have not yet produced sufficient leaf material to support traditional stocking rates, he notes.

Deferred grazing also decreases grass plant density and reduces herbage production the following year. Generally, cattle are turned onto deferred pastures before secondary tillers have reached the third-leaf stage. Tillers grazed before that stage are severely damaged, Manske says.

Cool-season grasses start the next spring's growth during the late summer and fall of the previous year. Many secondary tillers and most fall tillers overwinter and continue growth as lead tillers the following year. The leaf cells that have intact cell walls regreen early the following spring and continue to grow. Manske explains that when cattle graze the leaves of these young tillers during the fall, the plants do not have adequate leaf area to produce enough carbohydrates to survive the winter and resume growth in the spring. Measurements show that live grass density decreases on deferred pastures after only one year of the strategy's use.

"Twenty or so years of deferred grazing treatment decrease grassland productivity to below acceptable levels," Manske says. "Producers can restore the health of grasslands managed with deferred treatments by changing to grazing management practices that stimulate vegetative reproduction by tillering."

Grazing strategies that remove a small amount of leaf material between early June and mid July, when lead tillers are between the third-leaf stage and the flowering stage, can stimulate tillering, he says. Grazing during these growth stages can also activate other biological processes that contribute to greater herbage production that summer and the following year, and the production of secondary tillers extends by two to two and a half months the period during which grass nutritional quality meets the requirements of lactating cows.

Rotation management strategies that coordinate grazing periods with growth stages of grass plants and meet the plants' biological requirements show a 23 percent greater calf average daily gain and a 36 percent greater calf gain per acre than do deferred strategies. These rotation strategies have a 75 percent greater net return per cow-calf pair over pasture costs and a 73 percent greater net return per acre over pasture costs than do deferred grazing practices.

"These numbers show that producers can use such rotation strategies to maintain healthy, productive native prairie ecosystems and improve livestock performance," Manske says.

Uninhibited Sexual Activity on the Prairie Reduces Regional Profits

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Managing rangelands to promote sexual reproduction in grasses is not ecologically necessary, nor is it economically beneficial to beef operations, says a North Dakota State University range scientist.

"Most traditional grazing management practices using two or more pastures during the grazing season are based on the concept that maintaining the plant population requires grass sexual reproduction--seed stalk development, seed set, and seedling production. Strong animal performance depends on healthy, vigorous grasslands, so producers are wise to place priority on grass plant health," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center. "However, managing pastures for grass sexual reproduction is not an effective method of achieving either plant population health or strong animal performance."

Sexual reproduction is not the only method by which perennial grasses multiply. Most young grass plants in a Northern Plains grassland start not as seedlings but as tillers that grow from axillary buds on the crowns of an established plant, Manske explains.

These vegetative tillers make up the majority of the plant population because they have a competitive advantage over seedlings. Tillers initially draw support from the root systems of parent tillers, while seedlings rely on their own less-developed structures. Seed production to maintain genetic diversity of grasses is needed only every 40 or 60 years on healthy prairies. Proliferation of plants is most effectively achieved with grazing management practices that stimulate vegetative reproduction by tillering, Manske says.

A study at the Dickinson facility indicates that grazing management that stimulates vegetative tiller growth also strengthens animal performance. The study compared native rangeland pastures on the twice-over rotation treatment, which promotes grass vegetative reproduction, to native rangeland pastures under deferred grazing management, which promotes grass sexual reproduction. The evaluation was based on costs of livestock feed for 1,200-pound range cows during the grazing season, costs per pound of calf gain, and returns after pasture costs.

Summer native rangeland forage on the deferred strategy had production costs of $8.76 per acre and forage dry matter costs of $42.52 per ton. During the 122-day summer grazing period, a grazing cow-calf pair required 8.88 acres, at a cost of $77.79 for the period, or 64 cents per day. Calves gained 1.8 pounds per day, or 24.73 pounds per acre, at a cost of 35 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $75.93 per cow-calf pair and $8.55 per acre.

Grazing management that promoted grass vegetative reproduction was more economically efficient. Summer native rangeland forage on the twice-over rotation strategy had production costs of $8.76 per acre and forage dry matter costs of $39.02 per ton. During the 137-day summer grazing period, a grazing cow-calf pair required 9 acres, at a cost of $78.84 for the period. At 58 cents per day, livestock feed costs were 9.4 percent lower than those of the deferred treatment.

Cow accumulated weight was 118 percent greater on the biologically effective treatment than on the deferred strategy, Manske says. Calves on the twice-over rotation strategy gained 2.21 pounds per day, or 33.64 pounds per acre, at a cost of 26 cents per pound of gain. Calf accumulated weight gain was 54 percent greater and the cost per pound was 25.7 percent less on the twice-over pastures than on the deferred treatment.

When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs for the twice-over rotation strategy were $133.10 per cow-calf pair, 75.3 percent greater than those for the deferred strategy, and $14.70 per acre, 72 percent greater than those for the deferred strategy. Profits on summer pasture were $57.17 more from grazing management that promoted vegetative reproduction than from grazing management that promoted grass sexual reproduction. "The differences in animal performance and forage costs per day result from differences in plant response to grazing treatments," Manske explains.

While ungrazed lead tillers of a grass plant are in the vegetative stage, they produce hormones that prevent the six to eight axillary buds located on the crown from developing into tillers. When an ungrazed lead tiller enters the flowering stage, production of these inhibitory hormones decreases and the blocking of axillary bud activation is reduced. Usually only one of the axillary buds begins growth into a secondary tiller, and it produces the inhibitory hormones to suppress growth of the remaining axillary buds.

The goal of deferred management is to direct grassland ecosystem energy and resources into sexual reproduction of grasses by withholding grazing from one or two pastures until grass tillers have produced seed. As the lead tillers of grasses mature, the leaves dry and age. When cows are turned out onto deferred pastures, the grass plants have already reached their full weight in growth, and most of the leaves on lead tillers are fully expanded and at later stages of drying.

"The nutritional quality of grasses decreases substantially after plants have flowered, and it soon drops below livestock minimum dietary requirements," Manske says. "During the grazing period, the nutritional quality of native rangeland herbage on the deferred treatment was at or above the cows' requirements 13.1 percent of the time and below the requirements 86.9 percent of the time." When the crude protein content of the herbage drops below the 9.6 percent that lactating cows require, the animals use body fat for some of their milk production. The resulting weight loss leads to decreased milk production, which leads to lower calf weight gain per day.

The twice-over rotation strategy produces greater calf gain per acre at a lower cost per pound of gain because the system coordinates grazing periods with plant growth stages, stimulating beneficial processes within grass plants and the ecosystem. Under this strategy, cows are turned out onto the pastures during the early portion of the grazing season between early June and mid July, when lead tillers are between the third-leaf stage and the flowering stage. Grazing that removes a small amount of leaf material from grasses within this developmental period reduces the amount of inhibitory hormone produced and stimulates several secondary tillers to develop from the set of axillary buds.

The proliferation of secondary tiller growth on the twice-over rotation treatment increases plant density and herbage production. During the middle and late portions of the grazing season, leaves on this stimulated tiller growth are younger, less developed, and of higher nutritional quality than leaves on lead tillers. During the grazing period, the nutritional content of native rangeland herbage on the twice-over rotation treatment was at or above the cows' requirements 89.8 percent of the time and below the animals' requirements 10.2 percent of the time.

"The greater availability of herbage to meet the nutrient requirements of lactating cows improves animal performance, leading to reductions in the cost per pound of nutrient and in turn to reductions in the cost of livestock feed," Manske says. "The increased herbage quantity and quality extend the period of improved livestock performance two to two and a half months longer on the twice-over strategy than on pastures managed by traditional practices. These improvements result in the lower costs of calf weight gain and the higher net returns of the twice-over rotation strategy."

"Deferred grazing, which promotes sexual reproduction in grasses, offers neither ecological benefits nor economic advantages," he says. "The twice-over rotation strategy, which promotes vegetative reproduction, produces both healthy grasslands and healthy profits."

Old-Style Pasture-Forage Management Practices Need to Be Culled

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Beef producers need to cull low-performing pasture-forage management practices just as producers cull low-performing cows, says a North Dakota State University range scientist.

"The natural tendency of agricultural producers is to focus on improving the product sold at market, and beef producers tend to focus on increasing the weaning weight of calves. The practice of keeping high-performance cows and culling low-performance cows has greatly improved livestock performance over the past couple decades," notes Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

"However, both the land that produces pasture and hayland forage and the labor and tools that perform the work are also essential components of a managed production system. Selecting improved pasture-forage management practices is as important to a positive profit margin as is the process of animal selection and should be given the same careful attention," he emphasizes.

Production of herbage and plant nutrients is the source of new wealth generated from agricultural use of land resources, Manske says. The amount of value captured from the land is proportional to the efficiency of the pasture-forage management practices in capturing nutrients.

Traditionally, the costs of pasture and forage and of labor and tools have been viewed as the major parts of total livestock production costs rather than as sources of potential wealth, he says. Consequently, pasture and forage management practices are not characterized as producing high income or low income. "Most beef producers do not know if a particular parcel of land and the practices used to manage that land yield an income or are an expense; they do not sort pasture-forage management practices as keepers or culls," Manske says.

Beef producers continue to use the same basic concepts of pasture and forage management that were developed during the early stages of the Northern Plains beef industry, when the dry matter requirements for livestock were the major consideration and the cost of land area per animal added little to total production costs.

"These traditional practices sustained numerous family operations in the region during many natural and manmade calamities but are not adequately serving producers facing current conditions," Manske says. He notes that the old-style practices ineffectively address two major changes that have occurred.

The first major change is that today's fast-growing, high-performance cattle are genetically different from the old-style cattle. Modern cattle have higher rates of weight gain, produce greater quantities of milk, are larger, weigh more and deposit less fat on their bodies. Because of the higher rates of production and the reduced levels of body fat, modern animals perform best when provided with the required quantities of nutrients throughout the production year, Manske says. Traditional practices do not efficiently meet the higher nutrient requirements of modern animals.

The second major change is that the swine, poultry, and dairy industries have switched to efficient feed management systems that evaluate feed costs by the cost per unit of weight of the nutrients rather than by the cost per unit of dry matter. This shift has reduced production costs for these industries and increased competition for the beef industry, he says. With traditional practices, the beef industry cannot reduce production costs enough to remain competitive and return adequate profit margins.

Traditional livestock feed management systems are biologically inefficient and capture only a small portion of the value potentially available from the grasslands, haylands, and croplands in the Northern Plains. When high-performance livestock are fed forage from low-performance management practices, the result is animal performance below potential, high forage-feed costs and low profit margins. Pasture-forage management systems for beef production need to be improved to reduce production costs per cow-calf pair and to increase profit margins.

To evaluate the effectiveness of management strategies in reducing livestock pasture-forage costs, compare forage-feed costs per day, costs per pound of crude protein captured, and costs per pound of calf weight gain, Manske recommends. “When average forage-feed costs are 62 cents or less per day, captured crude protein costs are 25 cents or less per pound, and calf weight gain costs are 42 cents or less per pound, the management practice is a keeper. When the forage-feed costs, the captured crude protein costs, and calf weight gain costs are greater than these values, the management practice should be culled.”

Modern 12-month pasture-forage management systems with improved efficiency can increase production on the land and capture greater economic value from the land resource. Sustaining high levels of production from pasture and haylands requires the use of management strategies that place priority on plant health and growth and meet the biological requirements of plants and ecosystem processes, he says.

“Increasing the value captured from the land resource requires a major paradigm shift from the practices that capture the greatest quantity of dry matter per acre to practices that capture the greatest quantity of crude protein per acre. Nutrients, not dry matter weight, are the valuable product from pastures and haylands,” Manske says.

“The inefficiency of traditional management practices in capturing economic value from the land is enormous,” he notes. Culling traditional grazing and haying practices and replacing them with efficient pasture-forage management strategies will provide Northern Plains beef producers with the ability to double the cow herd size, reduce annual pasture-forage costs per cow by 30 to 50 percent, and increase net income 3 to 10 times on their current land resources.”

Management to Reduce Impact from Drought

Healthy Plants Have Smaller Forage Reductions during Precipitation Shortages

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Effective grazing management can help minimize herbage reductions during periods of below-normal precipitation, says a North Dakota State University range scientist.

"Most of western North Dakota is experiencing below-average herbage production on perennial grass spring pastures, native rangeland pastures, and grass and alfalfa haylands. Estimates of 25 to 60 percent reduction below normal herbage biomass are common," notes Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Climatic conditions have been receiving most of the blame for these reductions, although herbage production is affected by management practices as well as by the level of precipitation in relation to normal amounts."

The majority of the state's western region was dry during late summer and fall of 2001 and cool during the spring of 2002. The dry fall resulted in reduced fall tiller growth, with an average of fewer than 1.5 leaves per tiller. Tillers of cool-season grasses require about 2.5 fall leaves for normal herbage production the following year. Cold nights and cool days during the spring resulted in a moderate reduction in the daily grass growth rate. The combination of a dry fall and cool spring is responsible for a portion of the reduction in herbage biomass in the region, Manske says.

In addition, parts of western North Dakota received less-than-normal precipitation this spring. Large areas south of Interstate 94 have various levels of water stress and several areas in south central North Dakota are experiencing drought or near-drought conditions. The below-normal precipitation further restricted herbage production on pastures and haylands in these areas and created additional problems.

"The amount of herbage biomass reduction resulting from just the combination of restricted growth of last season's fall tillers and this spring's slightly reduced rate of grass growth has not been great enough to change grazing dates or stocking rates on pastures that have been properly managed and have healthy plants," Manske says. "The annual development of healthy grass plants occurred within the normal range of dates during the spring of 2002, with a delay of only 3 to 7 days from the average date. However, in some areas large reductions in herbage occurred because the dry fall and cool spring magnified existing problems caused by detrimental management practices."

The quantity of herbage biomass produced is related to plant size and plant density. These two characteristics are directly affected by the level of plant health, which is determined by the biological effectiveness of the grazing management practices used, Manske notes. Consequently, management practices that do not meet the biological requirements of the plants retard plant processes. The resulting deterioration in the level of plant health is manifested as decreased plant density and diminished plant size that lead to reduced herbage production.

Herbage reduction percentages caused by detrimental grazing management practices such as grazing before the third-leaf stage, grazing throughout the entire season, or grazing during the fall usually vary between 40 and 60 percent below the potential herbage biomass. The greatest reductions of herbage production observed in western North Dakota have occurred on domesticated grass spring pastures that were hayed during the summer and/or grazed during the fall, on native rangeland summer pastures that were grazed during the fall, and on domesticated grass and alfalfa haylands that were hayed late and/or grazed during the fall.

"The long-term solution to management-caused herbage reduction problems is to implement beneficial management strategies that meet the biological requirements of the plants," Manske says. He recommends three management practices that improve plant health:

- Begin grazing in the spring only after plants reach the third-leaf stage (early May for crested wheatgrass and smooth bromegrass and early June for native rangeland).
- Coordinate grazing rotation dates with grass growth stages. Plant density increases when secondary tiller growth is stimulated by grazing for 7 to 17 days during the period between the third-leaf and flowering growth stages (early June to mid July for native rangeland).
- Do not graze spring and summer pastures or haylands during the fall. The common assumption that grazing perennial plants after a frost does not hurt the plants is incorrect. Fall grazing decreases the carryover secondary tillers and the new fall growth tillers and reduces the amount of herbage biomass produced the following season.

Herbage weight of perennial plants increases from early season through May, June, and July until peak herbage biomass, which occurs during the last couple weeks of July. Herbage weight then decreases as plants age and dry, Manske explains. The amount of herbage biomass produced by healthy plants is related to precipitation levels during January through July, which affect plant size and plant density.

Herbage reduction caused by low precipitation is usually proportional to the levels of precipitation below the normal range. An estimate of the amount of herbage reduction low precipitation causes in healthy plants can be determined by a comparison between the local long-term mean precipitation received during January through July and the current year's precipitation for that period. The range of normal precipitation is plus or minus 25 percent of the long-term mean.

The procedure to estimate percent reduction in peak herbage biomass caused by below-normal precipitation requires just three simple calculations: first, the monthly precipitation for January through July is totaled to give the current seasonal precipitation; then, this precipitation amount is divided by the local long-term January through July precipitation amount to determine the current seasonal precipitation as a percentage of the long-term mean precipitation; next, that percentage is subtracted from 75 percent, which is the low-normal long-term precipitation value.

"The resulting estimated percentage of reduction in biomass that below-normal precipitation has caused in peak herbage biomass provides a guideline for the percent reduction in stocking rate needed for the remainder of the grazing season--until mid October--on pastures that have been properly managed and have healthy plants," Manske says.

For example, if the January through July seasonal precipitation amount is 65 percent of the long-term mean, the estimated 10 percent reduction from normal herbage biomass would suggest a 10 percent reduction in stocking rate--assuming the proper stocking rate was being used. This method does not determine the amount for stocking rate adjustments required on pastures managed by practices that diminish the health status of plants below potential levels.

