

Profitable prairie restoration: The EcoSun Prairie Farm experiment

Cody Zilverberg, W. Carter Johnson, David Archer, Scott Kronberg, Thomas Schumacher, Arvid Boe, and Craig Novotny

Ongoing conversion of grassland to cropland in the northern Great Plains, declining wildlife populations, and worsening soil and water quality prompted a South Dakota group to search for agricultural practices that would balance environmental concerns with farm economics. Thus was born the EcoSun Prairie Farm (<http://www.ecosunprairiefarms.org>), an experimental working farm based on the land ethic and philosophy of Aldo Leopold. EcoSun's primary objective was to see if converting cropland to native tallgrass prairie could simultaneously improve the environment—especially soil and water quality; prairie wetlands; and biodiversity, including wildlife—and provide sufficient income to support a farm family through the sale of grassland products. Six years later, EcoSun continues to sell native plant seed, hay, and beef, and to share lessons learned. As the restoration has progressed, many amphibians, game birds, and neotropical migrant birds have already returned to the farm, but an important measure of the project's long term success will be the number of producers that adopt the farming approach advocated and demonstrated by EcoSun.

EcoSun was founded as a nonprofit organization by three faculty members at South Dakota State University and one research scientist from the USDA Agricultural Research Service in Mandan, North Dakota. These four serve on the board of directors and provide a core of scientific knowledge in areas of soil science (Thomas Schumacher), forage breeding and production (Arvid Boe), wetland ecology (Carter Johnson), and animal science (Scott Kronberg). Initially, EcoSun signed a five-year lease on a section (~259 ha [~640 ac]) of land near Colman, South

Dakota. Guaranteeing five years was important for EcoSun because of the investment required to restore prairie and the low yields obtained from perennial plants in the establishment year. Restoration efforts began in 2008 with establishment of 24 ha (60 ac) of switchgrass (*Panicum virgatum*) monocultures planted for seed production and 41 ha (100 ac) of cropland and former Conservation Reserve Program land that was renovated by establishing mixtures dominated by warm-season grasses (figure 1). Each year, more land was restored, including a field of 45 ha (110 ac) planted to a mixture of 23 warm- and cool-season grasses and forbs. In 2011, the last large-scale restoration occurred when a 22 ha (55 ac) field was snow-seeded with seed harvested from a nearby prairie remnant owned by The Nature Conservancy.

DIVERSITY CRUCIAL TO FARM SUCCESS

Maintaining diversity of plant species is essential to EcoSun's conservation goals, but the organization has also been intentional about cultivating a variety of income streams. In 2009, the first year that products were

harvested, the only income was from switchgrass seed. The next year, a small quantity of summer hay and native wetland plant seed was added. By year five, the farm was generating revenue from many different sources: seed harvested from three grass species planted in monocultures (switchgrass: 3,435 kg [7,573 lb]; prairie cordgrass [*Spartina pectinata*]: 73 kg [161 lb]; and wedgrass [*Sphenopholis obtusata*]: 25 kg [55 lb]) and a variety of wetland forbs and grasslike species in smaller quantities; summer hay (47 t [52 tn]) and autumn hay (291 t [321 tn]); contract grazing (75 yearling heifers for 5.5 months); and beef (2,085 kg [4,600 lb]). The variety of products helps the farm to manage economic risk—if one crop fails or the market price of one product falls, income from other products can soften the blow.

Seed harvested from seasonal and temporary wetlands has been an important source of income for the farm. Whereas current row crop farming in the western Corn Belt encourages the draining of wetlands and shallow ground water to expand corn (*Zea mays*) acreage, EcoSun's goal is

Figure 1

Farm manager Craig Novotny and EcoSun board member Arvid Boe evaluate a field of grasses and forbs. Previously in a corn-soybean rotation, the field was planted to a 13-species mixture in 2008.



