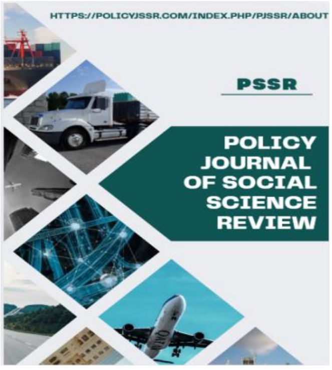
DOI: https://doi.org/10.5281/zenodo.20058071

Volume. 4, issue No. 5 (2026)



Policy Journal of Social Science Review

ISSN Online:3006-4635

ISSN Print: 3006-4627

COMPARATIVE ASSESSMENT OF SOIL PHYSICO-CHEMICAL PROPERTIES UNDER WHEAT AND MAIZE CROPPING SYSTEMS ALONG ALTITUDINAL GRADIENT IN YASIN VALLEY, GILGIT-BALTISTAN

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Article Details

Received on 15 April, 2026

Accepted on 04 May, 2026

Published on 06 May, 2026

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Page No: 100-117

ABSTRACT

Soil analysis is a critical diagnostic tool for assessing soil health, optimizing crop yields, and implementing effective nutrient management strategies. This study conducted a comparative assessment of soil properties under two primary cropping systems, wheat and maize, across various sites in Yasin Valley, District Ghizer. Soil samples were collected at a depth of 0–15 cm to evaluate physico-chemical variations. The results indicated that while both cropping systems maintained a relatively stable pH (mean 7.80), the soils in Yasin Valley are generally alkaline, with an average pH of 8.13. Electrical conductivity (EC) was slightly higher in maize fields (111.0 μS/cm), which predominantly featured a silt-loam texture. Analysis of macronutrients revealed that nitrate-nitrogen (NO3N) and available phosphorus (P) levels were consistent across both systems, whereas exchangeable potassium (K) was marginally higher in wheat fields. Although soil moisture fluctuated between sites, higher mean values were recorded in maize-cultivated areas. One-way ANOVA confirmed that variations in pH ($p < 0.005$) and EC ($p < 0.01$) were statistically significant between the two cropping systems, while NO3N, exchangeable K, and available P showed no significant differences. Furthermore, altitude was found to have a negligible influence on soil physico-chemical properties within the study area. These findings suggest that integrated management practices, including the use of organic fertilizers and regular soil monitoring, are vital for maintaining soil productivity. This research provides a baseline for farmers in mountainous regions to improve fertilizer efficiency, enhance crop yields, and support sustainable livelihoods.

Keywords: *Soil quality, Cropping systems, Soil health, Nutrient management, Mountain agriculture, Altitudinal variation.*

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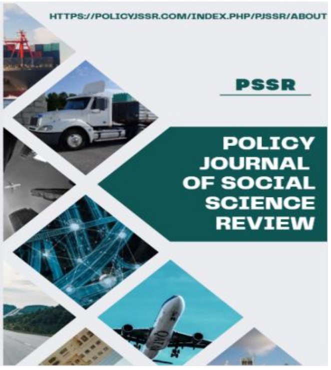

Policy Journal of Social Science Review

ISSN Online:3006-4635

ISSN Print: 3006-4627

Introduction

Soil serves as the primary reservoir of essential nutrients required for plant growth and development. Beyond supporting vegetation, soil organic compounds play a critical role in maintaining biodiversity and sustaining environmental quality (Ishaq et al., 2015). For agricultural sustainability, systematic analysis of soil properties is imperative, as soil quality (SQ) is frequently altered by anthropogenic factors such as constant tillage, intensive farming, and the application of synthetic fertilizers (Hussain et al., 2021). Alexander (1971) first introduced the concept of soil quality, emphasizing the need for management criteria to preserve land productivity (Bone et al., 2010). Poor land management accelerates soil erosion—losing an estimated 1.5 to 3 billion tons of soil globally each year, which leads to nutrient depletion and a decline in agricultural output (Erkossa et al., 2022).

