

Sugarcane Land Quality Evaluation and Limiting Factors Diagnosis in Typical Acidified Regions of Southern China Based on Minimum Data Set

Huirong Hao ¹, Yingu Wu ¹, Yanli Chen ², Chong Chen ¹, Jinqiu Xie ², Kelin Hu ^{1,*}

¹ Key Laboratory of Arable Land Conservation (North China), Ministry of Agriculture and Rural Affairs, College of Land Science and Technology, China Agricultural University, Beijing 100193, China; haohuirong229@163.com (H.H.); wuyingu0918@163.com (Y.W.); chenchongsxnd@cau.edu.cn (C.C.)

² Soil and Fertilizer Station of Guangxi Zhuang Autonomous Region, Nanning 530007, China; chengyanli9981@163.com (Y.C.); xie09060805@163.com (J.X.)

* Correspondence: hukel@cau.edu.cn

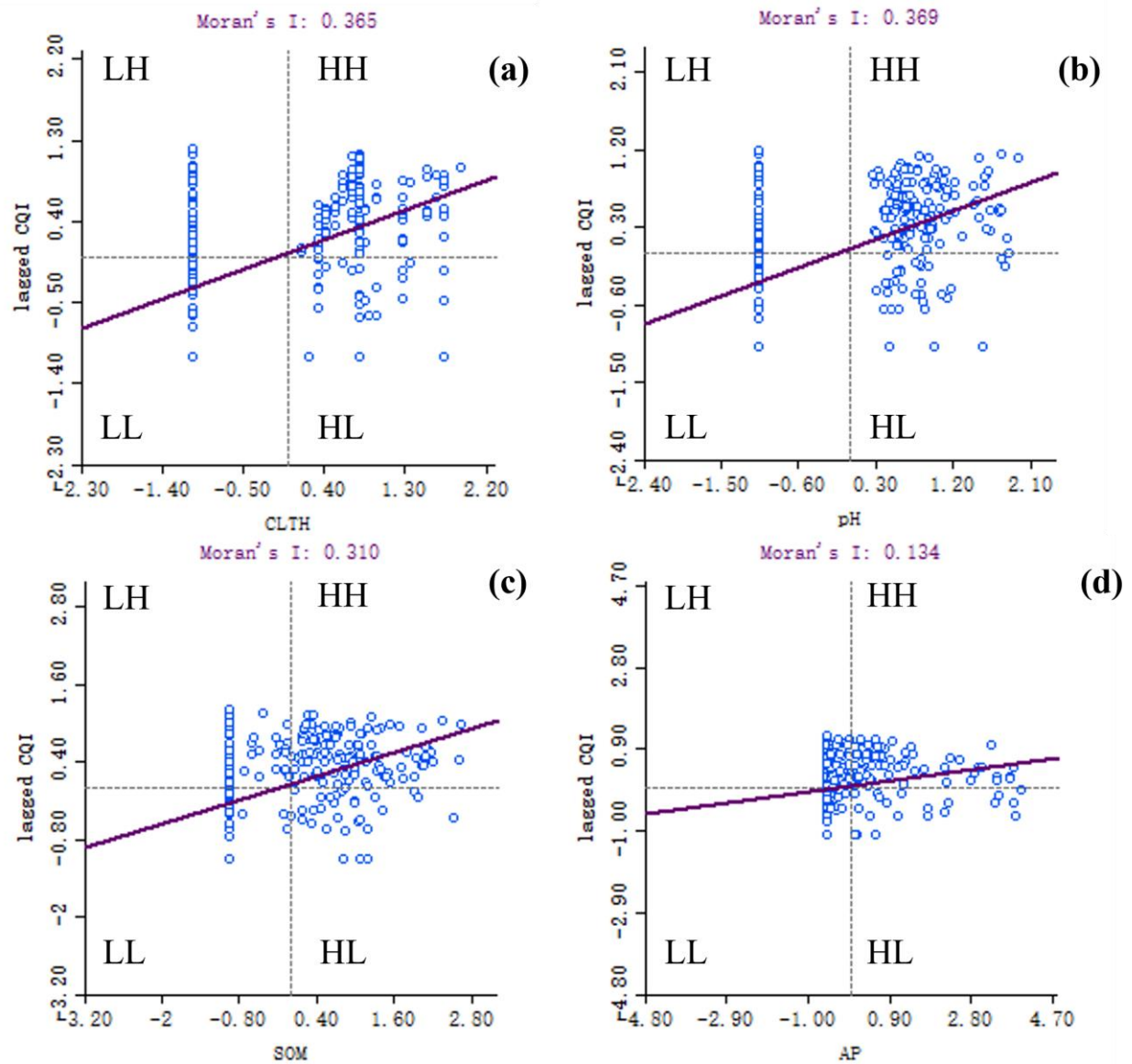


Figure S1. Spatial autocorrelation analysis of primary limiting factors (a, CLTH, b, pH, c, SOM, d, AP).

