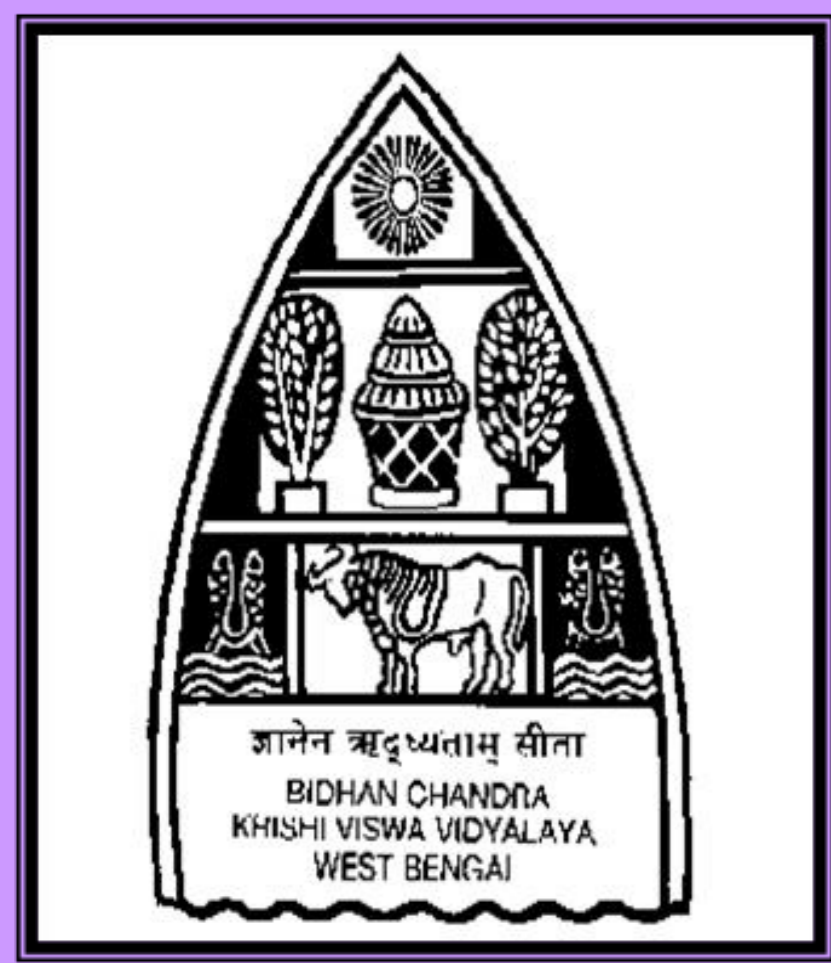


# IMPACT OF AGRICULTURAL LAND USE PRACTICES AND MONSOON AT MICRO-WATERSHED LEVEL ON SOIL PROPERTIES INCLUDING EARTHWORM POPULATION AND CROP PRODUCTION IN RED AND LATERITE AGROCLIMATIC ZONE UNDER MOIST SUB-HUMID REGION OF WEST BENGAL STATE IN INDIA



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## Introduction

- Land use is a crucial activity for the survival and growth of civilisation.
- Changes in land use patterns may result in changes in land cover patterns, which could have an impact on the structure of ecosystem.
- Land use change has been a global concern, leading to soil degradation and the nutrient cycle, as well as for food security and ecosystem services.
- So, Land use management is an essential tool for both the regulation of land allocation for particular applications and the preservation of natural resources for future generations.

## Objectives

Evaluating suitable agricultural land use practices towards conserving sustainability in efficient ecosystem services of land resources and securing sustainable food productions.

## Materials and methods

### Location

The study area was located in farmers' fields in three micro watersheds under the Paschim Medinipur district.

