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Incorporating native plant communities on farms for forage and wildlife

Laura Jackson
University of Northern Iowa

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Abstract
Rotational grazing systems have potential to reduce soil loss and fossil fuel use, and may increase biodiversity by providing a wildlife habitat. Establishing native, warm-season plant communities based on the region's native tallgrass prairie ecosystem as part of a rotational grazing system would benefit graziers by offering higher drought tolerance and pasture production levels in the midsummer months.

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Incorporating native plant communities on farms for forage and wildlife

Principal Investigator:
Laura Jackson
Biology
University of Northern Iowa

Farmer Cooperators:
Dan Specht
McGregor, Iowa

Mike Natvig
Cresco, Iowa

Matthew Stewart
Oelwein, Iowa

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$20,343 for year one
$19,865 for year two
$20,342 for year three

Abstract: *Rotational grazing systems have potential to reduce soil loss and fossil fuel use, and may increase biodiversity by providing a wildlife habitat. Establishing native, warm-season plant communities based on the region's native tallgrass prairie ecosystem as part of a rotational grazing system would benefit graziers by offering higher drought tolerance and pasture production levels in the midsummer months.*

Background

The industrialization of agriculture has converted or degraded much of the remaining natural habitat in the intensively farmed upper midwestern United States. While advances in sustainable agriculture may have success in reducing chemical inputs and soil losses, restoration of biological diversity has not often been a primary focus.

To restore native biological diversity and ecosystem processes within these agroecosystems, it will be necessary to renew relationships between farming and the natural ecosystems that can enhance the sustainability of both ("agroecological restoration").

The greatest potential for achieving this goal lies in working with livestock producers. In recent years, many livestock producers have converted to management-intensive grazing (MIG), in which pasture is the primary forage source for livestock. MIG works well because it maximizes the productivity and nutritional quality of the pasture, rotating the herd through paddocks and allowing the plant community in each paddock to rest for three to five weeks between grazing events. Depending on the intensity of grazing pressure, some remaining prairie pastures harbor a fairly diverse community of native plant species (prairie remnants). Some of the native, warm-season grasses could offer grazing options during the months when cold-season grasses are dormant or producing at low levels.

Dan Specht transplanting seedlings in the "refuge" area

Objectives of this project were to:
- Determine the best methods for establishing native warm-season grasses on preexisting cool-season grass-clover-alfalfa pastures,
- Evaluate the impact of grazing one and two years after pasture establishment on plant survival and growth, and to evaluate forage availability and quality in those years,
- Measure use of the prairie pastures by birds (game and non-game),
- Establish a three-acre diverse "refuge" adjacent to one of the pastures (Natvig farm), consisting of prairie, wetland, and savanna plant communities, and
- Communicate experimental results to farm interest groups, conservation organizations, and other interested people.

Approach and methods

Our goal was to compare several methods of converting a cool-season pasture to a prairie pasture mix using tools and skills available to the farmer, and to evaluate whether this new forage source could be advantageous. In cooperation with several farmers in northeast Iowa who are members of Practical Farmers of Iowa, experiments were initiated on three farms and completed on two farms to fit the particular soils and livestock management practices of the cooperators. On the Mike Natvig farm, the emphasis was placed on increasing biological diversity in a range of habitats on his pasture, including pond, wetlands, mesic prairie, and oak woodland sites. On the Matt Stewart farm, the emphasis was on establishment success, forage production, and forage quality as well as the changing species composition of the plots. An unreplicated side-by-side trial was begun on the Tom Frantzen farm, but was suspended when virtually none of the native grasses planted in 1995 survived in 1996.

Methods of site preparation and seeding were compared in an attempt to balance the practical requirements of available labor, equipment, and cattle management with the need for replication and unbiased representation of all treatments in all parts of the field. The seed mix of big bluestem, Indiangrass, Illinois bundleflower, and switchgrass was designed to provide affordable, native, warm-season grass forage for farmers, and to include an inexpensive native, nitrogen-fixing legume palatable to livestock.

Natvig farm design and treatments Three treatments were randomly assigned to four replicate plots each with the No Seed treatment serving as a control. The other two treatments were first chemically treated to suppress the original pasture sod. Drilled (DR) plots were subsequently seeded with a truax native seed drill. Broadcast-trample (BT) plots were seeded and cattle were used to incorporate the seeds into the soil by trampling.