Cody Zilverberg is postdoctoral associate in Natural Resource Management at South Dakota State University (SDSU), Brookings, South Dakota. **W. Carter Johnson** is professor in Natural Resource Management at SDSU. **Thomas Schumacher** is professor emeritus and **Arvid Boe** is professor in Plant Science at SDSU. **Scott Kronberg** is research scientist and **David Archer** is agricultural economist at the Agricultural Research Service (ARS) in Mandan, North Dakota. **Craig Novotny** is farm manager and restorationist at EcoSun Prairie Farms.

to restore shallow wetlands and groundwater to maintain water supplies for wetland plants with wildlife and commercial value. For instance, monocultures of prairie cordgrass and prairie wedgegrass were planted into some of the formerly drained wetlands on the farm, and their seed is harvested annually (figure 2). Other wetlands were planted to a larger variety of native species or allowed to naturally revegetate.

Restoring a wetland in the middle of an otherwise homogeneous field is an example of applying one of EcoSun's guiding principles: put the right plant in the right place. Unlike the typical Corn Belt farm that plants a single crop over large acreage—ideally in rectangular fields—EcoSun strives to enhance diversity by matching plants to the contours in the land. For instance, one 16 ha (40 ac) field planted to a mixture of prairie species contains four small wetlands within its borders. Each of these wetlands was restored and planted with species adapted to wetland soils. Thus, plant diversity of the entire field increased, and the restored wetlands produce high-value seed and abundant biodiversity.

Ecosystem services are difficult to monetize, but EcoSun captures some additional value by marketing “prairie-raised” beef produced on the farm. Yearling heifers graze EcoSun's pastures from May to October as part of a contract grazing arrangement with a rancher who retains ownership in the cattle (figure 3). In the autumn, EcoSun selects the best cattle and has them slaughtered, butchered, and packaged. The meat is locally marketed to conservation- and health-minded customers at restaurants, grocery stores, and directly through EcoSun's website; meat is marketed nationally through a new startup company, NuAgra.

Although the meat is perhaps the most highly-visible and “exciting” of the products offered by EcoSun, grass seed has been the economic mainstay. Income from seed has increased each year of EcoSun's operation. The farm has also increased its hay sales each of the past three years, as more land comes into production and the farm's managers improve their marketing skills. Most of the hay produced on the farm is not cut until autumn for several reasons: to produce high yields, to conserve nutrients, and to provide wildlife cover throughout the growing season.

BLENDING RESEARCH AND DEMONSTRATION

Most of EcoSun's efforts are dedicated to testing and demonstrating restoration and management at the field scale, but research has also been part of the farm from the beginning. Some of the research has been formal, such as a replicated design to determine the optimal seeding rate for switchgrass, whereas other research has been less formal, such as burning patches of grass at different times of the year and observing plant response.

Data collected at large and small scales complement each other by providing two perspectives on the same question. For instance, yield data from entire fields are collected two ways: by hand-sampling small areas and by weighing the bales made from the field at the end of the year. The hand-collected data give estimates of biomass production from an ecosystem perspective, whereas the bale data inform a farmer about how much yield, and therefore revenue, he might expect from each type of field. These data provide benchmarks to evaluate the farm's future performance, including trends in yield, and its performance relative to published research and other commercial farms.

Among the replicated research conducted on the farm has been the comparison of the yield of switchgrass monocultures

Figure 2

Carter Johnson, EcoSun chairman, stands in front of prairie cordgrass in a restored wetland on the farm.



to a mixture of 13 species at three different landscape positions. Results from these experiments have generally agreed with the data collected at the field scale: biomass yields of the mixtures are good, but switchgrass monoculture yields are better (Zilverberg et al. with editor). This illustrates the tradeoff between productivity and conservation that a commercial enterprise

Figure 3

Yearling stocker cattle graze parts of the farm each year. Temporary electric fencing is used for rotational grazing.



like EcoSun faces. EcoSun continues to experiment with strategies that will simultaneously optimize yield and diversity.

