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"Harnessing the Power of Prairie for Renewable Energy Production"

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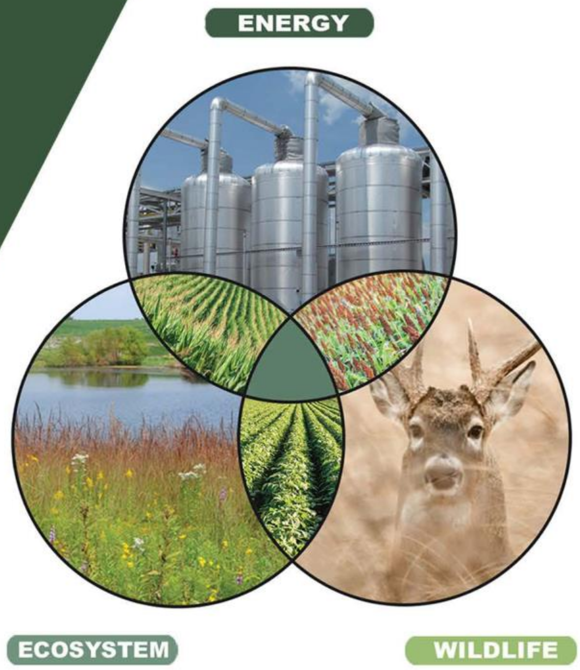

Harnessing the Power of Prairie for Renewable Energy Production

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1. Introduction

Agriculture in the United States Corn Belt area has intensified over the last century. Although this process has resulted in an extraordinary increase in crop production (Kucharik and Ramankutty, 2005; Ray et al., 2012; Nielsen, 2023), cultivation of a handful of crops has diminished the number of native wildlife species (Matson et al., 1997, Brown and Schulte, 2011). One approach to restore native perennial vegetation within croplands is through implantation of narrow strips of mixed native perennial species within row crop fields, known as "prairie strips" (Kemmerling et al., 2022), a conservation practice that provides multiple, long-term "disproportionate" benefits to society compared to other perennial vegetation because of the diversity of species incorporated. These benefits include improved water quality, wildlife habitat, and biodiversity across several taxa, including pollinators; reduced soil erosion, surface runoff and nutrient exports, greenhouse gas (GHG) emissions, and flood risk; and improved soil health, carbon sequestration, infiltration, water holding capacity and crop resilience to seasonal climatic variability (Zhou et al., 2014; Schulte et al., 2022; Henning et al., 2024). Prairie strips can be targeted to marginal, less profitable acres within row crop fields to improve farm profitability, can be harvested for biomass for renewable energy projects, or leveraged to generate credits with new emerging payments for ecosystem services markets (Pérez-Suárez et al., 2014; Keenor et al., 2021) to generate revenue for landowners while creating new economic development opportunities for rural communities (Schulte et al., 2022). In other words, small additions of land into prairie strips have the potential to provide dramatic, disproportionally large benefits to the landscape, and toward soil conservation, nutrient retention, wildlife habitat and the long-term economic productivity and sustainability of farmed landscapes (STRIPS, 2020).

In the nine decades since the Dust Bowl and the establishment of the Soil Conservation Service (the original name for Natural Resources Conservation Service), USDA has historically emphasized engineering practices or vegetative soil conservation strategies involving monocultural plantings of nonnative plants, largely excluding native species from in-field conservation practices and Farm Bill programs (Schulte et al., 2017). That changed when Congress first included prairie strips in the 2018 Farm Bill. The response from the U.S. Department of Agriculture (USDA) since then has been mixed. The Farm Services Agency (FSA) quickly established a new continuous practice for prairie strips (CP43) in the Conservation Reserve Program (CRP) and succeeded in establishing over 22,000 acres of prairie strips in 14 states (USDA – FSA, 2023). However, the actual reach of this program extends beyond this acreage, as approximately 10 times that amount of cropland is protected through prairie strips (i.e., at least 230,000 acres) (IAWA, 2021). Unlike many CRP practices that focus on converting large areas of crop fields into conservation practices, the CP43 prairie strip practice allows for just a small portion of a field, typically 5-10% and never more than 25%, to be planted with prairies (Zhang et al., 2023). However, the Natural Resources Conservation Service (NRCS) has yet to establish a conservation practice standard for prairie strips under the Environmental Quality Incentives Program (EQIP). Congress has an opportunity in the 2024 Farm Bill to direct NRCS to establish an interim conservation practice standard for prairie strips and incentivize farmers and landowners to adopt this potentially transformational conservation practice at scale.

