Cropping System Effects on Soil Quality in the Great Plains: Summary from a Regional Project

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Abstract

Soils perform a number of essential functions that are often assessed by measuring physical, chemical, and biological properties related to soil functions affecting the management goal. Information is needed on the temporal dynamics of commonly measured soil properties, the sensitivity of these properties to management, and the utility of new methods in soil quality assessments. In 1998, a regional project was initiated to utilize existing long-term cropping system studies at eight locations in the Great Plains to provide this information. The Soil Management Assessment Framework was used to calculate an index for soil properties repeatedly measured under contrasting management practices from 1999 to 2000. Index values were used to detect temporal changes in soil properties and management affects on soil properties. Results indicate soils from semi-arid locations developed under mixed or short grass prairie (Swift Current, SK, Mandan, ND, Akron, CO, and Bushland, TX) are more sensitive to management than soils receiving higher amounts of precipitation and developed under tall grass prairie (Fargo, ND, Brookings, CO, and Mead, NE). Temporal changes were related to weather and crop production differences among years. Differences between management practices were related to the incidence of fallow.

Introduction

Soils perform numerous functions in support of agroecosystems. Soils are a substrate for supporting plant growth, a reservoir for many nutrients essential for plant growth, a filter maintaining air quality through interactions with the atmosphere, a storage and purification medium for water as it passes through the soil, and a site for biological activity involved in the decomposition and recycling of animal and plant products. Physical, chemical, and biological soil properties are often selected to comprise a minimum data set for soil quality assessment of soil functions. Time of year to sample, choice of soil properties to measure, and how to interpret results are challenges to assessing soil functions. Interpretation of results is difficult given the multiple functions soils perform. Furthermore, it is common to observe conflicting results among soil properties. In 1998, the Great Plains Cropping System Network initiated a study utilizing existing long-term cropping system studies throughout the region to address a number of these issues.

The objectives for this regional study were:

1) To quantify the temporal dynamics exhibited by selected physical, chemical, and biological soil quality attributes in the upper 30 cm.
2) To compare selected physical, chemical, and biological soil quality attributes between contrasting management practices in the Great Plains and Western Corn Belt.
3) To assess several recently developed methods for their potential in quantifying soil quality attributes that may be sensitive to management.

Table 1. P-values for main effects and interactions for Soil Management Assessment Framework index values for eight sites in the Great Plains.

	Location							
Effect	Akron	Brookings	Bushland	Fargo	Mandan	Mead	Sidney	Swift Current
	P-value							
Treatment	0.16	0.11	<0.05	0.08	<0.01	0.13	0.83	0.02
Time	0.21	<0.01	<0.01	0.04	<0.01	<0.01	0.11	<0.01
Tmt*Time	<0.01	0.93	0.06	0.67	<0.01	0.08	0.11	0.06

Brookings The time effect resulted from an increase in index value following the first sampling and a decline in index values during the 2001 and 2002 growing seasons (Fig. 1). Between April 2001 and August 2002 precipitation was much below normal resulting in below average yields and lower residue inputs to the soil (Varvel et al., 2003).

Bushland The treatment by time interaction resulted from similar index values at the initial sampling, lower index values between continuous wheat and fallow in 2000, and similar index values between the two systems in 2001 (Fig. 1). Below average precipitation from 2000 to 2002 resulted in low yields and low amounts of residue being added to the soil (Varvel et al., 2003).

Fargo The time effect resulted from a decline in index values during 2000 and an increase in index values from the first sampling in 2001 through the last sampling in 2002 (Fig. 1). The index value for soil under perennial vegetation was similar to that in the annually cropped soil. Precipitation during the study was above average and residue inputs to the soil were above average (Varvel et al., 2003).

Mandan The treatment by time interaction resulted from similar index values across times in the annually cropped system compared to index values in the wheat-fallow system that were similar during the wheat year, declined during the fallow year, and were always lower than index values in the annual cropping system. Index values for soil under perennial vegetation were similar to those in the annually cropped no-tillage system (Fig. 1).

Mead The time effect resulted from a gradual increase in index values during the first two years of the study, a decline in index values from the middle of the second year to the end of the third year, and an initial increase during the fourth year with a decline in the index value for the last sampling period (Fig. 1). Index values for soil under annual cropping were 74% of that for soil under perennial vegetation. Below normal precipitation in 2000 through 2002 resulted in lower than normal yields and below normal residue inputs to the soil (Varvel et al., 2003).

Sidney There was no treatment or time effect observed at this location. The index value for the cropped plots averaged 0.54 and was 70% that for soil under perennial vegetation (index value = 0.77).