The long-term mean monthly precipitation amounts for numerous locations are available on the National Weather Service (NOAA) web site for North Dakota (www5.ncdc.noaa.gov/climatenormals/clim81/NDnorm.pdf). For the current season's precipitation, amounts collected at individual ranches and marked on the calendar can be used if a complete January through July data set is available.

Another source for the current season's precipitation amounts for many locations is the NDAWN web site (http://ndawn.ndsu.nodak.edu). These data start in April because NDAWN does not collect data for precipitation that occurs as snow. The precipitation amounts for January through March and the amount of precipitation that falls as snow during other periods must be obtained from other sources. Current season's precipitation data that include snow moisture are available on the National Weather Service site (www.crh.noaa.gov/bis/OtherHydro.htm Click on "text" for the desired month's precipitation data).

The following list of locations includes the long-term January through July precipitation, the 2002 January through July precipitation as a percent of the long-term seasonal mean, and the estimated percent reduction in stocking rate needed on healthy pastures in that area: Williston (9.8 inches, 101 percent, 0 percent), Watford City (9.7 inches, 116 percent, 0 percent), Manning (10.3 inches, 139 percent, 0 percent), Dickinson (11 inches, 114 percent, 0 percent), Beulah-Hazen (11 inches, 86 percent, 0 percent), Bismarck (10.7 inches, 67 percent, 8 percent), Bowman (10.7 inches, 73 percent, 2 percent), Hettinger (10.5 inches, 54 percent, 21 percent), and Shields (11.5 inches, 49 percent, 26 percent).

If the percentages of reduction in herbage biomass produced on domesticated grass spring pastures, native rangeland pastures, or grass and alfalfa haylands are greater than the estimated percentage of herbage reduction reached by the comparison between the long-term and current seasonal precipitation amounts, the health of the plants is below the potential level because the management practices have not met the plant biological requirements. When management practices meet the biological requirements of the plants and the level of plant health is high, the percentages in herbage biomass reduction that occur during periods of below-normal precipitation are smaller and less problematic than reduction percentages on areas with diminished plant health.

“Dry falls and cool springs, water stress during growing-season months, and summer drought are not abnormal climatic conditions in western North Dakota,” observes Manske. “Plant health status, which is affected by management practices, can magnify or diminish the negative effects these reoccurring environmental conditions have on herbage production. Management strategies that sustain high levels of plant health help to ensure that the problems accompanying below-normal precipitation are minor incidents rather than catastrophes.”

Drought Emergency Grazing Practices Will Have Costs Next Season

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Northern Plains beef producers who used emergency grazing to compensate for recent forage shortages will continue to experience the effects of last summer’s dry conditions even beyond the 2003 grazing season, says a North Dakota State University range scientist.

“Ranches without drought forage plans have been pressured into using ‘emergency’ practices that usually include grazing grass residue on domesticated-grass spring pastures, on summer pastures, and on grass haylands. These emergency grazing practices are commonly assumed to be less costly than the purchase of additional hay because of lower cash-flow costs, but the biological and financial costs will be evident next season in reduced production of herbage weight and subsequent reduction in pounds of calf per acre,” observes Lee Manske, range scientist at NDSU’s Dickinson Research Extension Center.

Many emergency grazing practices can negatively affect perennial grasses. Grasses reproduce primarily by vegetative tillering from axillary buds on the crowns of established plants and only infrequently by seed production and seedling development. Survival of perennial grasses through the winter and their regrowth in the spring depend on the plants’ ability to store sufficient nutrients during the latter portion of the growing season, Manske says.

The late-summer and fall greening of grasslands is the beginning vegetative growth stages of next year’s lead plants, he explains. The fall tillers will have active leaf material until the end of the growing season, when the chlorophyll fades and the leaves lose their green color. Throughout the winter, the crown of the plant, some portions of the root system and some leaf tissue remain active by using stored carbohydrates. If plants are healthy and have adequate carbohydrate reserves, most of the fall tillers will remain alive. Early in the spring, the leaf portions with intact cell walls can regreen and the tillers resume active growth.

The quantity of carbohydrates stored during the winter hardening process, which occurs between mid-August and mid-October, is closely related to the amount of active leaf material on each tiller. Emergency drought grazing practices can remove enough leaf material to diminish the quantity of carbohydrates stored. “Under these conditions, some tillers may not survive until spring, and plants that do will produce tillers with reduced height and weight,” Manske says.

Reductions in height during the succeeding growing season can range from 17 to 43 percent. Reductions in herbage weight are related to the severity of the grazing, with most pastures producing 50 percent or less of their normal herbage weight. Ranches that implemented emergency grazing practices this year should be prepared for diminished herbage production during the upcoming grazing season and for the necessary stocking rate reduction, he recommends.

“Producers facing these herbage reductions will most likely need additional sources of grazeable forage,” Manske says. “Seeded annual cereals like oats, forage barley or foxtail millet, which can be successfully grazed between the fourth- or fifth-leaf stage and the flowering stage, can be used for additional early and mid-season grazing. Spring-seeded winter cereals like winter rye, winter wheat, or winter triticale can serve as forage for additional late-season grazing.”

Purchasing emergency forage during growing seasons with drought conditions can be costly, but stopgap use of emergency grazing practices is not a satisfactory alternative. The actual costs of emergency grazing practices are greater than the costs of emergency forage because the reduced grassland productivity that results from the grazing practices can last for several years, Manske notes.

Two long-term practices that minimize the effects of growing seasons with below-normal precipitation can help beef producers:

• Implementing grazing management strategies that meet the biological requirements of the plants and enhance plant health status. Levels of herbage reductions during drought conditions are smaller in healthy plants than in weak plants, and healthy plants recover from these conditions more rapidly.

• Establishing forage contingency plans that decrease or eliminate dependence on emergency grazing measures. One contingency plan suggests that producers annually put up as hay the amount of harvested forage needed that year and put up an additional 10 to 20 percent as haylage. Putting up haylage preserves forage quality for many years and creates a supply for growing seasons in which precipitation levels are below normal and herbage production is inadequate.

Drought growing seasons occur with an average frequency of two in every 12 years in the Northern Plains, and ranches with drought forage plans face herbage reductions 16 percent of the time, Manske notes. However, ranches without drought forage plans will experience reduced herbage production with a greater frequency than this.

“These ranches must contend with herbage reductions not only in the years with below-normal precipitation but also in the following two- to three-year periods of grassland recovery from the stress of emergency grazing,” Manske emphasizes. “Consequently, for 33 to 50 percent of the years that ranches operate without a drought forage plan, they will have below-normal herbage production and the amount of forage produced will not be adequate to feed a fully stocked cow herd.”

“Growing seasons with drought conditions occur frequently and should not be considered abnormal, emergency situations. Grazing strategies that enhance plant health should be implemented and plans for a contingency supply of forage should be developed before the next growing season with drought conditions,” Manske says.

Management Practices Contributed to Last Summer's Herbage Reductions

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Traditional grazing and haying management practices contributed at least as much as low precipitation levels to last summer's herbage production shortfalls, says a North Dakota State University range scientist.

"During growing seasons with below-normal precipitation, traditional management practices intensify the problems caused by water stress in plants and add to the economic hardships created by reduced precipitation levels," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

The average peak herbage biomass in late July has a direct relationship with the long-term mean precipitation of an area, Manske explains. Percentages of herbage reduction in healthy plants are proportional to the levels of precipitation reduction below the normal range. Reductions in last season's January through July precipitation levels generally ranged from 0 percent to 26 percent below normal. Estimates of reduced herbage production in the Northern Plains during the 2002 growing season were much greater, ranging from 25 percent to greater than 60 percent.

"The additional reductions in herbage biomass were caused by the ineffectiveness of traditional management practices in meeting the biological requirements of the plants and by the resulting deterioration of plant health status," Manske says. "Plants with diminished health status are affected more severely than healthy plants during periods of below-normal precipitation and recover more slowly when conditions improve."

According to Manske, traditional grazing and haying management places priorities on animal husbandry practices rather than on plant health. Traditional management also places priorities on harvesting greater amounts of forage dry matter weight rather than on harvesting a greater portion of the produced nutrients, which are the more valuable resource.

"Because of the emphasis on these priorities, traditional practices capture only a small portion of the value potentially available from the land resources," he says. "Traditional management practices have provided forage dry matter to livestock for generations of beef producers, but the biological inefficiency of the practices leads to reduced herbage and nutrient production and to lower profit margins, results that producers in an increasingly competitive market can ill-afford."

Northern Plains beef producers can minimize the impacts of drought conditions and improve profit margins by implementing management strategies that place priorities on meeting the biological requirements of the plants and ecosystem processes, Manske says. Effective pasture-forage management strategies that improve the quality of the natural resources and increase the value captured from the land are based on three scientific premises:

• Coordinating livestock grazing with specific plant growth stages and seasons of the year beneficially manipulates plant biological processes, stimulates soil organism activity, and enhances the biological, geological and chemical cycles responsible for the flow of nitrogen, carbon, and water through ecosystems. This practice increases the biological effectiveness of management strategies and results in improved plant health and increased herbage production and nutrient flow in grassland ecosystems.

• Harvesting by grazing or mechanical haying of forage plants at the growth stage with the greatest nutrient weight per acre rather than the greatest dry matter weight per acre yields more nitrogen as crude protein and carbon as energy per acre. This practice improves the efficiency of nutrient capture and results in a reduced cost per pound of nutrient and in turn a reduced cost for that forage type as livestock feed.

•Meeting the daily nutritional requirements of modern high-performance livestock all year maintains animal production levels at genetic potentials. This practice improves the efficiency of nutrient conversion into saleable commodities like calf weight and results in stronger animal performance and lower annual pasture-forage costs than practices that overfeed or underfeed nutrients.

"Implementing effective 12-month pasture-forage management strategies will result in increased livestock weight gain per acre, reduced livestock production costs, reduced economic impacts during dry growing seasons, increased profit margins from beef production, and an enhanced regional agricultural economy," Manske says.

Pasture Recovery from Drought Depends on Previous Management

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Effective grazing management can help alleviate drought's detrimental effects on pastures, says a North Dakota State University range scientist.

"Parts of the Northern Plains experienced drought conditions during the 2002 growing season. Two primary factors determine the amount of time perennial grass pastures in these areas require for recovery before they can withstand grazing pressure at full stocking rate: the practices used to manage pastures prior to the dry conditions and the resulting level of plant health at the onset of the drought," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

"Certainly, the severity of drought stress and the severity and time of grazing during a drought affect plant response and recovery. However, effective pre-drought management minimizes reductions in herbage production during precipitation shortfalls and decreases pasture recovery time afterward," he emphasizes.

Management practices that meet plants' biological requirements produce strong, healthy vegetation, while traditional management practices like seasonlong, deferred, and repeat seasonal grazing produce only moderately healthy plants. Grazing prior to the time when grass tillers have the third new leaf in the spring or grazing summer pastures late into the fall leads to low levels of plant health, as does emergency grazing during drought.

Most beef producers whose operations were in drought-affected areas in 2002 and who used traditional management practices experienced herbage reductions at about twice the percentage of precipitation reduction, Manske says. In other words, if precipitation was reduced by 25 percent, herbage production may have been reduced by about 50 percent.

"The blame for the reduction in herbage biomass has been commonly and incorrectly placed solely on the reduction in levels of precipitation," he says. "About half of the reduction in herbage was caused by precipitation deficits and about half was caused by management practices used prior to the drought and by their effects on plant health."

Plant health has a considerable effect on herbage production during periods of water deficiency, Manske notes. The percentage of herbage reduction in healthy plants is about equivalent to the percentage of reduction in precipitation below the normal range. Percentages of herbage reduction greater than the precipitation reduction percentage result from the ineffectiveness of traditional management practices in meeting plant biological requirements and from the resulting deterioration in plant health. Plants that are in poor or moderate health when a drought begins incur extensive biological damage from the effects of water stress, and this damage results in the greater herbage production decreases.

The length of the recovery period for repair of plant biological damage and return to normal herbage production during the seasons following a drought also is related to plant health because plants at different health levels are impaired at different degrees from the effects of water stress. Moderately healthy plants and weakened plants are more severely damaged than healthy vegetation. The increasing amount of damage water stress causes to plants at decreasing health levels requires that the weaker plants have progressively longer recovery periods.

"Plants that are healthy at the onset of a drought need little or no recovery period from water stress at levels caused by the precipitation shortfall in 2002," Manske says. "Moderately healthy plants require one to two years to recover from water stress at levels occurring during 2002. Plants that are in poor health when a drought begins or that are weakened by emergency grazing during a drought require two to four years to recover. Herbage biomass production will be below normal during the recovery period for plants that were in moderate or poor health at the onset of drought conditions and stocking rate reductions will be necessary."

Management practices that produce low levels of plant health also cause slowed plant growth-stage development during the early portion of the growing season following the drought and delay the time at which grazing can begin without further damaging the grass. During the later portion of the grazing season, cool-season grasses produce vegetative fall tillers, which develop into the next year's lead tillers, Manske explains. The number of leaves that grow and survive until early spring affects the next season's herbage biomass production in relation to normal production levels.

Both the number of fall leaves, which is affected by the health status of the plants and the level of water stress, and the stress of leaf area removal from fall tillers by late-season grazing influence the rate of growth-stage development in the following growing season.

When fall tillers produce 2.5 to four leaves, plants develop through growth stages at normal rates the next season. However, fall tillers that enter winter dormancy with 2.5 leaves produce normal amounts of herbage biomass the next season, while fall tillers with four leaves produce greater than normal amounts. Fall tillers that develop only 1.5 leaves produce less than normal biomass the next season and their growth-stage development in the spring may be two to four weeks later than normal. Fall tillers that develop 2.5 leaves but have the equivalent of one leaf removed by grazing produce less than normal herbage biomass the following season. Most fall tillers with one or fewer leaves do not survive until spring; any surviving tillers produce low herbage biomass the next season, and their growth-stage development lags two to eight weeks behind normal rates.

Implementing grazing management practices that meet the biological requirements of the plants and enhance plant health status is the long-term solution to management-caused herbage reduction and will help minimize the effects of future drought conditions, Manske says. He recommends three effective management practices to improve plant health:

- Begin grazing in the spring only after plants have reached the third-leaf stage (early May for crested wheatgrass and smooth bromegrass and early June for native rangeland).
- Coordinate grazing rotation dates with plant growth stages. Plant density increases when secondary tiller growth is stimulated by light grazing for seven to 17 days during the period when grasses are between the third-leaf stage and flowering growth stage (early June to mid July for native rangeland).
- Do not graze spring and summer pastures or haylands during the fall. Fall grazing persists because of the common and incorrect assumption that grazing perennial plants after a frost does not hurt them. In fact, the grass plant's ability to survive the winter and produce biomass the following season depends on late-season growth.

Delayed grass growth-stage development and herbage biomass reductions greater than the percent reduction in precipitation create additional problems for producers coping with precipitation shortfalls. "Implementing management practices that meet plant biological requirements will enhance plant health status, minimize the reduction of herbage production during water deficit periods, and shorten pasture recovery time following a drought," Manske says. "While drought cannot be controlled, the management-caused problems that accompany it can be avoided or lessened with effective pasture management."

Proper Grazing Management Can Minimize Severity of Problems during Drought

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Biologically effective grazing management that improves plant health can help reduce the severity of problems beef producers encounter during drought conditions, says a North Dakota State University range scientist.

"Drought is a recurring natural phenomenon in the Northern Plains, with western North Dakota experiencing drought growing seasons about twice in every twelve-year period. The occurrence of drought conditions in 16 percent of growing seasons makes proper management of perennial grasses critical to the success of beef operations. Managing grasslands to enhance plant health prepares perennial grasses to withstand water stress and helps to minimize the herbage reductions that occur during the region's frequent periods of low-normal or below-normal precipitation," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

Drought can be simply understood as a period of low rainfall. However, drought is an ambiguous concept that is difficult to define, and drought's effects on vegetation are difficult to quantify. The degree to which a specific departure from normal precipitation levels affects vegetation varies with geographic region, time of year, and condition of plant health.

Several methods are used to measure drought severity and compare conditions among diverse regions. The National Weather Service presents two indices of drought, the Palmer Drought Severity Index (on the Web at www.cpc.ncep.noaa.gov/) and the U.S. Drought Monitor (www.drought.unl.edu/). The methods the Weather Service uses to measure moisture conditions are complex and performing the calculations requires training.

A simple procedure for evaluating rainfall shortage is to calculate the relationship of received precipitation to average long-term local levels. Received precipitation is divided by mean normal precipitation to give the percent of normal precipitation. The range of normal is ± 25 percent of the mean precipitation. Precipitation levels of 75 percent or less of the mean precipitation indicate dry conditions.