2. What are Prairie Strips?

In 2007, Iowa State University (ISU) established a catchment-scale experiment termed "STRIPS" (Science-based Trials of Row-crops Integrated with Prairie Strips) that interspersed strips of native prairie grasses and forbs within fields of corn and soybeans at the Neal Smith National Wildlife Refuge in Jasper County in central Iowa (Schulte et al., 2017). ISU selected native Central Tallgrass Prairie plant species for reconstruction and evaluation since prairie was the dominant plant community prior to Euro-American settlement in the nineteenth century and subsequent widespread agricultural land use. The prairie species were strategically planted to slow the movement of water within 12 small watersheds or catchments, 1 to 8 acres in size with slopes between 6 and 11%, in cropland under no-till management without cover crops (Zhou et al., 2010). Prairie vegetation was planted along the contours and bases of slopes in nine agricultural catchments on either 0% (100% row crops), 10% (90% row crops), or 20% (80% row crops) of the row crop acres within each catchment. Results were compared with three control catchments without prairie strips used solely for corn and soybean production. (Schulte et al., 2017). From 2007-2014 researchers monitored each catchment for corn and soybean yields, sediment, water, nitrogen, and phosphorus runoff; greenhouse gas emissions, and plant, insect, and avian biodiversity (Youngquist et al., 2020). The STRIPS experiment tested whether prairie strips could deliver increases in ecosystem services and benefits at disproportionately greater levels than the area of the catchments they occupied, compared with 100% row crop control catchments, with the expectation that prairie strips comprising 10% and 20% of agricultural catchments would result in greater than 10% and 20% increases in biodiversity and ecosystem services and benefits, respectively (Schulte et al., 2017). Over this 7-yr period, researchers at the STRIPS team found that planting just 10% of the field with prairie strips reduced sediment export by 95%, phosphorus export by 90%, and nitrogen export by nearly 85% in surface runoff water when compared to 100% losses in the control with no-prairie strips adoption. Nitrogen loss through groundwater was also reduced by 70% for untiled fields with prairie strips. Emissions of nitrous oxide, a highly potent greenhouse gas, were also reduced by 70% when prairie strips were located on footslopes (Iqbal et al., 2015; STRIPS, 2020). Previous research has also shown that prairie strips interspersed with row crops can provide habitat for native biodiversity (Hirsh et al., 2013; Zhang et al., 2023), improved soil health (Pérez-Suárez et al., 2014), reduced nutrient loss and runoff (Abu-Zreig et al., 2004, Hernandez-Santana et al., 2013), and other ecosystem services. Thus, and on top of the remarkable environmental benefits to soil health and wildlife, there is also an economic benefit following establishment of prairie strips, as more soil and nutrients stay in the field to fertilize crops, instead of being lost to the environment.

ISU researchers used a consistent, comprehensive statistical treatment of agronomic, biological, and hydrological measures and data that allowed for explicit consideration and comparison of tradeoffs among various performance indicators to assess the effects of prairie strips relative to the proportion of the catchments they occupied (Schulte et al., 2017). Starting in 2015, the team expanded their research to include evaluation of prairie strips on commercial corn and soybean fields across the state of Iowa. The summary below incorporates both sets of results.

3. "Disproportionate" Benefits of prairie strips

Besides the multiple benefits related to soil health and nutrient stewardship, research also demonstrated significant disproportionate biodiversity benefits from prairie strips. Replacing just 10% of cropland with prairie strips (i.e., leaving 90% of the field to row crops) led to greater catchment-level insect taxa richness (2.6-fold), pollinator abundance (3.5-fold), native bird species richness (2.1-fold), and abundance of bird species of greatest conservation need (2.1-fold), as compared with catchments containing 100% row crops (Schulte et al, 2017). Moreover, an average of 39 native plant species were found within the prairie strips, compared to 7.3 native plant species found in catchments without prairie strips (Hirsch et al., 2013). These native plants improve habitat for birds, pollinators, and other beneficial insects. Prairie strips further support lady beetles and several other species of insect predators that help to control harmful insect pests that damage corn and soybeans and reduce crop yields (Cox et al., 2014).

Multiple prairie wildflowers bloom throughout the growing season in prairie strips, supporting a diverse community of butterflies and pollinators including 70 species of native North American bee species and European honeybees (Youngquist et al., 2020; Kemmerling et al., 2023). Recent research also shows that the diversity of bees using prairie strips could increase with their floral diversity (Kordbacheh et al., 2020), and some wild bee species show improved body condition on fields with prairie strips as opposed to those without (Borchardt et al., 2023). European honeybee colonies kept at fields with prairie strips collected 50% more pollen during the growing season, had 24% greater worker bee populations by the end of September, were 24% heavier at their peak weight in August (indicating greater honey production), and 20% higher overwinter survival than honeybee colonies kept at control fields without prairie strips (Zhang et al., 2023). Prairie strips also benefit multiple butterfly species (Kemmerling et al., 2023).

