Can Soil Profile Mapping and AI-Assisted Yield Analysis Improve Explanation of Within-Field Yield Variability? A Depth-Resolved Case Study

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Abstract.

Understanding the causes of within-field yield variability remains a central challenge in precision agriculture. Because crop roots interact with the entire soil profile rather than only surface soil, depth-resolved measurements may provide additional insight into factors affecting long-term yield potential. This study evaluated the relationship between soil electrical conductivity measured throughout the profile using the Veris CoreScan™ system and normalized crop yield. Five years of yield data were normalized and combined on a common 10 × 10 m framework. Electrical conductivity measured at 60 cm depth (EC60) exhibited the strongest relationship with long-term yield potential. Ordinary least-squares regression produced an R^2 of 0.296, whereas a 95th percentile boundary-line analysis improved explanatory power to R^2 = 0.623. Results suggest that EC60 acts as a yield-limiting factor rather than a direct predictor of realized yield.

Keywords.
Soil, sensing, profile, EC, yield, boundary line, AI

Introduction

Within-field yield variability is influenced by numerous interacting soil, environmental, and management factors. Traditional soil characterization methods often emphasize surface measurements, even though crop roots interact with the entire soil profile and subsurface features can influence yield patterns (Doolittle et al. 1994; Kitchen et al. 2003; Xiaoshuai et al. 2019). The Veris CoreScan? system measures electrical conductivity, insertion force, moisture, and organic matter throughout the profile, providing a depth-resolved assessment of soil conditions (Christy et al. 1994; Xiaoshuai et al. 2019). The system is shown in Fig. 1. This study evaluated whether deep-profile measurements combined with AI-assisted analytics could improve understanding of long-term yield potential.

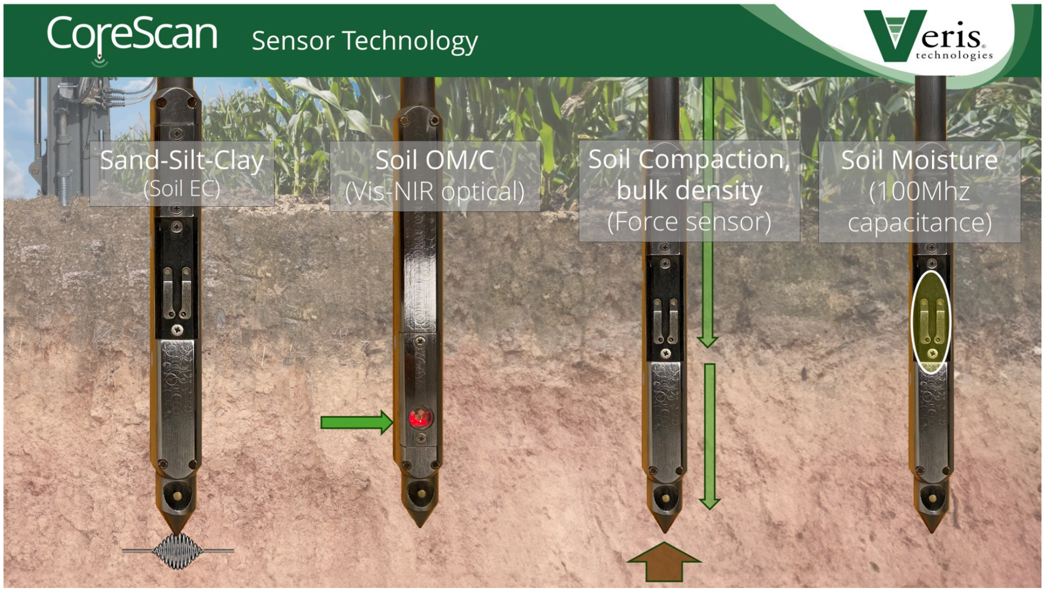

Fig. 1 CoreScan soil profile sensing technology

Materials and Methods

The study was conducted on a 20-ha field in central Kansas managed under continuous no-till production. CoreScan measurements were collected on approximately 0.5-ha spacing. CoreScan measurements revealed substantial spatial variability through the soil profile. Three-dimensional visualization highlights subsurface patterns that are difficult to identify using traditional surface-based measurements (Fig. 2).