Season: Pre-monsoon (*pre-Kharif*), Monsoon (*Kharif*), Post-monsoon (*rabi*)

Duration: 2 years (2020-2021)

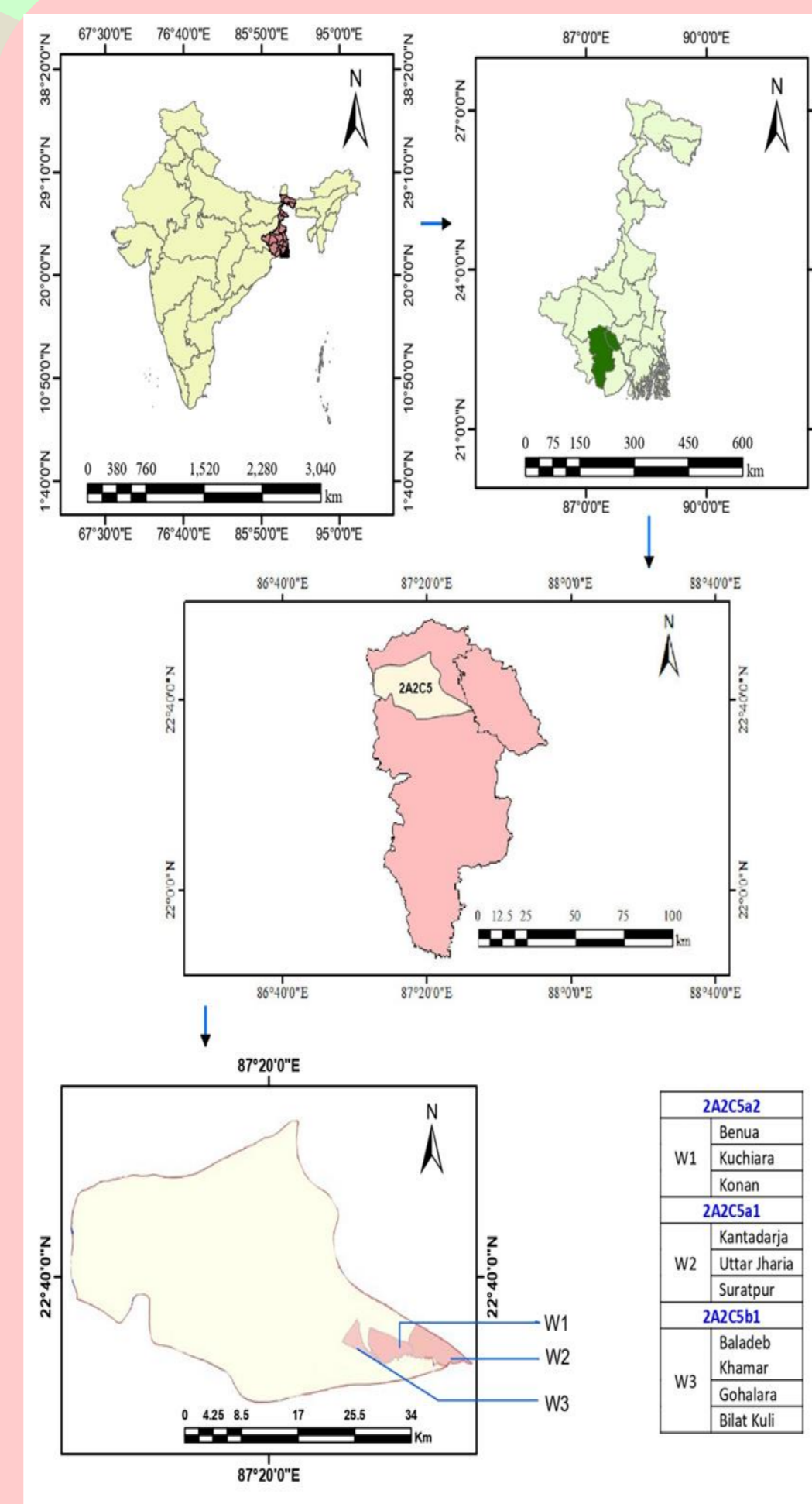
Experimental Plots for crops: Farmers' fields in micro watersheds

Replications: 3 (in each micro watershed)

Design of the experiment: Duncan's Multiple Range Test.