Swift Current The treatment effect resulted from index values being lower in the wheat-fallow treatment than in the wheat-lentil treatment (Fig. 1). The time effect resulted from index values in

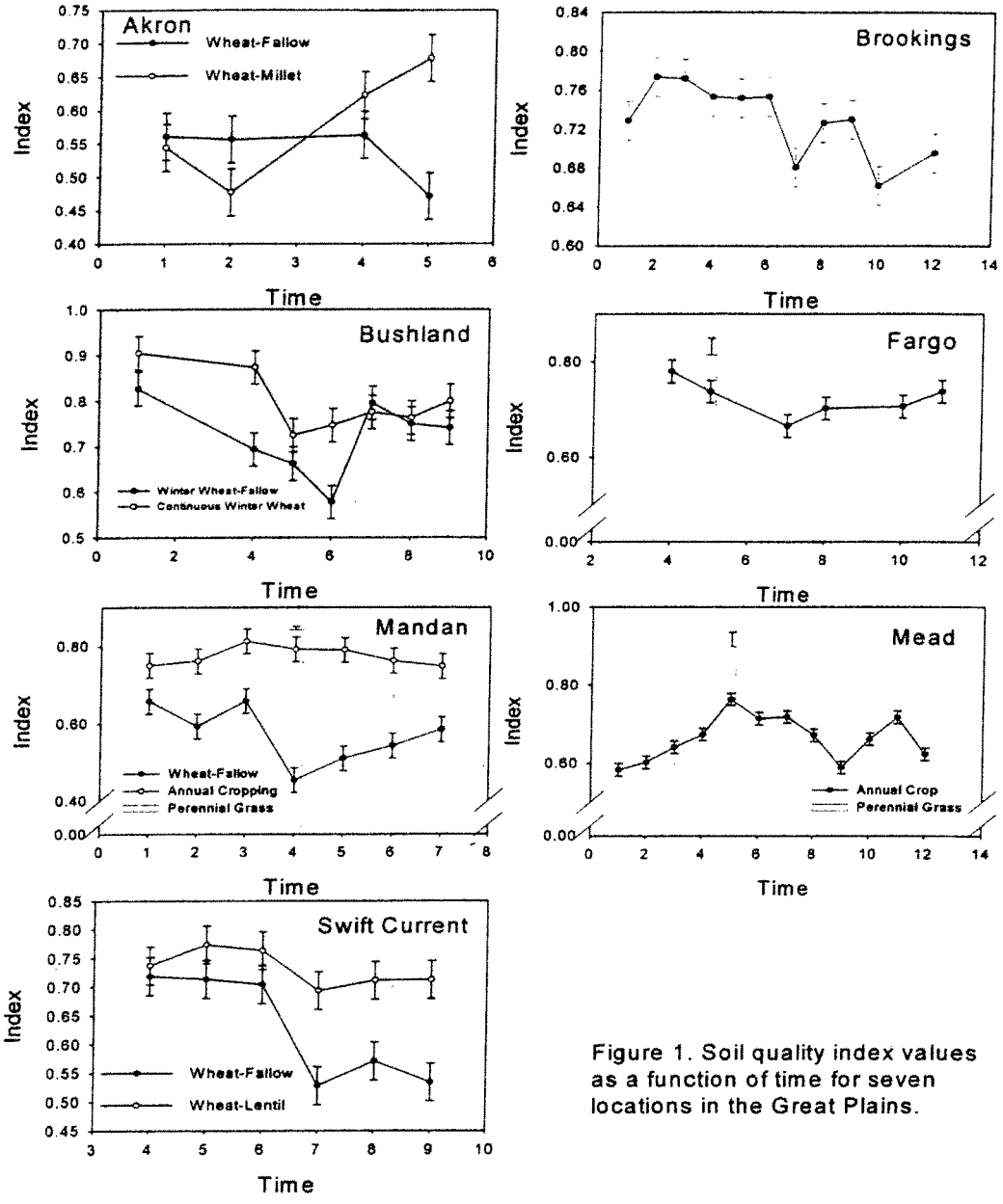
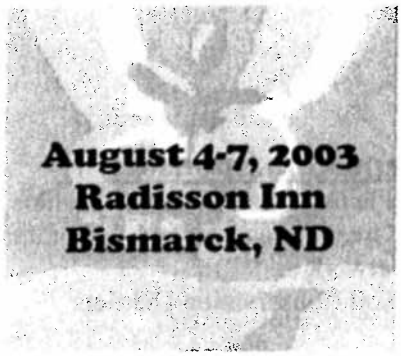


Figure 1. Soil quality index values as a function of time for seven locations in the Great Plains.

A CROPPING SYSTEMS SYMPOSIUM

DYNAMIC CROPPING SYSTEMS

Principles, Processes, and Challenges



J.D. Hanson and J.M. Krupinsky (Editors)

PROCEEDINGS