High-intensity, year-round rotational grazing

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Abstract
Compared to row crops, most forage crops reduce water runoff, therefore limiting soil erosion. Forage systems also require less chemical pest control than row crops. Because legume forage species fix nitrogen in the soil, they seldom require nitrogen fertilization. Despite these advantages, profitability limitations have kept forage use from expanding.

Keywords
Animal management and forage, Soils and agronomy, Agronomy, Animal Science

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Background

Compared to row crops, most forage crops reduce water runoff, therefore limiting soil erosion. Forage systems also require less chemical pest control than row crops. Because legume forage species fix nitrogen in the soil, they seldom require nitrogen fertilization. Despite these advantages, profitability limitations have kept forage use from expanding.

Although legume forage species offer higher yield and nutritive value, their persistence when grazed is uncertain, and reseeding reduces their economic advantages. The Animal Management interdisciplinary research issue team recognized when it formed in 1990 that economic returns from summer pastures could be improved by modifying a pasture’s botanical composition, its grazing management, or both. Rotational grazing increases animal production per acre by increasing forage yield and harvest efficiency while encouraging the persistence of these valuable forage legumes.

Prior to the team's establishment, information specific to Iowa was lacking on how rotational grazing affected plant and animal productivity. Because nutrient deficiencies may reduce cow rebreeding rates, it was necessary to determine the extent to which the stocking rate (of cattle) may be increased in an intensive rotational grazing system without adversely influencing reproductive efficiency. In addition, because more than one-third of the costs of beef cow-calf production in Iowa involves feeding stored feeds, the team has worked on improving the profitability of such enterprises by extending the grazing season to minimize the amount of stored feed needed. One approach they have investigated is the grazing of corn-crop residues (including systems for extending corn-residue grazing and evaluating its economic value). In addition, the work has considered the effects of this grazing on soil properties.
The team also conducted the first evaluation of stock-piled forage grazing in Iowa. Because summer and winter feed management plays a vital role in determining a cow’s ability to rebreed, all these approaches are being considered as parts of an overall system.

The Animal Management team's goals are to develop and demonstrate profitable forage-based beef production systems that sustain or enhance environmental quality. Toward these goals, the team has evaluated (1) summer systems that utilize legume forage species and intensive rotational grazing to optimize long-term animal production per acre while reducing inputs of fertilizer and herbicides, and (2) winter systems that minimize costs of using stored feeds by extending the grazing season via crop residues and/or stock-piled hay crop forages.

Findings

Evaluation of legume forage species: Summer grazing systems have been evaluated at two locations. At the Iowa State University Beef Nutrition Research Center located near Ames, replicated alfalfa-smooth bromegrass-orchardgrass and smooth bromegrass pastures were grazed by continuous (0.6 cow-calf units per acre) or high-intensity rotational (1.0 cow-calf units/ac) stocking systems in 1990 and 1991. In addition, replicated alfalfa-smooth bromegrass-orchardgrass pastures were grazed by a low-intensity rotational (0.6 cow-calf units/ac) system. When grazed by similar stocking system, cows grazing pastures containing alfalfa produced 15% greater calf weight gains than cows grazing nitrogen-fertilized smooth bromegrass and, therefore, had a greater profit than cows on smooth bromegrass pastures when compared in economic models, even if pastures had to be reseeded with alfalfa every five years. Pastures grazed by a high-intensity rotational system stocked at a rate 66% greater than the continuously stocked pastures had 44% greater calf production. However, the rebreeding rates of cows grazing pastures in a high-intensity rotational system were 12 percentage points less than in continuously stocked pastures. Because of the higher stocking rates, the greater profits of the high-intensity rotational system over the continuous system were quite robust; they remained greater even at considerably lower rebreeding rates. Grazing in a rotational system at the same stocking rate produced no greater amounts of calf per acre, but it did increase rebreeding rates. The increased rebreeding rate from the low-intensity rotational stocking system resulted from greater amounts of live forage per cow.