Note: t-statistics in parentheses; **, * indicate significant at the 1 % and 5 % levels, respectively.

Table S1 Assignment of categorical variables and its membership function.

Qualitative indicators	Assignment criteria				
	Broad Valley Basin	Middle Terrace of Plain	High Terrace of Plain	Intermontane Basin	Lower-hill Slope
TPO					
Indicator score	8 (0.95)	8 (0.95)	7 (0.90)	6 (0.80)	6 (0.80)
	Mid-hill Slope	Mountain Footslope	Upper-hill Slope	Mountain Backslope	Mountain Shoulder Slope
	5 (0.70)	4 (0.68)	3 (0.60)	2 (0.45)	1 (0.30)
CLT	Light loam	Sandy loam	Heavy loam	Medium loam	Clay
Indicator score	4 (0.9)	3 (0.85)	5 (0.95)	6 (1)	2 (0.70)
	Sand				
Indicator score	1 (0.60)				
	A Horizon-Loose and Subsoil-Compact Texture	Interlayered Texture	Thin-Layered Texture	Loose Texture	
TC					
Indicator score	7 (1)	5 (0.85)	3 (0.55)	1 (0.30)	
BIO	High	Moderate	Low		
Indicator score	3 (1)	2 (0.80)	1 (0.60)		
FND	Moderate	Low			
Indicator score	2 (0.85)	1 (0.70)			
OF	No constraints	Root-restrictive layer	Acidification	Stagnic properties	
Indicator score	6 (1)	3 (0.60)	5 (0.70)	2 (0.55)	
GRIW	Fully Adequate	Marginally Adequate	Barely Adequate	Inadequate	
Indicator score	4 (1)	2 (0.60)	3 (0.80)	1 (0.30)	
DC	Fully Adequate	Marginally Adequate	Barely Adequate	Inadequate	
Indicator score	4 (1)	2 (0.60)	3 (0.80)	1 (0.30)	

Note: TPO, topographic position; CLT, cultivated layer texture; TC, texture configuration; BIO, biodiversity; FND, forest shelterbelt network density; OF, obstacle factors; GRIW, irrigation capacity; DC, drainage conditions. Values outside parentheses represent the numerical scores assigned to categorical variables for PCA, while values in parentheses represent the corresponding membership values.

Table S2 The membership function and threshold parameters for quantitative indicators.

	BD	pH	SOM	TN	AP	AK	EST	CLTH	DOH
Threshold									
Parameters	The parabolic membership function		The S-shaped membership function						
x_1	1	4.5	6	0.5	3	30	30	15	30
x_2	1.1	6	40	2	40	200	100	20	60
x_3	1.2	7							
x_4	1.4	8.5							

Note: BD, bulk density; SOM, soil organic matter; TN, total nitrogen; AP, available phosphorus; AK, available potassium; EST, effective soil thickness; CLTH, cultivated layer thickness; DOH, depth of obstacle horizon.

Table S3 Sensitivity analysis of limiting-factor identification under different membership-score thresholds.

Classification	Membership -score threshold	Low-quality	Moderate-quality	High-quality	Total
Equal intervals	0.5	pH, SOM, AP, DOH	pH, SOM	——	pH, SOM
	0.6	pH, SOM, AP, DOH, CLTH	pH, SOM, AP	pH, SOM	pH, SOM
	0.7	pH, SOM, AP, DOH, CLTH	pH, SOM, AP, DOH	pH, SOM	pH, SOM, AP
Natural breakpoints	0.5	pH, SOM, AP, DOH	pH	——	pH, SOM
	0.6	pH, SOM, AP, DOH	pH, SOM, AP	pH, SOM	pH, SOM
	0.7	pH, SOM, AP, DOH, CLTH	pH, SOM, AP, DOH	pH, SOM	pH, SOM, AP

Note: SOM, soil organic matter; AP, available phosphorus; CLTH, cultivated layer thickness; DOH, depth of obstacle horizon; Equal intervals: High [0.72–0.87], moderate [0.57–0.72), and low [0.42–0.57); Natural breakpoints: High [0.69–0.87], moderate [0.60–0.69), and low [0.42–0.60).

Table S4 Moran's I Statistical Results.

Indicators	Moran's I	Z-score	p-value
CLTH (cm)	0.37	10.85	<0.001
pH	0.37	10.89	<0.001
SOM (g kg ⁻¹)	0.31	9.76	<0.001
AP (mg kg ⁻¹)	0.13	4.70	<0.001

Note: SOM, soil organic matter; AP, available phosphorus; CLTH, cultivated layer thickness.