Assessment of Multi-Year Variation of Corn Yields and Possible Causes On the Des Moines Lobe of Iowa

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Introduction

- Since the early 1990s, yield monitors have become an essential component of many precision farming operations. Yield monitors produce yield maps which can be analyzed to depict, among other things, the magnitude and location of yield variability within a field. Yield variability maps provide feedback for determining effects of weather, soil properties and management practices.
- Due to increased adoption of precision farming methods, large volumes of yield data are generated annually. Unfortunately analyses, interpretation and use of the data to explore underlying factors of within field and within soil map unit yield variation are consistently lagging behind the rate of data collection.
- Objectives for this study include:
  - Develop a methodology using GIS to identify crop yield variability within whole fields and within soil map units.
  - Identify climatic, soil and management factors responsible for the yield variability.
  - Develop a model that will be used to study causes of yield variability on a broad spatial scale.
  - Make recommendations to producers that will decrease variability and increase economic and environmental sustainability.

Materials and Methods

- A single farmer's database containing 16 years of geo referenced corn and soybean yield data was chosen based on the farmers uniform management.
- Data set: Two fields totaling 395 acres in Wright Co., Iowa.
  - Soil series (coverage): Clarion (38%), Nicollet (27%), Webster (18%) (figure 1).
- Using ESRI Arc GIS, yield data were filtered to omit extreme values defined as negative values, zero values and values greater than 5 std. deviations from the mean.
- The data was then analyzed using Anselin Local Moran's I (cluster analyses tool).
  - Clusters are defined as multiple adjoining points that are significantly higher (HH cluster) or lower (LL cluster) than the mean.
  - Using Euclidean distance Inverse distance weighting, clusters of variation were located within whole fields and within soil map units for individual years and combined years.
- Clusters as shown in figure 2, which appeared within the Clarion soil series in the same location for multiple years were selected for in-depth analysis in order to determine possible causes for the yield variation.
- A random soil sampling pattern was developed within each of the selected clusters and within the area of the mean crop yield. These samples will be analyzed for physical and chemical properties to explain the yield variations observed.

Results and Discussion

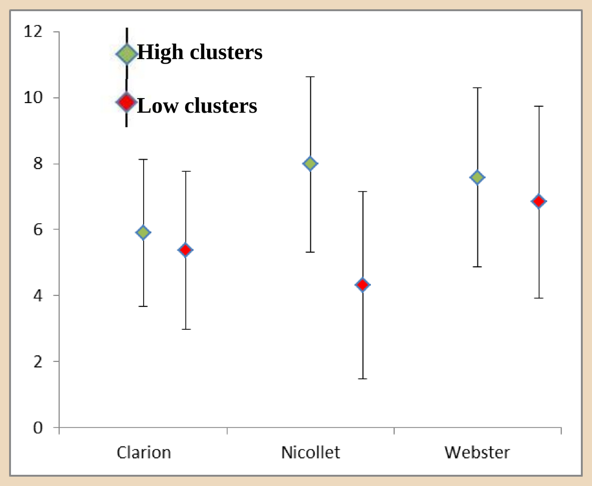

Figure 6. The average number of clusters per acre for each of the three major soil series within the study site.

- There is no significant difference between the average number of clusters per acre between any of the three major soil series (figure 6).
- There is no significant difference between the mean yield for any of the three major soil series (figure 7).
- Due to similarities in yield variability of the major soil series, detailed analyses were carried out on the Clarion series only in order to understand the causation for the variation.
- Two Clarion soil map units (138B and 138C2) were analyzed and sampled separately.

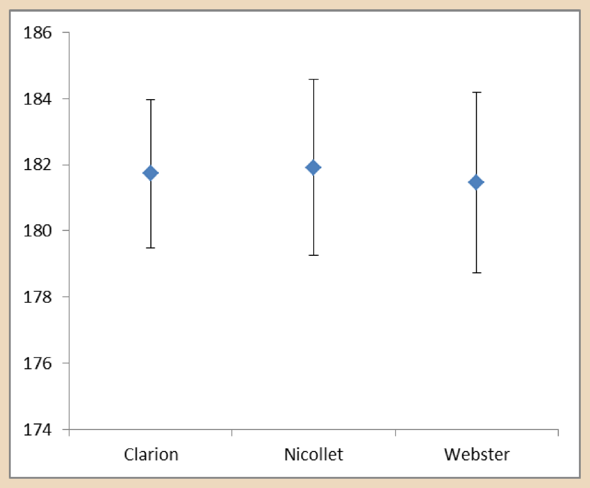

Figure 7. The mean yield(bu/ac) for each of the three major soil series within the study site.

