Undergraduate Student Work

Summer 2018

Collecting Carbon: An Analysis of Soil Carbon in Conservation Reserve Program Fields and Agricultural Fields

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Recommended Citation

Welcher, Cody; Magee, Destiny; and Elgersma, Kenneth, "Collecting Carbon: An Analysis of Soil Carbon in Conservation Reserve Program Fields and Agricultural Fields" (2018). *Undergraduate Student Work*. 4.
https://scholarworks.uni.edu/ugswork/4

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Collecting Carbon

An Analysis of Soil Carbon in Conservation Reserve Program Fields and Agricultural Fields

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Background

Intensive agricultural practices are associated with detrimental effects to the environment including, but not limited to, increasing the rate of soil erosion, introducing pollutants to water supply, reduced habitat for various species, and reduced atmospheric carbon sequestration in soils.

The Conservation Reserve Program allows farmers to enroll sensitive lands into the program and out of circulation for agricultural purposes. It has been shown to increase soil carbon sequestration, reduce erosion, increase water and air quality, and provide habitat restoration for displaced species, along with other benefits.

Research Questions

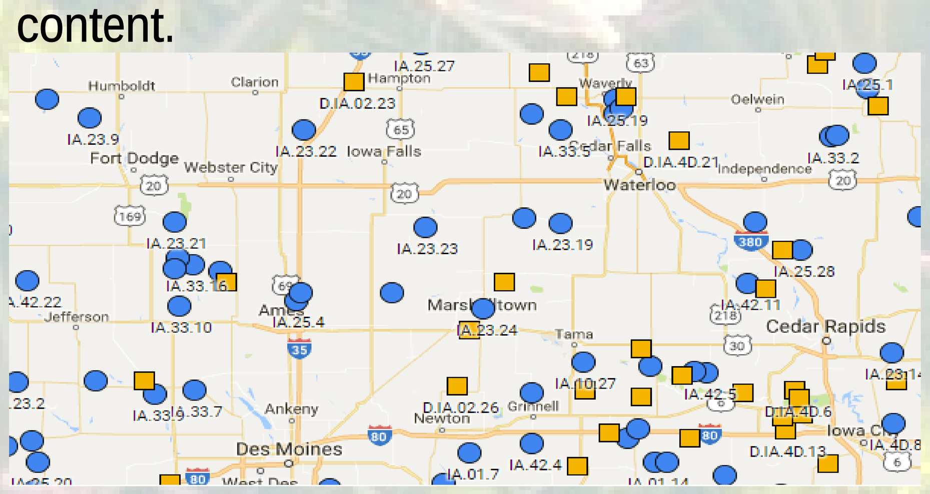
1) How much soil organic carbon is sequestered under CRP compared to adjacent crop lands?

2) Do CRP fields sequester greater amounts of carbon over time?

Methods

- Site locations within Iowa were selected by the USGS using stratified random sampling and provided to researchers, who began sampling these sites over the past two years.
- The within-site sampling scheme was also provided by USGS to maintain consistency across this 14-state, multi-institutional project. Samples were taken along 100-meter transects distributed throughout the field, with a 15-meter edge-of-field buffer.
- At 4 quadrats per field, researchers extracted a 15-cm deep bulk density soil core (4.8-cm diam.) and a 30-cm deep oak core (1.7-cm diam.). Bulk density soil cores were loaded into a plastic tube that was pre-weighed and pre-measured for bulk density. Oak cores were divided into 10-cm depth increments and placed into individual bags for future work. Sample locations were marked on a mobile GPS device.
- Samples were returned to the lab and refrigerated if unable to process on the same day.
- Samples were processed by weighing the bulk density core and wet soil, then extracting the soil and drying it at 105 °C for 24 hours to calculate dry soil bulk density.
- Subsamples were weighed into porcelain crucibles and loaded into a muffle furnace to analyze the organic carbon content utilizing the Loss-on-ignition (LOI) method. Samples were cycled at 500 °C for 200 minutes and then reweighed. The difference between post-Ash and pre-Ash measures the soil organic carbon content.

