On-Farm Assessment of Soil Quality Index in Ohio and Michigan

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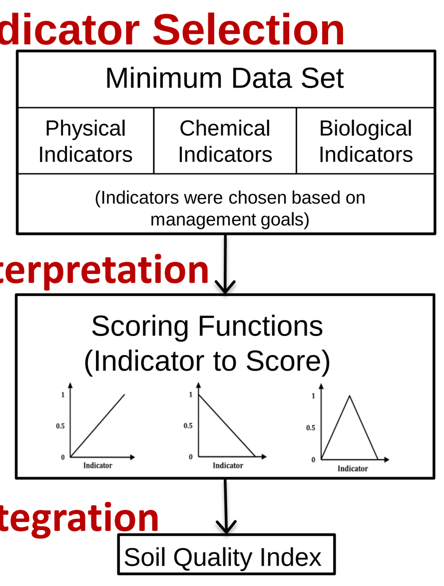
Introduction and Rationale

Soil quality index (SQI) is an effective method for assessing soil's capacity for crop production and other ecosystem services. Soil quality refers to the capacity of soil to function, sustain productivity, and maintain environmental quality (Doran and Parkin, 1994). Soil quality assessment includes characterization of the overall agro-ecological functions of soil by selecting some key soil properties (physical, chemical, and biological) that are good indicators, measuring these properties, scoring, and calculating soil quality index (Andrews et al., 2004; Beniston et al., 2015). SQI can be used to determine if soil quality is aggrading, sustaining, or degrading (Karlen et al., 2003). Researchers have proposed various conceptual frameworks to evaluate soil quality (Andrews et al., 2004; Armenise et al., 2013). There is no universal method to assess quality of all soils and diverse land uses. The objectives of this research are to (1) assess the effects of on-farm (Fig. 1) management practices (e.g. tillage, crop rotation) on soil quality (2) demonstrate the SQI assessment using scoring function analysis (Fig.2), and (3) identify key indicators of soil quality.

Experimental Procedure

Fig 1. On-farm sites in OH & MI



(adapted, Andrews, 1998)

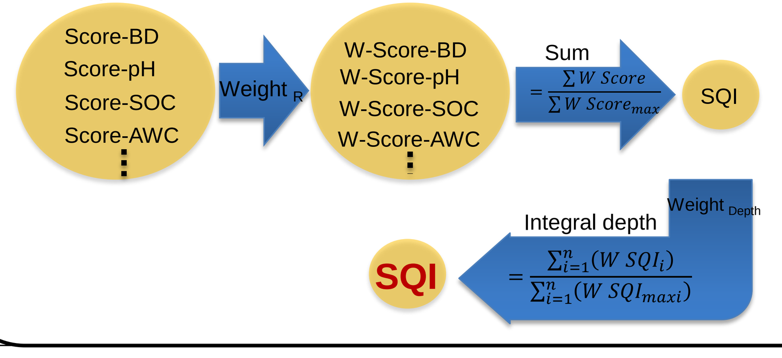
Fig 2. Conceptual framework for scoring function analysis

2. Interpretation

Factor	unit	5	4	3	2	1	Reference
BD	Mg m^{-3}	<1.2	1.2-1.3	1.3-1.4	1.4-1.5	>1.5	Lal (1994)
Texture	-	Loam	Silt loam, Silt, Silty clay loam	Clay loam, sandy loam	Silty clay, Loamy sand	Clay, Sand	
AWC	m^3 m^{-3}	>0.30	0.20-0.30	0.08-0.20	0.02-0.08	<0.02	
Ksat	cm h^{-1}	>2	0.2-2.0	0.02-0.2	0.002-0.02	<0.002	
pH	-	6.0-7.0	5.8-6.0 and 7.0-7.4	5.4-5.8 and 7.4-7.8	5.0-5.4 and 7.8-8.2	<5.0 and >8.2	Andrew et al. (2004) Lal (1994)
EC	µS m^{-1}	<300	300-500	500-700	700-1000	>1000	Lal (1994)
SOC	g kg^{-1}	50-100	30-50	10-30	5-10	<5	Gregoric et al. (1994), Lal (1994)

3. Integration

Integration of all indicator's score into one SQI value



$$W\ indicator_i = \frac{R_i}{\sum_{i=1}^{n} R_i}$$

W indicator$_i$ is the weighted index of each indicator, *R* is the correlation coefficient between each indicator and corn yield

$$Wdepth\ i = \frac{RD_i}{\sum_{i=1}^{n} RD_i}$$

W depth$_i$ is the weighted index of each depth, *RD* is the Root density (m m^{-3})

Results

In general, texture was the key indicator ($W_{indicator}$ = 0.30) among physical properties of soil and SOC ($W_{indicator}$ = 0.23) among chemical (Table 1). However in Gladwin site of MI with sandy soil (88% sand), available water content was the key indicator among physical properties of soil (Fig. 3). The SQI in on-farm sites were positively correlated with corn yield. Suggesting, corn yield increases with increase in SQI (Fig. 4). The SQI was not affected by tillage and crop rotation (Fig. 5).