To evaluate soil health effectively, specific physical and chemical indicators must be monitored (Zornoza et al., 2015). Key indicators include soil pH, electrical conductivity (EC), available phosphorus (P), exchangeable potassium (K), and nitrate-nitrogen (Jat, 2017). EC measures the concentration of dissolved salts and serves as a proxy for nutrient availability or excess, while pH dictates the chemical environment for nutrient uptake (Nadler, 2005). Among macronutrients, nitrogen is fundamental for photosynthesis and protein structure, phosphorus is essential for cell division and energy storage, and potassium regulates CO_2 assimilation and fruit maturation (Razaq et al., 2017; Sawan, 2018). Furthermore, soil moisture remains a decisive factor in the carbon cycle and overall climate resilience (Gebele et al., 2025).

In high-altitude cold deserts, soil properties are heavily influenced by topography and climate. These soils are often immature, characterized by a coarse texture with significant gravel content and limited nutrient retention capacity (Mbibueh et al., 2005). As altitude increases, soluble minerals like nitrogen and potassium are often lost through leaching and erosion, potentially leading to acidic conditions and nutrient deficiencies (Twagiramaria and Tolo, 2016). Consequently, understanding the interaction between altitude and land use is vital for mountain agriculture.

In the Gilgit-Baltistan region of Pakistan, the economy of smallholder farmers is inextricably linked to agriculture. While previous studies have documented soil organic carbon and pH in valleys like Bagrot and Altit, research remains limited regarding the specific impact of traditional cropping systems, such as wheat and maize, on soil health in high-altitude regions like Yasin Valley. In these mountainous landscapes, growing populations and land scarcity necessitate a shift toward optimized nutrient management to sustain agro-ecosystems.

This study addresses this gap by investigating the variation in soil physico-chemical properties under different cropping systems in Yasin Valley, District Ghizer. By evaluating how maize and wheat cultivation affects soil health, this research aims to provide a baseline for improving crop productivity and securing livelihoods for mountain communities.

Methodology

Study Area

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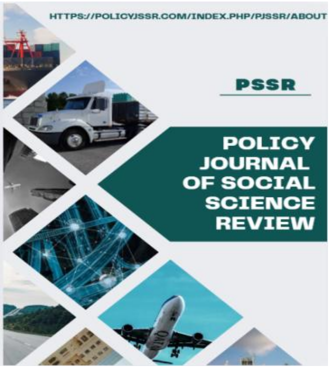

Policy Journal of Social Science Review

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Yasin is a tehsil within the Gupis-Yasin District, situated at an elevation of 2,585 meters (8,481 feet) with geographic coordinates of 36.3845756° N and 73.5355215° E. According to the Planning and Development Department of Gilgit-Baltistan, the area had a population of 170,000 in 2017. Characterized by its mountainous terrain, Yasin is located in the northern reaches of the district within the Hindu Kush range.

Geographically, Ghizer serves as a vital link; the Yasin Valley connects Gilgit and Chitral via the Shandur Pass, while the Ishkoman Valley provides access to China and Tajikistan through the Broghil Pass (Figure 1). Ghizer is characterized by a humid continental climate and is situated within the western Himalayan floristic zone (Abdul et al., 2020). Yasin Valley itself is a prominent feature of northern Pakistan's mountainous landscape, located approximately 148 kilometers from Gilgit. Agriculture serves as the primary source of income for the valley's inhabitants, with wheat, maize, and alfalfa being the most common crops. Additionally, farmers cultivate various vegetables to supplement their livelihoods.