Even at the highest stocking rate, amounts of available forage per cow exceeded demand in late May and early June of every year, even though forage was deficient later in the summer. Thus, hay production or lead-grazing of younger stock in May and June is necessary for optimum forage utilization. Although rotational grazing tended to improve alfalfa persistence compared to continuous grazing, losses of alfalfa from these eight-year-old stands were considerable under the wet conditions in 1990, regardless of grazing system. For this reason, an extra pasture is necessary for placing animals during extremely wet weather if alfalfa pastures are grazed.

In addition to evaluating grazing systems in this experiment, the team developed and calibrated a falling plane meter for estimating forage yield from the sward height (see Fig. 1). This instrument has proven useful for estimating live forage yield and therefore for calculating the carrying capacity of a paddock. The meter is also being used to relate the sward height to forage intake by cows.

Fig. 1. This plexiglass "sward stick" was developed as a quick, easy, and relatively accurate method to estimate forage yield in summer pastures. Instructions for fabricating this tool are available from team leader Jim Russell.
In evaluating soil compaction caused by grazing, the team determined that compaction was related to the distance from watering points and cow paths and the moisture level of the soil when cow travel occurred. The presence of forage increased infiltration considerably.

The second evaluation of summer grazing systems, conducted at the McNay Outlying Research Farm near Chariton from 1991 through 1993, compared continuous stocking (0.5 to 0.6 cow-calf units per acre) to grazing by rotational stocking (0.7 to 0.8 cow-calf units per acre) in smooth bromegrass-orchardgrass or birdsfoot trefoil-smooth bromegrass-orchardgrass pastures. Team members measured cow weight, body condition score, forage intake, calf weights, forage sward height, yield, *in vitro* digestibility, and botanical composition. In 1993, monthly forage production was also quantified.

Over the three years at McNay, incorporation of birdsfoot trefoil into a smooth bromegrass-orchardgrass pasture increased the forage sward height and live yield, respectively, by 17.7% and 24.6% compared to cool season grass pastures fertilized with 40 lb or more nitrogen per acre. In general, the results of this experiment indicate that incorporating birdsfoot trefoil in cool-season grass pastures will increase forage yield and thereby slightly increase calf production compared to nitrogen-fertilized cool-season grass pasture. However, the lower rebreeding rates of cows grazing birdsfoot trefoil is a concern warranting further study. Grazing in a rotational-stocking system allows a 40% higher stocking rate without an adverse effect on subsequent reproduction.

Lower forage allowances associated with rotational stocking at a higher rate reduced calf weight gains, but total calf production was 26.4% greater than that from continuously stocked pastures. Although the rotational system resulted in more efficient use of forage, methods of controlling the excess need to be developed. Relatively high correlations of forage dry matter intake with forage sward height or live forage allowance suggests that these measurements may be useful in developing more refined grazing systems.

**Evaluation of winter grazing systems:** The team evaluated winter grazing systems both at the Iowa State University Beef Nutrition Research Center and the McNay Outlying Research Farm. From 1988 through 1990, they compared corn-crop residue grazing in a continuous system at allowances of 0.5, 1.0, and 2.0 acres per cow per month for 56 days. In 1989 and 1990, residues were also strip-grazed at 0.5 ac/cows/month. All cows received supplements of 2 lb of soybean meal per day after 21 days of grazing. Cows grazing at 0.5 or 1.0 ac/cow/month under continuous stocking maintained their body weights. However, annual weight gains resulted only when the grazing allowance was increased to 2 ac/cow/month. This result suggests that the stocking rate at which corn-crop residues should be grazed is dependent on the body weight change needed in the cattle to maintain reproductive efficiency. Cows coming into the winter in poor condition should receive 2 ac corn-crop residues/cow/month, while cows that are in moderate or good condition can receive as little as 0.5 ac corn-crop residues/cow/month. The efficacy of strip-grazing corn-crop residues depended on weather conditions. Under the dry conditions of 1989, cow weight gains in fields that were strip-grazed at 0.5 ac/cow/month were as great as those in fields that were continuously grazed at 2.0 ac/cow/month.
However, under cold and wet conditions in 1990, cow weight losses were greater in fields strip-grazed at 0.5 ac/cow/month than in fields grazed at 0.5 to 2 ac/cow/month. The lack of strip-grazing success related strongly to nutrient losses resulting from weathering. Mean organic matter and digestible organic matter losses from weathering of corn-crop residues were over 16% and 27%, respectively.