Cattle trampling seeds into plot

Plots were managed during the first two years of establishment to discourage weed seed production and protect new seedlings. One plot was given over to a frost seeding trial in March 1997. Cattle trampled seeds into the barely thawed soil in half the plot, while seeds were broadcast after the trampling in the other section of the plot. Attempts to use burning to control weeds on some plots were not successful because not enough fuel was present for the burn in the first two seasons. Replicated plots were not grazed during the first growing season until after frost, but were grazed three times in the second growing season. The plots were grazed in mid-May and late June during the third season. A planned August 1997 grazing was deferred to accumulate enough fuel for a spring 1998 burn.

Measurement and statistical analysis Seedlings of native grasses and bundleflowers were counted in five randomly placed quadrants in

Stewart farm 1995. Broadcasting seeds on tilled area. Untilled plots (with vegetation) are nearby.

Students counting seedlings at Natvig farm, 1995

July and October 1995 and July 1996. Pasture biomass was measured three times in 1996 and seven times in 1997. Percentage cover of pasture grasses and forbs, annual weeds, and bare ground also was estimated in these plots.

Stewart farm design and treatments The 60 m by 240 m field was divided into twenty-four 10 m x 60 m strips. Sod suppression (glyphosate or tillage) and seeding (drill versus broadcast-trample) treatments alternated in a regular grid pattern across the field. This arrangement made it possible to conduct field operations (tillage and spraying) in a timely manner using available farm equipment, while distributing both treatments evenly across the entire range of field conditions.

For the first two years, plots were managed to discourage weed seed production and protect the new seeding. The site was grazed in mid-May 1995 and mowed in July 1995. Grazing took place in May 1996, and the plots were mowed in June, July, and August for weed control. In the third year, 1997, plots were grazed by 50 heifers in May, June, and August.

Measurement and statistical analysis Seedlings of native grasses and bundleflowers were counted in five randomly placed quadrants per replicate plot in July and September 1995 and in July 1996. Plant species biomass was measured once in 1996 and five times in 1997. Percentage cover of pasture grasses and forbs, annual weeds, and bare ground also was estimated in these plots.

Clippings from August 1996 and July and August 1997 were analyzed at the University of Wisconsin-Madison Department of Agronomy for crude protein, acid detergent fiber (ADF), and neutral detergent fiber (NDF). ADF includes cellulose and lignin. NDF includes all plant fibers, except pectin. Relative Feed Value (RFV), a standard index of dry forage quality for livestock feeding, was calculated.

Comparison of bird use in natural habitats and rotational grazing pastures (separate from other field experiments) Six rotational grazing sites, one native ungrazed prairie, and two ungrazed savannas in northeast Iowa were selected for study. Bird abundance and species richness were compared between pastures and native grasslands through counts at each site six times between May and August, 1996. Census taking was done in the early morning when the birds were actively vocalizing. Vegetation structure and landscape level features at each site were also assessed to determine what features might attract grassland birds.

Results and discussion

Natvig farm design and treatments Remnant native species did not reappear as hoped. Outside the replicated no-seed (NS) plots, several native species appeared once the cows were excluded. Although small amounts of wildflower seed had been scattered in upland and waterway areas through the entire 3-ha area outside the experiment, they were established only in the enclosures along the waterways.

Herbicide application in the drilled and broadcast-trampled treatments succeeded in temporarily reducing the vegetation cover of treated plots, especially of pasture grasses. There were no differences between drilled and broadcast-trampled (BT) treatments in components of vegetation.

By the end of the first growing season, bare ground in the sprayed plots had been replaced by vegetation, but its composition was highly variable. On the first sampling date, drilled plots had significantly greater numbers of native grass and bundleflower seedlings than the broadcast trampled-treatment plots.

Despite large initial (July 1995) differences in pasture composition among treatments and sites, there was no significant treatment effect on pasture composition at the very beginning of the second growing season. Native grasses and bundleflowers were a very small component of aboveground forage in late June 1996. By August, native grass biomass had increased relative to other components of the pasture, and was significantly higher in drilled than in broadcast-trampled plots.

In year three, pasture development saw cool-season pasture grasses and forbs experiencing rapid growth by late June. Native grasses were present in very small amounts in seeded plots throughout May and June. In late summer, native grasses grew faster than all other components of the pasture. The seeded treatment with no herbicide burndown proved unsuccessful in most area of the pasture.

