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Effect of Land Use Changes and Soil Depth on Selective Soil Physico-Chemical Properties in Tarn Taran District of Punjab

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Abstract- Soil degradation and changes in physico-chemical properties significantly impact crop production, posing challenges for feeding the growing population. This study evaluated these properties under various land-use systems in Tarn Taran district, Punjab. Soil properties such as bulk density (1.34–1.48 g cm^{-3}), porosity (33.85–50.21 %), water holding capacity (30.47–46.61 %), pH (7.44–8.58), electrical conductivity (0.19–0.42 dS m^{-1}), soil organic carbon (0.42–0.69 %), and available nutrients (nitrogen: 235.45–271.29 Kg ha^{-1}, phosphorus: 18.72–26.03 Kg ha^{-1}, potassium: 183.39–363.47 Kg ha^{-1}) were analyzed at two depths (0-20 and 20-40 cm) across five system systems i.e., pear orchard, fodder-based, legume-based, rice-wheat, and sugarcane system. The results indicated that the pear orchard system exhibits the best soil health, with higher organic carbon, nitrogen, and potassium levels, likely due to organic management practices. In contrast, the sugarcane system shows the lowest nutrient availability and soil health, reflecting intensive nutrient removal and poor replenishment. Nutrient content generally decreased with soil depth, with surface soils being more enriched. This study underscores the need for sustainable soil management practices to improve nutrient cycling, prevent soil degradation, and enhance long-term agricultural productivity and ecosystem resilience.

Keywords: Land use system, physico-chemical properties, Tarn Taran.

I. INTRODUCTION

Land use changes driven by population growth, agricultural intensification, and diverse land management practices significantly alter soil physico-chemical properties, thereby impacting soil quality and ecosystem sustainability (Lal, 2007). The conversion of natural ecosystems such as forests and grasslands into agricultural or urban landscapes causes substantial changes in soil structure, fertility, and hydrological functions. Physical soil properties like bulk density, porosity, and water holding capacity are profoundly affected by land use. Bulk density increases due to intensive cultivation or urbanization, leading to reduced porosity and restricting root growth and water infiltration (Bagwan et al., 2023).

This compaction typically results in poorer plant growth and lower agricultural productivity. The reduction in soil organic matter content, due to changes in land use, further lowers the water holding capacity of soil, adversely affecting its ability to retain moisture for plants, especially during dry periods. These changes collectively compromise soil productivity and disrupt hydrological functions, leading to broader ecological imbalances (Gupta et al., 2010). Chemical properties of soil, such as pH and electrical conductivity (EC), are also significantly altered by land use transformations. Soil pH, which indicates acidity or alkalinity, is highly sensitive to factors like deforestation, continuous cultivation, and the leaching of basic cations.

Alterations in soil pH can impede nutrient availability and microbial activity, both of which are essential for healthy plant growth (Nanganoa et al., 2019). Similarly, soil EC, which reflects the concentration of soluble salts, is influenced by irrigation practices and fertilizer use, often increasing under intensive agricultural systems. High soil EC can lead to salinity issues, further affecting soil fertility and crop yields (Mikha et al., 2006). Soil organic carbon (SOC) is a critical indicator of soil health and fertility. Land use changes, particularly the conversion of forests to croplands, lead to SOC depletion due to reduced organic matter inputs and accelerated decomposition. This reduction in SOC content affects soil structure, aggregate stability, and nutrient cycling, ultimately impairing soil quality and ecosystem functioning (Zanatta et al., 2007). The impacts of land use changes are evident at various soil depths, with surface layers experiencing the most direct effects from human activities. However, deeper soil layers also show changes in bulk density, porosity, and organic carbon distribution. These vertical variations reflect the intensity and duration of land management practices, providing critical insights into the long-term sustainability of soil use (Gardner et al., 2000).

This study aims to assess the effects of land use changes and soil depth on selected physico-chemical properties, including soil bulk density, porosity, water holding capacity, pH, EC, and SOC. By examining these parameters across different land use systems and soil depths, this research offers a comprehensive understanding of how land management practices influence soil quality. These observations are essential for developing sustainable land management strategies to mitigate soil degradation and promote ecosystem resilience.