While this technique is helpful in indicating rainfall deficiencies and the existence of dry conditions, it does not show the degree to which a specific deficiency in precipitation affects perennial grassland plants. Because of variable influences from temperature and time of year, the severity of a precipitation deficiency's effect on healthy vegetation is not consistent with percent of normal precipitation values.

The physiological and ecological status of grassland plants is determined by a balance between rainfall and evapotranspiration. When the amount of rainfall is less than potential evapotranspiration demand, a water deficiency exists in the soil. Under water deficiency conditions, plants are unable to absorb adequate water to match the transpiration rate, and water stress develops in those plants. Plants experiencing water stress conditions have reduced photosynthetic activity and limited growth.

Evaporation rates increase or decrease with changes in average temperature, and water deficiencies occur at variable levels of precipitation, depending on the average period temperature. When high average temperatures increase evapotranspiration rates, water deficiency conditions can exist even when precipitation levels are within the normal range.

Growing-season months with water deficiencies great enough to cause water stress in healthy perennial plants can be determined from just temperature and precipitation information. Water deficiency exists during months in which the total received precipitation expressed in millimeters is less than twice the mean temperature of the month expressed in degrees centigrade.

Evaluation of 112 years of growing-season temperature and precipitation information from Dickinson, North Dakota, indicates that water deficiency severe enough to cause healthy perennial grassland plants physiological damage from water stress occurs when the amount of monthly rainfall and the percent of long-term mean monthly normal precipitation are below the following levels: 0.42 inches and 29 percent in April, 0.91 inches and 39 percent in May, 1.31 inches and 37 percent in June, 1.6 inches and 71 percent in July, 1.53 inches and 87 percent in August, 1.05 inches and 79 percent in September, and 0.52 inches and 55 percent in October. In August and September, water deficiency conditions have existed even when precipitation levels were above the low-normal range.

During the past 112 years, water deficiency conditions have placed grassland plants under water stress in 32.4 percent of the growing-season months: water stress limited the growth and herbage production of grassland plants about two months during every six-month growing season, on average. Water deficiency conditions have occurred with the following frequencies in each growing-season month: 16.1 percent in April, 14.3 percent in May, 8.9 percent in June, 37.5 percent in July, 50.9 percent in August, 50.9 percent in September and 48.2 percent in October.

Only seven (6.25 percent) of the past 112 years have had all growing-season months with no water deficiency conditions. Over a forty-year career, a beef producer will likely see only two or three growing seasons in which perennial grassland plants do not experience water stress.

Despite the high frequency of water deficiency conditions, many beef producers operate as if each year had ideal growing conditions. Management practices based on the assumption that precipitation levels will be normal during every growing season magnify the biological and economic problems livestock producers endure during periods of low rainfall.

Traditional grazing management practices designed for priorities other than to meet plant biological requirements cause plant health to deteriorate, and these practices intensify the severity of drought-related problems. Reduction in herbage biomass production during water deficiency periods is far greater for plants in poor health than it is for healthy plants, and grasses in poor health at the start of a water deficiency period require a longer time to recover than healthy plants.

The severity of problems experienced during recurring periods of low precipitation should not be attributed entirely to rainfall shortage. The effects from low rainfall are increased by annual operational management plans that do not take into account the region’s frequent water deficiency conditions and by grazing practices that do not manage grasslands specifically for the health of the plants.

Grazing management practices that meet the biological requirements of grass plants and enhance plant health status are the long-term solution to management-caused herbage reduction problems and will help minimize the effects of future drought conditions. Producers can implement three effective management practices to improve plant health:

- Begin grazing in the spring only after plants have reached the third-leaf stage (early May for crested wheatgrass and smooth bromegrass and early June for native rangeland).
- Coordinate grazing rotation dates with plant growth stages. Plant density increases when secondary tiller growth is stimulated by light grazing for 7 to 17 days during the period when grasses are between the third-leaf stage and flowering growth stage (early June to mid July for native rangeland).
- Do not graze spring and summer pastures or hay lands during the fall. The grass plant’s ability to survive the winter and produce biomass the following season depends on late-season growth.

Producers can minimize the severity of water deficiency problems by recognizing the frequency of their occurrence and implementing grazing management appropriate to the region’s challenging climatic conditions. Management practices that improve plant health and prepare forage grasses for water stress should be a permanent part of every grazing strategy in the Northern Plains.

Grazing Management to Reduce Grasshoppers

Grazing Management Can Reduce Grasshopper Problems

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Problems with high numbers of grasshoppers can be reduced with biologically effective grazing management strategies, says a North Dakota State University range scientist.

"Grasshopper populations have a history of periodic outbreaks, which can occur as the outward expansion of a 'hot spot' or as an escalation of low to high numbers across an area," states Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "The periodic outbreaks in the Northern Plains tend to be associated with drought conditions and heavy grazing on native rangeland and domesticated grasslands. Little can be done to alter precipitation levels, but grazing management practices that increase the amount of vegetation cover can help to control pestiferous grasshopper species and suppress population outbreaks when weather conditions favor the insects."

Grassland management strategies that repeatedly remove most of the vegetation reduce plant density and herbage biomass production. Areas with open vegetation canopy and spots of bare ground are favorable grasshopper habitat, offering ideal egg-laying sites and basking sites where grasshoppers warm themselves in the early morning sun to speed metabolic rates and improve growth rates. Under these grassland conditions, amounts of solar radiation that reach the soil surface increase, as does airflow over the ground. The resulting increase in light and decrease in humidity discourage growth of important agents that cause grasshopper diseases, and the higher soil and air temperatures accelerate grasshopper egg production, egg development, and the growth and maturation of the young insects.

Grazing management practices that decrease vegetation cover, as the seasonlong strategy does, promote grasshopper population increases. Practices that enhance vegetation cover discourage grasshopper population increases. The twice-over rotation system on native rangeland is effective in grasshopper management because the strategy leads to greater plant density and herbage production and fewer open areas in the vegetation canopy cover.

These plant community characteristics develop because the twice-over rotation system is biologically effective. It coordinates grazing with grass growth stages and removes a small amount of leaf material from grass plants between the third-leaf stage and the flowering stage. This timed defoliation stimulates plant processes and soil organism activity that enhance plant growth, and the greater herbage biomass production leads to microhabitat conditions unfavorable for grasshopper population increases. Compared to seasonlong grazing treatments, the twice-over rotation system has 25 percent greater grass basal cover, an average of 33 to 45 percent more herbage biomass production during each growing-season month, and 31 percent less open area in the vegetation canopy.

A recent study confirms that grasshopper populations are lower on the twice-over rotation treatment than on the seasonlong treatment. Dr. Jerry Onsager, retired research entomologist, USDA-Agricultural Research Service, followed grasshopper numbers for five growing seasons on native rangeland areas managed with either a seasonlong strategy or the twice-over rotation system. The average number of grasshopper days per square meter was 748 on the seasonlong treatment, considerably greater than the average of 229 on the twice-over rotation treatment. During the last two years of the study, a local grasshopper outbreak with an average density of 22.6 adult grasshoppers per square meter occurred on the seasonlong treatment. This population outbreak did not occur on the twice-over rotation treatment, which maintained an average of only 3.9 adult grasshoppers per square meter.

The improvement in the vegetation characteristics of rangeland managed with the twice-over rotation system yields lower temperatures, higher relative humidity, and reduced sunlight within the grasshopper microhabitat. These changes negatively affect the growth and survival of immature grasshoppers in the nymphal stages and result in reduced grasshopper numbers and in suppression of local grasshopper population outbreaks.

Grazing Strategies Offer Natural Grasshopper Management

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Improved grazing management strategies can help control pest grasshopper populations, says a North Dakota State University range scientist.

"Rangeland pestiferous grasshopper populations tend to increase when grassland habitat conditions are favorable for the development of the insect from egg to adult. Habitat conditions on grasslands can be modified by defoliation practices, and producers can implement biologically effective grazing management to minimize the potential for grasshopper population outbreaks," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

Grasslands with reduced plant density and reduced standing herbage offer favorable habitat for rangeland grasshoppers, Manske explains. The favorable habitat conditions can result from heavy grazing pressure, drought, and poorly timed grazing periods that do not allow grass plants time to recover from defoliation.

With reduced vegetation canopy cover and enlarged areas of bare ground, the amount of solar radiation that reaches the soil surface increases, as does the airflow over the ground. The reduced vegetation structure results in higher air and soil temperatures and lower humidity in grasshopper microhabitat. These grassland habitat conditions are favorable for pest grasshopper population increases.

"Grassland habitat with open vegetation canopy and areas of bare ground provides ideal basking sites, where grasshoppers warm themselves in the early morning sun to speed metabolic rates and increase growth rates," Manske explains. Patches of bare ground also are favored egg-laying sites. Higher soil and air temperatures accelerate grasshopper egg development, growth and maturation of young insects, and egg production of adult females.

In addition, habitat with intense sunlight and low humidity near the soil discourages the growth of important pathogens that cause grasshopper diseases. As a result, mortality rates of immature grasshoppers decline and greater numbers of the insects survive into adulthood, Manske says.

Areas with habitat unfavorable to grasshoppers are those on which plant density is increased so that only a few small spots of bare ground occur and on which adequate herbage biomass remains after grazing periods so that the vegetation canopy is nearly closed, Manske notes. The increased vegetation structure reduces the amount of sunlight reaching the ground and increases the humidity near it. In these grassland habitat conditions, grasshopper metabolic rates and growth rates slow and disease increases mortality rates among young grasshoppers.

"Many traditional management practices produce habitat favorable for grasshopper population outbreaks," Manske warns. "Commonly used practices that help grasshopper populations increase to problem levels include beginning grazing before plants have reached the third-leaf stage; grazing spring and summer pastures or haylands during the fall; and management treatments such as seasonlong, deferred, and repeat seasonal grazing that leave little residual vegetation following defoliation periods."

"Producers can suppress potential grasshopper outbreaks by implementing grazing management that minimizes habitat favorable to the insects," Manske says. He recommends three management practices that develop grassland habitat unfavorable for grasshopper outbreaks:

- Delaying the start of grazing until grasses have reached the third-leaf stage (early May for crested wheatgrass and smooth bromegrass and early June for native rangeland)

- Grazing native rangeland with a twice-over rotation management system that coordinates rotation dates with plant growth stages

- Grazing complementary forage types during the fall rather than grazing spring and summer pastures or haylands late in the season.

The importance of effective grazing management in controlling grasshoppers was evident during a recent small-scale outbreak, Manske reports. Habitat on areas managed with a seasonlong grazing system was favorable for the insects, and the density of adult grasshoppers on these pastures averaged 22.6 per square meter. In contrast, habitat conditions on areas managed with a twice-over rotation grazing system discouraged proliferation of the grasshoppers: the average density of adults on areas under this biologically effective management was only 3.9 per square meter.

Implementing improved cultural management practices is not a quick fix to a major problem, Manske explains. Grazing management strategies that produce habitat unfavorable for grasshopper population outbreaks are a long-term solution to grasshopper problems and take three or more years to show substantial results.

“Regardless of this delay, pastures that were grazed using traditional management and that had increasing grasshopper numbers last summer and fall need a change of management,” he says. “These areas need to be managed with grazing practices that beneficially stimulate biological and ecosystem processes so that plant density begins to increase and residual vegetation canopy starts to become denser and covers a greater portion of the soil surface.”

Manske warns that unless the problems with habitat conditions on these pastures are addressed, the number of grasshoppers could rise to an unmanageable level during the upcoming grazing season. He emphasizes that because rangeland grasshopper outbreaks are a serious and recurring problem, implementing long-term grazing strategies that effectively produce grassland habitat unfavorable for grasshopper development is simply sound management.

Grazing Management Can Reduce Grasshoppers While Increasing Beef Production Profits

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Crisis management of grasshopper populations after they have reached outbreak numbers is an expensive, no-win situation that producers can work to avoid, says a North Dakota State University range scientist.

"Producers can be proactive and change their grazing practices before grasshopper numbers reach problem levels. By implementing grassland management practices that produce habitat conditions unfavorable for grasshopper growth and development, producers can reduce the intensity and duration of recurring outbreaks," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

Grasshopper populations fluctuate in response to changes in habitat condition. Grasshoppers thrive in habitat where reduced vegetation canopy and large areas of bare ground provide the hot, dry conditions that reduce grasshopper pathogens, increase egg production, elevate metabolic rates, and accelerate maturation rates of immature insects. Grasshoppers are a natural part of grazinglands and haylands of the Northern Plains, and population densities remain below problem levels as long as the habitat conditions remain unfavorable for population increases.

Most traditional management practices produce habitat with conditions near the threshold between those unfavorable and those favorable for grasshopper population increases. During years with normal or above-normal precipitation, grasshopper populations remain below problem levels on pastures under traditional management, but during years with below-normal precipitation or increased stocking rates, grasshopper numbers increase. After a few years with favorable habitat conditions, grasshopper populations can reach outbreak levels.

These outbreaks are often perceived to be associated with the drought conditions alone rather than with the combination of drought stress and deleterious management practices. Traditional management that does not meet plant biological requirements reduces plant health status. Plant communities with weakened health status are able to endure only minimal stress and require long periods to recover from stress conditions. In contrast, healthy plant communities can endure considerable stress and can quickly rebound from stress.

Long-term grassland management strategies that meet the biological requirements of the plants improve grassland health. Such plant-friendly management strategies as the twice-over rotation system coordinate grazing periods with grass growth stages to stimulate beneficial processes within grass plants and the ecosystem. Grazing that removes a small amount of leaf material from grass plants between the three-leaf stage and flowering stage stimulates vegetative tiller development from axillary buds on the plant crowns and increases the activity of symbiotic soil organisms in the rhizosphere around grass roots.

Together, the resulting increases in plant density and herbage biomass production and the improvements in biogeochemical cycles create habitat with greater vegetation canopy and smaller and fewer areas of bare ground. These healthy grassland habitat conditions reduce the microhabitat favorable for grasshopper growth and reproduction.

The enhanced vegetation structure limits the amount of solar radiation that reaches the soil surface and decreases the airflow over the ground so that air and soil temperatures in grasshopper microhabitat are lower and humidity is higher. The decreased availability of the basking sites grasshoppers need to warm themselves and elevate their metabolic rates slows the insects' growth rates. Unfavorable conditions on egg-laying sites reduce egg production and development, and improved conditions for important pathogens that cause grasshopper diseases result in increased mortality rates of immature grasshoppers.

The features of habitat on healthy grassland ecosystems check grasshopper increases so that the population numbers remain below problem levels. During a two-year local outbreak, the biologically effective twice-over rotation grazing system averaged only 3.9 adult grasshoppers per square meter, 82.7 percent fewer grasshoppers than the outbreak density of 22.6 adult grasshoppers per square meter on the traditional management practice of seasonlong grazing.

Plant-friendly grassland management designed to improve the health status of ecosystems has the additional benefit of improving livestock performance and increasing profit margins per acre. Comparisons between the biologically effective twice-over rotation system and a traditional seasonlong grazing practice show that the twice-over rotation system requires 29.1 percent fewer acres per cow-calf pair for a summer, has 49.2 percent greater calf weight gain per acre, has 33.3 percent lower cost per pound of calf gain, and has 110.7 percent greater economic return after pasture and forage costs per acre.

"Proactive long-term grazing management that produces healthy grassland habitat with unfavorable conditions for increases in grasshopper populations is positive for the ecosystem and profitable for beef producers," Manske says.

Biologically Effective
12-Month
Pasture-Forage Management

Efficient 12-Month Pasture-Forage Management Systems Reduce Beef Production Costs

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Implementing efficient 12-month livestock feed management systems based on biological and ecological sciences will increase value capture from land resources, improve the profit margin for beef production, and enhance the regional agricultural economy, says a North Dakota State University range scientist.

"The potential amount of new wealth generated from agricultural use of land resources is limited by the biological capacity of the plants to produce herbage and nutrients from soil, sunlight, water, and carbon dioxide. It is also limited by the effectiveness of management practices in capturing value from plant production," states Lee Manske, range scientist at NDSU's Dickinson Research Extension Center.

"Traditional grazing and haying management practices place priorities on animal husbandry practices and focus on harvesting greater amounts of forage weight. Such practices lead to diminished herbage and nutrient production and capture only a small portion of the value potentially available from the land resource," Manske says. "The result is high livestock feed costs and low profit margins. Increasing value capture from the land requires management strategies with improved biological effectiveness, nutrient capture efficiency, and nutrient conversion efficiency."

The solar energy that plants capture during photosynthesis is both the primary force driving all ecosystem functions and the foundation for all uses of grasslands, Manske explains. The performance level of the plant component of grassland ecosystems determines the performance levels of all other ecosystem components; therefore, sustaining high levels of herbage and nutrient productivity from pastures and haylands requires using management strategies that place priority on plant health and growth.