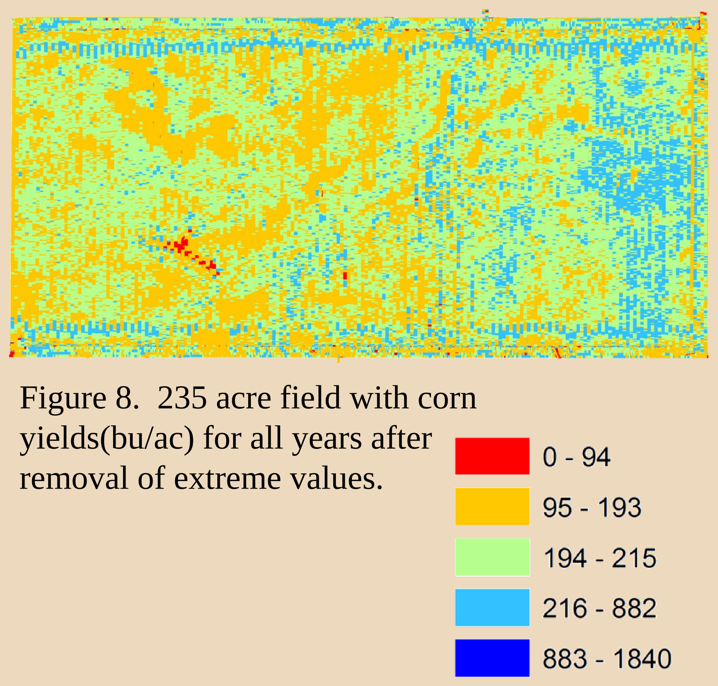

Figure 8. 235 acre field with corn yields(bu/ac) for all years after removal of extreme values.

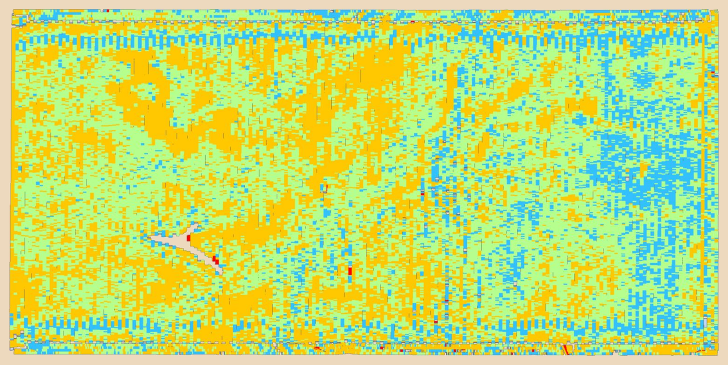

Figure 9. 235 acre field with corn yields(bu/ac) for 2011 after removal of extreme values.

- When all years of raw data were combined, visual yield patterns were no different from that of individual years (figures 8 and 9).
- Analysis of variability is therefore required to identify clusters of high and low yields.
- Due to the large quantity of data when combining multiple years, few clusters of variability were identified (figure 10).
- When data were analyzed on a yearly basis many clusters were identified (figure 11).
- When comparing multiple single-year data sets (figures 2a-2c) high and low clusters were observed in the same locations.
- To better study soil properties influencing crop yield variability, single-year data sets were overlapped to identify locations of consistent high and low clusters (figure 2d).
- A random sampling pattern was developed for both high and low clusters and the mean to study soil properties (figure 2d).
- Initial soil analyses show consistent differences in physical soil properties associated with high and low clusters.