List of Treatments (i.e., agricultural land use systems selected) in each watershed

Treatments	Cropping seasons			Land use management farmers' choices				
	Pre-Kharif	Kharif	Rabi	Irrigation During Pre-Kharif	Boundary plantation	Organic manure	Tillage operation	Livestock Grazing
1. (C1)	Fallow	Rice	Rice	without	with	with	With	With
2. (C2)	Fallow	Rice	Rice	without	without	without	With	Without
3. (C3)	Sesame	Rice	potato	With	with	with	With	Without
4. (C4)	Sesame	Rice	potato	With	without	without	With	Without
5. (C5)	Rice	Rice	Potato	With	with	with	With	Without
6. (C6)	Rice	Rice	Potato	With	without	without	With	Without
7. (C7)	Cucumber	Rice	Cauliflower	With	with	with	With	Without
8. (C8)	Cucumber	Rice	Cauliflower	With	without	without	With	Without
9. (C9)	Groundnut	Rice	Potato	With	with	with	With	Without
10. (C10)	Groundnut	Rice	Potato	With	without	without	With	Without
11. (C11)	Ridge gourd	Rice	Potato	with	with	with	With	Without
12. (C12)	Ridge gourd	Rice	Potato	with	without	without	With	Without
13. (C13)	Fallow	Rice	Mustard	without	with	with	With	Without
14. (C14)	Fallow	Rice	Mustard	without	without	without	With	Without
15. (C15)	Sesame	Rice	Fallow	with	with	with	With	Without
16. (C16)	Sesame	Rice	Fallow	with	without	without	With	Without
17. (C17)	Jute	Fallow	Tomato	with	with	with	With	Without
18. (C18)	Jute	Fallow	Tomato	with	without	without	With	Without
19. (C19)	Jute	Fallow	Cabbage	with	with	with	With	Without
20. (C20)	Jute	Fallow	Cabbage	with	without	without	With	Without



Location of the study area and three micro watersheds (2A2C5a2, a1 and b1)

## Discussion

From the overall results for 2020 and 2021, it was found that matured earthworm population ranged from 3.00 in C5 to 6.67 in C13 and C14 agricultural land use systems. Scatter diagram obtained through PCA showed the impact of soil moisture, infiltration, porosity, bulk density and SOC.

From the overall results for 2020 and 2021, it was found that yield of kharif rice ranged from 1.73 t/ha in C12 to 2.25 t/ha in C6 agricultural land use system, while the yield of potato was 17.63 t/ha in C12 to 18.36 t/ha in C9 agricultural land use system. Scatter diagram obtained through PCA showed the impact of soil moisture, total aggregate, infiltration, porosity, soil pH, SOC, soil available N and number of earthworms in soil on yield of kharif rice and potato in 2020 and 2021.

## Conclusions

- The population of earthworms was significantly influenced by a various soil parameters such as soil moisture levels, infiltration rate, porosity, bulk density, and soil organic carbon content; and crop sequence followed.
- Boundary plantation showed no special effect on increasing earthworm population in soils of crop fields (with the same cropping sequence and other agricultural land use practices).
- The production of rice is reliant on soil characteristics like soil organic carbon content, soil available nitrogen, total soil aggregate, bulk density, permeability, and of course, on the population of earthworms.
- Potato production was also influenced by several soil factors such as soil moisture content, total soil aggregate, infiltration, soil organic carbon content, soil available nitrogen, and, of course, on the population of earthworms.
- From the overall result, it was found that the production of the two main crops (i.e., Rice and Potato) in the study area was influenced by the population of earthworms, which varied according to different agricultural land use practices with variation in crop sequence followed.

## References

- AISLUS. (1984). Watershed Atlas of India (1:1 million Scales); Compendium of Watersheds. All India Soil and Land Use Survey (AISLUS), New Delhi. p.99.  
 Bacha, B. and Sahoo, S. (2019) Effect of Different Land Use Practices on Earthworm Abundance and Soil Properties. *International Journal of Science and Research*, 9, 1290-1294.