During the winters of 1990 and 1991, continuous and strip grazing of corn-crop residues at 0.5 ac/cow/month were compared over the entire winter from grain harvest to mid-March. Similar to the results in the 56-day experiments, no advantage to strip-grazing of corn-crop residues was observed. Following a promising small plot trial in 1991, team members broadcast-seeded common rye into corn fields at second cultivation, which was grazed with corn-crop residues in the winter of 1992. Rye forage yields were low, apparently because of shading, and little additional forage for winter grazing was produced by rye in these corn-crop residue fields. In each of the full-season experiments, hay in large, round bales was fed to maintain a cow body condition score of 5 (on a 9-point scale); 5 is necessary to maintain reproductive performance. Over the three years, cows grazing corn-crop residues required approximately one ton less hay per cow than those maintained in a drylot.

Soil compaction in fields in which corn-crop residues had been grazed for the entire season was evaluated by soil penetration resistance and water infiltration. These measurements showed little effect of crop residue grazing (as managed in these studies) on soil compaction. However, these results may have been affected by removal of the cattle in mid-March, the moisture level of the soil, and/or the soil type. These studies need to be conducted at other sites and under various conditions before more general conclusions can be drawn.

Grazing of stock-piled hay crop forages at the McNay Outlying Research Farm has been evaluated since 1992. Forage from fields containing endophyte-free tall fescue and a spreading alfalfa or bromegrass with (1993) or without (1992) red clover was harvested for hay until early August. Subsequent residual growth was strip-grazed by gestating beef cows at 2 ac/cow after a killing frost until mid-March. Grazing of the stock-piled hay crop forages was compared to strip-grazing of corn-crop residues or maintaining cows in drylot. Hay was fed to cows in each system to maintain a body condition score of 5. Measurements taken included cow weights, condition scores, forage intake, and subsequent reproduction; hay yield, storage losses, and amount fed; stock-piled forage and corn-crop residue yields and nutrient composition; and the botanical composition of stock-piled fields and ground cover of the corn-crop residue fields.

Although weather conditions during the growing season differed considerably between years, the initial dry matter yields of the stock-piled tall fescue-alfalfa and corn-crop residues were remarkably similar. Trends in total and digestible organic matter yields resembled those for dry matter. Although the yields of stock-piled forage and corn-crop residue at grazing initiation did not differ greatly across the years, the composition of the forage was dramatically altered. The loss of digestible organic matter from corn-crop residues was greater than that from fescue-alfalfa or smooth bromegrass. Weather caused considerable differences in the rate of nutrient loss between years; losses were much greater during the wet conditions.
of winter 1992-1993. In addition, there was no significant difference between rates of dry matter, organic matter, or digestible organic matter loss between grazed and non-grazed areas in 1992-1993. During winter 1993-1994, the rate of loss of digestible organic matter from forage in ungrazed areas was only 22% that of grazed forage. There were essentially no losses of dry matter or organic matter from forage in ungrazed areas.

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As with rates of loss in the amount of total and digestible nutrients, rates of change in concentration of digestible organic matter differed greatly between years, with concentrations decreasing nearly three times more rapidly during winter 1992-1993 than winter 1993-1994. The loss rate of digestible organic matter concentration between forage species or between grazed and ungrazed areas during the winters of either year did not differ. There were no significant differences in cow body condition score changes between treatments over the two years of the experiment. However, total-grazing-period weight gain of cows grazing stock-piled tall fescue-alfalfa, stock-piled smooth bromegrass with or without red clover, and corn-crop residues were 32.7, 9.8 and 11.5 kilograms, compared to -0.4 kg for cows maintained on hay in a drylot.