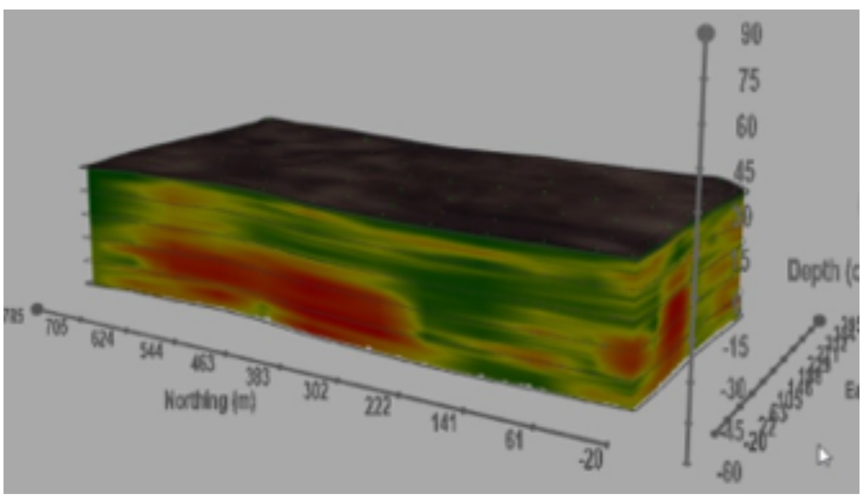

Fig. 2 Three-dimensional visualization of soil profile EC variability

Five years of crop yield data were cleaned, normalized, and averaged onto a common 10 × 10 m grid (Fig. 3). Multiple CoreScan variables were evaluated against normalized yield. EC60 exhibited the strongest relationship and was selected for detailed analysis. Artificial intelligence tools assisted with data normalization, spatial integration, statistical evaluation, figure preparation, and manuscript development.