"Traditional practices, which place management priorities on the various uses of the grassland ecosystems or on promoting grass sexual reproduction and seed production, are not biologically effective," he says. "Biologically effective management strategies meet the requirements of the plants and promote vegetative reproduction by tillering from axillary buds–the primary method of grass reproduction in the prairies. They also stimulate beneficial activity of rhizosphere organisms and facilitate the functioning of ecological processes at higher levels. Such biological conditions result in the enhanced production of herbage and nutrients on pastures and haylands."

Efficient capture of nutrients is also a major consideration of an effective management system. The valuable agricultural products from pastures and haylands are the nutrients, and various types of forages used for livestock feed should be evaluated by the cost per unit of weight of nutrients rather than by the cost per unit of weight of dry matter, Manske notes. Feeding forages to meet livestock nutrient requirements and supplementing dry matter is more cost efficient than feeding forages to meet dry matter weight requirements and supplementing nutrients.

The proportion of produced nutrient weight captured by grazing or haying is the efficiency of a harvest method. Traditional management practices that focus on harvest of forage dry matter weight capture nutrients inefficiently, and the loss of forage nutrients produced but not captured raises livestock feed costs, he says. Efficient management strategies time harvest to coincide with the plant growth stages that yield the greatest nutrient weight per acre.

Nutrient weight is related to the percent nutrient content of forage and to the weight of forage dry matter at the time of grazing or haying. The optimum plant growth stage for harvest is when the herbage production curve and the nutrient quality curve cross for a specific forage type. Grazing or haying a forage at this time yields a high proportion of captured nutrients and results in lower costs per unit of nutrient and lower pasture-forage costs per day.

“Efficient conversion of nutrients into a saleable commodity is another major consideration of an effective management system,” Manske says. “The traditional pasture-forage management practices used in the Northern Plains were developed during the era of low-performance livestock. Over the past several decades, the type of livestock in the region has shifted to a fast-growing, high-performance animal, but pasture-forage management strategies have not been adjusted to take full advantage of the livestock’s genetic potential.”

Modern high-performance cattle have a reduced level of production efficiency when their immediate nutritional needs are not met. Nutrient deficiency in the cattle diet for two weeks results in calf weaning weights below potential and in high annual expenses for cow maintenance. The effects become more severe as the period of deficiency increases. With traditional management practices, cattle diets lack adequate nutrients 40 to 60 percent of the days in a year, he says.

Traditional practices do not systematically change forage types in response to varying livestock nutrient demands but change forage feed selections in response to the depletion of a forage source. In traditional practices, timing of cow production periods is not coordinated with pasture and harvested forage quality but is determined by selection of calf weaning dates that match changing market patterns. Effective management strategies for modern high-performance livestock provide nutrients at the times and in the amounts required during each production period to maintain efficient conversion of the nutrients into saleable commodities.

“The efficiency of pasture-forage management strategies can be improved through the coordination of grazing and haying periods with plant growth stages and through the selection of appropriate combinations of forage sources to be fed or grazed in a 12-month sequence so that the dietary quantity and quality requirements of cow production periods coordinate with the herbage production curves and nutritional quality curves,” Manske says. “Systems with these characteristics meet livestock biological and nutritional requirements during each production period. The resulting efficient capture and conversion of nutrients are reflected in lower costs per unit of weight of nutrients, land area per animal unit, feed costs per day, and cost per pound of calf weight gain.”

“The livestock forage feed costs from pasture and haylands are largely determined by the biological effectiveness and nutrient capture and conversion efficiency of the management strategy. Efficient 12-month pasture-forage management systems enhance plant growth, capture a high proportion of the produced nutrients, and efficiently convert those nutrients into saleable commodities such as calf weight,” says Manske. “These strategies improve livestock weight performance, reduce livestock production costs, and increase profit margins.”

Reducing Pasture-Forage Costs for Range Cows during Early Lactation

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Producers can reduce pasture and forage costs and improve profit margins by feeding harvested forages to range cows during the early lactation production period, says a North Dakota State University range scientist.

"Each year beef producers struggle to determine which forage type can be fed at the lowest cost during the early lactation period after the calves are on the ground and before spring domesticated grass pasture is ready for grazing," notes Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center. "The forage types selected must meet livestock nutrient and dry matter requirements, and to ensure that comparisons offer a reliable assessment, the costs for forage types should be compared by the cost value of basic units like cost per pound of crude protein and total feed cost per day per cow."

During the early lactation production period, a 1,200-pound range cow requires a daily intake of 27 pounds of dry matter at 10.1 percent crude protein (2.73 pounds of crude protein per day or 123 pounds of crude protein for a 45-day early lactation production period). Costs for five forage feed types for 1,200-pound range cows during a 45-day early lactation production period were evaluated by comparisons of land rent values, production costs per acre, forage dry matter costs per ton, crude protein costs per pound, and feed costs per day and per production period, Manske reports. The forage types evaluated were native range supplemented with range cake, mature crested wheatgrass hay, crested wheatgrass hay cut early, forage lentil hay cut late, and forage barley hay cut early.

Native range pastures during early spring have a crude protein content of around 9.2 percent. The forage dry matter consumed by animals costs $140.16 per ton, and crude protein costs 76 cents per pound. Crude protein supplementation is required, at a cost of 8 cents per day. The forage from native range pasture and the supplementation to feed a range cow during early lactation cost $1.97 per day in the evaluation, or $88.43 for the 45-day production period.

Crested wheatgrass hay cut late, at a mature plant stage, has low nutritional quality, with a crude protein content of around 6.4 percent. Forage dry matter costs $34.80 per ton, and crude protein costs 28 cents per pound. Crude protein supplementation is required, at a cost of 30 cents per day. Mature crested wheatgrass hay and the supplementation to feed a range cow during early lactation cost $1.05 per day, or $47.25 for the 45-day production period.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5 percent. Forage dry matter costs $40.80 per ton, and crude protein costs 14 cents per pound. Roughage supplementation is required, at a cost of 14 cents per day. Early cut crested wheatgrass hay and supplemented roughage to feed a range cow during early lactation cost 52 cents per day, or $23.40 for the 45-day production period.

Forage lentil hay cut at a late plant stage has a crude protein content of around 14.7 percent. Forage dry matter costs $37.00 per ton, and crude protein costs 13 cents per pound. Roughage supplementation is required, at a cost of 15 cents per day. Forage lentil hay cut late and supplemented roughage to feed a range cow during early lactation cost 49 cents per day, or $21.92 for the 45-day production period.

Forage barley hay cut early, at the milk stage, has a crude protein content of around 13.0 percent. Forage dry matter costs $28.80 per ton, and crude protein costs 11 cents per pound. Roughage supplementation is required, at a cost of 11 cents per day. Forage barley hay and supplemented roughage to feed a range cow during early lactation cost 41 cents per day, or $18.23 for the 45-day production period.

Production costs per acre for harvested forages are greater than pasture rent per acre, so traditional assumptions have often favored grazing native range over feeding harvested forages. In fact, comparisons based on cost per pound of crude protein indicate that a more economical strategy than grazing livestock on early spring range is feeding forages harvested at the optimum growth stage to capture a great amount of crude protein per acre, Manske states.

“Grazing livestock on native rangeland during early spring is expensive because the forage dry matter and crude protein costs are high,” Manske explains. “Although the nutritional quality of early spring native range vegetation is increasing, the crude protein content remains below the level required by livestock during early lactation, and supplementation is required. In addition, the weight of the herbage on early spring pastures is only about one third of the mid summer herbage weight and livestock grazing native rangeland therefore require about three times as many acres per month in the early spring as they do during the summer.”

Comparisons of production costs per acre, pasture rent per acre, or cost per bale of feed do not accurately reflect forage feed costs because forage dry matter weight per acre and nutrient weight per acre captured through grazing or haying vary with forage type and plant growth stage, and the variations are not proportional to these per acre costs, Manske emphasizes. Comparisons of basic cost values accurately reflect livestock production costs. Two basic cost values are cost per pound of crude protein, which is related to the forage dry matter cost and the quantity of nutrients per unit of forage weight, and total feed cost per cow per day or per production period, which includes production costs per acre, costs of forage dry matter, and costs of crude protein.

Implementing management strategies that feed appropriate harvested forages to meet livestock requirements at low costs per pound of crude protein will reduce livestock feed costs, reduce livestock production costs, and help improve the profit margin of beef production.

Forage Feed Costs for Range Cows during Early Lactation

	Native Range	Crested Wheatgrass Hay cut late	Crested Wheatgrass Hay cut early	Forage Lentil Hay cut late	Forage Barley Hay cut early
% Crude protein content	9.2%	6.4%	14.5%	14.7%	13.0%
Production cost/acre	$8.76	$28.11	$26.50	$71.48	$68.21
Forage dry matter cost/ton	$140.16	$34.80	$40.80	$37.00	$28.80
Crude protein cost/lb	$0.76	$0.28	$0.14	$0.13	$0.11
Cost Per Cow					
acres/month	6.48	0.80	0.43	0.14	0.13
cost/day	$1.89	$0.75	$0.38	$0.34	$0.30
Supplemented crude protein					
lbs/day	0.25	1.00	0.0	0.0	0.0
cost/day	$0.08	$0.30			
Supplemented roughage					
lbs/day	0.0	0.0	8.2	8.4	6.0
cost/day			$0.14	$0.15	$0.11
Total feed cost per day	$1.97	$1.05	$0.52	$0.49	$0.41
Cost for Early Lactation	$88.43	$47.25	$23.40	$21.92	$18.23

Early Grazing Damages Grass and Reduces Profits

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Turning livestock onto native range too early in the spring can be costly to producers, says a North Dakota State University range scientist.

Grazing too early in the season damages plants and limits herbage production by removing leaf area from grass that has not recovered from winter dormancy," says Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "This damage from early grazing reduces the forage available to livestock later in the season and decreases profits."

Manske says grass cannot withstand defoliation until it reaches the third-leaf stage, when plants have produced sufficient foliage to support growth. "The arrival of plants at the third-leaf stage is the most reliable indicator that producers can use to determine when grazing may safely begin," he notes. The date on which the third new leaf appears varies by plant type. Most native range cool-season grasses are ready for grazing in early June and warm-season species are ready about two weeks later.

Research shows that starting grazing on native range in early May results in a loss of 75 percent of the potential herbage and that starting grazing in mid May results in a loss of 45 to 60 percent of the potential herbage, Manske states. Those reductions in herbage production lead to reductions in stocking rate, calf average daily gain, calf gain per acre, net returns per cow-calf pair and net returns per acre. Delaying grazing until early June on rotation grazing systems or until mid June on seasonlong treatments results in smaller reductions in potential herbage production and produces greater economic returns for the cow-calf operation, Manske stresses.

Cool-season domesticated grasses can serve as alternative spring forage sources until native range grasses are ready for grazing, Manske says. Like native range, complementary spring domesticated grass pastures should be grazed only after plants arrive at the third-leaf stage. No perennial grasses develop the third new leaf before late April, but domesticated grass species such as crested wheatgrass and smooth bromegrass reach the third-leaf stage three to five weeks earlier than cool-season native species. Pastures of domesticated grasses can support grazing livestock from early May until grazing on native range can begin safely in early June.

"Allowing livestock to graze native range early in the season may seem less costly than feeding livestock harvested hay, but the lower cow-calf gain that results from reductions in native range forage production ultimately yields lower net returns for a cow-calf operation," Manske observes. "Coordinating grazing with grass growth stages to meet the biological requirements of grass plants and livestock helps to protect rangeland health and increase profits for beef producers."

Grazing Native Rangeland in May Reduces Ranch Income

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Using native rangeland as early season pastures reduces beef producers' profit margins, says a North Dakota State University range scientist.

"Turning livestock onto native pastures before grasses have reached the third-leaf stage damages plants, limits herbage production, increases forage costs, and decreases livestock production and profits. Delaying grazing on native rangeland until early June, when grasses have three new leaves, can improve grass plant health and boost producers' incomes," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

Native range grasses grazed too soon after winter dormancy cannot produce adequate leaf area to support plant growth at normal rates, and herbage production falls far below potential while plants recover from the stress of early defoliation, Manske explains. "The earlier defoliation begins, the greater the loss of herbage production and the longer the recovery time will be."

Starting grazing on native rangeland in early May results in a loss of 75 percent of that season's potential herbage production. Starting grazing in mid May results in a loss of 45 to 60 percent. These herbage reductions lead to decreased stocking rate, calf average daily gain and net returns per acre, and the reduced production can persist beyond a single growing season.

"Grasses are able to withstand grazing pressure when they have produced three to three and a half new leaves in the spring," Manske says. Cool-season grasses at the third new leaf stage will have more than three leaves on a tiller. Lower portions of the one to four fall leaves that overwinter will have intact cell walls and will regreen early in the spring. This leaf area provides nourishment for new leaf growth. The cell walls in the top portions of the fall leaves rupture during the winter and these leaf portions remain brown.

The date on which grasses reach the third-leaf stage varies with plant type, Manske notes. Most native range cool-season grasses are ready for grazing in early June and warm-season species are ready for grazing in mid-June. A recent study at the NDSU Dickinson Research Extension Center found that several forage sources offer economical alternatives to grazing native range during May.

Native Rangeland Grazed in May

"Grazing native range pastures in May is not the low-cost practice it is commonly assumed to be," Manske says.

Forage on native rangeland managed with a one-pasture seasonlong treatment that started grazing in early May, before the third-leaf stage, had production costs of $8.76 per acre and pasture-forage costs of $1.35 per day. Calves gained an estimated 1.8 pounds per day at a cost of 75 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were a loss of 58 cents per acre.

Forage on native rangeland managed with a one-pasture seasonlong treatment that started grazing in mid May, before the third-leaf stage, had production costs of $8.76 per acre and pasture-forage costs of $1.15 per day. Calves gained 1.8 pounds per day at a cost of 64 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were 83 cents per acre.

Crested Wheatgrass Hay

Mature crested wheatgrass hay is expensive livestock feed because the amount of crude protein captured per acre is low, but this hay is less expensive than pasture forage from native rangelands grazed before grasses reach the third-leaf stage, Manske notes.

Crested wheatgrass hay cut at a mature plant stage and fed during May had production costs of $28.11 per acre and harvested-forage costs of 93 cents per day. Calves gained an estimated 1.8 pounds per day at a cost of 52 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after harvested-forage costs were $17.40 per acre.

Domesticated Grass Pastures

Cool-season domesticated grass pastures can serve as a less expensive source of early season forage than mature harvested hay. Grazing on complementary spring domesticated grass pastures should begin only after plants have arrived at the third-leaf stage. Crested wheatgrass and smooth bromegrass reach this stage three to five weeks earlier than cool-season native species and can support grazing livestock from early May until grazing on native range can begin safely in early June.

Forage on unfertilized crested wheatgrass pastures with grazing starting in early May, after the third-leaf stage, had production costs of $8.76 per acre and pasture-forage costs of 52 cents per day. Calves on these pastures gained 1.91 pounds per day at a cost of 27 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $13.29 per acre.

Forage on fertilized crested wheatgrass pastures with grazing starting in early May, after the third-leaf stage, had production costs of $21.26 per acre and pasture-forage costs of 51 cents per day. Calves on these pastures gained 2.18 pounds per day at a cost of 24 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $41.82 per acre.

Native Rangeland Grazed in June

“Using alternative forage sources and delaying the start of grazing on native range until early June, after grasses have reached the third-leaf stage, not only reduces forage costs in May but also promotes growth of adequate leaf area and so leads to greater herbage biomass production on the native range pastures,” Manske says. “This improvement increases livestock performance and, in turn, income per acre.”

Forage on properly stocked native rangeland managed with a one-pasture seasonlong treatment with grazing starting in early June, after the third-leaf stage, had production costs of $8.76 per acre and pasture-forage costs of 81 cents per day. Calves on this treatment gained 2.09 pounds per day at a cost of 39 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $7.02 per acre.

Forage on properly stocked native rangeland managed with a multiple-pasture twice-over rotation system with grazing starting in early June, after the third-leaf stage, had production costs of $8.76 per acre and pasture-forage costs of 58 cents per day. Calves on these pastures gained 2.21 pounds per day at a cost of 26 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $14.79 per acre.

Reducing Costs in May

“Turning cows with calves onto native rangeland pastures during May has lower production costs per acre and requires less labor than feeding hay does,” Manske admits. “However, delaying the start of grazing on native rangeland until early June, when grasses have reached the third-leaf stage, allows for greater growth of potential herbage production, lower pasture-forage costs and increased net returns per acre.”

The value of the lost herbage and nutrients on native range grazed in May is greater than the cost of feeding mature hay during that month and far greater than the cost of an alternative such as grazing domesticated grass pastures like crested wheatgrass or smooth bromegrass, which has lower costs than feeding mature hay, he says. These alternative complementary domesticated grass spring pastures can potentially yield greater per-acre economic returns than any other grazing scenario during May.