II. MATERIAL AND METHODS

Study area

To achieve the experiment's objective, an investigation was conducted at Tarn Taran district, Punjab, during season of 2023-24. The geographical coordinates of the survey area located between 31° 05' to 31° 30' 05” North latitude and 74° 30' to 75° 15' 05” East longitude and also presented in Fig 1. The dominant soil texture was sandy loam.

Fig 1: Research work location site in Tarn Taran District, Punjab

Soil parameters analysis

To assess the fertility status of soil. Experimental plots were laid out for specific crops, and soil samples were collected from two depths i.e., 0-20 and 20-40 cm. The samples were dried in the shade, powdered with a clean wooden pestle and mortar, passed through a 2 mm sieve, and stored in polyethylene bags for laboratory and were analyzed for pH and EC in soil:water suspension (1:2) using glass electrode and conductivity meter (Jackson, 1967). Organic carbon was determined by the Walkley and Black’s method (1934). Available nitrogen was determined by using alkaline potassium permanganate method (Subbiah and Asija, 1956). Available phosphorus was determined by Olsen method using 0.5 M $NaHCO_3$ solution adjusted at pH 8.5 using spectrophotometer (Olsen et al.,1954). Available potassium was determined using 1N neutral ammonium acetate method (Merwin and Peech, 1951) using flame photometer.

Statistical analysis

Analysis of variance for the experiment was done by using MS-excel 2007 and SPSS version 8.0. Analysis of variance was used to compare the difference between means among treatments by using Duncan’s Multiple Range Test (DMRT) (Duncan, 1955) at statistical level of $p \leq 0.05$.

III. RESULTS AND DISCUSSION

Bulk density

Bulk density, an indicator of soil compaction and porosity, is crucial for root growth and water movement. The values range from 1.34 g cm^{-3} to 1.48 g cm^{-3} across treatments and depths, with significant variations were observed in table 1. At the 0-20 cm depth, the lowest bulk density is observed in pear orchard (1.34 g cm^{-3}), indicating less compaction and potentially better root penetration and aeration. This is likely due to the perennial nature of pear orchards, which enhance organic matter through leaf litter and root turnover (Mandal et al., 2018). Conversely, sugarcane system exhibits the highest bulk density (1.42 g cm^{-3}), suggesting greater soil compaction.

Sugarcane cultivation often involves intensive tillage and heavy machinery, which could increase compaction (Berihu, 2021). Rice-wheat system, fodder based system, and legume based system have intermediate values, with slight variations but statistically significant differences. Rice-wheat system's value (1.40 g cm^{-3}) could reflect the influence of continuous cropping and puddling in rice cultivation, which tends to compact soil (Kaur and Bhat, 2017). A similar trend is observed at the 20-40 cm depth, with pear orchard maintaining the lowest bulk density (1.41 g cm^{-3}) and sugarcane system having the highest (1.48 g cm^{-3}). This pattern highlights the persistence of management-induced impacts even at deeper soil layers. Across all treatments, bulk density values are slightly higher in the 20-40 cm depth compared to the 0-20 cm depth, likely due to reduced organic matter and increased compaction at greater depths.

Table-1. Effects of land use and soil depth on soil chemical properties in Tarn Taran district.

Treatment	Bulk density (g cm^{-3})		Water holding capacity (%)		Soil porosity (%)	
	0-20 cm	20-40 cm	0-20 cm	20-40 cm	0-20 cm	20-40 cm
L_{RW}	1.40^{ab}	1.47^{ab}	37.61^{c}	33.98^{cd}	43.02^{c}	39.79^{c}
L_{PO}	1.34^{d}	1.41^{d}	46.61^{a}	41.20^{a}	50.21^{a}	46.83^{a}
L_{FD}	1.37^{cd}	1.43^{cd}	46.60^{a}	38.58^{ab}	48.57^{ab}	43.73^{ab}
L_{SU}	1.42^{a}	1.48^{a}	34.55^{c}	30.47^{d}	38.52^{d}	33.85^{d}
L_{LB}	1.39^{bc}	1.45^{bc}	42.61^{b}	36.46^{bc}	46.01^{bc}	41.98^{bc}
LSD ($p \leq 0.05$)	0.02	0.02	3.57	3.15	2.94	2.57
SE(m)±	0.01	0.01	1.24	1.08	1.01	0.88

Mean within a column followed by the same letter are not significant difference at ($p \leq 0.05$); LSD: Least significant difference at $p \leq 0.05$ level; SE(m)±: Standard error mean; NS: Non-Significant; L_{RW}: Rice-wheat cropping system; L_{PO}: Pear Orchard; L_{FD}: Fodder cropping system; L_{SU}: sugarcane cropping system; L_{LB}: Legume cropping system.

