Optimal efficiency in the use of Iowa's energy, soil, and feed resources for beef production

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Abstract
Soil erodes over six times faster from cultivated Iowa cropland than from pastureland, even though almost 12 percent more of the pastureland acres are classified as highly erodible than the cropland acres. Because of serious concern about excessive erosion of Iowa’s topsoil, profitable alternatives to row-crop production are needed for soils like those found in much of southern Iowa.

Keywords
Animal Science, Agronomy, Economics, Animal management and forage, Farmer profitability, Enterprise budgets, Soils and agronomy

Disciplines
Agricultural and Resource Economics | Agricultural Economics | Agricultural Science | Agronomy and Crop Sciences | Animal Sciences | Economics

Lead Investigators
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Background and goals

Soil erodes over six times faster from cultivated Iowa cropland than from pastureland, even though almost 12 percent more of the pastureland acres are classified as highly erodible than the cropland acres. Because of serious concern about excessive erosion of Iowa’s topsoil, profitable alternatives to row-crop production are needed for soils like those found in much of southern Iowa.

Growth of forages for beef feeder-calf production is a practical alternative because the fossil energy needed (in fuel and fertilizer) to produce forage legumes is only about 73 percent of that needed for corn. And about 75 percent of the energy used in forage production is needed for forage harvest. Improving forages can also help farmers save money by reducing feed costs, which constitute about 42 percent of the total cost of maintaining beef cows. In one study that involved grazing of corn residues, the most profitable one-third of cow-calf producers fed 28 percent less stored feed than the least-profitable one-third.

Thus, if cows are maintained primarily on forages grown on these southern hills, and their calves are fed grain and grain by-products grown in less erodible areas of the state, a sustainable beef industry can be a reality for Iowa. In the process, these pasture or hay crop forages can significantly improve soil conservation.

In terms of plant species, fertility, and grazing management, only one-quarter of Iowa pasture is considered in good condition by Soil Conservation Service standards. Because good reproductive performance of beef cows is essential for optimizing profitability in a livestock enterprise, and because this performance is impaired when cows do not consume sufficient nutrients, the productivity and quality of such pastures must be improved. Such improvements include planting more productive forage species, adapting weed control practices, enhancing fertility, and implementing grazing methods that optimize long-term productivity and nutritional quality of forages.

Poorly managed grazing can deplete root nutrients, discourage the persistence of desirable plants, and allow weed infestation. These problems are made worse when cows selectively overgraze on previously grazed locations. Overgrazing results in reduced feed intake because a cow grasps less with every bite; conversely, forage that is too tall becomes fibrous and unpalatable, also reducing cows’ intake. Establishing an optimal height for a wider variety of forages, combined with controlling the number of grazing animals and using rotational grazing (where paddocks reduce the animals’ selectivity by controlling their movement), can help farmers maximize the efficiency with which their pastures are used.

The goals of this project were to develop and demonstrate beef production systems that optimize the economic and energy efficiency of cow-calf production by maximizing the use of legume forage species in grazing systems in summer pastures and minimizing the use of harvested feeds during the winter.

Approach

Summer grazing systems: Researchers began by studying birdsfoot trefoil, a legume...
suited to dry soils of the central United States, on approximately 100 acres of cool-season grass pasture at the McNay Memorial Research Farm near Chariton, Iowa. In the spring of 1989, eight 10-acre pastures established the previous year were fertilized and planted either with smooth bromegrass (a perennial, drought-resistant grass) and orchardgrass (an aggressively growing, perennial bunchgrass of modest nutritional value) or with birdsfoot trefoil, smooth bromegrass, and orchardgrass. While the birdsfoot trefoil established itself satisfactorily, the drought conditions in 1989 resulted in inadequate grass establishment. Thus, project personnel re-seeded the grasses in 1990.

Then, in 1991, two of the birdsfoot trefoil pastures and two of the grass pastures were divided into eight paddocks, and cows with calves began grazing in a rotational system under intensive management at a stocking rate of one cow-calf unit per acre. The four undivided pastures were grazed in a continuous system at a stocking rate of 0.6 cow-calf units per acre. The two types of pastures were then compared.

Forage yield was estimated in the rotationally grazed pastures by sward (forage) height measurements taken at two locations in each paddock at the time of each rotation. (Researchers measured sward height with a specially designed falling plane meter called a "sward stick"; see photo.) Researchers also estimated forage yield and determined botanical composition from clippings taken at 12 locations in each of the pastures before, during, and at the conclusion of the 112-day grazing season.

Cows and calves were weighed monthly, and the cows' body condition was assessed when grazing began as well as at the beginning and end of the breeding season. Pregnant cows were identified 42 days after the breeding season ended.

In concurrent work over the three years of the project, researchers evaluated alfalfa in a summer grazing system at the Iowa State University Beef Nutrition Research Center near Ames using an approach similar to that used at McNay. Alfalfa pastures were also grazed by cows with calves, either continuously, rotationally, or by using a mobile "buffer" fence to control the area grazed.