LESSONS LEARNED

The farm leaders have made many management changes over the first six years of operation and have gained useful insights from ongoing evaluation of their project. With respect to establishment strategies, EcoSun's farm manager and restoration ecologist, Craig Novotny, has taken several approaches. For instance, prairie cordgrass has been planted by installing plugs by hand, using a tree planter, and using a no-till drill. Using a drill requires the least amount of labor, but seed placed in the bottom of a wetland may wash away and seedlings may be drowned before becoming established. Using a tree planter reduces establishment risk and requires less seed than drilling, but requires starting plants in a greenhouse. For future large-scale plantings, Novotny stated, "I would prefer to use a drill if enough seed was available. When we first started out, we didn't have enough seed from the population of prairie cordgrass we wanted. So, we had to grow our own plants started from plugs. Now, we produce enough seed for our own use and for sale to others."

For someone interested in harvesting their own seed, Novotny recommends investing in a small, used combine that has a good reputation and for which parts are readily available. "The 12-foot head on our combine works well for harvesting our prairie cordgrass because it's planted in relatively small patches," he said, "but a 20-foot wide head would be better for our larger switchgrass fields."

Tillage and planting machinery have been used for establishing fields, in addition to herbicides, fire, and most recently, cattle. "We use the cattle as ecosystem engineers," said Novotny. "We sometimes let them graze areas targeted for restoration rather than mowing the areas with large machinery."

Although valued for their ecosystem engineering, EcoSun's cattle are also expected to turn a profit. Scott Kronberg, EcoSun's livestock production specialist, believes that a long-term land-tenure arrangement would allow development of additional livestock enterprises, such as a cow-calf beef herd, a grass-based

dairy, or pastured poultry. "Considerably more profit could be generated from the grassland by adding pastured chicken production—both egg and broiler," he said.

These lessons reflect the specific management knowledge gained from the experiment, but the biggest question answered was about the viability of the farm. "The most important thing we've learned, and the thing that we were the most uncertain about when we started, is that the farm is profitable and hence has potential to be adopted as an alternative farming method in the western Corn Belt," said Carter Johnson, but "this approach is not a get-rich-quick scheme." It may take two years before perennial plants are harvested and provide economic return. In addition, even after perennials are well established, it is difficult to compete with high commodity crop prices, like those experienced from 2010 to 2012.

MEASURING SUCCESS

Success at EcoSun depends on maintaining the delicate balance between the dual goals of conservation and profitability. For instance, although monocultures of switchgrass reduce soil erosion and build organic matter relative to a corn-soybean (*Glycine max*) rotation, they lack biological diversity. On the other hand, diverse fields of prairie plants have proven to be lower yielding than switchgrass monocultures, are more difficult to manage because they contain ecologically important broad-leaved plants that are sensitive to herbicides needed to control invasive weeds, and produce mixed-species seed with lower market value than single species lots.

So, through six years of operation, has EcoSun been successful? Farm revenue increased every year as more land came into production and marketing skills improved (figure 4). Gross revenue reached US\$138,000 on 221 ha (546 ac) in 2012 despite severe summer drought. A landowner who provided his own labor would have had a net income of US\$60,000. Although this was less than what could have been earned at the historically high corn prices of recent years, it was more than the median household income (US\$49,415; US Census Bureau 2013) in South Dakota. Many farm families choose to farm because of the lifestyle, and some may be willing to

accept a lower income in exchange for a lifestyle that promotes conservation of soil, water, and wildlife while performing animal husbandry. This style of farm may also appeal to landowners who have off-farm income or live elsewhere, but who wish to be good stewards of their ancestral land and maintain a place to hunt and recreate.