## Results

Table 1 Numbers of matured earthworms in post-monsoon period

Treatment	No. of earthworms per m <sup>2</sup> area (Mean of three replicated plots)	
	2020	2021
C1	6.00 <sup>abc</sup>	5.00 <sup>abcde</sup>
C2	6.33 <sup>abc</sup>	6.67 <sup>a</sup>
C3	5.67 <sup>abcd</sup>	5.00 <sup>abcde</sup>
C4	4.00 <sup>ed</sup>	3.33 <sup>de</sup>
C5	3.00 <sup>d</sup>	3.00 <sup>e</sup>
C6	4.00 <sup>cd</sup>	4.33 <sup>abcde</sup>
C7	4.67 <sup>abcd</sup>	3.67 <sup>ede</sup>
C8	5.00 <sup>abcd</sup>	4.00 <sup>bcde</sup>
C9	5.67 <sup>abcd</sup>	6.33 <sup>ab</sup>
C10	5.00 <sup>abcd</sup>	5.67 <sup>abcd</sup>
C11	4.00 <sup>ed</sup>	3.00 <sup>e</sup>
C12	4.33 <sup>bcd</sup>	5.00 <sup>abcde</sup>
C13	7.00 <sup>ab</sup>	6.33 <sup>ab</sup>
C14	7.33 <sup>a</sup>	6.00 <sup>abc</sup>
C15	6.00 <sup>abc</sup>	5.33 <sup>abcde</sup>
C16	6.00 <sup>abc</sup>	5.67 <sup>abcd</sup>
C17	4.67 <sup>abcd</sup>	4.00 <sup>bcde</sup>
C18	4.33 <sup>bcd</sup>	4.67 <sup>abcde</sup>
C19	4.00 <sup>ed</sup>	3.00 <sup>e</sup>
C20	5.67 <sup>abcd</sup>	4.33 <sup>bcde</sup>

For a column, values followed by different letters differ significantly at p<0.05 by Duncan's Multiple Range Test. (Gomez and Gomez, 1984; IBM, 2022).

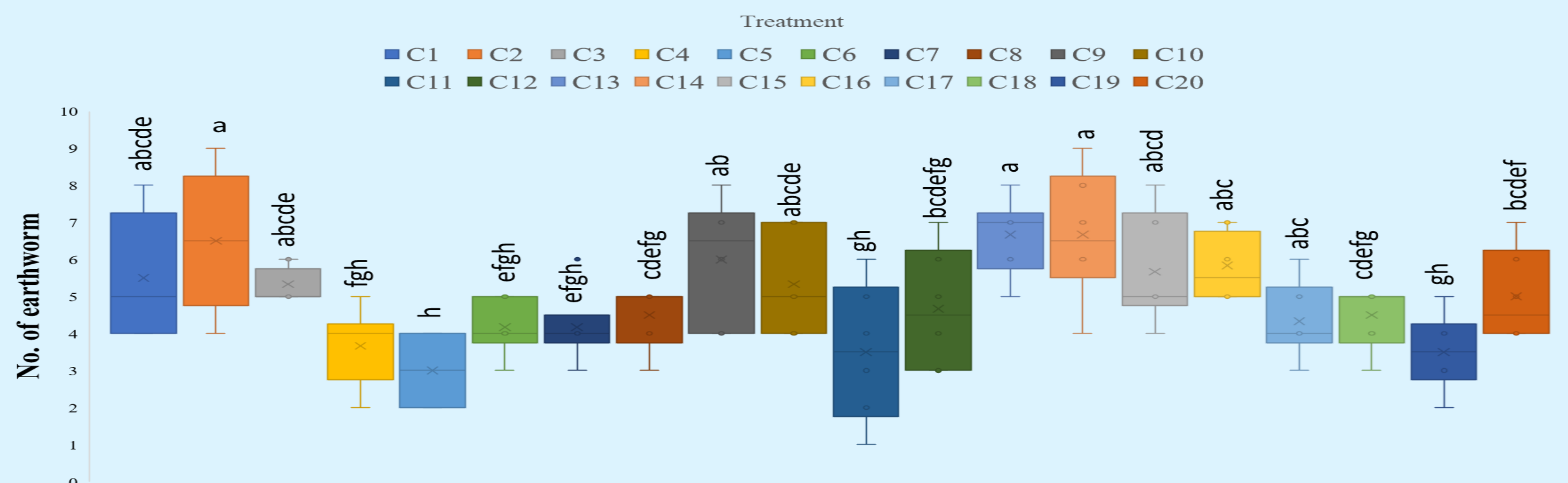


Figure 1: PCA Scatter plot: Relationship of earthworm population (overall 2020 & 2021) with other soil parameters under different agricultural land use practices.

Figure 2: Overall number of matured earthworms in the study area.