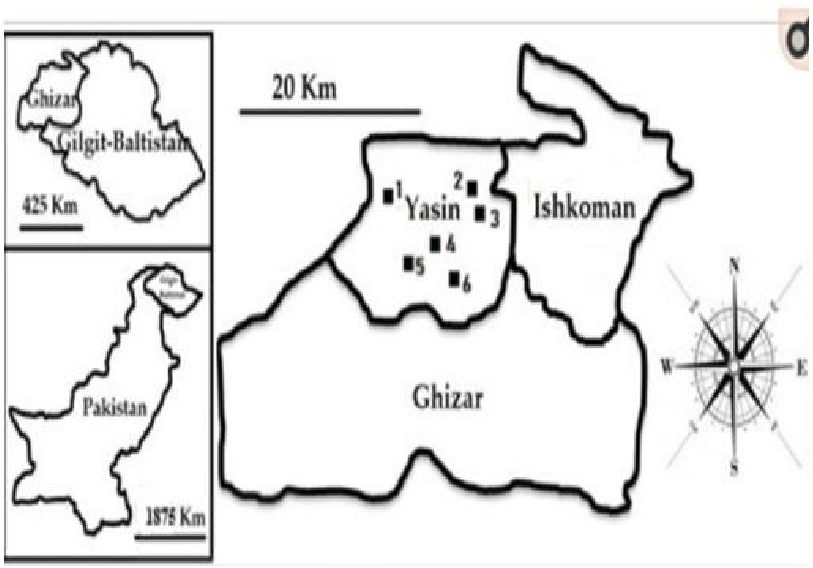

Figure 1 Location map showing study area and sampling points (n=05)

Soil Sampling and Preparation

The study area comprises six villages in the Yasin Valley: Gindai, Yasin Proper, Thaus, Sandi, and Barkolti. These sites were selected because no prior research has established a baseline for their soil properties. Within these locations, soil samples were collected from two distinct cropping land-use systems: maize and wheat fields.

In November 2022, a total of 60 composite soil samples were collected from wheat and maize fields across the study area. Utilizing a random sampling design, six samples were obtained per crop type

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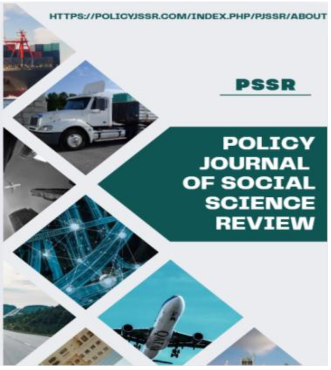

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ISSN Online:3006-4635

ISSN Print: 3006-4627

from each of the selected villages. Soil was excavated to a depth of 15 cm, and samples were sealed in labeled polyethylene bags for transport. Prior to analysis, samples were air-dried, ground, and passed through a 2 mm sieve to ensure homogeneity. Laboratory analyses were performed at the Department of Biological Sciences, Karakoram International University.

Laboratory Analysis

Soil pH was determined in a 1:1 (w/v) soil-to-water suspension using an OAKTON PC 700 meter, following the protocol described by McLean (1982). Briefly, 10 g of soil was mixed with 10 mL of distilled water and agitated periodically with a glass rod for two hours to ensure homogenization before recording the electrode reading.

Electrical conductivity (EC) was measured in a 1:5 (w/v) soil-to-water extract using a Milwaukee SM 302 EC meter (Rayment & Higginson, 1992). A suspension of 10 g soil and 50 mL distilled water was agitated in a mechanical shaker for 30 minutes and stirred with a glass rod prior to measurement.

Extraction of Macronutrients (N, P, K): The fertility status, including nitrate-nitrogen (NO_3N), available phosphorus (P), and exchangeable potassium (K), was determined using the Ammonium Bicarbonate-Diethylene Triamine Penta-Acetic Acid (AB-DTPA) extraction method (Jones (2001).

Nitrate-Nitrogen (NO_3N): A 1 mL aliquot of soil extract was treated with 3 mL copper sulphate, 2 mL hydrazine sulphate, and 3 mL NaOH. The mixture was heated in a water bath at 38°C for 20 minutes. After cooling, 3 mL of NO_3N color development reagent was added. Following a 20-minute incubation at room temperature, absorbance was measured via spectrophotometry at 540 nm.