From a conservation perspective, success on the farm is clear. Many native plant and animal species have increased in abundance on the farm, including at-risk grassland birds such as bobolinks (*Dolichonyx oryzivorus*) and grasshopper sparrows (*Ammodramus savenarum*), and other grassland obligates such as upland sandpipers (*Bartramia longicauda*). In restored wetlands, there have also been major increases in amphibians, primarily spring peepers (*Pseudacris crucifer*) and western chorus frogs (*Pseudacris triseriata*). Improvements in wildlife habitat and soil erosion occurred rapidly during the first few years. During high intensity spring rainfall events, researchers have observed severe rill erosion occurring on adjacent corn and soybean fields, but not on the restored grassland. Reduced soil erosion also translates into improvements in water quality. In contrast to the short time frame required for improvements in wildlife habitat and soil erosion, other improvements in soil quality, such as the organic matter content, will require more than a few years to make significant gains.

Hundreds of people have visited the farm since its inception, ranging from local farmers, to conservation agency personnel, to a group of Kazakh farmers on a tour of the United States. Classes of young students at South Dakota State University have toured the farm, as have classes of retired persons participating in the Osher Lifelong Learning Institute. "We're definitely getting the word out there," said Johnson. "We're approaching agriculture from a different perspective, and we can show people what it looks like in practice. We're hoping that it helps people to think in a new way, consider new alternatives to the way we typically farm."

TAKING THE NEXT STEP

When EcoSun's five-year lease ended after the 2012 harvest, board members were faced with a difficult decision. The price of corn and soybeans had risen dramatically in the years since the project was initiated, and land

Figure 4

Sources of revenue (blue, red, and green bars) and operating costs (purple bar) on EcoSun since establishment in 2008. Costs do not include labor or land rental (Archer et al. 2013).

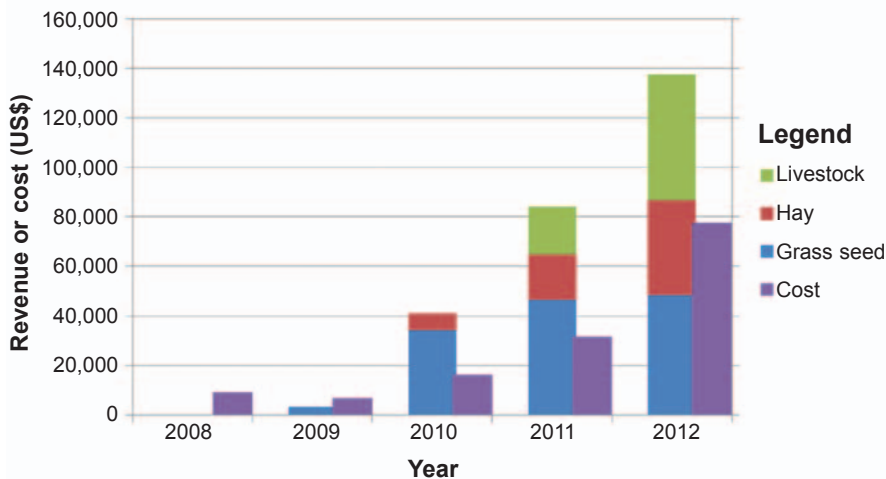
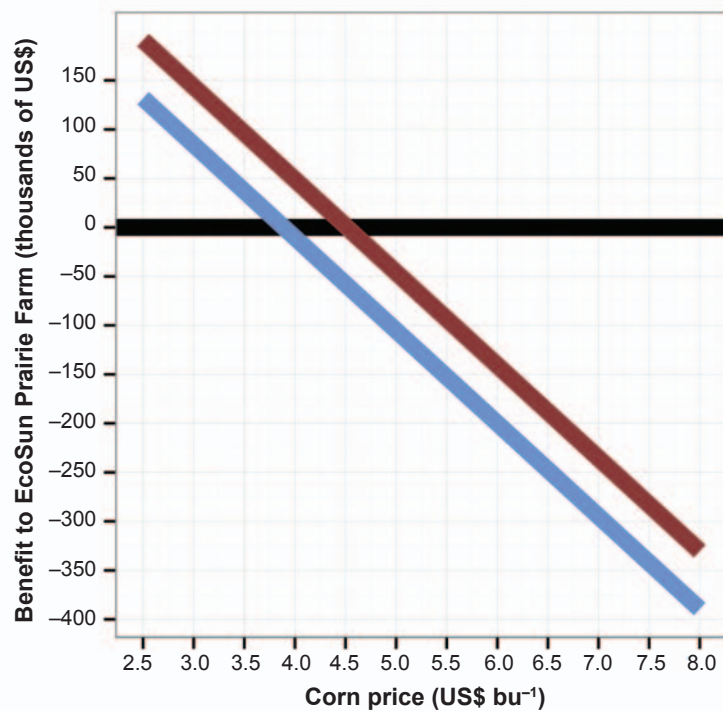