Water holding capacity

Water holding capacity (WHC) reflects the soil's ability to retain moisture, directly influencing plant water availability and drought resilience. The WHC values range from 30.47 to 46.61 per cent, with presented in table 1. At the 0-20 cm depth, pear orchard and fodder based system exhibit the highest WHC (46.61 and 46.60 %, respectively), significantly superior to other treatments. The enhanced WHC in pear orchard could be attributed to higher organic matter content and improved soil structure from orchard management practices. Similarly, fodder cropping may contribute to soil health by minimizing soil disturbance and promoting organic matter inputs (Beyene et al., 2023). Sugarcane system shows the lowest WHC (34.55%), likely due to soil degradation and compaction associated with sugarcane farming. Compacted soils have reduced pore spaces, limiting water retention. Rice-wheat and legume based system fall in between, with WHC values of 37.61 and 42.61 per cent, respectively. Rice-wheat system's relatively lower WHC might result from the depletion of organic matter due to intensive cropping. WHC decreases across all treatments in the deeper 20-40 cm layer. Pear orchard remains the highest (41.20 %), on the other hand sugarcane system had the lowest WHC (30.47 %). This reduction with depth is typical, as organic matter and root activity diminish in subsoil layers.

Soil porosity

Soil porosity, representing the fraction of pore space in soil, is vital for aeration, water infiltration, and microbial activity. Porosity values range from 33.85% to 50.21%, with significant differences ($p \leq 0.05$) among land use and depth (Table 1). At the 0-20 cm depth, pear orchard showed the highest porosity (50.21 %), emphasizing its superior soil structure. Enhanced porosity is associated with increased macropores and stable aggregates, likely fostered by perennial vegetation and minimal soil disturbance (Dai et al., 2024). Sugarcane System records the lowest porosity (38.52 %), consistent with its high bulk density and low WHC. Intensive cultivation practices in sugarcane fields often disrupt soil structure and reduce porosity (Berihu, 2021). Rice-wheat, fodder based, and legume based systems have intermediate porosity values (43.02, 48.57 and 46.01 %). Porosity decreases across all treatments at the 20-40 cm depth, similar the trends observed in WHC. Pear orchard retains highest porosity (46.83 %), while sugarcane system exhibits the lowest (33.85 %). The decline with depth reflects reduced organic inputs and compaction effects.

Soil pH

The pH values range from 7.44 to 8.58 across treatments and depths, indicating slightly alkaline to moderately alkaline conditions (Table 2). At the 0-20 cm depth, pear orchard exhibits the lowest pH (7.44), which could be attributed to organic acid release from decaying litter and root exudates in the orchard system (Malik et al., 2018). Sugarcane system, in contrast, has the highest pH (8.23), likely due to intensive fertilizer application and reduced organic matter content (Liebig et al., 2017). Rice-wheat, fodder based and legume based systems exhibit intermediate pH values (7.91, 7.67, 7.77), with significant statistical differences among them. The trend of higher pH in sugarcane and rice-wheat systems indicates potential challenges in nutrient availability, particularly for micronutrients. At the 20-40 cm depth, the pH increases across all treatments, reflecting a typical trend where subsoil alkalinity is higher due to reduced organic matter and leaching of basic cations (Liebig et al., 2017). Sugarcane system again shows the highest pH (8.58), while pear orchard maintains the lowest (7.56), indicating that management practices significantly influence soil acidity levels.

Table-2. Effects of land use and soil depth on soil physical properties in Tarn Taran district.

Treatment	pH		EC (dS m^{-1})	
	0-20 cm	20-40 cm	0-20 cm	20-40 cm
L_{RW}	7.91^{b}	8.32^{ab}	0.39^{ab}	0.32^{ab}
L_{PO}	7.44^{c}	7.56^{c}	0.24^{c}	0.19^{c}
L_{FD}	7.67^{bc}	8.06^{b}	0.28^{c}	0.22^{c}
L_{SU}	8.23^{a}	8.58^{a}	0.42^{a}	0.37^{a}
L_{LB}	7.77^{b}	8.22^{b}	0.35^{b}	0.28^{b}
LSD ($p \leq 0.05$)	0.18	0.17	0.05	0.05
SE(m)±	0.06	0.05	0.02	0.01

Mean within a column followed by the same letter are not significant difference at ($p \leq 0.05$); LSD: Least significant difference at $p \leq 0.05$ level; SE(m)±: Standard error mean; NS: Non-Significant; L_{RW}: Rice-wheat cropping system; L_{PO}: Pear Orchard; L_{FD}: Fodder cropping system; L_{SU}: sugarcane cropping system; L_{LB}: Legume cropping system.