“The high costs of starting spring grazing before grasses have reached the third-leaf stage are an unnecessary financial burden for beef producers,” Manske says. “With today’s competitive market, using lower-cost alternatives to early season grazing is essential to reduce pasture-forage costs and increase profit margins for cow-calf operations.”

Native Pasture Is Not the Cheapest Feed for Range Cows in May

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Results from a recent study that compared the costs of forage strategies for lactating cows during May will surprise some beef producers, says a North Dakota State University range scientist.

“Traditional evaluation methods comparing forage cost per unit of weight suggest that traditional forage choices are the least expensive feeds, but this measure does not accurately reflect livestock feed costs,” states Lee Manske, a range scientist at NDSU’s Dickinson Research Extension Center. “A broader consideration of factors indicates that producers using well-chosen forage alternatives to native range and mature crested wheatgrass hay should see lower feed costs and improved profit margins.”

The study, conducted at the Dickinson facility, evaluated the costs of native rangeland, unfertilized and fertilized crested wheatgrass pastures, and two harvested-forage types--mature crested wheatgrass hay and forage barley hay cut at the milk stage--as feed for 1200-pound range cows during the 31-day spring lactation production period in May. Evaluations included land rent values, production costs per acre (including equipment and labor), forage dry matter costs per ton, crude protein costs per pound, and total feed costs per day and per period. Costs per pound of calf gain and returns after pasture costs were compared for pasture types.

“The pasture- or harvested-forage type with the lowest cost per ton or the lowest cost per acre is not the lowest-cost livestock feed,” emphasizes Manske. “Land costs, production costs, equipment costs, and labor costs per acre are important, but these costs do not regulate the costs of livestock feed. The cost of livestock feed is determined primarily by the cost per unit of weight of the nutrients contained in the forages.”

Native range pasture had lower land rent value, equipment costs, labor costs, and production costs per acre than forage barley hay but had the highest per day feed cost. During May, native rangeland grass tillers have not yet produced their third new leaf. An acre of this immature growth yields only 195 pounds of forage dry matter and 32 pounds of crude protein for range cows to consume, and 4.77 acres are required to provide adequate forage for a 1200-pound cow for the 31-day period.

The forage with the lowest feed cost per day during May was forage barley hay cut at the milk stage. This hay has 4,733 pounds of forage dry matter and 606 pounds of crude protein per acre for cows to consume, and a 1200-pound cow requires the forage from only 0.13 acres during May. The greater production costs per acre for forage barley hay are prorated across greater quantities of nutrients per acre, so lower costs per pound of nutrient and lower livestock feed costs per day result, he explains.

Crested wheatgrass hay cut late is expensive livestock feed because it has high costs per pound of crude protein, observes Manske. Cutting domesticated grass hay at a mature plant stage yields about the amount of forage dry matter per acre the plants will potentially produce that year, but the low yield in weight of nutrients per acre causes high nutrient costs. Crested wheatgrass hay cut at the boot stage yields 19 percent less dry matter but 85 percent more crude protein per acre than mature crested wheatgrass hay. Feeding lactating range cows early cut wheatgrass hay rather than mature crested wheatgrass hay in May results in a 50 percent lower cost of nutrient per pound and a 39 percent reduction in the livestock feed cost per day for that period.

Livestock feed costs per day do not differ between unfertilized and fertilized crested wheatgrass pastures. Production costs per acre are nearly 60 percent greater for the fertilized pastures, but the land area requirement is about 60 percent less. The important difference, however, is in the weight gain of the livestock. The amount of nutrients captured per acre and converted into saleable calf weight greatly affects the economic returns per acre, states Manske. Cows gain 78 pounds per acre more and calves gain 58 pounds per acre more on fertilized crested wheatgrass pastures. Cost per pound of calf gain is 11 percent lower and returns after pasture costs are 26 percent greater per cow-calf pair and 215 percent greater per acre on fertilized crested wheatgrass pastures.

Evaluation of costs of pasture forage and harvested forage should be based on costs per unit of weight of the nutrients, stresses Manske. Generally, the lowest-cost livestock feed is the forage with the lowest cost per pound of nutrient.

Spring native range forage had a crude protein content of around 16.3 percent, production costs of $8.76 per acre, forage dry matter costs of $89.85 per ton, and crude protein costs of 28 cents per pound. During the spring lactation period, a grazing cow-calf pair required 4.77 acres, at a cost of $41.85 for the period, or $1.35 per day. Calves gained an estimated 1.80 pounds per day, or 11.70 pounds per acre, at a cost of 75 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were a loss of $2.79 per cow-calf pair and a loss of 60 cents per acre.

Spring unfertilized crested wheatgrass pasture had a crude protein content of around 16.8 percent, production costs of $8.76 per acre, forage dry matter costs of $35.39 per ton, and crude protein costs of 11 cents per pound. During the spring lactation period, a grazing cow-calf pair required 1.88 acres, at a cost of $16.47 for the period, or 52 cents per day. Calves gained an estimated 1.91 pounds per day, or 32.18 pounds per acre, at a cost of 27 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $24.98 per cow-calf pair and $13.29 per acre.

Spring fertilized crested wheatgrass pasture had production costs of $21.26 per acre and forage dry matter costs of $34.29 per ton. During the spring lactation period, a grazing cow-calf pair required 0.75 acres, at a cost of $15.95 for the period, or 51 cents per day. Calves gained an estimated 2.18 pounds per day, or 90.11 pounds per acre, at a cost of 24 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $31.36 per cow-calf pair and $41.82 per acre.

Crested wheatgrass hay cut late, at a mature plant stage, had a crude protein content of around 6.4 percent, production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of 28 cents per pound. During the spring lactation period, mature crested wheatgrass hay would be fed at 27 pounds of dry matter per day to provide 1.7 pounds of crude protein per day. An additional 0.8 pounds of crude protein per day would need to be provided, at a cost of $7.27 per period. Production of mature crested wheatgrass hay for a lactating cow would require 0.58 acres and would cost $21.70 for the period, or 70 cents per day. Total forage and supplement costs would be $28.97 for the period, or 93 cents per day.

Forage barley hay cut early, at the milk stage, had a crude protein content of around 13 percent, production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of 11 cents per pound. During the spring lactation period, early cut forage barley hay would be fed at 19.3 pounds of dry matter per day to provide 2.5 pounds of crude protein per day. An additional 10.7 pounds of roughage per day would need to be provided, at a cost of $5.80 per period. Production of early cut forage barley hay for a lactating cow would require 0.13 acres and would cost $8.68 for the period, or 28 cents per day. Total forage and supplement costs would be $14.48 for the period, or 47 cents per day.

Capturing More Value from Summer Pastures Improves Beef Profit Margins

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Taking into account the biological requirements of range plants in grazing systems can increase the value captured from land and reduce forage feed costs during summer, says a North Dakota State University range scientist. In NDSU studies, twice-over grazing boosted returns by up to 20 times over seasonlong grazing strategies.

"Reducing forage feed costs is essential to improving profit margin because they constitute the greatest portion of the total production costs for a beef cow and calf," says Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Land area costs, which include the costs for forage dry matter and nutrients, are 70 to 90 percent of livestock forage feed costs. Reducing land area costs during summer depends on increasing herbage and nutrient production and on improving nutrient capture efficiency. Producers can realize these benefits by implementing biologically effective grazing management strategies."

A study conducted at the Dickinson facility evaluated three grazing strategies on native rangeland--6-month seasonlong, 4.5-month seasonlong, and a twice-over rotation. The study was based on costs of livestock feed for 1,200-pound range cows between June 1 and October 15, costs per pound of calf gain, and returns after pasture costs. The study also evaluated the costs of livestock feed from two harvested-forage types--forage barley hay cut at the milk stage and pea forage hay cut at a late plant stage. Feed cost evaluations included land rent values, production costs per acre (including equipment and labor), forage dry matter costs per ton, and total feed costs per day and per period.

The twice-over rotation strategy was the most economically efficient grazing practice. Livestock feed costs per day on the twice-over strategy were 28 percent lower than those on the 4.5-month seasonlong and 50 percent lower than those on the 6-month seasonlong strategies. Cost per pound of calf gain on the twice-over strategy was 33 percent lower than that on the 4.5-month seasonlong and 59 percent lower than that on the 6-month seasonlong strategies. Returns per acre after pasture costs from the twice-over rotation strategy were double those from the 4.5-month seasonlong strategy and almost 20 times those from the 6-month seasonlong strategy.

The twice-over rotation strategy produces the greatest calf gain per acre at the lowest cost per pound of gain because the system is biologically effective, Manske explains. It coordinates grazing periods with plant growth stages. As a result, the strategy sustains grass health, increases herbage and nutrient production, and improves the efficient conversion of nutrients from the land base into saleable calf weight. The twice-over strategy enhances productivity of grasslands and leads to reductions in the cost per pound of nutrient, which in turn lead to reductions in the cost of livestock feed and calf accumulated weight. The seasonlong strategies offer neither ecological benefit nor economic advantage, he says.

Harvested forage is believed to be expensive feed, but when forage plants are cut at the optimum time, greater amounts of nutrients can be captured per acre, Manske points out. As a result, harvested forages can be a source of low-cost livestock feed because the cost per pound of nutrient will be low even with high production costs per acre. Livestock feed costs were 47 cents per day for forage barley hay and 55 cents for pea forage hay. Harvested at the plant growth stage when maximum crude protein per acre could be captured, these hays cost less than forage grazed on the twice-over system.

Traditional pasture and forage management practices were developed to capture maximum dry matter weight per acre. However, livestock feed costs depend less on the cost of dry matter weight than on the cost per pound of nutrients captured in the forages, he says. Evaluating livestock feed costs from the cost of nutrients will allow producers to determine which pasture-forage management practices reduce beef costs by efficiently capturing value from the land resources.

Summer native range forage on the 6-month seasonlong strategy had production costs of $8.76 per acre and forage dry matter costs of $77.50 per ton. During the 137-day summer lactation period, a grazing cow-calf pair required 18.10 acres, at a cost of $158.55 for the period, or $1.16 per day. Calves gained 1.80 pounds per day, or 13.59 pounds per acre, at a cost of 64 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $13.63 per cow-calf pair and 75 cents per acre.

Summer native range forage on the 4.5-month seasonlong strategy had production costs of $8.76 per acre and forage dry matter costs of $54.75 per ton. During the 137-day summer lactation period, a grazing cow-calf pair required 12.70 acres, at a cost of $111.25 for the period, or 81 cents per day. Calves gained 2.09 pounds per day, or 22.55 pounds per acre, at a cost of 39 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $89.18 per cow-calf pair and $7.02 per acre.

Summer native range forage on the twice-over rotation strategy had production costs of $8.76 per acre and forage dry matter costs of $39.02 per ton. During the 137-day summer lactation period, a grazing cow-calf pair required 9 acres, at a cost of $78.84 for the period, or 58 cents per day. Calves gained 2.21 pounds per day, or 33.64 pounds per acre, at a cost of 26 cents per pound of gain. When calf weight was assumed to have a value of 70 cents per pound, returns after pasture costs were $133.10 per cow-calf pair and $14.70 per acre.

Forage barley hay cut early, at the milk stage, had a crude protein content of around 13 percent, production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of 11 cents per pound. During the 137-day summer lactation period, early cut forage barley hay would be fed at 19.3 pounds of dry matter per day to provide 2.5 pounds of crude protein per day. An additional 10.7 pounds of roughage per day would need to be provided, at a cost of $25.65 per period. Production of early cut forage barley hay would require 0.56 acres and would cost $38.36 for the period. Total forage and supplement costs would be $64.01 for the period, or 47 cents per day.

Pea forage hay cut at a late plant stage had a crude protein content of around 14.4 percent, production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of 13 cents per pound. During the 137-day summer lactation period, late-cut pea forage hay would be fed at 17.4 pounds of dry matter per day to provide 2.5 pounds of crude protein per day. An additional 12.6 pounds of roughage per day would need to be provided, at a cost of $30.21 per period. Production of late-cut pea forage hay would require 0.51 acres and would cost $45.21 for the period. Total forage and supplement costs would be $75.42 for the period, or 55 cents per day.

“It’s clear that coordinating grazing and haying with optimum plant growth stages of forage plants increases the value captured from land resources, reduces livestock feed costs, and improves profit margin from beef production,” Manske says.

Coordinated Rotational Grazing Can Minimize Late-Season Drop in Animal Performance

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Rotational grazing strategies coordinated with grass growth stages can help producers avoid the drop in livestock performance typically seen late in the grazing season with traditional grazing systems, says a North Dakota State University range scientist.

"Late-summer cow-weight loss and decreased calf gains common in animals on traditional native-rangeland management strategies cause substantial reductions in economic returns," states Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Improved rotation strategies can activate secondary tiller growth in grasses and improve animal performance during the later portion of the grazing season. Those strategies start grazing after the third-leaf stage and have two grazing periods in each of three to six pastures."

Reduced animal performance under grazing strategies such as seasonlong, repeat seasonal, deferred, or rest grazing systems is a result of nutritional changes in forage late in the season, Manske explains. As lead tillers of grasses age, cell components move from aboveground structures to belowground structures, and the nutritional quality of the tillers decreases substantially.

Secondary tillers are less mature and have greater nutritional quality than older lead tillers during the later portion of the grazing season, but traditional grazing systems do not stimulate growth of increased numbers of secondary tillers. As a result, herbage production and nutritional quality of the existing herbage decline.

During late July the crude protein content of the herbage on traditional systems drops below the 9.6 percent required by lactating cows, Manske notes. Cows draw on stored body fat to provide for a portion of their milk production. Reductions in cow weight and milk production follow. The decrease in milk production results in reduced calf average daily gain.

Research data demonstrate the diminished late-season performance of animals on a seasonlong strategy, Manske reports. Cows gain an average of 1.5 pounds daily during the early portion of the grazing season but lose an average of 0.3 pounds daily during the later portion. Calf average daily gain is 2.3 pounds during the early portion of the grazing season but decreases to 1.9 pounds during the later portion.

Animal performance on a deferred grazing strategy follows a similar pattern, Manske observes. Cows gain an average of 1.2 pounds daily during the early portion of the grazing season but lose an average of 0.4 pounds daily during the later portion. Calf average daily gain is 2.3 pounds during the early portion of the grazing season but decreases to 1.4 pounds during the later portion.

Grassland managers can change their grazing strategies to activate the growth of secondary tillers in perennial grasses, Manske notes. The process of stimulating secondary tillering in grasses is similar to the strategy of using steers to graze portions of leaves on young winter wheat plants during the fall to stimulate the growth of wheat tillers. Removing a small amount of leaf material from perennial grasses during the early portion of the grazing season, when the lead tillers are between the third-leaf stage and the flowering stage, can activate secondary tiller growth. Native grasses on the Northern Plains reach this stimulation period between early June and mid July.

Multi-pasture systems that move livestock rapidly in an arbitrary sequence not coordinated with grass growth stages do not produce satisfactory stimulation of secondary tiller growth, Manske emphasizes. He explains that to activate secondary tillering on summer pastures, grazing pressure should be shared among three to six pastures during the stimulation period. The first grazing period on each pasture should last no fewer than seven and no more than 17 days. A second grazing period lasting twice as long as the first should occur during the later portion of the grazing season, before mid-October.

A successful grazing strategy for three pastures of equal size allows livestock to graze each pasture for 15 days during the stimulation period of June 1 to July 15, when lead tillers are between the third-leaf and flowering stage, and to graze each pasture again for 30 days between July 15 and Oct. 15. The grazing sequence should be the same for both periods each year. The first pasture grazed each season should be the last pasture grazed the previous year.

The increase in secondary tiller growth stimulated during the first grazing period improves production and nutritional quality of the herbage and delays by two to two and a half months the period during which cows lose weight, Manske reports. Cow milk production is greater and calf average daily gain is higher during the later portion of the grazing season because stimulated secondary tillers have greater nutritional quality than lead tillers during the second grazing period.

Average daily gain for cows on rotation strategies with two grazing periods coordinated with grass growth stages is 2.0 pounds during the early part of the grazing season and 0.7 pounds during the later portion. Average daily gain for calves on rotation strategies is 2.3 pounds during the early and late portions of the grazing season.

Manipulation of secondary tiller growth can improve livestock performance until late September or mid October, but the biology of native grass plants does not permit extending this improved performance longer, Manske says. Nutritional quality of herbage on native rangeland grazed after mid October is below the requirements of lactating cows. Forages that meet the nutritional requirements of lactating cows after mid October include Altai and Russian wildryes, which retain their aboveground nutritional quality until about mid November, and spring-seeded winter cereals.

Extended Fall Grazing That Improves Profits

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Beef producers who extend livestock grazing on native rangeland or cropland aftermath past the end of the growing season to mid-November can increase their profits by switching to domesticated wildrye pastures for the last 30 days of the grazing season, says a North Dakota State University range scientist.