Figure 5

Raising hay and seed produces the same net revenue as corn at US\$4.52 bu⁻¹ (red line) when hay is valued at US\$75 tn⁻¹, switchgrass seed is US\$2.65 lb⁻¹, and switchgrass seed is produced on 22% of a 600 ac farm. If no switchgrass seed is produced, the hay farm would produce the same net profit as corn at US\$3.89 bu⁻¹ (blue line). The distance between the red line and the horizontal black line indicates the net revenue that would be gained or lost by raising hay and seed rather than corn at a wide range of corn prices.



ure, the board considered discontinuing the project. However, urged by supporters who viewed the farm as an important example of native grassland farming, the board decided to continue the project with annual lease renewals. The farm received favorable rainfall in 2013, so EcoSun is optimistic about yields, although final numbers are not yet available. The decline in the price of corn from 2012 to 2013 may also lead to some relief in land rental cost and makes farming hay and grass seed economically competitive (figure 5).

EcoSun is now looking beyond the borders of the flagship farm and working to find ways to provide information and land management recommendations to others interested in replicating grassland farming. “We’ve had a lot of people tell us they’re interested in our work, and they’d like to do something similar on their land, but they don’t have the knowledge, equipment, or time to do it themselves,” Johnson said. “Right now we’re looking for sources of funding to provide arrangements that will reduce the cost of establishing commercial prairie vegetation on other farms.” For instance, cost-share programs could replace the revenue lost during the first two years when establishment is taking place or might cover the cost of seed and initial planting. While some producers make farming decisions based primarily on profitability, there are many others, especially on smaller farms, that would prefer grassland to row crops if it is profitable. Reducing establishment costs might be enough encouragement for those farmers to make the transition. If EcoSun succeeds at spreading its farming style to more acres, it will be a victory for the region’s soils, lakes, wetlands, conservation-minded farmers, and wildlife as well.

REFERENCES

- Archer, D.W., W.C. Johnson, C.J. Zilverberg, C. Novotny, T. Schumacher, A. Boe, and S. Kronberg. 2013. Economic Performance of a Corn Belt Grass Farm. Poster presented at the 68th International Annual Conference of the Soil and Water Conservation Society, Reno, Nevada, July 21–24, 2013.
- US Census Bureau. 2013. Median household income by state – single-year estimates. <http://www.census.gov/hhes/www/income/data/statemedian/>.
- Zilverberg, C.J., W.C. Johnson, V. Owens, A. Boe, T. Schumacher, K. Reitsma, C.O. Hong, C. Novotny, M. Volke, and B. Werner. With editor. Biomass yield from planted mixtures and monocultures of native prairie vegetation across a heterogeneous farm landscape. *Agriculture, Ecosystems, and Environment*.

prices and rent had followed suit. Should EcoSun renew their lease at the new, higher land rental rates? Or should they take the lessons learned, publish their findings, and move

on? Unlike corn or soybeans, EcoSun’s products don’t enjoy generous safety net insurance programs. Due to increased land rent and the risk associated with crop fail-