Table 1. Weighting factor for soil function and indicators

Soil Function	Indicators	R	Weight index	Depth (cm)	Weight depth	
					NT	MT and CT
Physical Properties	Texture	0.73	0.30	0-10	0.52	0.65
	BD	0.46	0.19	10-20	0.22	0.17
	AWC	0.18	0.17	20-40	0.17	0.11
	Ksat	0.00	0.00	40-60	0.10	0.06
Chemical Properties	SOC	0.56	0.23			
	pH	0.28	0.12			
	EC	0.00	0.00			
Total			1.00		1.00	1.00

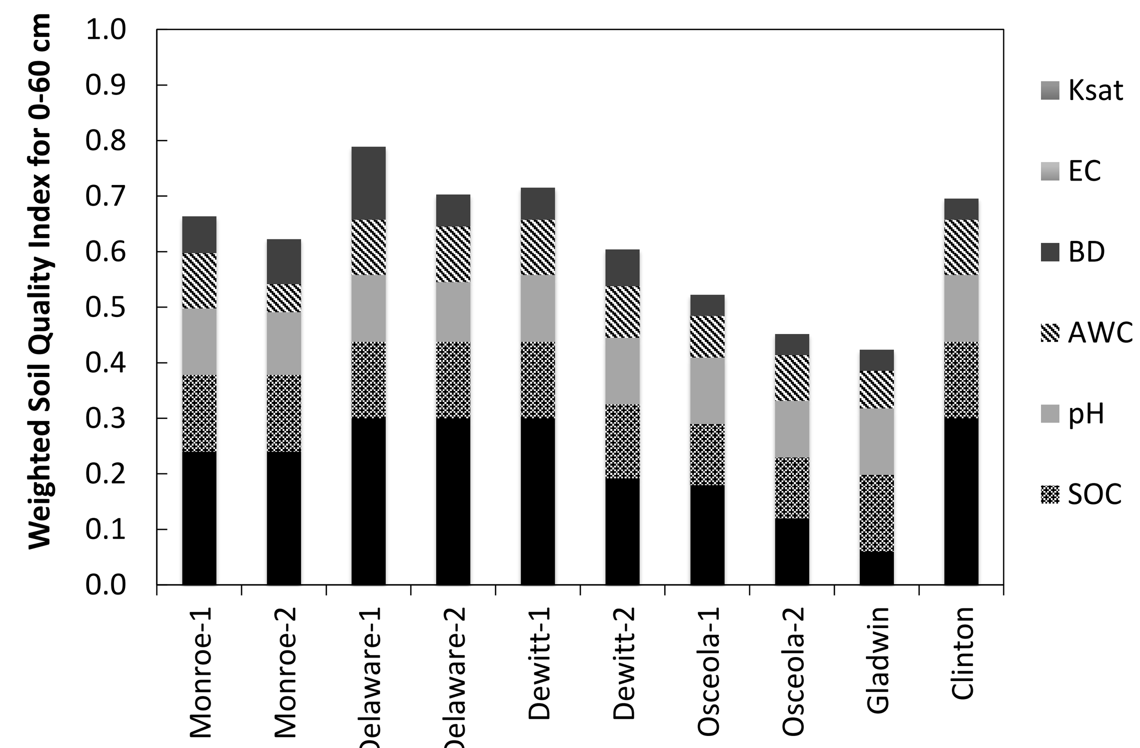


Fig. 3 SQI for the 10 on-farm sites in Ohio & Michigan

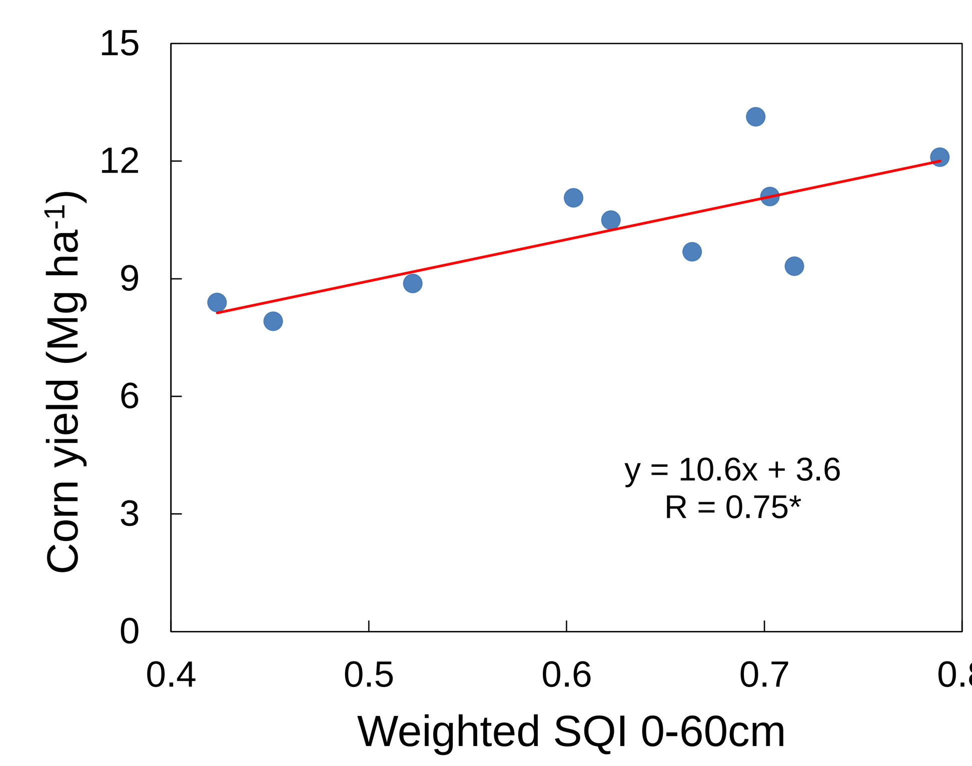


Fig. 4 Relationship between corn yield and soil quality index for the ten on-farm sites