"Grazing native rangeland or cropland aftermath pasture-forage types from mid-October to mid-November reduces the quantity of harvested forage needed per cow by about 1,000 pounds of dry matter forage. For this reason, the grazed mature plant residue of these fall pasture-forage types is widely assumed to be the lowest-cost late-season forage," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

"However, performance of livestock grazing this maturing vegetation decreases, and the forage is no less expensive than alternatives that provide the animals with adequate nutrients to maintain weight. Producers who determine the actual forage costs of extending the grazing season for this 30 days on native rangeland or cropland aftermath will find that these management practices are not improving profit margins," he observes.

Most beef producers know that animal weight gains are lower during the fall than during the early portion of the grazing season, but few producers know the actual amount of the reduction in animal performance during the later portion of the season, Manske says.

Beef producers can infer from experience a close approximation of the weight of calves when they go out to pasture in the spring, and, if the calves are sold at weaning, producers know about the average weight of calves when they come off pasture in the fall. The difference between the two estimated weights gives producers a general idea of calf weight performance across the entire grazing season, Manske says. But the extent of the reduction in cow and calf weight gain during the late portion of the grazing season may not be obvious when animal performance during spring, summer, and fall is averaged.

Cow and calf weight gain performance during the fall portion of the grazing season on traditional grazing management systems is far below the animals' genetic growth potentials, he says. Cows lose a great deal of weight--from around a quarter to two-thirds of a body condition score in a month. Calves gain very little weight--only around 25 percent to 40 percent of their potential weight gain.

"These reductions in animal performance result from the changes that forage plants undergo as they follow their annual pattern of growth," Manske explains. "As grasses in the Northern Plains mature during the growing season, they transfer the contents of leaf cells to other plant parts, including the root system. A decrease in herbage weight and nutrient quality results. By the late portion of the grazing season, most plants are in the late stages of aging, or senescence, and herbage quantity and quality are greatly reduced from mid-season levels."

The weight of the fall herbage on native rangeland pastures not previously grazed that season is only about 40 percent to 60 percent of the mid-summer herbage weight on ungrazed grasslands. Typically, summer stocking rates on traditional management systems are not adjusted after mid-October to reflect the reduction in fall aboveground herbage biomass. That lack of adjustment leads to livestock weight performance reductions beyond those caused by the natural decrease in herbage weight and nutrient quality.

"Nutritional quality of native rangeland grasses decreases rapidly following the plants' flowering stage, and the quality falls below the crude protein requirements of a lactating cow around mid-July to early August," Manske says. The crude protein content of native rangeland herbage during the fall is around 4.8 percent, about half the content of mid-summer herbage and about half the crude protein content required by lactating cows. Cows grazing herbage with nutrient content below their dietary requirements draw on stored body fat to provide for a portion of their milk production, and their weight decreases. The loss of weight leads to decreased milk production, which results in reduced calf weight gain per day.

A study at the NDSU Dickinson Research Extension Center calculated animal performance during the fall separately from animal performance during the other portions of the grazing season. This study with 15 years of data determined the reductions in cow and calf weight gain on native rangeland and cropland aftermath grazed during the late portion of the grazing season and ascertained the high cost of grazing those forage types during the fall.

The study evaluated cow and calf weight performance, fall pasture costs, returns after pasture-forage costs, and costs per pound of calf weight gain for four pasture-forage types grazed by 1,200-pound range cows with calves during the 30-day fall period from mid-October to mid-November. The pasture-forage types were:

- Native rangeland managed by traditional seasonlong grazing practices, at $8.76 rent per acre. Cow weight performance was a loss of 52.20 lbs, at a rate of 12.90 lbs per acre and 1.74 lbs per day. Calf weight performance on these native rangeland pastures was a gain of 17.73 lbs, at a rate of 4.38 lbs per acre and 0.59 lbs per day. When calf accumulated weight was assumed to have a value of 70 cents per pound, the gross return was $12.41 per calf, and the net returns after pasture costs were a loss of $22.98 per cow-calf pair and a loss of $5.69 per acre. During the 30-day fall period, each accumulated pound of calf weight cost $1.99.

- Native rangeland managed by deferred grazing practices, at $8.76 rent per acre. Cow weight performance was a loss of 22.20 lbs, at a rate of 9.96 lbs per acre and 0.74 lbs per day. Calf weight performance on these native rangeland pastures was a gain of 23.10 lbs, at a rate of 10.36 lbs per acre and 0.77 lbs per day. When calf accumulated weight was assumed to have a value of 70 cents per pound, the gross return was $16.17 per calf, and the net returns after pasture costs were a loss of $3.36 per cow-calf pair and a loss of $1.51 per acre. During the 30-day fall period, each accumulated pound of calf weight cost 85 cents.

- Cropland aftermath of annual cereals, at $2 rent per acre. Cow weight performance was a loss of 48.17 lbs, at a rate of 7.27 lbs per acre and 1.61 lbs per day. Calf weight performance on these cropland aftermath pastures was a gain of 12.57 lbs, at a rate of 1.90 lbs per acre and 0.42 lbs per day. When calf accumulated weight was assumed to have a value of 70 cents per pound, the gross return was $8.80 per calf, and the net returns after pasture costs were a loss of $4.46 per cow-calf pair and a loss of 67 cents per acre. During the 30-day fall period, each accumulated pound of calf weight cost $1.05.

- Altai wildrye, at $8.76 rent per acre. Cow weight performance was a gain of 16.50 lbs, at a rate of 11.87 lbs per acre and 0.55 lbs per day. Calf weight performance on these Altai wildrye pastures was a gain of 52.77 lbs, at a rate of 37.96 lbs per acre and 1.73 lbs per day. When calf accumulated weight was assumed to have a value of 70 cents per pound, the gross return was $36.94 per calf, and the net returns after pasture costs were $24.76 per cow-calf pair and $17.81 per acre on Altai wildrye pasture. The cost of calf weight gain was 23 cents per pound during the 30-day fall period.

The Altai wildrye was the only grazed forage type that produced a profit during the 30-day fall period. Although calves gained a small amount of weight during the fall portion of the grazing season on native rangeland and cropland aftermath pasture-forage types, the market value of the calf accumulated weight at 70 cents per pound is less than the rent costs of the native rangeland and cropland aftermath pastures. The loss of weight by cows on traditional management treatments also should be considered a cost.

“Cow and calf performance on the Altai wildrye pastures was stronger because that pasture-forage type meets the nutritional requirements of lactating cows after mid-October,” Manske says. “Wildryes such as Altai and Russian are the only perennial grasses that retain nutrient quality in the aboveground portions until around mid-November. No perennial grass in the Northern Plains retains sufficient nutritional quality to dependably meet the nutritional requirements of lactating cows later than mid-November.”

“Extending the grazing season one month on traditionally managed pasture-forage types does not reduce feed cost and greatly reduces livestock weight performance from potential weight gains,” Manske says. “Economically extending the grazing season by about a month beyond the end of the growing season for perennial plants, which usually occurs around mid-October, requires use of pasture-forage types that have sufficient nutrient quality to meet livestock dietary requirements and sufficient herbage quantity to permit efficient capture of a relatively high proportion of the produced nutrients from the land base."

Reducing Pasture-Forage Costs for Cow-Calf Pairs during the Fall

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Permitting cow-calf pairs to graze native rangeland during late October and November is not as cost efficient as it is often assumed to be, says a North Dakota State University range scientist.

"Grazing cow-calf pairs on fall native range pastures may seem economical because it requires no expenditure for harvested hay, but the practice results in loss of cow weight, low calf weight gain, and low or negative net return," states Lee Manske, range scientist at the NDSU Dickinson Research Extension Center. Strategies such as turning livestock onto fall domesticated grass pastures or providing harvested forage during the fall may seem more costly, but ultimately result in lower pasture-forage costs.

Manske says western North Dakota native range pastures have an average rent value of $8.76 per acre. The land area required to provide adequate herbage for a cow and calf for the 30 days between mid-October and mid-November is 4.4 acres. On fall-grazed native range pasture, the forage portion of the herbage dry matter available for livestock intake costs $97.33 per ton, and the forage portion of the crude protein available for livestock intake costs $1.01 per pound. Pasture-forage costs for the 30-day period of mid-October to mid-November are $38.54 per cow-calf pair on fall-grazed native rangeland.

In addition to high pasture-forage costs, low animal performance must be considered when the economic efficiency of fall grazing is evaluated, observes Manske. Lactating cows grazing native rangeland pastures at 2.5 acres per month during the fall lose an average of 0.8 pounds per day, which is a loss of 9.8 pounds per acre. Calves with these cows gain 0.9 pounds per day, which is only 10.9 pounds per acre.

The costs and livestock performance were determined from average custom farm work rates, average land rent values, and researched herbage yields and cattle weights.

When calf weight is assumed to have a value of 70 cents per pound, the gross value of the calf weight gained is $7.63 per acre. With average pasture rent at $8.76 per acre, the net return after pasture costs is a loss of $1.13 per acre during the mid-October and November period. "The economic value of calf weight gained would need to be 80 cents per pound to pay just the average pasture rent," Manske says.

The weight loss of cows grazing native rangeland during late October and November and the reduced performance of calves with these cows result from changes that occur naturally in maturing herbage. As lead tillers of grass plants age, cell components move from leaves to roots, and the nutritional quality of the herbage decreases substantially, Manske explains. To produce adequate amounts of milk and maintain body weight, lactating cows require about 9.6 percent crude protein from the forage they consume. The nutritional quality of native rangeland herbage during late October and November is around 4.8 percent crude protein, with a portion of this protein tied to the supporting tissue of the plant and impossible for ruminants to digest.

The quantity of herbage also decreases as grass plants age. The weight of the herbage on fall pastures is only about 40 percent to 60 percent of the midsummer herbage weight on grasslands that have had no grazing all growing season, Manske states. The number of acres of native rangeland required to provide sufficient dry matter for each cow-calf pair during the fall is about double the number required during the summer.

Because of biological changes in maturing herbage, the cost of grazing native rangeland during the fall is considerably higher than the cost of grazing native rangeland during the summer, Manske emphasizes. When the rent value per acre is the same for both summer and fall pastures, the cost per ton of dry matter doubles and the cost per pound of crude protein quadruples on each acre of grassland grazed during the fall. The number of acres allotted per cow-calf pair on fall pastures should be twice the number allotted on summer pastures; as a result, pasture-forage costs for the 30-day fall-grazing period on native range are double the costs of 30-day periods of summer grazing. If fall pasture is rented by the animal unit month (AUM) at the same rate as summer pasture, the amount paid per acre to the landowner is cut in half.

An alternative to relying on native rangeland pastures during the fall is turning livestock onto domesticated Altai wildrye pastures, notes Manske. The wildryes are a group of perennial grasses that do not translocate their aboveground cell contents belowground until late in the growing season. Wildrye pastures can be grazed by lactating cows until about mid-November.

The average rent value of Altai wildrye pastures grazed during the period of mid-October to mid-November is $14.22 per acre. The land area required to provide adequate herbage for a cow and calf for 30 days is 1.39 acres. The forage portion of the herbage dry matter available for livestock intake costs $36.46 per ton, and the forage portion of the crude protein available for livestock intake costs 29 cents per pound. Pasture-forage costs on fall Altai wildrye pastures grazed for the 30-day period of mid-October to mid-November are $19.77 per cow-calf pair. Cows grazing Altai wildrye pastures gain an average of 0.55 pounds daily during the period of mid-October to mid-November. Calf average daily gain on Altai wildrye pastures is 1.73 pounds, which is 37.96 pounds per acre. When calf weight is assumed to have a value of 70 cents per pound, the net return after pasture costs is $12.35 per acre.

Another cost-effective alternative to depending on native rangeland pastures is providing harvested forages during the fall period. Domesticated cool-season grasses and annual cereal grasses cut at the appropriate stages are good sources of harvested hay. Properly timed harvest is critical to ensure the quality of hay, Manske says. The greatest amount of crude protein per acre can be captured in forage when perennial and annual grasses are harvested at the flowering growth stage.

Crested wheatgrass cut at a mature plant stage has a crude protein content of around 6.4 percent. This low-quality hay has dry matter costs of $34.80 per ton and crude protein costs of 28 cents per pound. Production of mature crested wheatgrass hay to feed a lactating cow during mid-October to mid-November requires 0.73 acres and costs 70 cents per day, or $21.00 for the 30-day period. Lactating cows could not acquire adequate quantities of crude protein from this mature hay, and animal performance would be unsatisfactory.

In contrast, crested wheatgrass cut early, at the boot stage, has a crude protein content of around 14.5 percent. This high-quality hay has dry matter costs of $40.80 per ton and crude protein costs of 14 cents per pound. Production of early cut crested wheatgrass hay to feed a lactating cow during mid-October to mid-November requires 0.40 acres and costs 35 cents per day, or $10.50 for the 30-day period.

Forage barley cut at the milk stage has a crude protein content of around 13 percent. This hay has dry matter costs of $28.80 per ton and crude protein costs of 11 cents per pound. Production of forage barley hay to feed a lactating cow during mid-October to mid-November requires 0.12 acres and costs 28 cents per day, or $8.25 for the 30-day period.

Pasture-forage costs for the 30-day period of mid-October to mid-November are $38.54, $19.77, $10.50, and $8.25 per cow-calf pair for native rangeland, Altai wildrye, early cut crested wheatgrass hay, and forage barley hay, respectively. Each of the alternative sources of forage for cows and calves from mid-October to mid-November costs less than permitting livestock to graze native rangeland, stresses Manske. These reductions in fall pasture-forage costs for a cow-calf pair range from 49 percent to 79 percent.

Feeding Harvested Forages Cuts Costs

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Beef producers can reduce forage costs by feeding livestock economical harvested forages rather than extending the grazing period on native rangeland or cropland aftermath pastures after the calves are weaned, says a North Dakota State University range scientist.

"Extending the grazing season on native rangeland pastures or cropland aftermath pastures is often assumed to be a low-cost strategy because production costs per acre for these grazed forages are relatively low. In fact, these are not inexpensive forages. The nutrient weight captured per acre in them is very low and, as a result, the feed cost per day and the cost per ingested pound of nutrient are high. A study at the NDSU Dickinson Research Extension Center indicates that for dry gestating cows, harvested forages with low costs per pound of nutrient provide a more economical feed source than the traditional forages producers use to extend grazing," says Lee Manske, a range scientist at the Dickinson facility.

The amount of new wealth generated from land resources is related to the quantity of forage nutrients captured per acre, not to the quantity of dry matter weight, so increasing economic wealth from livestock agriculture requires the use of efficient pasture-forage management strategies that focus on capturing nutrients, Manske says. Forages grazed or harvested at plant stages that yield high amounts of dry matter and low amounts of crude protein per acre, like traditional late-season pastures and late-cut crested wheatgrass hay, have high costs per pound of nutrient and are generally expensive forages for livestock. However, forages grazed or harvested at plant stages that yield great amounts of crude protein per acre have lower costs per pound of nutrient and are relatively low-cost forages for livestock.

Forage barley hay cut at the milk stage and pea forage hay cut at a late plant stage yield great amounts of crude protein per acre, about 606 pounds per acre and 685 pounds per acre, respectively. Even though the production costs per acre for these harvested-forage types are relatively high, the cost per pound of nutrient and the feed cost per day are low. In contrast, forage from reserved native range pastures grazed between mid-November and mid-December is expensive because animals capture only about 8.6 pounds of crude protein per acre.

"The results of the study illustrate the relationship between cost of nutrient and total feed cost," Manske says. The study evaluated feed costs of reserved native rangeland pasture forage, cropland aftermath pasture forage, forage barley hay, and pea forage hay for 1,200-pound cows during the dry gestation period. An average 1,200-pound cow requires 768 pounds of dry matter, 353 pounds of energy (total digestible nutrients), and 48 pounds of crude protein during the 32-day production period.

Reserved native rangeland pasture has production costs of $8.76 per acre, forage dry matter costs of $97.33 per ton, and crude protein costs of $1.01 per pound. A cow grazing properly stocked reserved native rangeland would require 4.27 acres during the 32-day dry gestation production period, and the forage to feed the animal would cost $37.44 per production period. The animal would require supplementation of an additional 0.34 pounds of crude protein per day, at a cost of $3.26 per period. Total forage and supplement costs would be $40.70 for the period, or $1.27 per day.

Cropland aftermath pasture of annual cereal stubble has production costs of $2.00 per acre and forage dry matter costs of $29.63 per ton. The forage has very low crude protein content. A cow grazing cropland aftermath pasture would require 7.10 acres during the dry gestation production period, and the forage to feed the animal would cost $14.20 for the period. Additional crude protein was not supplemented, even though the crude protein content of the forage was below the requirements of a dry gestating cow. The animals lost an average of 1.14 pounds per day and an average of 4.82 pounds per acre; accumulated weight loss was 36.48 pounds per period, which is about half of one body condition score. Total forage and supplement costs would be $14.20 for the period, or 44 cents per day.