Soil EC

Electrical conductivity (EC), an indicator of soil salinity, varies from 0.19 to 0.42 dS m^{-1}, showed in table 2. At depth 0-20 cm, pear orchard has the minimum EC (0.24 dS m^{-1}), reflecting minimal salt accumulation likely due to organic matter-driven leaching and high infiltration rates. On the other hand, sugarcane system shows the highest EC (0.42 dS m^{-1}), consistent with its intensive fertilizer use and potential salinity buildup from irrigation practices (Sharma, 2021). Rice-wheat, fodder based and legume based systems show moderate EC values, indicating varied salt accumulation levels influenced by crop management and water use efficiency. Similar trends are observed at depth 20-40 cm, where EC decreases slightly across all treatments, reflecting the natural leaching of salts into deeper layers. However, sugarcane system still records the highest EC (0.37 dS m^{-1}), while pear orchard remains the lowest (0.19 dS m^{-1}). This pattern was linked to salt accumulation from fertilizers and irrigation, with higher EC in sub-surface layers due to leaching from surface soils. Increased leaching and soil erosion from continuous farming and crop residue removal contributed to this trend (Wang et al., 2020).

Soil organic carbon

The soil organic carbon (SOC) levels at two soil depths, 0-20 and 20-40 cm, across five land use systems showed in fig 2. Soil organic carbon plays a critical role in soil health, influencing nutrient availability, water retention, and overall soil fertility. The pear orchard system, exhibits higher SOC levels, with 0.69 per cent at 0-20 cm and 0.56 per cent at 20-40 cm. This suggests better organic matter retention, likely enhanced by the presence of perennial vegetation and organic amendments commonly used in orchards (Li et al., 2023). The fodder system has moderate SOC, showing 0.57 per cent at 0-20 cm and 0.47 per cent at 20-40 cm, reflecting its capacity to maintain a relatively stable organic matter content despite regular harvesting (Osman and Osman, 2013). The legume-based system, known for improving soil organic carbon through nitrogen-fixing plants, shows values of 0.52 per cent at 0-20 cm and 0.41 per cent at 20-40 cm, indicating a positive effect on organic carbon content, though not as high as in the pear orchard system (Karimi et al., 2020). The rice-wheat system has relatively low SOC, with 0.48 per cent at 0-20 cm and 0.36 per cent at 20-40 cm, likely due to intensive farming practices that may deplete organic matter over time. The sugarcane system shows the lowest SOC levels, with 0.42 per cent at 0-20 cm and 0.31 per cent at 20-40 cm, which may be due to the high nutrient demands of sugarcane and the possible depletion of organic matter from intensive cropping (Kizilkaya et al., 2011). This decline was due to reduced organic residue deposition and tillage practices that exposed organic matter to decomposition (Chen et al., 2022).