Table 2: Crop yield (t/ha) of individual crops in 2020 and 2021

Treatment	Crops grown (2021 and 2021)			Yield (t/ha) (Pooled of 2020 and 2021)		
	Pre-kharif	kharif	Rabi	Pre-kharif	Kharif	Rabi
C1	Fallow	Rice	Rice	-	2.06 <sup>ab</sup>	2.76 <sup>d</sup>
C2	Fallow	Rice	Rice	-	1.91 <sup>ab</sup>	2.66 <sup>d</sup>
C3	Sesame	Rice	potato	0.40 <sup>f</sup>	1.90 <sup>ab</sup>	18.35 <sup>b</sup>
C4	Sesame	Rice	potato	0.35 <sup>e</sup>	1.86 <sup>ab</sup>	18.22 <sup>b</sup>
C5	Rice	Rice	Potato	1.86 <sup>d</sup>	2.01 <sup>ab</sup>	18.22 <sup>b</sup>
C6	Rice	Rice	Potato	1.84 <sup>d</sup>	2.25 <sup>a</sup>	17.81 <sup>b</sup>
C7	Cucumber	Rice	Cauliflower	6.53 <sup>c</sup>	1.84 <sup>ab</sup>	7.66 <sup>e</sup>
C8	Cucumber	Rice	Cauliflower	6.12 <sup>c</sup>	1.81 <sup>ab</sup>	7.53 <sup>e</sup>
C9	Groundnut	Rice	Potato	1.73 <sup>d</sup>	1.89 <sup>ab</sup>	18.36 <sup>b</sup>
C10	Groundnut	Rice	Potato	1.67 <sup>d</sup>	1.83 <sup>ab</sup>	18.17 <sup>b</sup>
C11	Ridge gourd	Rice	Potato	9.13 <sup>b</sup>	1.76 <sup>ab</sup>	17.88 <sup>b</sup>
C12	Ridge gourd	Rice	Potato	8.92 <sup>b</sup>	1.73 <sup>b</sup>	17.63 <sup>b</sup>
C13	Fallow	Rice	Mustard	-	1.87 <sup>ab</sup>	0.75 <sup>d</sup>
C14	Fallow	Rice	Mustard	-	1.78 <sup>ab</sup>	0.68 <sup>d</sup>
C15	Sesame	Rice	Mustard	0.34 <sup>e</sup>	1.90 <sup>ab</sup>	-
C16	Sesame	Rice	Fallow	0.30 <sup>e</sup>	1.77 <sup>ab</sup>	-
C17	Jute	Fallow	Tomato	13.81 <sup>a</sup>	2.06 <sup>ab</sup>	16.48 <sup>b</sup>
C18	Jute	Fallow	Tomato	13.61 <sup>a</sup>	-	15.94 <sup>b</sup>
C19	Jute	Fallow	Cabbage	13.59 <sup>a</sup>	-	25.04 <sup>a</sup>
C20	Jute	Fallow	Cabbage	13.05 <sup>a</sup>	-	23.05 <sup>a</sup>