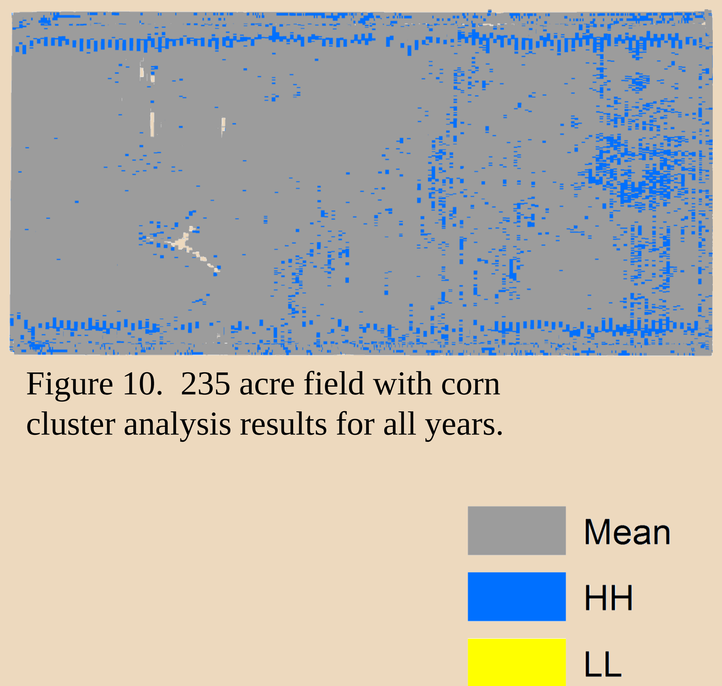

Figure 10. 235 acre field with corn cluster analysis results for all years.

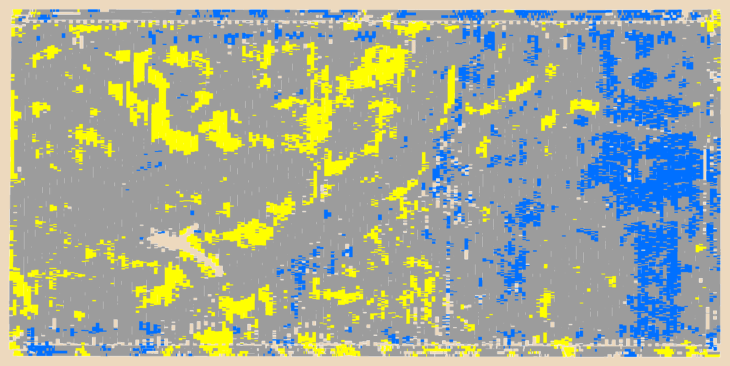

Figure 11. 235 acre field with corn cluster analysis results for 2011.