Research also suggests that prairie strips have the potential to reduce the harmful effects of neonicotinoids, a widely used category of pesticide crop protection products that can be transported to adjacent habitats from crop fields through drift or runoff. Results indicate that while clothianidin, thiamethoxam, and imidacloprid can be detected in milkweed leaf tissue samples taken from prairie strips, it is unlikely that monarch larvae will be harmed from this route of neonicotinoid exposure (Hall et al., 2022). Prairie strips have also been shown to reduce harmful bacteria and antimicrobial resistance genes associated with swine manure from agricultural runoff (Alt et al., 2023), and antibiotics (tetracycline, sulfamethazine, and tylosin) are unlikely to persist throughout the growing season in soil under prairie strips or row crop management (Iverson et al., 2022).

Fields with prairie strips support more native bird species and at higher densities than fields without prairie strips (Schulte et al., 2016; Giese, 2023). Birds utilizing prairie strips habitat included several grassland bird species of greatest conservation need such as the Dickcissel, Eastern Meadowlark, Field Sparrow, and Grasshopper Sparrow (Giese, 2023). Grassland birds nesting in prairie strips have similar daily nest survival rates as larger patches of grassland in Iowa (Stephenson, 2022).

In terms of grain yields, researchers found that prairie treatments were unlikely to be associated with *any* decrease in corn and soybean yields when compared with full-field corn and soybean plots (Damiano and Niemi, 2020). Prairie strips significantly improve multiple soil metrics, including soil organic carbon, but their affect does not extend very far into adjacent cropland and because of this, it is speculated that they have little effect on crop yields (Dutter et al., 2023). Native plant species and plant communities established within prairie strips are not likely to cause weed pressure or crop losses in farm fields (Hirsh et al., 2013). Natural vegetation adjacent to soybean production can boost yields through improved pollination (Garibaldi et al., 2021), though this phenomenon has not yet been documented in the US.

Financial assessments demonstrate that prairie strips represent a low-cost agricultural conservation option for farmers and farmland owners relative to alternative conservation practices (Tyndall et al., 2013). The range of costs for establishing prairie strips is calculated based on average land rent across cropland quality, as measured by CSR2, the updated Corn Suitability Rating index. On average, water runoff from every nine acres of row crops can typically be treated with just one acre of prairie strips. For every 10 acres of farmland, average total annual costs of converting one acre of cropland to prairie ranges from $200 to $300 (STRIPS, 2020).

Summarizing, prairie strips can be managed to increase catchment-level insect and bird taxa richness, including lady beetles and other insect predators, butterflies, pollinator abundance, native bird species richness, abundance of bird species of greatest conservation need, and native plant species. Additionally, prairie strips have the potential to reduce the harmful effects of neonicotinoids pesticides, bacteria and antimicrobial resistance genes associated with swine manure from agricultural runoff, and antibiotics in both wildlife and water quality. Most prairie restorations have the broad intent to restore ecosystems to reference conditions and land use (Hallett et al., 2013), but restoring prairie strips to strategic locations in and around crop fields will advance the simultaneous goals of optimizing biodiversity, ecosystem services, and biomass yields without grain yield penalties in modern agroecosystems (Kemmerling et al., 2023).

4. Horizon II Summary

Scaling up reconstructed prairie strips and cover crops is at the heart of the Horizon II Partnership for Climate Smart Commodities project led by Roeslein Alternative Energy (RAE; *https://roesleinalternativeenergy.com/*). RAE is a developer, owner, and operator of renewable energy production facilities that convert biomass feedstocks and agricultural wastes to clean, renewable natural gas and sustainable co-products like soil amendments. Anerobic digestion and renewable natural gas displace petroleum-based diesel fuel and gasoline, providing a significantly more environmentally friendly alternative. At present, RAE focuses on incorporating native prairie restoration into their business operations. The Horizon II project seeks to source biomass from reconstructed prairie and cover crops in Iowa and Missouri. This biomass will then be mixed with manure in methane digesters to produce renewable natural gas and a host of environmental benefits and ecosystem services, including improving biodiversity outcomes, addressing climate change through carbon sequestration and reduced GHG emissions, and providing more sustainable and climate smart corn, soybeans, pork, and beef commodities.

RAE was launched in 2012 by Rudi Roeslein, co-founder and Chairman of Roeslein & Associates, a global leader in engineering, modular fabrication, and construction of industrial plant facilities, including aluminum can manufacturing. Rudi's vision is to restore 30 million acres of prairie and scale up an additional 100 million acres of cover crops throughout the Mississippi River Basin, while providing energy production, ecological services, and wildlife benefits.