Available Phosphorus (Av. P): A 1 mL aliquot of the AB-DTPA extract was diluted with 9 mL of distilled water and mixed with 2.5 mL of color reagent. After a 15–20 minute incubation, the concentration was determined using a spectrophotometer at a wavelength of 880 nm.

Exchangeable Potassium (Ex. K): A 1 mL extract was mixed with 4 mL of distilled water and 5 mL of LiCl working solution. Concentrations were measured using a flame photometer. Samples exceeding the calibration range were diluted with distilled water accordingly.

Soil Moisture Determination: Soil moisture content was determined via the gravimetric method. Samples of a known mass were collected using a soil auger and stored in airtight aluminum containers. The samples were weighed, oven-dried at 105°C for approximately 24 hours until a constant weight was achieved, and cooled to room temperature. The moisture content was calculated based on the mass differential between the fresh and dry soil.

$$\text{Soil moisture} = \% \frac{wet\ weight - dry\ weight}{Dry\ weight} \times 100$$

Data Processing and Statistical Analysis

All data regarding soil physicochemical characteristics were entered into Microsoft Excel (v. 2007) and subsequently analyzed using IBM SPSS Statistics (v. 24.0, 2016). Descriptive statistics, including the mean, standard deviation, and standard error, were calculated for all parameters. Significant differences between groups were determined using a one-way Analysis of Variance (ANOVA).

Results

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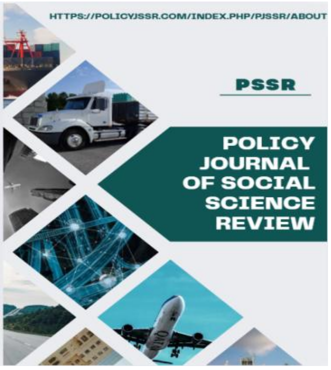

Policy Journal of Social Science Review

ISSN Online:3006-4635

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Status of soil characteristics in crop fields

Soil characteristics in wheat crop fields

Data were analyzed to determine the physico-chemical status of the soil across different cropping systems. The mean concentrations for soil fertility indicators, including pH, EC, NO_3.N, Av.P, Ex.K, and moisture content, are summarized in Table 1.

Soil pH and EC: Mean pH values ranged from 7.50 to 8.80, with the minimum value recorded in Yasin and the maximum in Barkolti. Electrical conductivity (EC) fluctuated between 49.50 µS/cm and 80.16 µS/cm; the lowest EC was observed in Sandi, while the highest was recorded in Gindai. Moisture Content: Soil moisture ranged from 8.13% to 30.83%. The highest moisture levels were recorded in Gindai, while the lowest were found in Thaus.

Nutrient Concentration NO_3.N and P): Nitrate-nitrogen (NO_3.N) concentrations ranged from 6.13 mg/kg to 7.34 mg/kg, with Sandi and Thaus exhibiting the maximum and minimum values, respectively. Available phosphorus varied from 1.29 mg/kg to 2.76 mg/kg, with the highest concentration in Gindai and the lowest in Yasin. Potassium (Ex.K): Exchangeable potassium levels varied significantly, ranging from 1.02 ppm to 81.62 ppm. The maximum value was recorded in Gindai, while the minimum was observed in Thaus.

Table 1: *Mean value with standard error of soil fertility indicators for the Wheat*

Locations	pH	EC	Moisture	NO_3.N	Av.p	Ex.K
Yasin proper	7.50±0.08	77.33±8.53	15.18±0.17	7.13±0.07	1.29±0.15	103.83±1.89
Gindai	7.88±0.05	80.16±8.88	30.83±0.34	6.66±0.63	2.76±0.18	81.62±4.55
Sandi	8.03±0.08	49.50±5.69	9.24±10.21	7.34±1.79	1.42±0.26	118.25±8.08
Thaus	8.05±0.04	63.00±9.85	8.13±0.06	6.13±0.65	1.86±0.73	102.42±7.91
Barkholti	8.08±0.04	78.50±6.71	21.40±0.28	6.62±0.89	1.89±0.36	110.38±11.30

