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# Evaluating the applicability of soil moisture-based metrics for gauging the resiliency of rainfed agricultural systems in the midwestern United States

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## Highlights

- Soil moisture has the potential to be used as a measurement of the resiliency.
- We examined the applicability of four soil moisture metrics to measure resiliency.

- These metrics helped with identifying promising treatments to address resiliency.
- No-till and reduced input treatments were the most and least promising.

## Abstract

Measuring and improving resiliency is the key goal of climate risk management in rainfed agriculture. Currently, available metrics are generally used to qualitatively measure the resilience of agricultural systems at broader scales. Moreover, these metrics showed non-linear responses to climate variability, thus often fail to capture the temporal dynamics of resilience at field scales. Our objective for this study is to combine a few soil moisture-based metrics to gauge the resiliency of three promising rainfed agricultural treatments, namely the no-till, organic, and reduced input treatments against the conventional treatment. These treatments have been established at the Kellogg Biological Station Long-Term Ecological Research (KBS-LTER) experiment in a randomized complete block design with six blocks per treatment. All four of these treatments consisted of maize (*Zea mays*)-soybean (*Glycine max*)-winter wheat (*Triticum aestivum*) in rotation. Long-term (1993–2018) soil moisture data from this experiment was collected to compute the soil moisture metrics while the total crop biomass, crop yield, and soil organic carbon data were statistically analyzed to evaluate the robustness of the metrics to gauge the resiliency of these systems. Results have shown that, among the soil moisture metrics, the mean relative difference, the Spearman's rank correlation coefficient, and soil water deficit index were suitable, while the index of temporal stability was not suitable to gauge the resiliency of different rainfed agricultural systems. The no-till treatment was identified as the most resilient treatment in terms of soil moisture retention, effectiveness for drought mitigation, and crop yields. Meanwhile, the reduced input treatment was the least resilient in terms of soil water conservation and drought recovery. The results of this study can be extended to other Midwest regions of the United States and similar climatological areas around the world.

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## Keywords

Agricultural drought; Climate risk management; Mean relative difference; Soil water deficit index; Resiliency