Analyzing historical crop yields can reveal key soil health insights

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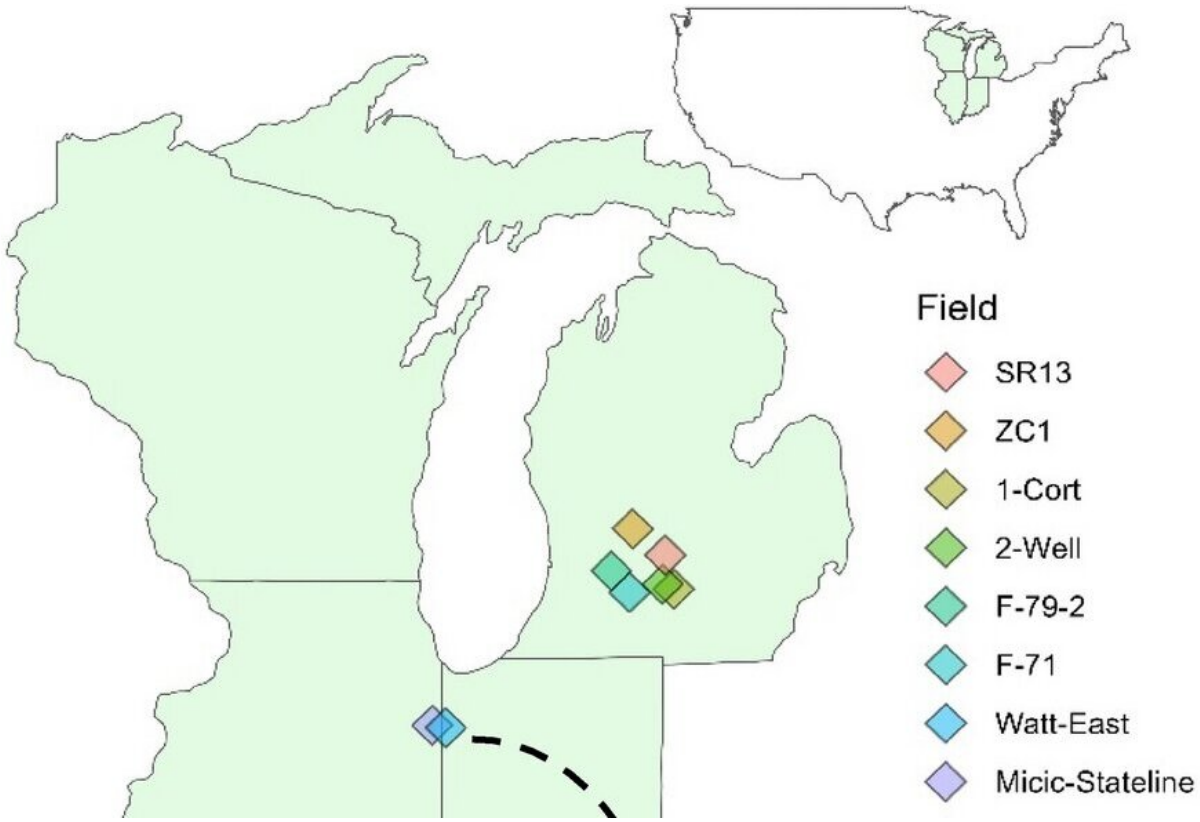

The field site locations in Michigan, Illinois, and Indiana, with an example field showing the three soil sampling locations (colored circles) randomly selected within each of the four levels of yield stability zones (YSZ); unstable (US), low and stable (LS), medium and stable (MS), and high and stable (HS), determined in each field. Map created by Ruben Ulbrich using ArcGis software 10.8.2. (www.esri.com). Credit: *Scientific Reports* (2024). DOI: 10.1038/s41598-024-51155-y

New research from Michigan State University shows how evaluating historical crop yields across distinct areas of agricultural fields can provide farmers with essential information on soil health characteristics and carbon sequestration. The paper was published in *Scientific Reports*.

The research was led by MSU soil scientist Bruno Basso and included Ames Fowler, Fidel Maureira, Neville Millar and Ruben Ulbrich from Basso's laboratory, as well as William Brinton, founder and chief scientist at Woods End Laboratories, a soil health analysis company headquartered in Maine.

Basso is an expert in sustainable agriculture who serves as John A. Hannah Distinguished Professor in the MSU departments of Earth and Environmental Sciences, and Plant, Soil and Microbial Sciences, as well as the W.K. Kellogg Biological Station.

For years, Basso has worked with farmers around the world to develop and implement methods of analyzing spatial and temporal data—which assesses crop management across space and time—to increase yields while lessening negative environmental impacts.

"Agriculture is facing major challenges around feeding a growing world population, climate change and environmental damage such as soil erosion and water pollution," Basso said. "Boosting soil health can play a major role in combating these issues.

"We know that soil health involves biological, chemical, and physical attributes, and we can help influence those to allow soil to provide water and nutrients, as well as sequester carbon."

For this project, researchers sought to determine the relationship between historical crop yields and soil health, with the hypothesis that high-performing regions of fields have higher-quality soil and vice versa.

"It may seem obvious that areas with good yields have better soil, but we have to remember that there is a tremendous amount of variability within fields," Basso said. "What we're trying to do is give farmers prescriptive and precise recommendations on how to optimize their operations by minimizing the use of inputs and mitigating negative environmental impacts, while also maximizing yield.

"To achieve this, it takes a lot of information and a systems approach that integrates the climate-plant-soil interactions to capture the complex dynamics of agricultural systems."

Basso said that to obtain this data previously, it required intensive soil sampling across large areas to account for the variability. This is prohibitively expensive for most farmers at the scale needed to gather reliable information.

Researchers are aiming to reduce the reliance on traditional soil testing by using historical yield data and a novel analysis metric known as yield stability zones. These zones leverage both yield level and stability—the consistency of yield—over time, offering a more nuanced understanding that accounts for small-scale, in-field variability.

Ten commercial corn and soybean fields in Michigan, Illinois and Indiana were used in the study. Management practices varied across fields and were not controlled during the research.

Scientists identified yield stability zones in each field using high-resolution, gridded yield monitor data downloaded from harvesting machines. The yield history of each field ranged from 11 to 18 years. Soil samples were also collected and analyzed. The research team scrutinized the data both regionally and locally, considering variations in management practices.

Researchers found that yield stability zones successfully identify differences in areas of fields based on statistically distinct relative soil organic carbon and relative soil health. Basso said the analysis is relevant across various soil types and management practices, and this information can help farmers act more efficiently.

"For example, we saw that low-stability zones have shallower or more compacted soils, higher bulk densities and are located on steeper slopes," Basso said. "Unstable zones had higher soil organic carbon levels associated with flow accumulation and topsoil accumulation from erosion processes.

"These findings suggest that yield stability zones can identify the feedback relationships between soil formation, soil organic carbon accumulation, soil health and yield potential, particularly in terms of increased water and nutrient holding capacity."

More information: Ames Fowler et al, Spatial patterns of historical crop yields reveal soil health attributes in US Midwest fields, *Scientific Reports* (2024). DOI: 10.1038/s41598-024-51155-y

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