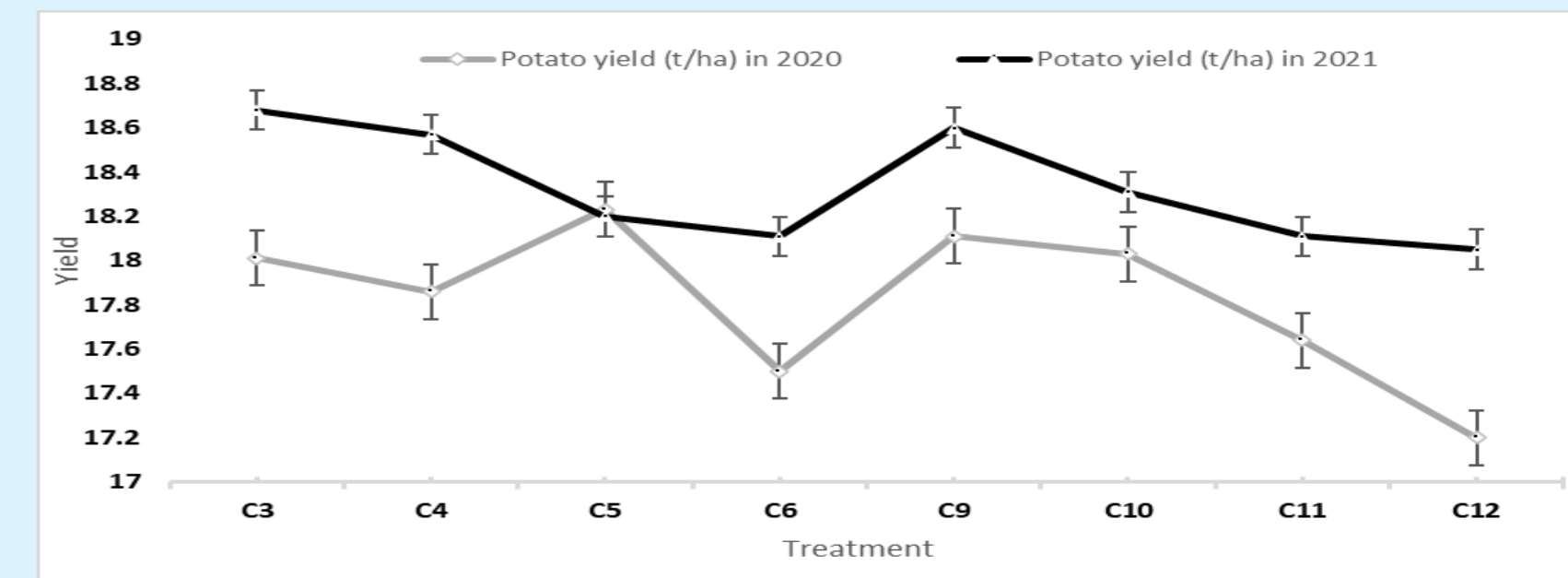
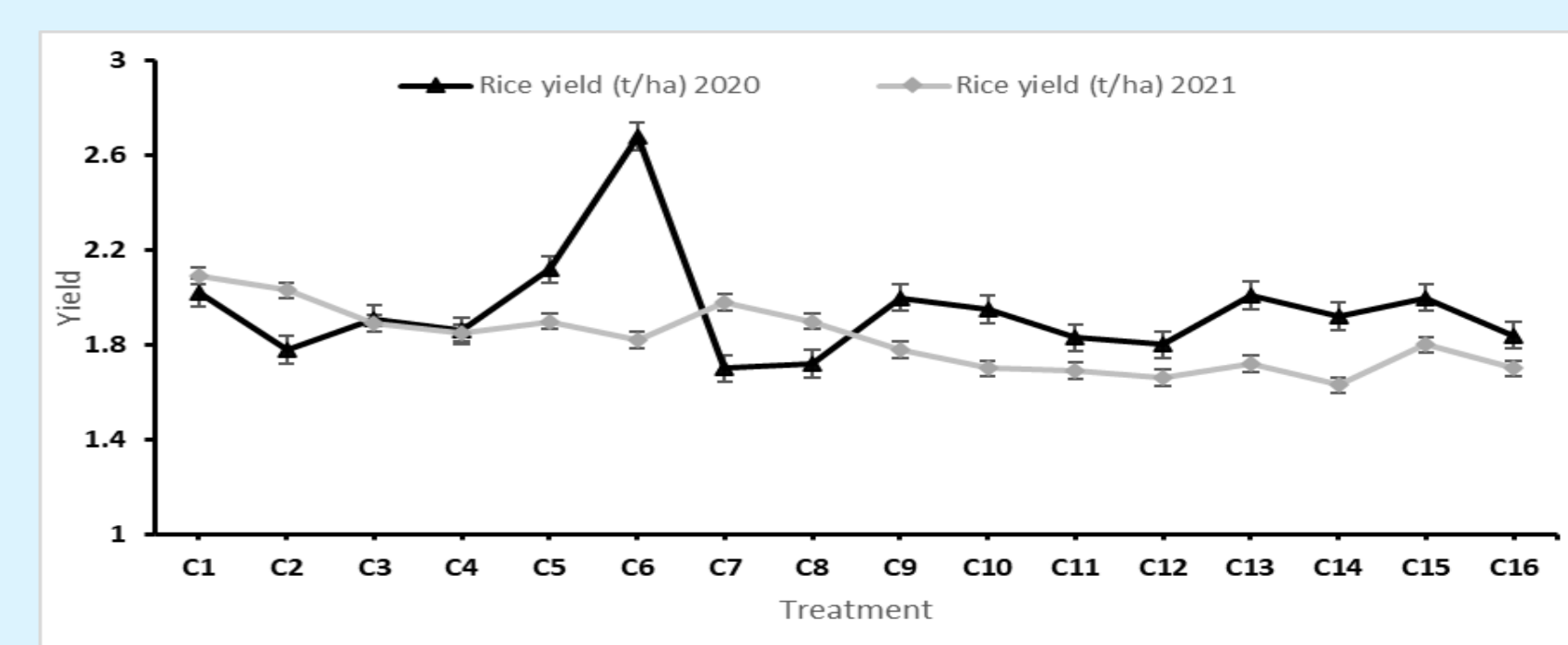