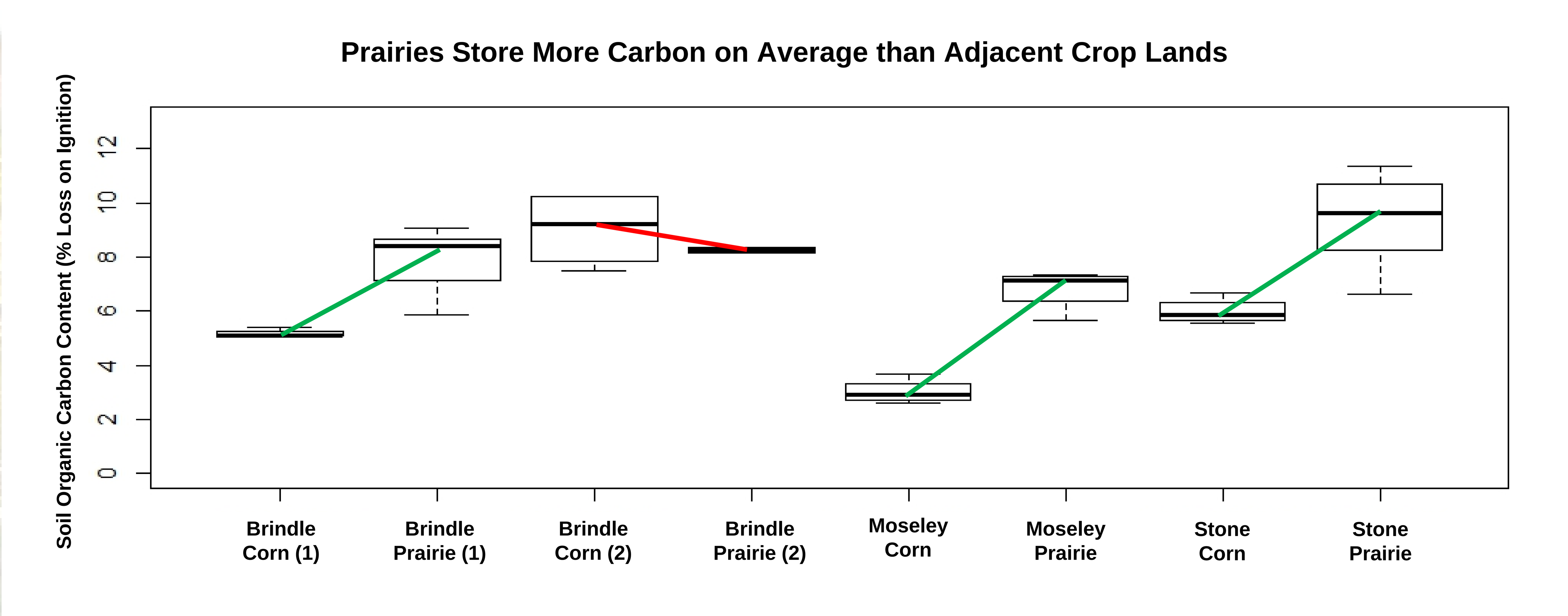
Oak core (depth increments not shown).



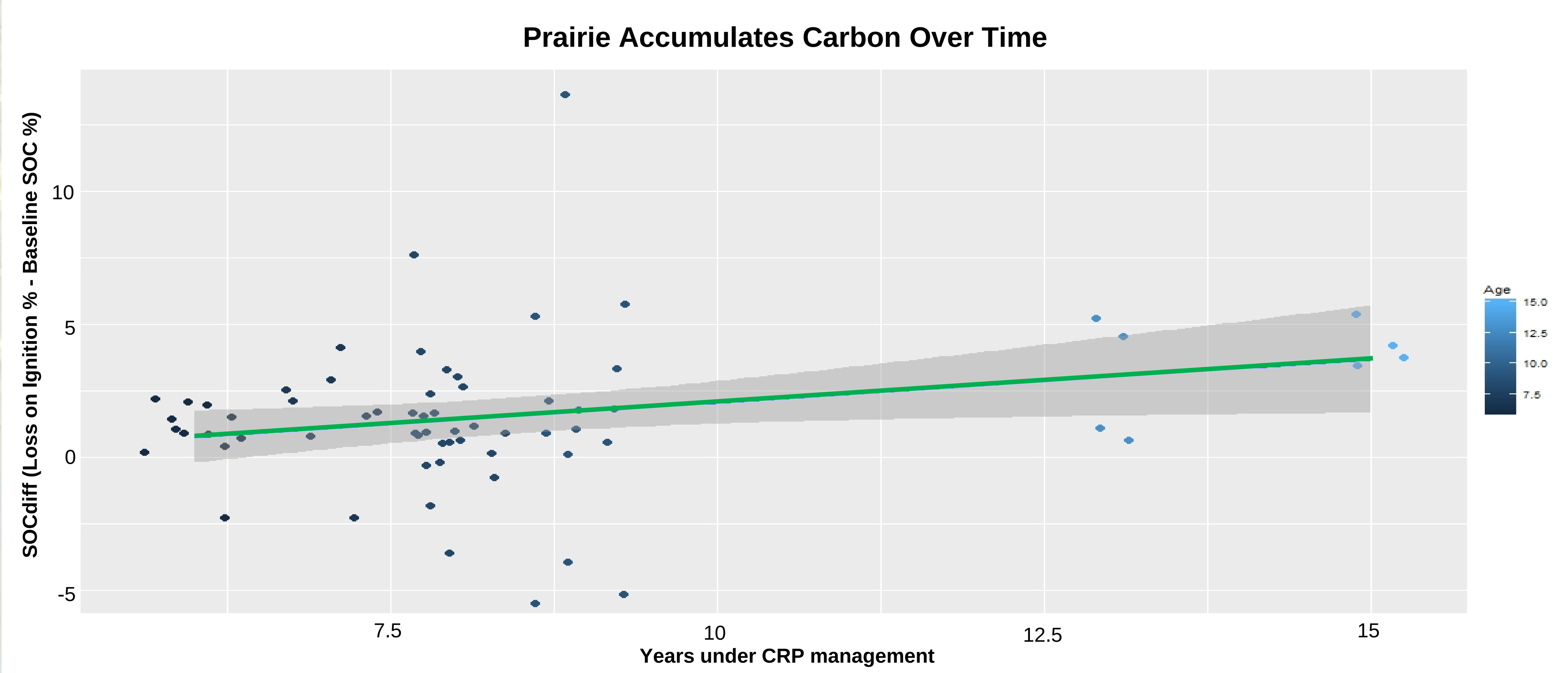
Small snapshot of CRP sites in the northern/central Iowa area provided by USGS.