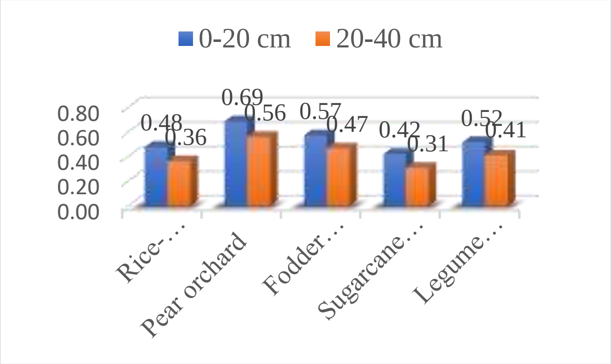

Fig 2: Effect of land use system on soil organic carbon (%) at both depths

Available nitrogen

The fig 3 presents the soil available nitrogen measurements across five agricultural systems at two depths: 0-20 cm and 20-40 cm. Available nitrogen is a key nutrient that influences plant growth, crop yield, and soil fertility. The pear orchard system has maximum nitrogen levels, particularly at 0-20 cm (271.29 Kg ha-1), indicating better nitrogen retention, likely due to organic matter and orchard management practices. The fodder system displays a decrease from 239.65 Kg ha-1 at the surface to 214.89 Kg ha-1 at sub-surface, which may be attributed to its high nitrogen demand and lower nitrogen retention in deeper layers. The rice-wheat system shows relatively lower nitrogen availability, with 243.01 Kg ha-1 at 0-20 cm and 226.46 Kg ha-1 at 20-40 cm, suggesting nitrogen depletion in the surface soil due to intensive cropping. The sugarcane system shows the minimum nitrogen levels at both depths, with 235.45 Kg ha-1 at 0-20 cm and 206.09 Kg ha-1 at 20-40 cm, likely due to its intensive nutrient requirements and nitrogen leaching. The legume-based system, known for its nitrogen-fixing plants, demonstrates a balanced nitrogen distribution, with values of 254.21 Kg ha-1 at top layer and 235.73 Kg ha-1 at deeper layer, reflecting sustainable nitrogen cycling through biological fixation.

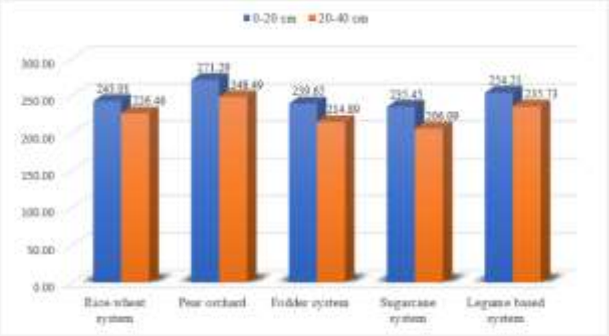

Fig 3: Effect of land use system on available nitrogen (Kg ha^{-1}) at both depths

Available phosphorus

In the fig 4 on soil available phosphorus illustrates its variability across land-use systems and soil depths, highlighting the effects of management practices on soil fertility. At the 0-20 cm depth, the legume-based system shows the highest phosphorus content (26.03 Kg ha^{-1}), followed by the rice-wheat system at 25.00 Kg ha^{-1}. Legume based system and rice-wheat system reflects continuous fertilizer inputs. The fodder cropping system shows moderate phosphorus levels (23.29 Kg ha^{-1}), indicating balanced nutrient inputs. However, the sugarcane system exhibits the lowest phosphorus content (18.72 Kg ha^{-1}), likely due to high nutrient removal and insufficient replenishment. The pear orchard also shows low phosphorus levels (19.50 Kg ha^{-1}), possibly due to slower nutrient cycling. At the 20-40 cm depth, phosphorus content decreases across all systems, reflecting reduced organic matter and limited root activity. Legume based (24.33 Kg ha^{-1}) and rice-wheat system (23.69 Kg ha^{-1}) maintain the highest phosphorus levels, while sugarcane system (15.91 Kg ha^{-1}) and pear orchard (17.41 Kg ha^{-1}) remain lowest. These findings stress the importance of sustainable nutrient management practices, including organic amendments and balanced fertilization, to address deficiencies and enhance phosphorus availability, particularly in sugarcane system.

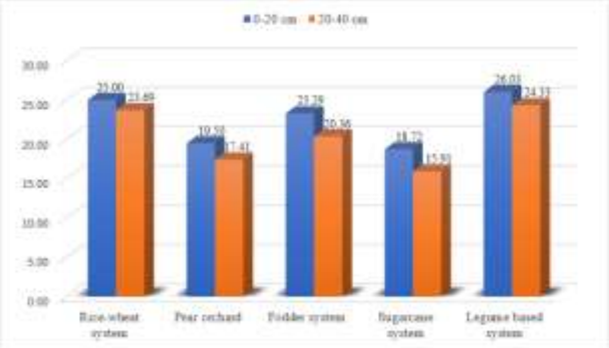

Fig 4: Effect of land use system on available phosphorus (Kg ha^{-1}) at both depths