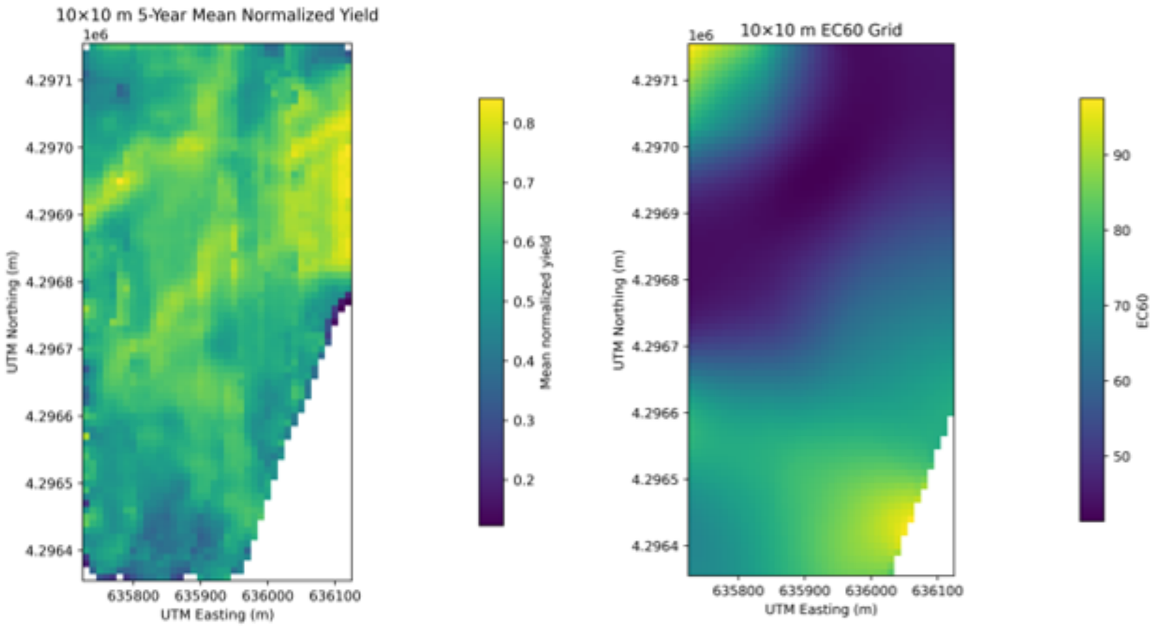

Fig. 3 Normalized yield and 60 cm EC measurement contours

Results and Discussion

Ordinary least-squares regression demonstrated a moderate relationship between EC60 and normalized yield (R^2 = 0.296). A 10-bin, 95th percentile boundary-line analysis produced a substantially stronger relationship (R^2 = 0.623), indicating that EC60 is more closely associated with yield potential than with realized yield (Fig. 4). These findings suggest that deep-profile soil properties influence the productive capacity of the soil, while weather and management factors influence realized yield outcomes.

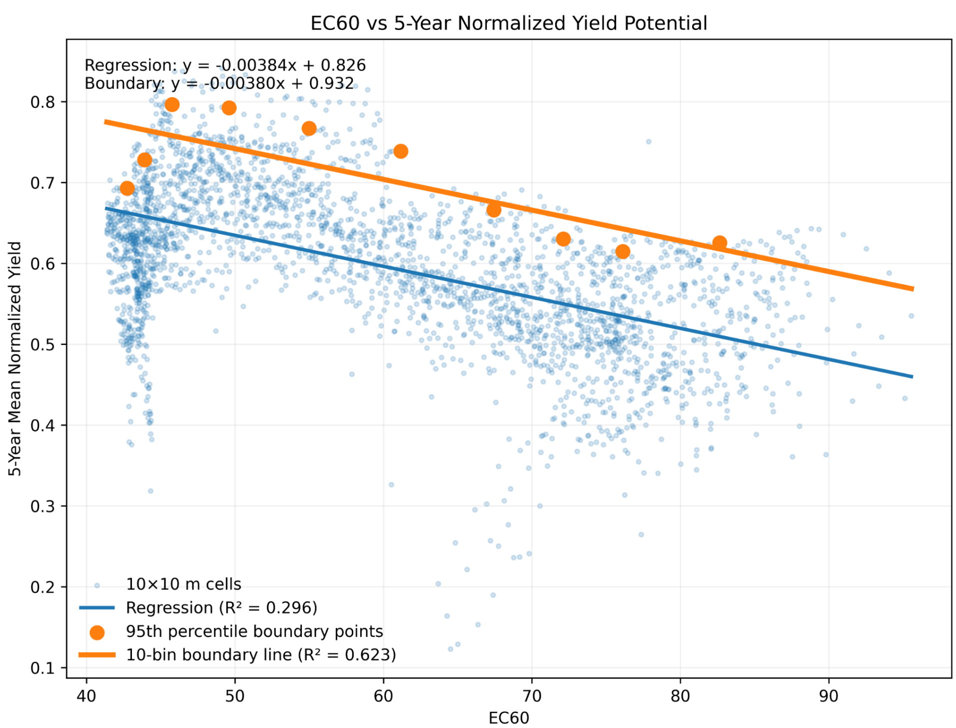

Fig. 4 Relationship between EC60 and mean normalized yield

Conclusions

Deep-profile EC60 measurements were associated with long-term yield potential. Boundary-line analysis provided substantially stronger explanatory power than conventional regression. The combination of CoreScan profile sensing and AI-assisted analysis provides a promising framework for identifying yield-limiting soil conditions and supporting management zone development.

Acknowledgements

This poster was generated with the assistance of artificial intelligence tools. The authors provided yield datasets, CoreScan measurements, analytical guidance, and the images used in Fig. 1 and Fig. 2. Artificial intelligence was used to assist with data processing, statistical analysis, figure generation, poster layout, and preparation of draft text. Final interpretation, review, and approval of all content were performed by the authors.

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