ANOVA results indicated that pH and EC varied significantly across all studied wheat field sites ($p < 0.05$). Conversely, no significant differences were observed among the sites for NO_3.N and available potassium (Table 2)

Table 2: *ANOVA for soil tested parameters of wheat between different locations of study site.*

Parameters	pH	EC (uS/cm)	Moisture %	NO_3.N mg/kg	Av.p mg/kg	Ex.K ppm
F Value	14.483***	2.673*	1.208^{ns}	0.23^{ns}	4.747***	3.323***

Note: *, **, ***, and "ns" indicates p<0.05(5%), p< 0.01(1%), p<0.001 and non-significant respectively.

1.2 Soil characteristics in maize crop fields

Table 3 presents the mean values for the analyzed soil parameters. The soil pH ranged from 7.66 to 8.13; the minimum value was observed in Yasin

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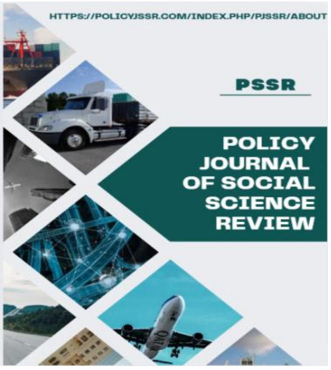

Policy Journal of Social Science Review

ISSN Online:3006-4635

ISSN Print: 3006-4627

Proper, while the maximum was recorded in Thaus. Electrical conductivity (EC) varied significantly, ranging from 1.11 µS/cm to 77.83 µS/cm. The highest EC value was recorded in Gindai, whereas the lowest was noted in Yasin Proper.

Soil moisture content fluctuated between 8.28% and 19.04%, with the maximum and minimum values observed in Gindai and Thaus, respectively. Regarding nutrient concentrations, nitrate-nitrogen (NO_3.N levels ranged from 6.03 mg/kg to 8.35 mg/kg, peaking in Thaus and reaching its minimum in Yasin Proper. Available phosphorus (P) concentrations deviated from 1.39 mg/kg to 2.69 mg/kg; the lowest concentration was found in Gindai, while the highest was recorded in Yasin Proper. Finally, exchangeable potassium (K) varied between 1.00 ppm and 1.17 ppm, with the minimum value recorded in Thaus and the maximum in Barkolti.

Table 3: *Mean value with standard error of soil parameters for Maize*

		pH	EC	Moisture	NO_3.N	Av.P	EX.K
1	**Yasin proper**	7.66±0.98	111.0±11.53	17.00±0.31	6.03±0.27	2.69±0.25	105.34±4.60
2	**Gindai**	7.98±0.16	77.83±14.06	19.04±0.13	7.11±0.081	1.39±6.25	105.15±10.69
3	**Sandi**	7.85±0.18	60.50±14.64	10.81±0.28	6.66±1.08	2.06±0.53	110.21±10.69
4	**Thaus**	8.13±0.19	77.00±6.67	8.28±0.16	8.35±1.07	2.16±0.58	100.68±8.25
5	**Barkholti**	7.81±0.04	125.0±12.45	17.17±0.22	7.55±1.70	1.42±0.26	117.15±8.84

ANOVA results indicated that pH and EC differed significantly ($p < 0.05$) across all studied sites for maize. In contrast, soil moisture and available potassium showed no significant differences among the sites (Table 4).