Heavy cows can lose weight during the dry gestation period without detrimental future effects on reproduction and production performance. However, loss of weight during the dry gestation period should be considered an additional cost for thin cows and cows with moderate body condition score because replacement of lost weight costs more during other production periods, Manske notes.

Forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of 11 cents per pound. A cow would be fed 11.5 pounds dry matter of forage barley hay per day. Production of forage barley hay to feed a cow during the dry gestation period would require 0.07 acres, and the forage would cost $5.12. The animal would require an additional 12.5 pounds of roughage per day, at a cost of $7.00 per period. Total forage and supplement costs would be $12.12 for the period, or 38 cents per day.

Pea forage hay has production costs of $86.87 per acre, forage dry matter costs of $37.40 per ton, and crude protein costs of 13 cents per pound. A cow would be fed 10.3 pounds dry matter of pea forage hay per day. Production of pea forage hay to feed a cow during the dry gestation period would require 0.07 acres, and the forage would cost $6.08. The animal would require an additional 13.7 pounds of roughage per day, at a cost of $7.67 per period. Total forage and supplement costs would be $13.75 for the period, or 43 cents per day.

"Managing pastures and harvested-forage hayfields as a source of dry matter feed for animals results in inefficient capture of nutrients from the land resource. Producers can generate greater new wealth from the land by replacing traditional management practices with strategies that capture greater weight of nutrients per acre and efficiently convert them into saleable commodities like calf weight," Manske says.

Spring-Seeded Winter Cereals Can Extend the Northern Plains Grazing Season

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Northern Plains beef producers should consider using spring-seeded winter cereal pastures as an alternative to native rangeland as a source of late-season forage, says a North Dakota State University range scientist.

"Beef cows grazing native rangeland pastures after mid October have negative weight performance, and the pasture and forage costs per day for grazing native rangeland during the fall are extremely high. Pastures of spring-seeded winter cereals such as winter rye provide forages that extend the grazing season economically and improve animal performance from mid November to mid December," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

A decline in performance of animals grazing native rangeland begins in midsummer because the crude protein levels of native grass lead tillers drop below a lactating cow's dietary requirements in mid to late July. However, secondary tillers can remain at or near lactating cow crude protein requirements until late September or mid October. Defoliation management that stimulates vegetative reproduction of secondary tillers can minimize the late-summer decline in animal performance and extend by two to two and one-half months the length of time that native rangeland grasses meet beef cow dietary requirements.

Because of biological limitations of native grasses in the Northern Plains, these species cannot be manipulated to maintain adequate crude protein levels to meet beef cow requirements after mid October. Wildryes like Altai and Russian, which retain aboveground crude protein levels near cow requirements until about mid November, can be used to extend the grazing period another month, but no perennial grass species in the Northern Plains has nutritional quality that consistently meets beef cow dietary requirements later than this.

Further extending the grazing period requires evaluating and finding annual-plant pasture forages that meet beef cow dietary requirements economically from mid November to mid December. A recent study compared two late-fall pasture treatments: spring-seeded winter cereal and fall-grazed reserved native range pasture.

"An interpretation of livestock feed costs that is based only on production costs per acre indicates that at an average rent value of $8.76 per acre, fall-grazed reserved native rangeland has lower costs than spring-seeded winter rye, which has average per-acre production costs of $42.84 for land rent, seed costs and custom costs for labor and equipment," Manske says. "However, the land area required to produce adequate forage for a 1200-pound range cow on spring-seeded winter rye was 0.54 acres, only 12.6 percent of the 4.27 acres required on reserved native rangeland pastures during the late fall. Supplementation of 0.34 pounds of crude protein per day to meet the nutritional requirements of the cow grazing fall native rangeland would add 10 cents per day, or $3.26 per period, to the expense."

The costs to feed a 1200-pound range cow for the 32-day period of mid November to mid December are $40.70 for native rangeland forage and supplementation and $23.13 for spring-seeded winter rye, a 43 percent reduction in fall pasture costs for the winter rye. Daily pasture-forage costs per cow were 72 cents on spring-seeded winter rye, compared to $1.27 on reserved native rangeland.

"In addition to being less expensive, winter cereals also improve animal performance. Cows that grazed native rangeland and did not receive crude protein supplements lost an average of 1.1 pounds per day during the fall period," Manske says. "In contrast, cows grazing winter rye gained an average of 1.05 pounds per day during mid November to mid December. After 32 days of grazing, average cow weight between animals grazing native rangeland and those grazing spring-seeded winter rye would differ by 69 pounds."

Spring-seeded winter cereals have a greater chance of providing sufficient forage during late fall than traditional summer-seeded winter cereals because in western North Dakota water deficiency conditions are likely to occur sometime during the period from August through October. As a result, summer-seeded winter cereals are likely to be subjected to water stress while the seedlings are small and have limited root systems with which to absorb water. Because of the low amount of precipitation received from the beginning of June to the end of October in 2003, a midsummer seeding of a winter cereal last year would not have provided forage for fall grazing. The spring-seeded winter rye, however, provided fall forage in 2003 at a fairly high stocking rate of 0.51 acres/AUEM.

Spring seeding winter cereals for fall forage pasture has generally been perceived as losing a growing season for crop production. To address this concern, an attempt to produce a summer hay crop on the same land used to produce a forage crop for fall grazing was made with a mixed oat-winter rye treatment. Double cropping with a spring cereal and a winter cereal should be biologically possible during May, June, and early July, when soil water is usually at its highest levels and water deficiency conditions occur relatively infrequently. However, the data for the mixed oat-winter rye treatments indicate that this double cropping has two major problems that diminish its attractiveness as a practice for producing late fall annual cereal pastures.

First, when the spring oats on the mixed treatment were swathed and baled for hay, at the late milk to early dough stage, the cutting and removal of some leaf material of the winter rye plants caused a measurable reduction in the leaf height and herbage weight of the winter rye. The growth was not regained during the remainder of the season.

Second, the oat plants senesced during the middle portion of the growing season and were dry during October through December, and the dry oat stubble restricted the availability and utilization of a substantial quantity of winter rye forage.

"Both factors affected the amount of herbage grazing cows removed from the mixed treatment," Manske says. "During the 32 days of the grazing period, an average of 1779.54 pounds per acre of herbage was removed from the winter rye treatments, and an average of 390.25 pounds per acre of herbage was removed from the oat-winter rye treatments. The herbage removed from the oat-winter rye treatments was only about one-third of that available for grazing. The 637.11 pounds per acre of available herbage that was not grazed was primarily winter rye that was shorter than the stiff oat stubble. About 0.70 AUM's of forage per acre remained ungrazed on the oat-winter rye treatments."

A basic strategy for providing both late-fall pasture and harvested hay on the same cropland area is to spring plant a portion of a field with winter cereal separately and to spring plant another portion of the field with spring cereal. The spring cereal is mechanically harvested for hay at an early stage in summer, stored nearby, and delivered as feed to cows on the cropland acres during winter. The spring-seeded winter cereal is grazed during the late fall. About 0.5 to 1.0 acres of winter cereal will be needed per cow for a month of grazing. Dividing the cropland area into four pastures permits opening successive segments with ungrazed forage at a rate of about one pasture per week.

"Spring-seeded winter rye planted separately provides an economical late-fall annual cereal pasture forage that meets beef cow nutritional requirements and allows grazing dry cows to gain weight from mid November to mid December," Manske says.

Harvesting More Crude Protein Per Acre Reduces Forage-Feed Costs

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Changing from traditional forage systems that try to harvest the most dry matter per acre to forage management systems that harvest the greatest weight of crude protein per acre can help beef producers reduce forage-feed costs and increase animal performance, says a North Dakota State University range scientist.

"Over the past several decades the genetic potential of beef cattle has improved and the animals now produce more pounds of beef per cow. However, profit margins have not improved proportionately because the beef industry continues to use inefficient forage management technology developed for low-performance cows rather than adopt efficient feed management practices that provide high-quality, lower-cost forages and meet the increased dietary requirements of modern animals," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center. "Implementing forage management systems developed to harvest more forage nutrients per acre will help the individual operator improve profit margins and enable the industry to remain competitive."

Today's fast-growing, high-performance cattle are genetically different from the old-style cattle, Manske says. "Modern cattle are larger and heavier, gain weight more rapidly, produce more milk, and deposit less fat on their bodies. The greater size of modern animals increases their nutrient demand throughout the production year, and their higher production levels increase the demand further, so that the increase in required nutrients is not simply proportionate to the animals' greater size."

A high-performance cow that has medium milk production and is 20 percent larger than an old-style animal requires 24 percent more energy and 34 percent more crude protein per year. During the nongrazing season, from mid November to late April, the high-performance cow requires 20 percent more energy and 24 percent more crude protein than the old-style cow, he says.

"For efficient function, modern beef animals need forages with greater amounts of nutrients than the amounts in traditionally harvested forages. Simply supplying greater quantities of dry matter of the same type of forage supplied to old-style cattle on traditional forage systems is not adequate," Manske says.

Traditional management systems place a priority on capturing as much dry matter forage weight as possible. Consequently, they are inefficient at capturing nutrients. Hay harvested for the greatest dry matter weight loses about 50 percent of its peak crude protein weight per acre. Because of this inefficiency, the forage does not contain sufficient nutrients to meet the requirements of modern livestock, and the nutrients it does contain are costly, Manske explains.

Pasture and harvested forages from traditional systems are deficient in crude protein 40 percent to 75 percent of the days in a year for modern cattle. Even with supplements provided during the period before calving, range cow diets based on forages from traditional systems are deficient in crude protein 20 percent to 50 percent of the days in a year for high-performance animals.

Harvested forage from traditional systems could sustain old-style cattle throughout their production cycles because the animals had lower nutrient demands and could store nutrients as body fat when forage quality was high and draw on fat reserves when the diet was deficient in nutrients. Modern cattle have a limited nutrient store on which to draw during times of deficiency because the animals do not build fat reserves, Manske says. With these cows, the deficiencies in a diet based on forages from traditional systems result in animal performance below potential, high forage-feed costs, and low profit margins.

Meeting the dietary requirements of modern cattle during all production periods is critical to animal performance, and meeting these requirements economically is critical to strong profit margins, Manske stresses. He explains that the nutrients in the dry matter--not the dry matter itself--are biologically necessary to support the life and production of a beef cow. Energy and crude protein are the major nutrients and, because crude protein costs more per pound than energy (TDN), the most important cost consideration for livestock feed is the price paid per pound for crude protein.

Forage costs are affected by the efficiency of the harvest strategy and the quantity of nutrients captured per acre relative to the potential quantity of nutrients produced. Cutting hay at peak dry matter weight captures the greatest weight of dry matter per acre but not the greatest amount of crude protein per acre. Cutting forage hays at their optimum harvest times reduces livestock forage costs per production period because the prorated cost per pound of crude protein is lower when greater pounds of crude protein per acre are captured during harvest.

Domesticated perennial grass hays like crested wheatgrass and smooth bromegrass yield greater pounds of crude protein per acre when harvested during early developmental stages, around the boot stage to flowering stage. Annual cereal hays like forage barley and oat forage yield greater pounds of crude protein per acre when harvested during early developmental stages, around the flowering stage to late milk stage. Annual legume hays like pea forage and forage lentil generally yield greater pounds of crude protein per acre when harvested during the middle and late stages of development, before the lower leaves dry.

The forage costs for a 1,200 pound range cow during the 167-day nongrazing season, from mid November to late April, are reduced when the animal is fed harvested forages cut at the optimum growth stage with the highest yield of crude protein per acre. During the nongrazing season, forage-feed costs for domesticated perennial grass hay cut at the boot stage are 33 percent less than the forage-feed costs of $116.53 for mature domesticated perennial grass hay.

Forage-feed costs for annual cereal hays cut at the milk stage are 4 percent less than the forage-feed costs of $66.89 for annual cereal hays cut at the hard dough stage. Forage-feed costs for annual legume hays cut at a late growth stage are 23 percent less than the forage-feed costs of $97.33 for annual legume hays cut at an early growth stage.

“Annual pasture and harvested-forage costs are the major expense for a cow-calf operation. By developing and implementing biologically efficient forage management systems that reduce the costs of forage nutrients per pound, the beef industry can achieve the true cost reductions it needs to remain competitive with the poultry and hog industries,” Manske says.

Not All Harvested Forages Are Expensive Livestock Feed

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Beef producers who wish to reduce livestock feed costs should consider feeding mechanically harvested forages rather than grazing cows on native rangeland next winter, says a North Dakota State University range scientist.

"Many producers believe the costs of using harvested forage as winter feed are high, and they can be, but not for the reason most people believe," says Lee Manske, range scientist at NDSU's Dickinson Research Extension Center. "Commonly used late-cut domesticated grass hays are expensive livestock feed not because mechanical harvesting or other production factors add directly to the cost; they are expensive because traditional harvest practices are inefficient at nutrient capture and the costs of harvest are prorated across very few pounds of nutrients."

"The valuable products from pastures and haylands are the nutrients, and the cost of livestock feed depends on the price paid per pound of nutrient, not the cost per acre or per ton of feed. The proportion of produced nutrient weight captured by grazing or haying is a measure of harvest method efficiency. When nutrient capture is efficient, both grazed and harvested forages can be inexpensive livestock feeds," Manske says.

Traditional harvest practices capture only 102 pounds of crude protein per acre. Total production costs for crested wheatgrass hay cut at the mature stage are $28.11 per acre, at a prorated cost of 28 cents per pound of crude protein. Livestock feed costs for this late-cut hay are 85 cents per day.

Generally, the forage harvest methods that efficiently capture crude protein at 25 cents or less per pound and provide feed for beef cows at 62 cents or less per day will permit positive net returns from beef production when the value of calf weight produced is 70 cents per pound at weaning, Manske says.

Allowing cattle to graze forages late into the nongrowing season has long been regarded as the least costly method of feeding beef animals. Production costs per acre for harvested forages are greater than pasture rent per acre, and a high percentage of the harvested-forage production costs consist of costs for labor and equipment that are not necessary in grazed-pasture production.

"When only those factors are considered, it's easy to logically conclude that having a cow graze her own feed is less costly than feeding hay," Manske says. But the conclusion is incorrect because land costs, production costs, equipment costs, and labor costs do not independently determine the cost of livestock feed and because the costs per acre for pasture and the costs per ton for harvested forages are not directly comparable."

However, the cost per pound of ingested forage nutrients from pastures and the cost per pound of forage nutrients from harvested forages can be compared. "To determine feed costs accurately, producers need to consider the efficiency of nutrient capture as it is reflected in cost per pound of nutrient. Lower-cost forages will be provided by management strategies that efficiently capture the produced nutrients from the land base, whether the forage is harvested by grazing or mechanical methods," he says.

Manske notes that grazing cows on native rangeland during the nongrowing season is very inefficient at nutrient capture and the costs increase dramatically after mid October because the amount of nutrients captured per acre from mature forage is low. Grazing cows capture only about 8.7 pounds of crude protein per acre during the nongrowing season, at a prorated cost of more than $1 per pound. Using grazed native range results in livestock feed costs of $1.67 per day despite its low production costs of only $8.76 per acre.

"A less costly source of livestock nutrients than either grazed native range or common domesticated perennial grass cut late is annual cereal and annual legume forages mechanically harvested at the optimum plant growth stage to capture nutrients efficiently," Manske says. "Annual forages have very high production costs, but harvesting them at the proper time captures their high nutrient content efficiently and results in low feed costs per day."

Cutting forage barley early, at the milk stage, efficiently captures 606 pounds of crude protein per acre at a prorated cost of only 11 cents per pound. The forage has livestock feed costs of 38 cents per day even though it has high production costs of $68.21 per acre. Cutting pea forage hay at a late plant stage efficiently captures 685 pounds of crude protein per acre at a prorated cost of only 13 cents per pound. This forage has livestock feed costs of only 43 cents per day even though it has high production costs of $86.87 per acre.

"Extending the grazing season has traditionally been regarded as less expensive than feeding harvested forages, but having cows graze their own feed is not necessarily the lowest-cost strategy," Manske says. "Several harvested-forage types are less expensive than forage consumed by cows in most grazing scenarios. Feeding harvested forages during the fall and winter does require the producer to perform additional planning and work during the spring and summer, but the cost reductions that result from the strategy can be considerable."

Is Feeding Beef Cows during the Nongrowing Season an Expense or an Income?

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Most beef producers view feeding harvested forages to livestock during the nongrowing season as a major expense, but results from a recent study suggest that the costs for some types of harvested forage could be considered an investment into a source of substantial income, says a North Dakota State University range scientist.