Frost seeding trial Compared to the summer 1995 BT treatment, the March 1997 frost seeding trial was more effective in establishing native grasses. In the frost seeding trial, researchers observed an average of 0.5 plants per m^{-2} in the paddock that was broadcast before trampling, and 2.5 plants per m^{-2} in the paddock that was broadcast after trampling. These differences were clearly visible from a distance. Switchgrass was more frequent and big bluestem less frequent than expected in the paddock broadcast-seeded before trampling, compared to the paddock in which seeds were broadcast after trampling. In other heavy cattle trampling areas, switchgrass also was more commonly observed.

Collecting biomass from Stewart farm, 1997

Burning, grazing, and plant establishment Burning and grazing interacted in unexpected ways. To carry out the prescribed spring burn, it was necessary to defer fall grazing to accumulate enough fuel for the burn. However, even when grazing was deferred, a combination of poor fuel availability, cool wet weather, and early growth of the cool season grasses prevented successful prescribed fires during 1995 and 1997.

In the first season (1995), grazing cattle ate more forage than expected which was good for livestock production, but left little forage for the following spring's scheduled burn. Midsummer grazing in 1996 occurred when the native grass seedlings that were just beginning their rapid phase of growth. They were exposed to competition from a thick, tall stand of Kentucky bluegrass, which had been growing for six weeks since the last grazing event. In 1997, the midsummer grazing date was shifted and there was very little new bluegrass growth to compete with the native grasses.

Stewart farm design and treatments The sod suppression method had a pronounced and statistically significant effect on the competitive environment of the emerging seedlings. While herbicide appeared to slow the growth of the original pasture species somewhat, it did not eliminate them as intended. Differences in ground cover had mostly disappeared by the end of the first growing season. Only orchardgrass maintained significant differences across sod suppression treatments.

Repeated observations after planting revealed that native grass and bundleflower seedlings differed in their germination behavior. Bundleflower seedlings emerged nearly synchronously within two weeks of planting (June 15, 1995). Only 7 to 17 percent of the seedlings survived until September of the establishment year and continued to decline precipitously through July 1996. Native grass seedlings emerged more slowly, but their survival rate in the first year (39 to 57 percent) was much higher than the bundleflower.

Forage composition and yield after establishment year Although the bundleflower grew well initially, it did not persist in any of the plots and was not a significant component of the sward at the time the study site was grazed and forage samples collected. Despite planting big bluestem and Indiangrass at equal rates, big bluestem made up 88 percent of the plants compared to 7 percent for Indiangrass.

The plots were first harvested for biomass in August 1996, the growing season after the establishment year. The proportion of warm-season grass biomass at this time was nearly zero for herbicide plots regardless of the seeding method used. For tillage plots, warm-season grass biomass comprised 18.9 and 11.1 percent for drilled and broadcast plots, respectively. Forage availability for the August 1996 harvest was significantly higher for tillage plots. Overall yield for the two June 1997 grazings was higher for tillage plots than for herbicide plots.

By June 1997, the proportion of warm-season grasses in tillage plots had increased to an average of 35 percent. By August, warm-season grass biomass had increased to 80.3 percent in drilled plots, which was 61 percent greater than in broadcast plots. Forage availability was 58 percent greater in drilled/tilled plots than in broadcast/trampled plots in August, reflecting the greater proportion of warm-season grasses present in these plots during their prime production period.

Species composition of the competing pasture vegetation changed markedly in the second and third years of observations. Annual weeds represented 78 percent of the biomass of tilled plots vs. 3 percent of untilled plots in August 1996. A year later, the mean biomass of annual weeds across all treatments was reduced to 9 percent of total forage, while native grasses gained both in total biomass and as a percent of the total forage.

Despite herbicide treatment meant to suppress the existing sod, these plots were dominated by orchardgrass in 1995 and 1996, but substantial mortality of this species, reported throughout northern Iowa in the winter of 1996-1997, resulted in a shift to perennial forbs.

Forage quality Forage quality is an important consideration for livestock farmers, especially those with dairy herds. Lactating dairy cows and calves have the highest nutritional requirements. Both crude protein levels and relative feed values for these plots were variable and generally lower than have been reported elsewhere for intensively managed cool-season pastures.

