



Soil Health Responses to Tillage, Residues, and Manure in Potato Rotation Systems in Peru

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Introduction

- Coastal Lima: arid desert climate, sandy soils and salinity constraints.
- Potato production is exposed to soil degradation and intensive management.
- Regenerative practices tested: minimum tillage, residue incorporation and sheep manure.

Objective

- To determine which soil properties had been improved through regenerative agriculture practices adopted in this study
- To develop a Soil Health Index (SHI) to assess individual and combined effects of tillage, residues and manure.

Study site

- CIP La Molina Experimental Station, Lima, Peru.
- Soil health assessed during the second potato season (7 May–26–29 August 2025).

Methods

Experimental design for long term trial at La Molina Experimental Station-Peru



Figure 1. The split-split plot experimental design of this study

Indicator selection: 13 indicators tested and combined into the SHI,

including: bulk density at 12cm (BD₁₂) and 30 cm (BD₃₀), penetration resistance, aggregate stability, hydraulic conductivity (Hc), soil organic carbon (SOC), pH, electrical conductivity (EC), macrofauna abundance, Shannon index, the decomposition rate of green tea (k_{green}), and rooibos tea (k_{red}) And potato yield

Indicator scoring: normalization using percentile-based linear functions: “more is better” or “less is better”.

Indicator integration: SHI = arithmetic mean of indicator scores.

Results: management responses

Source of variation	F1	F2	F1:F2	F3	F1:F3	F2:F3	F1:F2:F3
Yield	0.546	0.722	0.358	0.265	0.490	0.998	0.917
SOC	0.876	0.727	0.317	< 0.001***	0.831	0.552	0.322
pH	0.121	0.952	0.883	0.538	0.898	0.522	0.465
EC	0.005**	0.408	0.506	0.070	0.128	0.994	0.442
Penetration resistance	0.456	0.242	0.720	0.018*	0.924	0.304	0.075
Aggregate stability	0.210	0.025*	0.341	< 0.001***	0.074	0.813	0.718
Hc	0.102	0.612	0.495	0.328	0.441	0.339	0.660
BD ₁₂	0.195	0.664	0.687	0.041*	0.142	0.529	0.222
BD ₃₀	0.421	0.574	0.597	0.606	0.252	0.474	0.538
Shannon index	0.151	0.682	0.736	0.697	0.085	0.106	0.041*
Abundance	0.787	0.066	0.201	< 0.001***	0.850	0.730	0.740
k _{red}	0.482	0.271	0.454	0.077	0.588	0.907	0.685
k _{green}	0.304	0.515	0.580	0.599	0.453	0.124	0.588
SHI	0.157	0.142	0.315	0.002**	0.627	0.612	0.374

Table 1. p-values of 13 indicators and SHI, F1: tillage method, F2: residue management, F3: manure rates

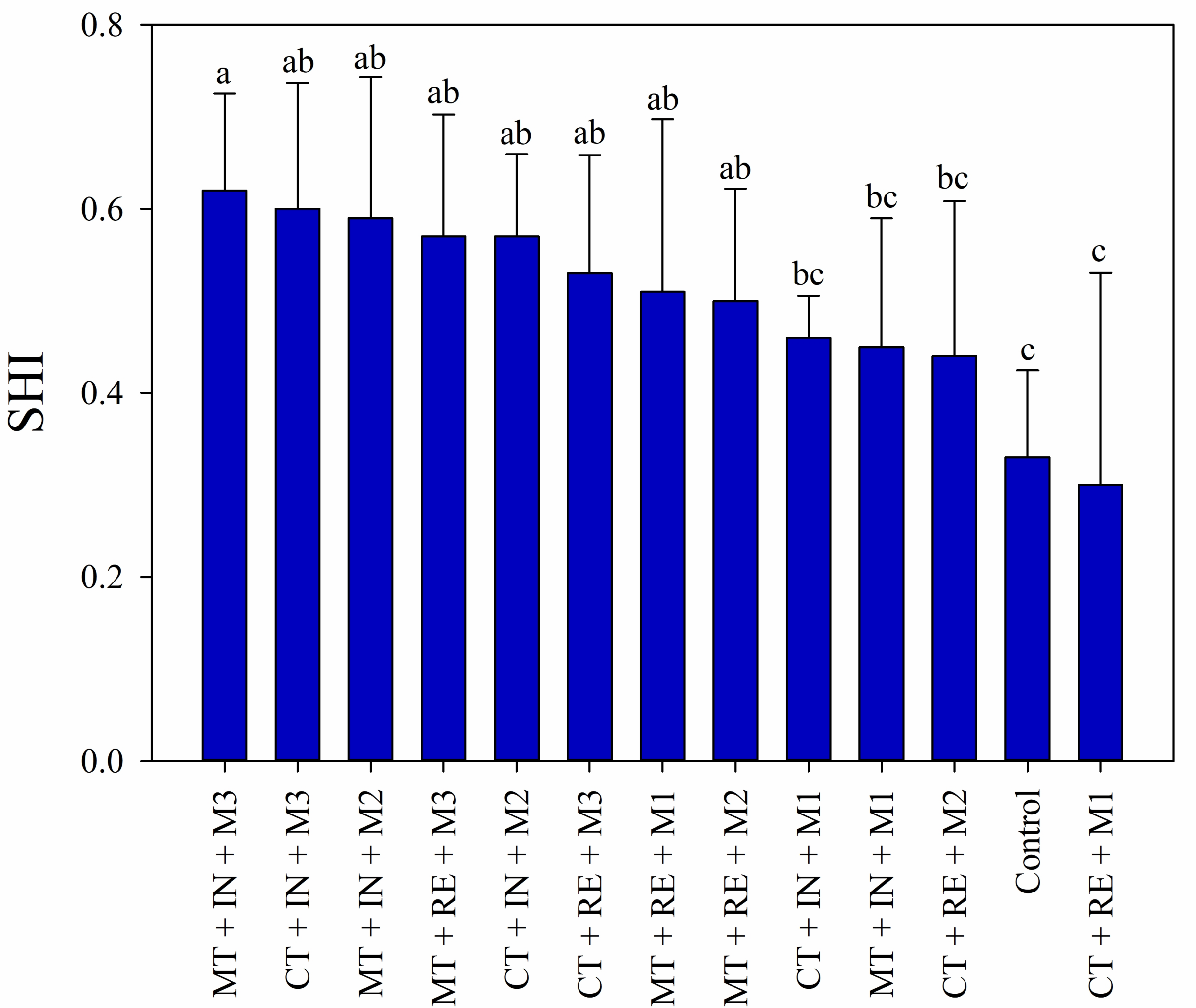
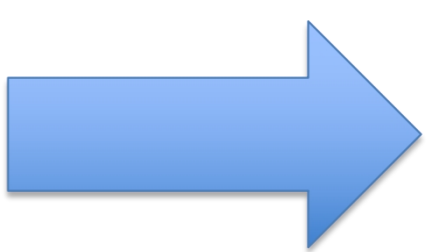


Figure 2. SHI scores across 12 treatments + control

Conclusions

- Sheep manure application – primary driver
- Minimum tillage and residue incorporation – limited effects, only EC and aggregate stability, respectively
- SHI proved effective in integrating multiple soil indicators
- Potato yield not significantly influenced by any practices



- Importance of organic amendments for improving soil health in sandy, saline soils
- Minimum tillage and residue incorporation require longer timeframes to become evident