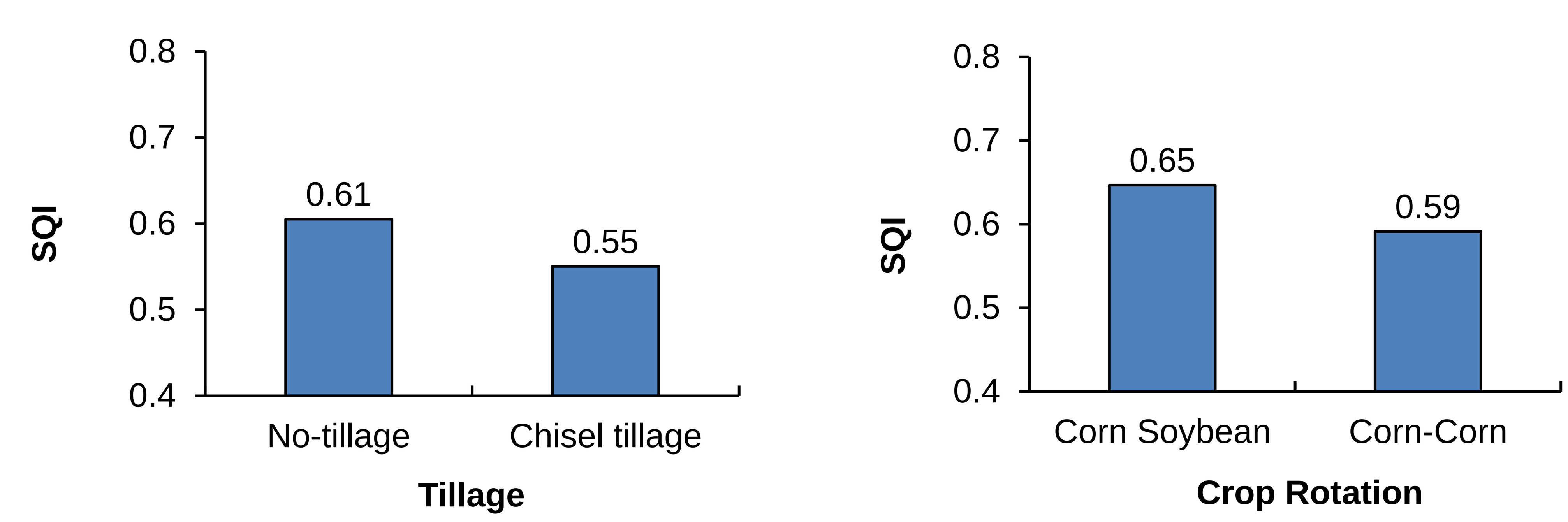


Fig. 5. Tillage and crop rotation on soil quality

Conclusions

The data support the following conclusions:

1. Key soil parameters for assessing SQI are SOC, texture & AWC
2. SQI can be assessed by the weighted scoring method.
3. There is a strong positive correlation between SQI & crop yield

Recommendations

Regional assessment of soil quality index, including most of the CS-CAP sites with a minimum set of data, is in progress.

References

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