Figure 3: Rice and potato yield overall (2020 and 2021) under various agricultural land use practices, i.e., treatments

Table 3: Analysis of various soil parameter under different agricultural land uses (i.e., treatments)

Treatments	Bulk density	Porosity (%)	Moisture (%)	SOC (%)
C1	1.49 <sup>de</sup>	43.77 <sup>ef</sup>	32.35 <sup>bc</sup>	0.54 <sup>ef</sup>
C2	1.40 <sup>d</sup>	47.33 <sup>a</sup>	37.43 <sup>a</sup>	0.49 <sup>b</sup>
C3	1.55 <sup>b</sup>	41.45 <sup>bc</sup>	34.10 <sup>b</sup>	0.52 <sup>c</sup>
C4	1.58 <sup>a</sup>	40.22 <sup>b</sup>	33.91 <sup>b</sup>	0.67 <sup>d</sup>
C5	1.45 <sup>e</sup>	45.30 <sup>bc</sup>	9.33 <sup>m</sup>	0.74 <sup>b</sup>
C6	1.44 <sup>bc</sup>	45.61 <sup>bc</sup>	34.36 <sup>b</sup>	0.84 <sup>a</sup>
C7	1.44 <sup>bc</sup>	45.97 <sup>b</sup>	16.31 <sup>k</sup>	0.52 <sup>bc</sup>
C8	1.46 <sup>bc</sup>	44.94 <sup>cd</sup>	14.52 <sup>k</sup>	0.69 <sup>c</sup>
C9	1.55 <sup>b</sup>	41.34 <sup>bc</sup>	30.21 <sup>de</sup>	0.41 <sup>j</sup>
C10	1.43 <sup>b</sup>	46.97 <sup>a</sup>	31.38 <sup>cd</sup>	0.36 <sup>i</sup>
C11	1.59 <sup>a</sup>	40.10 <sup>b</sup>	28.77 <sup>e</sup>	0.46 <sup>j</sup>
C12	1.50 <sup>cd</sup>	43.51 <sup>f</sup>	18.89 <sup>i</sup>	0.55 <sup>c</sup>
C13	1.45 <sup>e</sup>	45.84 <sup>b</sup>	12.61 <sup>j</sup>	0.39 <sup>k</sup>
C14	1.49 <sup>cd</sup>	43.74 <sup>ef</sup>	24.02 <sup>gh</sup>	0.55 <sup>c</sup>
C15	1.54 <sup>b</sup>	42.01 <sup>f</sup>	25.17 <sup>fg</sup>	0.42 <sup>j</sup>
C16	1.44 <sup>bc</sup>	45.86 <sup>b</sup>	22.07 <sup>hi</sup>	0.45 <sup>j</sup>
C17	1.55 <sup>b</sup>	41.61 <sup>b</sup>	26.80 <sup>f</sup>	0.54 <sup>ef</sup>
C18	1.51 <sup>c</sup>	43.08 <sup>f</sup>	29.87 <sup>de</sup>	0.49 <sup>h</sup>
C19	1.48 <sup>ef</sup>	44.37 <sup>de</sup>	22.76 <sup>hi</sup>	0.52 <sup>bc</sup>
C20	1.50 <sup>cd</sup>	43.32 <sup>f</sup>	21.47 <sup>i</sup>	0.54 <sup>ef</sup>

For a column, values followed by different letters differ significantly at p<0.05 by Duncan's Multiple Range Test. (Gomez and Gomez, 1984; IBM, 2022).

