Quantification of the impact of prairie strips on grain yield at NSNWR

Luis Damiano & Jarad Niemi (niemi@iastate.edu), Department of Statistics, Iowa State University

May 13, 2020

We quantify the impact that the presence of prairie strips has on grain yield at Neal Smith National Wildlife Refuge (NSNWR).

Data and methods

Yield monitor data collected at the three NSNWR STRIPS sites for the period 2007-2019 are available in shapefile format, except for year 2017 (all data lost) and Interim 2016 (no data). Observations, recorded as points in a 2-dimensional space, are assigned to a catchment if the coordinate pair is located within the catchment boundaries as illustrated in Figure 1. The yield is then averaged across all catchment observations in a given year.

We model the logarithm of moisture-adjusted grain yield expressed in units of bushels per acre at standard agronomic moisture concentrations based on yield volume and moisture as reported by the yield monitor. Figure 3 provides estimated marginal means for each treatment. Following [1], we used a mixed-effect, linear regression model in which block and treatments were treated as fixed effects, and catchment and year were treated as random effects.

Results

We focus exclusively on the following research question: what is the magnitude of the decrease of crop grain yield associated with the presence of prairies in the aforementioned agricultural sites? The model provides relevant quantities via the treatment marginal means: the mean log grain yield for each treatment averaged over the fixed effects. Each of these measures the expected log grain yield for a theoretical catchment subject to each treatment on an average block, year, and watershed. Figure 2 shows CIs for the marginal means in bushels per acre.

To quantify the impact, we compare the effects on log grain yield of having no prairies versus the mean of having 10% of prairie strips, 10% of prairies at the footslope, and 20% of prairie strips. Table 1 summarizes this contrast.

Crop	Point estimate	95% CI	Prob. of a reduction
Maize	0.05	(0.15, -0.07)	0.80
Soybeans	-0.01	(0.10, -0.14)	0.40

Table 1: Percentage reduction in yield of a plot with prairie (10% of prairie strips, 10% of prairies at the footslope, and 20% of prairie strips) compared to an all-crop plot. Negative values indicate increased yield in a plot with prairie.

Given the model and the data, we find 80% and 40% probability that prairie treatments are associated with *any* decrease in mean grain yield for corn and soybeans, respectively. The estimated percentage reduction in yield for cropped areas in a prairie treated field compared to a full row-crop field are 0.05 (0.15, -0.07) and -0.01 (0.10, -0.14) for corn and soybeans, respectively.

Acknowledgements

We would like to thank Chris Witte, Monica Maier Shea, and the Heartland Coop for providing and organizing the data.

References

[1] Lisa A. Schulte, Jarad Niemi, Matthew J. Helmers, Matt Liebman, J. Gordon Arbuckle, David E. James, Randall K. Kolka, Matthew E. O'Neal, Mark D. Tomer, John C. Tyndall, Heidi Asbjornsen, Pauline Drobney, Jeri Neal, Gary Van Ryswyk, and Chris Witte. Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn–soybean croplands. *Proceedings of the National Academy of Sciences*, 114(42):11247–11252, 2017.

Appendix

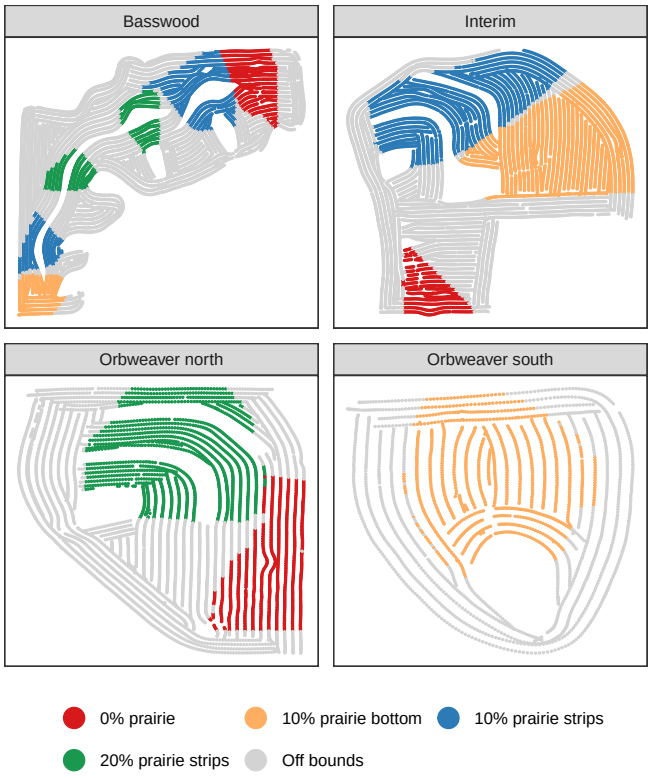

Figure 1: Observations assigned to each watershed.