Bulk density soil core (without coring rod).

Results & Statistical Analysis



Only sites containing both corn and CRP fields were included in this analysis to eliminate soil variability between locations. Four 15-cm deep bulk density cores were collected at randomly generated points in each CRP field and each adjacent corn field. Samples were then analyzed using the Loss-on-ignition method. ANOVA showed a statistically significant increase in prairie compared to adjacent corn fields ($p = 0.0005363$). (Note: Brindle 1 and Brindle 2 are separate locations owned by the same land owner.)



CRP sites sampled across Iowa were enrolled in the CRP program for different lengths of time. The graph above relates soil organic matter accumulation to duration in CRP. Soil cores were collected to a depth of 15-cm at each transect in each site. Soil organic content was measured using the Loss-on-ignition method. GPS points at each sampling location were inputted into WebSoilSurvey to determine "baseline" soil organic carbon (SOC) content. This baseline SOC was then subtracted from calculated LOI values to generate a "SOCdiff" value. This helps us determine if carbon content has increased or decreased under CRP. SOCdiff values increased significantly over time ($p = 1.561 \times 10^{-8}$), demonstrating carbon accumulation in CRP soils. (Note: the x-axis values are jittered in the figure above to improve clarity of the figure.)

Conclusions

1. Our data show a highly significant difference in soil organic carbon under CRP fields and crop lands. This provides evidence for CRP fields being more effective at sequestering atmospheric carbon than crop lands. There are many factors at work in regards to soils, and because of this, correlations can be difficult to pinpoint. Overall, we see an increase in SOC under CRP fields, most of the time being a very dramatic increase. The Brindle 2 plot is our only exception to this, showing a slight decrease in SOC from crop land to prairie. This could be due to a number of reasons: perhaps the Brindle 2 crop land was recently turned over from a CRP field, or maybe the CRP field was recently planted and is still suffering the "carbon cost" of tilling and planting the CRP field. Alternatively, it is possible that some conditions and farm practices may increase C accretion.
2. Our data show there is a highly significant accumulation in soil organic carbon under CRP fields over time. This provides evidence for CRP fields accumulating higher amounts of atmospheric carbon over time if allowed to remain as a CRP field rather than being put back into crop rotation. This trend might look only slightly positive, but when it is put into the context of soils where changes occur very slowly and generally require much longer timelines, this represents a substantial change.

Acknowledgements

Funding was provided by the USGS and the Summer Undergraduate Research Program at the University of Northern Iowa which allowed for the collaboration between students and mentors for this research project. We thank the Tallgrass Prairie Center and the U.N.I. Biology Department for providing support and educating us so well on plant identification and nomenclature. We would like to thank the land owners who allowed us access to their land in all years over the course of this project.