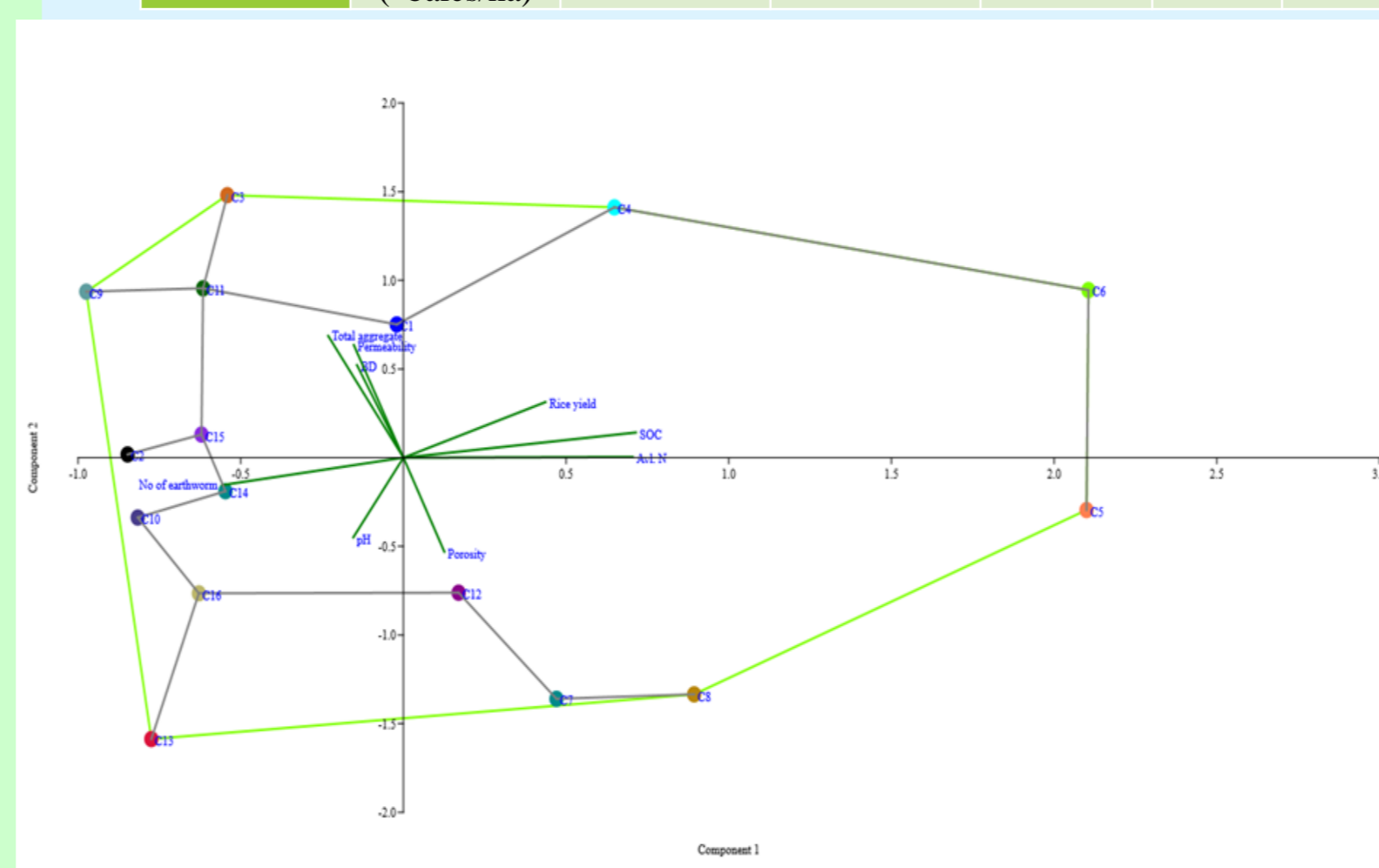


Figure 4: PCA Scatter plot: Relationship of rice yield with other soil parameters under different agricultural land use practices