Because of the higher quality and lower weather losses from stock-piled forages or corn-crop residues during the winter of 1993-1994, cows were fed less hay than in 1992-1993. To maintain body condition over the entire wintering period, cows grazing stock-piled tall fescue-alfalfa required 1088 kg hay/cow; those grazing smooth bromegrass with or without red clover required 1120 kg hay/cow; and those grazing corn-crop residues required 1678 kg hay cow, while those maintained in a drylot required 2284 kg hay /cow. As a result excess hay remained after the winter for the tall rescue-alfalfa and smooth bromegrass systems, whereas the corn-crop residue and drylot systems were deficient in hay. In addition, weather caused losses to baled hay of 8.1% and 6.9%, respectively, for tall fescue-alfalfa and smooth bromegrass. Bale weather losses were 20.9% and 8.1% from first and second cuttings of tall fescue-alfalfa and 6.8% from second-cutting smooth bromegrass-red clover during winter 1993-1994.

Because of the wet summer in 1993, the proportion of alfalfa in the tall fescue-alfalfa decreased over time. In contrast, because of frost-seeding, the proportion of red clover increased in the smooth bromegrass pastures over time. Inasmuch as the similar trends in forage composition occur between the grazed and nongrazed fields, the changes in sward botanical composition seem unrelated to winter grazing.

Overall, this experiment suggests that grazing of stock-piled forage can decrease the amount of hay needed to maintain cows by as much as 1.5 tons of hay per cow. At the stocking rates used in this work, the stock-piled system leaves a considerable excess of hay that could either be used by additional animals or sold. Grazing corn-crop residues will also decrease the amount of hay required to maintain cows by as much as one ton of hay/cow. Weathering losses of nutrients from stock-piled forages or corn-crop residues can be high, and this risk must be considered when these forages are used in management systems. However, under dry, cold conditions, the weather losses from stock-piled forages were so low that given an adequate number of acres, cows could have possibly been maintained on them all winter.

Goals for 1995

To work toward their goal of developing and demonstrating practices that optimize profitability in livestock production while protecting the environment, the team has planned three projects for the coming year. These future efforts will refine the systems studied to date. Reduction in the seasonal variation of forage quantity and quality will be one thrust; another will involve expanding use of the falling plane meter to effect more uniform
grazing of paddocks. Methods of predicting forage production and forage intake will be evaluated further so that models can be developed for use by producers. Such models would help calculate carrying capacities as well as rotation time lengths.

Because grazing had to be terminated earlier than desired during two of the three years in which the team studied mixed grass and grass-legume pastures at the McNay Farm (due to weather and other factors), methods of managing risks associated with summer grazing will be examined. In particular, the team will stock pastures at a level estimated at 20% below the maximum carrying capacity for a "normal" year—the intention here being to have adequate forage for grazing for the entire season even in years that are excessively wet or dry. Any excess forage produced as a result of this method during normal years will be harvested.

With a rotational system, this reduced stocking rate should still be higher than that used for continuous grazing, but the economics of this reduced-risk system will need to be compared with systems having higher stocking rates and higher risks over a period of several years.

The team's major goal in terms of evaluating winter grazing systems will focus on lengthening the grazing season by using stock-piled hay crop forages and/or corn-crop residues. Results from 1993-1994 suggest that stock-piled forages may retain their nutrients well enough that if adequate acres of stock-piled forages are provided, grazing may be continued for almost the entire season. Again, the most profitable use of the excess hay from such a system needs to be determined. Because most beef operations in Iowa have some corn-crop residues, the team intends to evaluate systems of integrating this residue with stock-piled forage grazing. These evaluations should be conducted in southern Iowa as well as central and northern Iowa where temperatures are colder and snow cover is heavier.

Grazing management during March and April is difficult because of low grazeable forage supply, low-quality stored forages, and mud while calving is taking place. A typical remedy, placing cows on summer pastures too early, may reduce summer pasture yields. The team will pursue additional funding to evaluate practices such as grazing of stock-piled cool and warm-season species, brown-midrib sorghum, or double-cropped small grains to manage cows during early spring. Methods for renovating permanent pastures used for spring calving will likely be included in this work. Because managing calving on numerous small pastures is difficult, the team will depend in part on producer cow record summaries and replicated experiments with pregnant, fall-calving cows. Animal production will be measured as well as the effects on forage yield and botanical composition of both early spring and summer pastures and soil physical properties.

In addition to publications in academic and technical journals, the team's work has been featured frequently in the popular farm press. Field days are held each year.

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