**Winter grazing systems:** In this part of the study, researchers used stockpiled forage to minimize the use of harvested feeds for winter feeding of beef cows. Two fields were seeded with fescue (a grass) and alfalfa at the McNay Farm in 1989. Again, apparently because of drought, plants established themselves poorly on these pastures and were totally re-seeded in 1990.

Researchers also investigated using corn-crop residue grazing to minimize the use of harvested feed for winter feeding. This work, also conducted at the ISU Beef Nutrition Research Center, included various stocking rates and grazing approaches including strip grazing, which helps avoid trampling and contamination of crop residues by soil. Cows were provided with hay in instances of extreme cold or heavy snowfall. Researchers sampled crop residues at four locations intermittently throughout the winter grazing season each year; samples were analyzed for dry matter,
organic matter, crude protein, fiber, and other components. Cow body weights were also measured.

Findings

Summer grazing systems: Calves produced from cows grazing in pastures that contained legume forage species weighed more than those from cows grazing nitrogen-fertilized grasses. Calf production was 13 percent greater in alfalfa/cool-season grass than in smooth bromegrass pastures and 6.2 percent greater on birdsfoot trefoil pastures than on grass pastures.

Cows grazing alfalfa also had higher body weights, and cows grazing birdsfoot trefoil had higher body condition scores, than did those grazing grass pastures. Although increased cow weights did not correspond with the number of cows that became pregnant, a higher proportion of those continuously grazing birdsfoot trefoil became pregnant than did those continuously grazing cool-season grass pastures; thus, legume forages increased calf production both through increased reproductive efficiency and calf weight gains.

Rotational grazing of higher numbers of cows and calves also increased calf production. But cows at that higher stocking rate gained less weight, or lost more weight, than those continuously grazing pastures at stocking rates 25-40 percent lower. Overall, it appears that although rotational grazing will allow for increases in stocking rate and an accompanying increase in calf production, in order to maintain reproductive efficiency the stocking rate should be no more than 33 percent higher than that for continuous grazing.

Rotationally grazed pastures offer greater carrying capacity primarily because forage is used more efficiently. This system results in less dead forage and more digestible forage than from continuously grazed pastures. These are both effects of cows grazing less selectively because of the design and function of high-intensity rotational systems.

A higher proportion of legume forage remained in rotationally grazed pastures; this result, which was particularly evident during drought, indicated that rotational grazing may allow increased persistence of legume species in pastures. In wet conditions, the grazing of alfalfa seems detrimental regardless of the grazing system. Thus, researchers recommend that producers place cows in an alternative pasture during excessive precipitation in order to preserve the legume component of alfalfa-grass pastures.

Although controlled grazing with buffer fences conserved some forage and resulted in increased cow weight gains, it did not affect calf production. Furthermore, this system does not allow legume species to "rest" and is, therefore, of limited value in a legume-grass pasture.

Winter grazing systems: This research indicates that corn-crop residue grazing is a satisfactory alternative to feeding stored feeds for maintaining beef cows in the winter. Cow weight gains can be controlled by adjusting the stocking density in response to weather conditions. For example, if cows start the winter season in good condition, a stocking rate of one cow per 0.5 acre per month for about the first two months of winter will be satisfactory if weather conditions permit. But if the cows have lost weight during the previous summer (as they did in the intensively managed rotational system in this experiment, probably because of the high stocking rate combined with the drought) or if heavy, early snowfalls occur, corn-crop residues should be grazed at a stocking rate only half as high. If this is not feasible, supplemental feed can maintain the cows' condition.

Strip grazing of corn-crop residues is an efficient practice provided early snowfalls do not occur. Because it prevents trampling and soil contamination, strip grazing might be especially useful in years of heavy autumn rains. To be efficient, crop-residue grazing must be used flexibly to adjust for a variety of factors and conditions.
Summary: This project has demonstrated that calf production is higher in legume pastures than in grass pastures and that no nitrogen fertilization is needed. The project has also shown that rotational grazing allows higher numbers of cows and calves to be fed while the forage plants are maintained, thus saving the cost of re-establishing the forage stand. The balancing act lies in also maintaining the animals’ reproductive efficiency while allowing the legumes an adequate rest period. Maintenance costs of the beef herd may be minimized—and profits thus optimized—by maximum use of crop-residue grazing during the winter.

Implications

Iowa agriculture is at a crossroads. At the same time that Iowans see a need to alter practices to limit soil erosion and water pollution, land that has been enrolled in the Conservation Reserve Program and seeded with forages will soon become available for row-crop farming again. A livestock enterprise can be integrated with row cropping to provide farmers with an opportunity for greater diversification. But farmers will first need to see that livestock enterprises can be profitable in addition to minimizing environmental costs.

If properly managed, intensively managed rotational grazing of legume-grass pastures could maximize productivity of cow-calf enterprises from summer pastures. However, the largest single factor affecting the profitability of cow-calf production is the amount of stored feed that has to be fed to cows over the winter. Thus, intensively managed rotational grazing of legume-grass pastures combined with grazing of crop residues during the winter should be the most profitable system of beef cow-calf production in Iowa.

These researchers are also analyzing economic data from the year-round grazing systems. The Leopold Center’s animal management issue team, one of six Center-initiated and supported interdisciplinary research teams, continues research on the feasibility of these approaches.