"The weight added to a calf during the dry gestation, third trimester, and early lactation production periods has economic value when the calf is sold. If the value of this calf weight is less than the costs of forage during the nongrowing season, the forage costs are an expense. If the value of the calf weight is greater than the costs of forage, the difference is an income. Results of a study at the NDSU Dickinson Research Extension Center indicate that while native range forage grazed during the nongrowing season is an expense, certain harvested forages are a source of substantial potential profit," states Lee Manske, a range scientist at the Dickinson facility.

The pasture and forage costs for a cow and calf and the value of calf weight were evaluated for three types of forage used as livestock feed during the 167-day nongrowing season. The three forage types were reserved native range pasture supplemented with range cake, mature crested wheatgrass hay supplemented with range cake and alfalfa-corn silage, and forage barley hay cut early.

An average 1,200-pound cow with a calf born in mid March requires 4,143 pounds of dry matter, 2,202 pounds of energy (TDN), and 339 pounds of crude protein during the 167-day (5.5-month) nongrowing season from mid November until late April. The dry matter and nutrients need to be provided from the forage type selected.

Native Range

Reserved native rangeland pasture has production costs of $8.76 per acre and forage dry matter costs of $122.13 per ton. A 1,200-pound cow would require 28.89 acres of properly stocked native range pasture for the 167-day nongrowing season, and the forage to feed the animal would cost $252.99. Crude protein supplementation from range cake would cost $26.08. Total forage and supplement costs would be $279.07 per nongrowing season, or $1.67 per day.

Calves born in mid March weighed an average of 95 pounds. Calf weight gain during the early lactation production period was 1.8 pounds per day and accumulated weight gain was 81 pounds. Total calf weight was 176 pounds, at a cost of $1.59 per pound. When calf weight was assumed to have a value of 70 cents per pound, the gross value was $123.20 per calf. Net returns after pasture-forage costs were a loss of $155.87 per cow-calf pair grazing reserved native rangeland pastures.

Crested Wheatgrass

Mature crested wheatgrass hay has production costs of $28.11 per acre and forage dry matter costs of $34.80 per ton. Production of mature crested wheatgrass to feed a 1,200-pound cow during the 167-day nongrowing season would require 2.72 acres, and the forage would cost $77.92. Nutrient supplementation would cost $11.50 for range cake and $15.75 for alfalfa-corn silage. Total forage and supplement costs would be $105.17 per nongrowing season, or 63 cents per day.

Calves born in mid March weighed an average of 95 pounds. Calf weight gain during the early lactation production period was 1.9 pounds per day and accumulated weight gain was 85.5 pounds. Total calf weight was 180.5 pounds, at a cost of 58 cents per pound. When calf weight was assumed to have a value of 70 cents per pound, the gross value was $126.35 per calf. Net returns after pasture-forage costs were $21.18 per cow-calf pair fed mature crested wheatgrass hay.

Forage Barley Hay

Forage barley hay cut early, at the milk stage, has production costs of $68.21 per acre and forage dry matter costs of $28.80 per ton. Production of early cut forage barley hay to feed a 1,200-pound cow during the 167-day nongrowing season would require 0.54 acres, and the forage would cost $37.52. Roughage supplementation would cost $29.69. Total forage and supplement costs would be $64.21 per nongrowing season, or 38 cents per day.

Calves born in mid March weighed an average of 95 pounds. Calf weight gain during the early lactation production period was 1.9 pounds per day and accumulated weight gain was 85.5 pounds. Total calf weight was 180.5 pounds, at a cost of 36 cents per pound. When calf weight was assumed to have a value of 70 cents per pound, the gross value was $126.35 per calf. Net returns after pasture-forage costs were $62.14 per cow-calf pair fed early cut forage barley hay.

Crude Protein Makes the Difference

"The amount of income or expense for a forage type is determined by the difference between the value of calf weight and the pasture-forage costs," Manske explains. "The major factor determining pasture-forage costs is the cost per pound of crude protein from a forage type. The cost per pound of crude protein is determined by the efficiency of nutrient capture for the harvest management of a forage type."

Cows grazing reserved native range pastures captured 8.74 pounds of crude protein per acre; the prorated cost of the nutrient was $1.04 per pound. This high cost of crude protein produced pasture-forage costs greater than the calf weight value. Reserve native range pastures returned a loss of $5.40 per acre.

Haying crested wheatgrass at the mature stage captured 102 pounds of crude protein per acre; the prorated cost of the nutrient was 28 cents per pound. Mature crested wheatgrass hay returned $7.79 per acre above the pasture-forage costs. Cutting crested wheatgrass hay earlier, at the boot stage, increased the net return after pasture-forage costs to $26.41 per acre.

Haying forage barley at the milk stage captured 606 pounds of crude protein per acre; the prorated cost of the nutrient was 11 cents per pound. Early cut forage barley hay returned $115.07 per acre above the pasture-forage costs.

"Net returns of more than $100 per acre from the forage barley hay should be viewed as a source of substantial income," Manske says. Some other annual plants grown on cropland and harvested as livestock forage for the nongrowing season have potential to be a source of income: among them are oat forage hay cut early, pea forage hay cut late, forage lentil hay cut late, and oat-pea forage hay.

"The forage production costs, land rent costs, equipment costs, and labor costs do not directly determine livestock forage costs. The amount of nutrient captured per acre prorated against the forage production costs determines the forage costs when the cows' daily nutrient requirements are met," Manske says. "If supplementation is needed, supplement costs and forage costs together determine livestock feed costs."

"The valuable product from pastures and haylands is the nutrients, not the dry matter weight," he says. "Beef producers who determine the prorated costs per pound of nutrient and select a forage type with lower feed costs than the value of calf weight have changed feeding beef cows during the nongrowing season from a major expense into a source of substantial income."

Reducing Forage Feed Costs for Third-Trimester Range Cows

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Northern Plains beef producers who follow traditional pasture-forage management strategies can reduce production costs by feeding range cows in their third trimester of pregnancy harvested annual cereal or annual legume forage, says a North Dakota State University range scientist.

"Commonly used methods of evaluating feed costs for third-trimester range cows compare production costs per acre, labor costs per acre, or cost per bale of feed. These traditional comparisons are the basis for the long-held belief that grazed native range forage is a less costly feed source than harvested forages. But, improving the profit margin of beef production requires an understanding of the factors that contribute to livestock feed costs," states Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

Land rent values, production costs per acre, forage dry matter costs per ton, crude protein costs per pound, and feed costs per day and per production period were evaluated for five forage feed types for 1,200-pound range cows during the 90-day third trimester production period. The forage types evaluated were native range supplemented with range cake, mature crested wheatgrass hay, crested wheatgrass hay cut early, forage barley hay cut early and forage lentil hay cut late.

Native range pasture during the winter dormancy period has a crude protein content of around 4.8 percent. Late-season native range forage has production costs of $8.76 per acre, forage dry matter costs of $120.83 per ton, and crude protein costs of $1.26 per pound. A cow grazing during the third trimester requires 4.97 acres of winter native range pasture per month, at a cost of $1.45 per day. The nutrient content of winter native range forage is below the 7.8 percent required by livestock, and 0.72 pounds of crude protein per cow per day would need to be provided, at a cost of 22 cents per day. The forage from native range pasture and the supplementation to feed a range cow in the third trimester cost $1.67 per day, or $149.94 for the 90-day production period.

Crested wheatgrass hay cut late, at a mature plant stage, has a crude protein content of around 6.4 percent. This low-quality hay has production costs of $28.11 per acre, forage dry matter costs of $34.80 per ton, and crude protein costs of 28 cents per pound. Production of mature crested wheatgrass hay to feed a range cow in the third trimester requires 0.57 acres per month, at a cost of 52 cents per day. The nutrient content of this forage is below livestock requirements, and 0.33 lbs of crude protein per cow per day would need to be provided, at a cost of 10 cents per day. Mature crested wheatgrass hay and supplementation to feed a range cow in the third trimester cost 62 cents per day, or $56.04 for the 90-day production period.

Crested wheatgrass hay cut early, at the boot stage, has a crude protein content of around 14.5 percent. This high-quality hay has production costs of $26.50 per acre, forage dry matter costs of $40.80 per ton, and crude protein costs of 14 cents per pound. Production of early cut crested wheatgrass hay to feed a range cow in the third trimester requires 0.30 acres per month and costs 27 cents per day. The additional 11 pounds of roughage needed per animal per day would cost 19 cents per day. Crested wheatgrass hay cut early and supplemental roughage to feed a range cow in the third trimester cost 46 cents per day, or $41.30 for the 90-day production period.

Forage lentil hay cut at a late plant stage has a crude protein content of around 14.7 percent. This forage lentil hay has production costs of $71.48 per acre, forage dry matter costs of $37 per ton, and crude protein costs of 13 cents per pound. Production of fully developed forage lentil hay to feed a range cow in the third trimester requires 0.10 acres per month and costs 24 cents per day. The additional 11 pounds of roughage needed per animal per day would cost 19 cents per day. Forage lentil hay cut late and supplemental roughage to feed a range cow in the third trimester cost 43 cents per day, or $38.70 for the 90-day production period.

Forage barley hay cut early, at the milk stage, has a crude protein content of around 13 percent. This forage barley hay has production costs of $68.21 per acre, forage dry matter costs of $28.80 per ton, and crude protein costs of 11 cents per pound.

Production of early cut forage barley hay to feed a range cow in the third trimester requires 0.09 acres per month and costs 21 cents per day. An additional 9.5 pounds of roughage needed per animal per day would cost 17 cents per day. Forage barley hay and supplemental roughage to feed a range cow in the third trimester cost 38 cents per day, or $34.21 for the 90-day production period.

"To select a management strategy that is most profitable, producers need to compare feeding alternatives in a way that accurately reflects the cost of those feeds," Manske states. A common practice is to compare production costs per acre. The production costs per acre for the five forage types are $8.76 for winter-grazed native range, $26.50 for early cut crested wheatgrass, $28.11 for mature-cut crested wheatgrass, $68.21 for early cut forage barley, and $71.48 for late forage lentil hay.

"An interpretation of livestock feed costs that is based only on production costs per acre indicates that winter-grazed native range is the least costly feed for range cows in the third trimester and late forage lentil hay is the most costly," Manske says. "Comparisons of cost of crude protein and 90-day forage feed costs, however, indicate that winter-grazed native range forage is the most costly feed source, followed by mature crested wheatgrass hay."

The lowest-cost feeds are forage barley cut early, forage lentil hay cut late, and early cut crested wheatgrass hay. The crude protein costs per pound are 11 cents for forage barley, 13 cents for forage lentil hay, 14 cents for early cut crested wheatgrass, 28 cents for mature crested wheatgrass, and $1.26 for winter-grazed native range. The 90-day forage feed costs for range cows in the third trimester are $34.21 for forage barley, $38.70 for forage lentil hay, $41.30 for early cut crested wheatgrass, $56.04 for mature crested wheatgrass, and $149.94 for winter-grazed native range. The ranking of third-trimester production forage feed costs follows the same order as that of crude protein costs.

"Land rent values, production costs per acre, and forage dry matter costs per ton are important but do not accurately reflect livestock feed costs because the nutrient weight per acre captured through grazing or haying varies with forage type and plant growth stage and the variations are not proportional to these production costs," Manske notes. Cost per pound of nutrient (crude protein) is a more reliable indicator of livestock feed costs: a 1,200-pound range cow in the third trimester requires 168 pounds of crude protein during the 90-day production period, and the cost per pound of crude protein directly affects the feed costs for that cow. "Few beef producers compare feed costs based on cost per pound of nutrient, in this case, crude protein," he says.

Comparison of cost of crude protein provides an assessment of a component of forage costs that accurately reflects livestock feed costs, stresses Manske. Implementation of management strategies that provide forages at lower costs per pound of crude protein will reduce livestock feed costs, reduce livestock production costs, and help improve the profit margin of beef production.

Forage Feed Costs for Third Trimester Cows
NDSU Dickinson Research Extension Center

	Native Range	Crested Wheatgrass cut late	Crested Wheatgrass cut early	Forage Lentil Hay cut late	Forage Barley Hay cut early
% Crude protein content	4.8	6.4	14.5	14.7	13
Production cost/acre	$8.76	$28.11	$26.50	$71.48	$68.21
Forage dry matter cost/ton	$120.83	$34.80	$40.80	$37.00	$28.80
Crude protein cost/lb	$1.26	$0.28	$0.14	$0.13	$0.11
Cost Per Cow					
Acres/month	4.97 $1.45/day	.57 $0.52/day	.30 $0.27/day	.10 $0.24/day	.09 $0.21/day
Supplemented crude protein	0.72 lbs/day $0.22/day	0.33 lbs/day $0.10/day	0.0	0.0	0.0
Supplemented roughage	0.0	0.0.	11 lbs/day $0.19/day	11 lbs/day $0.19/day	9.5 lbs/day $0.17/day
Total feed cost per day	$1.67	$0.62	$0.46	$0.43	$0.38
Cost for third trimester	$149.94	$56.04	$41.30	$38.70	$34.21

Beef Producers Can Generate Greater Economic Wealth from the Land Resource

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Pasture and forage management strategies that meet the biological requirements of grass plants could generate greater economic wealth for the Northern Plains than traditional management practices currently used in the region, says a North Dakota State University range scientist.

"Traditional management practices focus on the use of grasslands for livestock forage and wildlife habitat rather than on management of the grassland resource. The common forage management practices place priorities on animal husbandry activities and on harvesting the greatest weight of dry matter per acre to produce livestock weight. Livestock weight is the commodity sold at the marketplace, but not the source of new wealth," says Lee Manske, a range scientist at NDSU's Dickinson Research Extension Center.

"The source of new wealth and the basic unit of economic value is the nutrients produced by plants on the land resource and transferred as food by the meat animal to the human consumer. Grazing management practices that focus on meeting plant biological requirements increase the quantity of nutrients produced on and captured from the land, thereby increasing the amount of wealth generated from the land resource," he explains.

Humans place caring properly for animals higher than meeting the biological requirements of plants. This hierarchy need not be changed, but the activities that provide proper care and handling of livestock should be conducted so that plant biological needs are met, not sacrificed, Manske says.

The performance level of the plant component in the ecosystem determines the performance level of the livestock. Management designed to enhance grassland resources manipulates processes that meet the requirements of the grass plants and promote the vegetative growth of secondary tillers from axillary buds, stimulate beneficial activity of soil rhizosphere organisms, and facilitate the functioning of ecological processes at higher levels. These changes result in the perpetuation of healthy, productive grasslands with denser plant cover, increased quantities of herbage and nutrients, improved animal performance, higher quality habitat for wildlife, and greater economic return per acre.

The wealth agricultural production generates from grassland resources is limited by the biological capacity of the plants to produce herbage and nutrients from soil, sunlight, water, and carbon dioxide and by the effectiveness of management treatments in capturing value from plant production. Generating greater wealth from land resources requires increasing the rate of nutrient production through enhanced photosynthesis in plants and stimulated activity of soil organisms and increasing the rate of nutrient transfer to the grazing animal through improved efficiency of nutrient capture.

Manske says these increases can be achieved through moderate grazing of grass plants between the third-leaf and flowering stages. Defoliation of grasses at this time triggers biological processes that result in increased herbage production and enhanced nutrient cycling within the ecosystem. In addition, grazing vegetative lead tillers and stimulated secondary tillers of grasses gathers greater quantities of nutrients per acre than traditional harvest of the grasses when the forage dry matter is mature.

Forage dry matter is not the economically valuable product from the land, and the quantity of forage dry matter produced or the market value of that product is not an accurate indicator of the wealth generated from the land, Manske notes. "The amount of dry matter needed to feed a cow varies with the quantity of nutrients contained in the forage dry matter, so the cost of livestock feed is determined primarily by the cost per unit of nutrient weight rather than by the cost per unit of forage dry matter weight. The nutrient cost per unit of weight is determined by the weight of the nutrients grazed or mechanically harvested per acre prorated against the land costs, production costs, equipment costs, and labor costs per acre."

Land area per animal unit is related to the quantity of nutrients captured per acre and the quantity of nutrients a cow-calf pair requires. As greater quantities of produced nutrients are captured per acre, each animal unit requires less land area, feed costs decrease, and economic wealth generated from the land increases.

A typical traditional management treatment in the Northern Plains captures nutrients inefficiently and requires about 23.93 acres to produce the feed for one 1200-pound cow for a year. Manske's research indicates that changing the priority of management practices from capturing the greatest quantity of dry matter per acre to capturing the greatest quantity of nutrients per acre reduces to 11.68 acres the land area required to produce the forage for a cow, reduces the pasture and forage costs from $246 to $171 per cow, and increases the economic return after pasture and forage costs from $5.47 per acre to $21.54 per acre for the calf weight sold at weaning for 70 cents per pound.

"When the biological requirements of the forage plants are met and the produced nutrients are efficiently captured and transferred to the meat animal, the land resources of the Northern Plains can generate greater economic wealth through livestock agriculture," Manske says.

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