5. Farm Bill

While the 2018 Farm Bill sparked a proliferation of prairie strips adoption through the quick actions of FSA to establish CP43, NRCS has yet to establish a conservation practice standard for prairie strips in EQIP nearly six years later. The lack of a nationally available stand-alone prairie strips conservation practice standard disadvantages America's farmers and farmland owners and deprives them of one of the most highly effective 'Climate Smart Agriculture' conservation practices. Receiving cost share to enrolling row crop acres in prairie strips through three-year and five-year EQIP contracts would be more attractive to some farmers and farmland owners than 10-year and 15-year rental contracts through Continuous CRP. As thoroughly documented over the last 15 years, adoption of prairie strips provides significant quantifiable environmental benefits that should be recognized through EQIP.

Iowa NRCS established a creative work around to this challenge by using other existing conservation practice standards (CPS) through EQIP to establish prairie strips, primarily Conservation Cover (CPS 327), Field Border (CPS 386), Filter Strip (CPS 393), Contour Buffer Strips (CPS 332), and Upland Wildlife Habitat Management (CPS 645). Iowa NRCS uses these conservation practices in combination or individually to design prairie strips to accommodate landowners' conservation goals and local site conditions, including priority resource concerns such as reducing sheet and rill soil erosion on highly erodible lands such as hillsides and end rows on steep slopes. (USDA-NRCS, 2021).

Three years after the 2018 Farm Bill, Iowa NRCS, in collaboration with ISU and FSA, produced a Technical Note (USDA-NRCS, 2021) that established various standards for prairie strips using the four conservation practice standards. Specifications included that prairie strips should not exceed 25% of field acreage, should have minimum widths of at least 30 feet, and should not exceed 120 feet in width. It also advises to increase strip widths in locations with anticipated high volumes of surface water runoff, on steep slopes, in soils with high clay content, and near waterbodies to buffer against pesticide drift. Increasing the width of prairie strips improves habitat for wildlife and beneficial insects. To reduce weed competition, NRCS further advises mowing two to three times during the growing seasons in the first two years of establishing prairie strips. Annual maintenance such as prescribed burning, spot spraying, spot mowing, grazing, and interseeding are needed to promote plant diversity, foster healthy plant communities, control weeds, and monitor the effectiveness of prairie strips systems. Iowa NRCS advises to conduct maintenance activities outside of the primary nesting and fawning season (May 15 – August 1). Finally, NRCS promotes flexibility in location and design of prairie strip systems to better suit farm operability and permits farm equipment to pass over prairie strips, making prairie strips convenient in addition to being a highly effective conservation and climate smart agricultural practice.

Unfortunately, because there is no current stand-alone conservation practice standard for prairie strips, NRCS is unable to track the acres of prairie strips through general EQIP, and therefore is not capable of fully quantifying the benefits of the practice. In addition, prairie strips are not currently available in EQIP outside of Iowa. Until 2021, cost share payments for existing EQIP subcomponents of prairie strips (CPS 327, 386, 393 and 332) were not competitive in the face of high establishment costs for prairie strips and CRP rental rates. More recently Iowa NRCS combined CPS 327 three-year contracts with CPS 645 five-year contracts to better reflect actual prairie establishment costs. These higher cost share rates are more competitive with CRP rental rates, but this has not been implemented beyond Iowa, and NRCS is still unable to track adoption of prairie strips through separate EQIP contract practice subcomponents.

6. Ask/Conclusion

Establishing native plant species within agricultural monocultures represents a transformational opportunity to offset habitat destruction and environmental degradation while addressing the climate and biodiversity crises. Prairie strips provide disproportionate benefits for water quality, soil conservation, carbon sequestration, nutrient runoff, and biodiversity benefits for birds, monarch butterflies, pollinators, and other beneficial insects without incurring grain yield penalties to crops. NRCS did not act on a request from Iowa Agriculture Water Alliance, ISU, Iowa Wildlife Federation, National Wildlife Federation, and Natural Resources Defense Council to create an interim prairie strips practice standard in 2021, nor did they officially respond to the request. Congress should direct NRCS to establish a stand-alone practice standard for prairie strips in the 2024 Farm Bill. In addition, prairie strips are one of the most effective Climate Smart Agriculture conservation practices, as measured through carbon sequestration and reduced GHG emissions through avoided nitrogen fertilizer application. USDA should add prairie strips to their list of Climate Smart Agriculture and Forestry (CSAF) Mitigation Activities list.

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