Crude protein levels for all treatments were highest for the June 1997 grazing. Both August samples had relatively low crude protein levels for all treatments. The herbicide treatment retained high percentages of orchardgrass, and the lower protein levels in these plots reflect the tendency for older tissue and reproductive tissue to contain less protein than the younger, more leafy tissue present in cool-season grasses earlier in the season.

Fiber and relative feed value Relative feed value is an index of dry forage quality. An RFV of 150 is equivalent to prime alfalfa hay. An RFV range of 100 to 300 is appropriate for

UNI students looking at a research plot on the Natvig farm. Native grasses and cupplant are in flower

most classes of livestock, including dairy heifers. Relative feed values were highest for all treatments in June 1997 and lowest in August 1996. These differences were very likely influenced by several factors including seasonal changes in grass structure and composition, weather conditions and grazing management. In 1997, relative feed values were higher for herbicide plots than for tillage plots, but did not differ between seeding methods within sod suppression methods.

Comparison of bird use in natural habitats and rotational grazing pastures The study showed no significant difference between grazed pastures and native sites for total species richness, grassland species richness, woodland species richness, or the abundance of several species of neotropical migrant grassland species such as meadowlark.

Pasture on the Stewart farm supported up to six desired neotropical migrant grassland bird species, compared to seven at Hayden Prairie (a 200-acre site in Howard County), northeast Iowa's largest and best tallgrass prairie. Pastures on the Natvig farm supported 17 species of woodland birds and two grassland species, compared to 19 species of woodland birds and five grassland species at a nearby savanna. The farms lacked species with large area requirements and highly specialized nesting requirements, such as bobolink, sedge wren, and Northern harrier. The Stewart farm had high numbers of brown-headed cowbirds, a nest parasite known to reduce the nesting success of neotropical migratory songbirds.

Conclusions

- Clean tillage and drilling are most reliable for establishing dense stands of native warm-season grasses. Sod suppression with glyphosate following by seed drilling is acceptable for areas where tillage is not possible.
- Native grass could be grazed lightly by the second year and show vigorous growth by the third year.
- Bundleflower, showy tick trefoil, and

cupplant all have drawbacks as components of native grass restoration efforts. Fowl manna grass, a native experimental forage species, appeared to be the most plausible option for wet waterways.
- Prairie pasture restoration will require reintroduction of most native grasses.
- Burning during native grass establishment is conducted at the expense of grazing.
- Birds use rotational grazing pastures as they would use prairie and savanna nature preserves. Grazing later in the season for native grasses would help sustain bird populations.

Impact of results

While we suspect that the dominant prairie grasses will prove to be tolerant of rotational grazing with appropriate rest periods, some prairie grasses and forbs will not. Devising establishment and grazing strategies that favor a forb component in prairie grass stands may be more of a challenge.

Prairie pastures may require very different management than that used for cool-season pastures. Periodic burning may be needed unless we can manage grazing to mimic the effects of fire. A combination of grazing and burning may help retain a plant community dominated by prairie species, but pure stands of prairie species are likely to be impossible to maintain. Prairie pastures are more likely to contain a mixture of cool-season forage species, warm-season prairie grasses, and grazing-tolerant prairie wildflowers. Successful agroecological restoration will, by necessity, involve devising practical, flexible systems that provide for preservation of both biodiversity and profitability.

Education and outreach

Several publications have resulted from this project, four of them appearing in *Restoration Ecology*. *Prairie Seedlings Illustrated* sold more than 800 copies and has been reprinted. More than ten public lectures were given on prairie and ecological restoration. Posters and seminars were presented on 12 occasions at Iowa State University, University of Wisconsin-Madison, the Iowa Academy of Science, University of Northern Iowa, Grinnell College, and other meetings. The prairie restoration project was featured at Practical Farmers of Iowa field days from 1995 to 1998. The Leopold Center helped fund a two-day Prairie Pastures Field Workshop in July 1997 that was attended by 112 people from five states. The pastures on the farms of Matt and Diana Stewart and Mike Natvig were each visited by more than 150 people over a three-year period.

For more information contact Laura Jackson, Biology, University of Northern Iowa, Cedar Falls, Iowa 50614; (319) 273-2705, email Laura.L.Jackson@uni.edu.