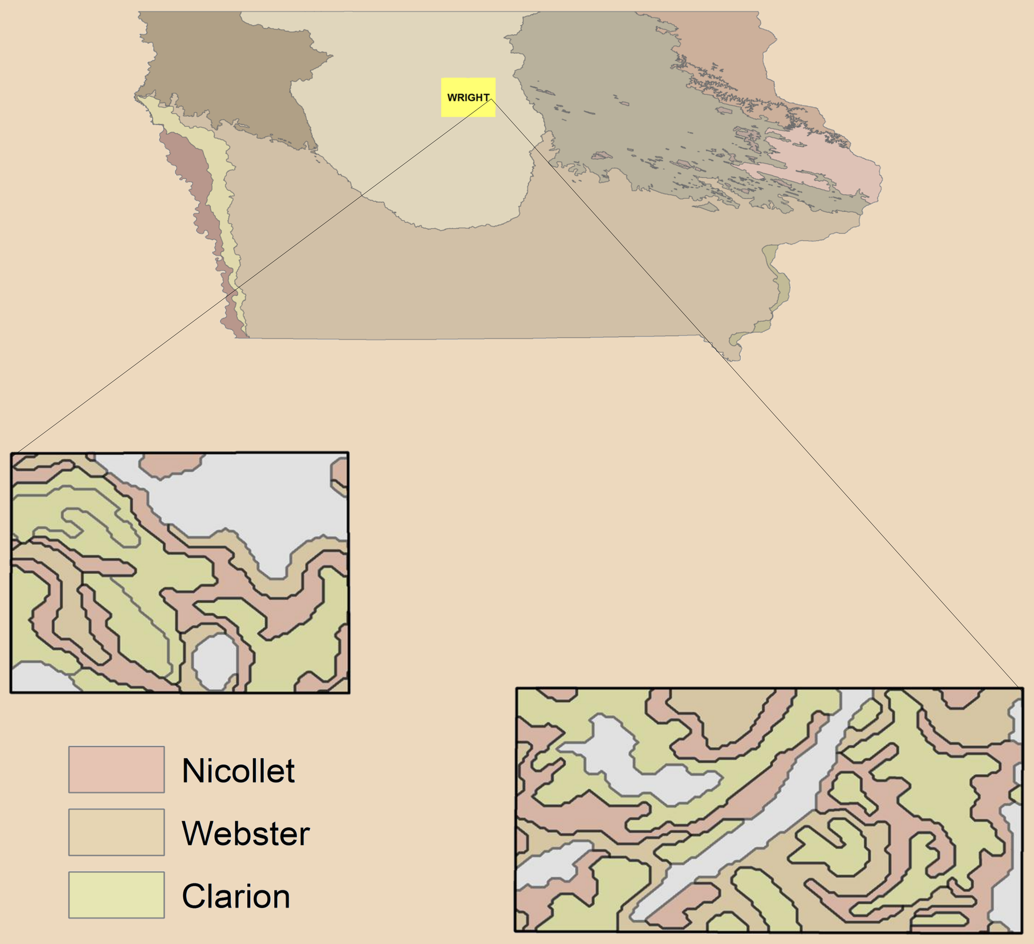

Figure 1. Soil maps of the selected data locations in Wright, Co., Iowa.

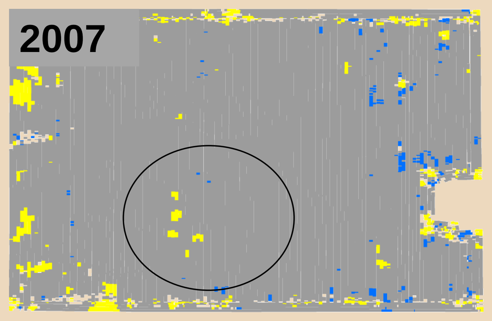

Figure 2a.

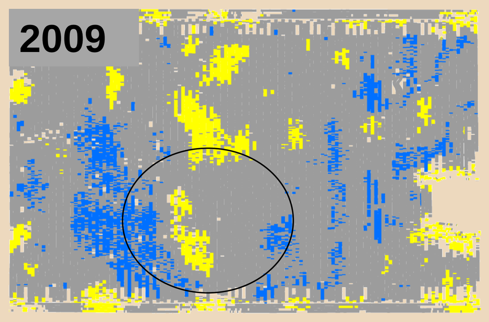

Figure 2b.

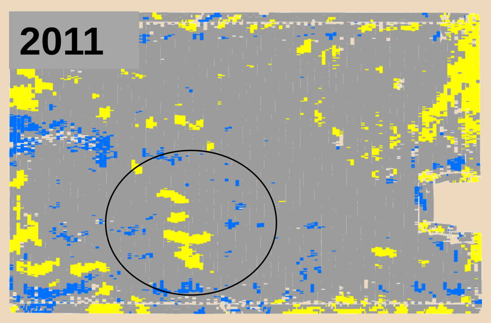

Figure 2c.

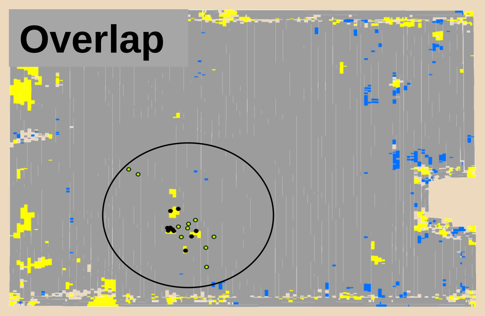

Figure 2d.

Figure 2. 160 acre field with corn cluster analysis for 3 consecutive years. Figure 2d shows the area where LL clusters overlap among years and the selected random sampling pattern.

Mean

HH

LL

Summary

- The method developed during this study is effective at identifying crop yield variability at a large scale.
  - Clusters are more identifiable when comparing single years of data than when combining multiple years of data.
  - Preliminary analysis of the physical properties of the Clarion soil samples shows significant variability that is spatially consistent with the identified variability clusters.

Follow up

- As a next step, the method described will be used again to determine the causes of yield variability within either the Nicollet or the Webster soil series.
- A follow up study will be necessary to ensure the effectiveness of the method developed using:
  - A different farmer with varying management techniques.
  - A different major soil association.

References

Dobermann A., Ping J., Adamchuk V., Simbahan G., Ferguson R., Classification of Crop Yield Variability in Irrigated Production Fields, Agronomy Journal Vol. 95, 2003.

Jaynes D., Kaspar T., Colvin T., James D., Cluster Analysis of Spatiotemporal Corn Yield Patterns in an Iowa Field, Agronomy Journal, Vol. 95, 2003.

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