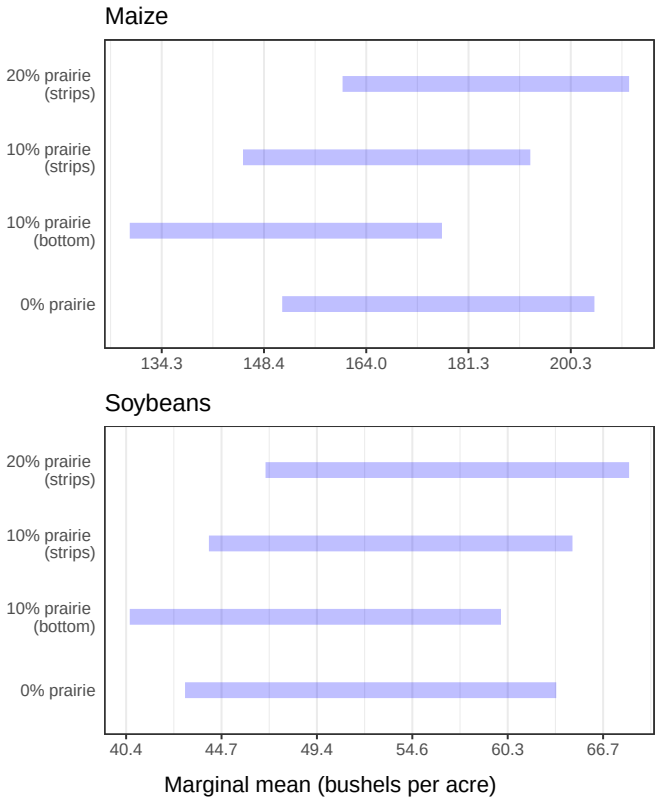

Figure 2: Estimated 95% CI for the marginal means. These estimate the expected crop grain yield for a theoretical catchment subject to each treatment on an average block, year, and watershed.

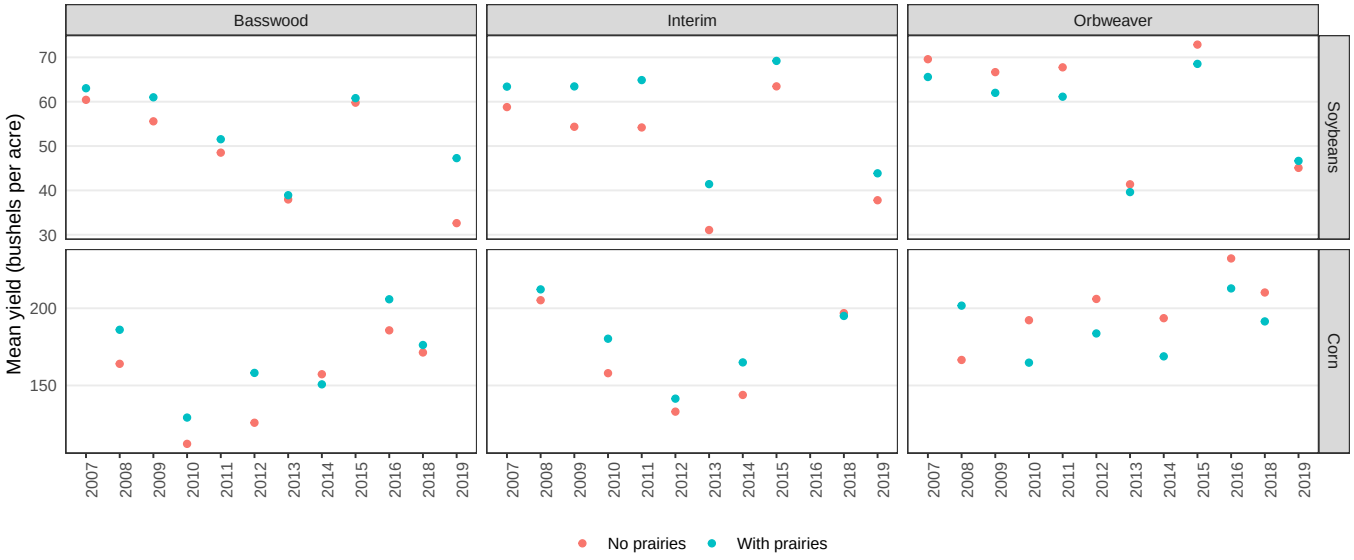

Figure 3: Mean yield across no-prairie catchments versus mean yield across catchments with any prairie treatment.