Available potassium

The soil available potassium demonstrates significant variability among land-use systems and soil depths, reflecting the impact of agricultural practices on nutrient dynamics in fig 5. At the 0-20 cm depth, the pear orchard shows the highest potassium content (363.47 Kg ha^{-1}), attributed to organic matter accumulation from perennial vegetation, such as leaf litter and minimal soil disturbance. The legume-based system follows with 321.53 Kg ha^{-1}, benefiting from improved soil structure and nutrient availability contributed by nitrogen-fixing legumes. The rice-wheat system also records relatively high potassium levels (307.37 Kg ha^{-1}), likely due to consistent fertilizer inputs in this intensive cropping system. In contrast, the sugarcane system has the lowest potassium content (235.87 Kg ha^{-1}), potentially caused by high nutrient removal and insufficient replenishment. The fodder system displays moderate levels (263.49 Kg ha^{-1}), indicating balanced nutrient management. At the 20-40 cm depth, potassium availability declines across all systems due to reduced root activity and lower organic matter content. Pear orchard retains the highest value (259.86 Kg ha^{-1}), while sugarcane system remains the lowest (183.39 Kg ha^{-1}). These results emphasize the importance of sustainable nutrient practices, particularly in sugarcane system, to prevent potassium depletion and maintain soil fertility.

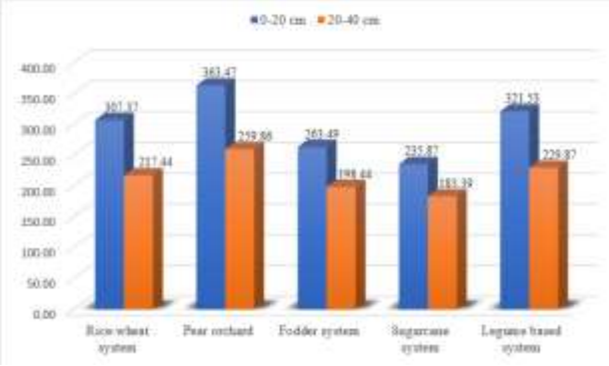

Fig 5: Effect of land use system on available potassium (Kg ha^{-1}) at both depths

IV. CONCLUSION

Soil health was found to be better in pear orchards, followed by fodder-based, legume-based, rice-wheat, and sugarcane systems. Most soil properties, except bulk density and pH, decreased with depth. The study emphasizes the need for sustainable soil management practices to maintain soil health in cultivated land. This includes using organic materials, proper fertilization, and systematic research, useful to local soil characteristics and land use types. Implementing these practices is crucial for enhancing agricultural productivity and ensuring long-term soil health and ecosystem sustainability.

REFERENCES

1. Bagwan, W.A., Gavali, R.S. and Maity, A., (2023). Quantifying soil organic carbon (SOC) density and stock in the Urmodi River watershed of Maharashtra, India: implications for sustainable land management. Journal of Umm Al-Qura University for Applied Sciences, 9(4): 548-564.
2. Berihu, T. (2021). The effects of applying a combination of bio-slurry and inorganic fertilizers on teff yield and soil properties in the highlands of northern Ethiopia. Land Restoration Training Programme.
3. Bhuyan, S., Patgiri, D. K., Medhi, B. K., Deka, B., Kandali, G. G., Medhi, S. J., ... and Sandillya, M. (2024). Prediction of Soil Quality Index (SQI) and Its Minimum Dataset Indicators for Rice-

Based Cropping Systems in the North Bank Plain Zone of Assam. Eurasian Soil Science, 57(10): 1718-1729.

4. Blake, G. R. and Hartge, K. H. (1986). Bulk density. In: Methods of soil analysis, Part 1 Physical and mineralogical methods. American Society of Agronomy, Madison, WI, USA, 5: 363-375.
5. Chen, Y., Li, Y., Qiu, T., He, H., Liu, J., Duan, C., Cui, Y., Huang, M., Wu, C. and Fang, L., (2024). High nitrogen fertilizer input enhanced the microbial network complexity in the paddy soil. Soil Ecology Letters, 6(2): 230205.
6. Dai, W., Shi, R., Li, X., Zhao, Z., Xia, Z., Li, D., and Ding, S. (2024). Factors and Mechanisms Affecting Arsenic Migration in Cultivated Soils Irrigated with Contained Arsenic Brackish Groundwater. Microorganisms, 12(12): 2385.
7. Esilaba, A.O., Opala: A., Nyongesa, D., Muindi, E.M., Gikonyo, E., Kathuku-Gitonga, A.N., Kamau, D.M., Kamau, M., Kisinyo: O., Wendt, J. and Mutegi, J., (2023). Soil acidity and liming handbook for Kenya.
8. Gardner, C. M., Robinson, D., Blyth, K., and Cooper, J. D. (2000). Soil water content. In Soil and environmental analysis: 13-76
9. Gupta, R.D., Arora, S., Gupta, G.D. and Sumberia, N.M., 2010. Soil physical variability in relation to soil erodibility under different land uses in foothills of Siwaliks in NW India. Tropical ecology, 51(2): 183.
10. Karimi, E., Shirmardi, M., Dehestani Ardakani, M., Gholamnezhad, J., and Zarebanadkouki, M. (2020). The effect of humic acid and biochar on growth and nutrients uptake of calendula (Calendula officinalis L.). Communications in Soil Science and Plant Analysis, 51(12): 1658-1669.
11. Kaur, R. and Bhat, Z.A., (2017). Effect of different agricultural land use systems on physico-chemical properties of soil in sub-mountainous districts of Punjab, North-West India. Journal of Pharmacognosy and Phytochemistry, 6(3): 226-233.
12. Keen, B. A. and Raczkowski, H. (1921). The relation between the clay content and certain physical properties of a soil. The Journal of Agricultural Science, 11(4): 441-449.
13. Kizilkaya, R., Karaca, A., Turgay, O. C., and Cetin, S. C. (2011). Earthworm interactions with soil enzymes. Biology of earthworms: 141-158.
14. Lal, R., (2007). Soil science and the carbon civilization. Soil Science Society of America Journal, 71(5): 1425-1437.
15. Li, H., Chang, L., Wei, Y. and Li, Y., (2023). Interacting effects of land use type, soil attributes, and environmental factors on aggregate stability. Land, 12(7): 1286.
16. Liebig, M.A., Ryschawy, J., Kronberg, S.L., Archer, D.W., Scholljegerdes, E.J., Hendrickson, J.R. and Tanaka, D.L., 2017. Integrated crop-livestock system effects on soil N, P, and ph in a semiarid region. Geoderma, 289: 178-184.
17. Malik, A.A., Puissant, J., Buckeridge, K.M., Goodall, T., Jehmlich, N., Chowdhury, S., Gweon, H.S., Peyton, J.M., Mason, K.E., van Agtmaal, M. and Blaud, A., (2018). Land use driven change in soil pH affects microbial carbon cycling processes. Nature communications, 9(1): 3591.
18. Mandal, A., Toor, A.S. and Dhaliwal, S.S., (2018). Effect of Land uses on physico-chemical properties and nutrient status of surface (0–15 cm) and sub-surface (15–30 cm) layers in soils of South-Western Punjab, India. Int. J. Curr. Microbiol. Appl. Sci, 7: 2659-2671.
19. Mikha, M.M., Vigil, M.F., Liebig, M.A., Bowman, R.A., McConkey, B.R.I.A.N., Deibert, E.J. and Pikul, J.L., (2006). Cropping system influences on soil chemical properties and soil quality in the Great Plains. Renewable Agriculture and Food Systems, 21(1): 26-35.
20. Nanganoa, L.T., Okolle, J.N., Missi, V., Tueche, J.R., Levai, L.D. and Njukeng, J.N., (2019). Impact of different land use systems on soil physicochemical properties and macrofauna abundance in the humid tropics of Cameroon. Applied and Environmental Soil Science.
21. Osman, K.T. and Osman, K.T., (2013). Physical properties of soil. Soils: Principles, Properties and Management: 49-65.
22. Sharma, D., (2021). Reclamation and Management of Salt-affected Soils for Crop Production with Special Emphasis on Coastal region: Trend and Prospects. Souvenir: 11.
23. Walkley, A. and Black, C. A. (1934). An examination of Degtjareff method for

determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science, 37: 27-38.

24. Wang, J., Yuan, G., Lu, J., Wu, J. and Wei, J., (2020). Variation of salts and available nutrients in salt-affected soil during leaching process under the influence of organic ameliorators. Chemistry and Ecology, 36(3):256-269.
25. Zanatta, J.A., Bayer, C., Dieckow, J., Vieira, F.C.B. and Mielniczuk, J., (2007). Soil organic carbon accumulation and carbon costs related to tillage, cropping systems and nitrogen fertilization in a subtropical Acrisol. Soil and Tillage Research, 94(2): 510-519.