Table 4: *ANOVA for soil tested parameters of maize at different fields of Yasin*

Parameters	pH	EC (uS/cm)	Moisture %	NO_3.N mg/kg	Av.P mg/kg	Ex.K ppm
F value	3.652*	4.786**	0.866^{ns}	0.648^{ns}	1.806^{ns}	0.495^{ns}

Note= *** (p<0.001), ** (p<0.01), * (p<0.05) and ns show not significant

Comparative analysis of Parameters between wheat and maize crop fields:

The soil pH analysis across the wheat and maize fields of the Yasin Valley reveals a consistently alkaline environment, with mean values ranging from 7.50 to 8.13. As illustrated in the Figure, the highest alkalinity was recorded in the maize fields of Taus proper (pH = 8.13), whereas the lowest mean value was observed in the wheat fields of Yasin proper (pH = 7.50). While both crops generally occupied soils within a similar alkaline range, localized variations were evident; for instance, wheat fields in Barkholti and Sandi exhibited higher pH levels than corresponding

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maize fields, while the opposite trend was observed in Gindai and Yasin proper (Figure 2). These results suggest that while the regional soil profile is characteristically basic, specific land-use patterns and micro-locations within the valley influence the exact degree of soil alkalinity.

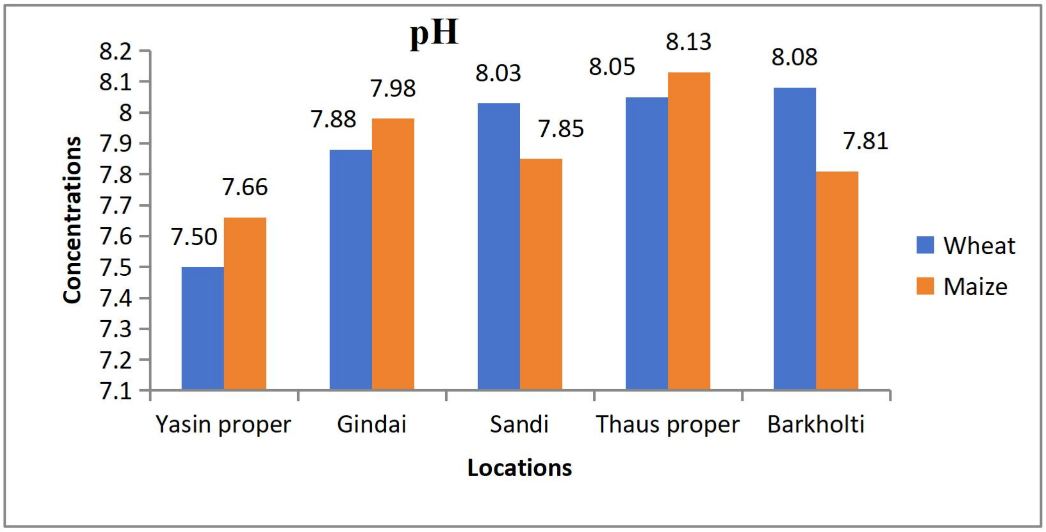

Figure 2: Mean values of pH in wheat and maize fields of Yasin.

The electrical conductivity (EC) of soil in the study area showed significant spatial variation across the different sampling sites. The mean EC values fluctuated between 49.5 µS/cm and 125 µS/cm. The highest EC concentration was observed in the maize fields of Barkholti (125 µS/cm), while the minimum level was recorded in the wheat fields of Sandi (49.5 µS/cm). In most locations, including Yasin proper, Sandi, Thaus proper, and Barkholti, the maize fields exhibited higher electrolytic concentrations compared to wheat fields. Conversely, Gindai was the only location where the wheat field showed a slightly higher EC value (80.16 µS) than the maize field (77.83 µS/cm) (Figure 3). These fluctuations indicate varying levels of soluble salts in the soil profile depending on the specific location and crop type.

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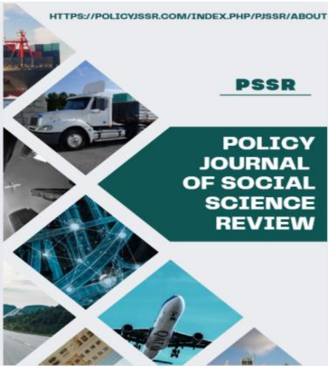

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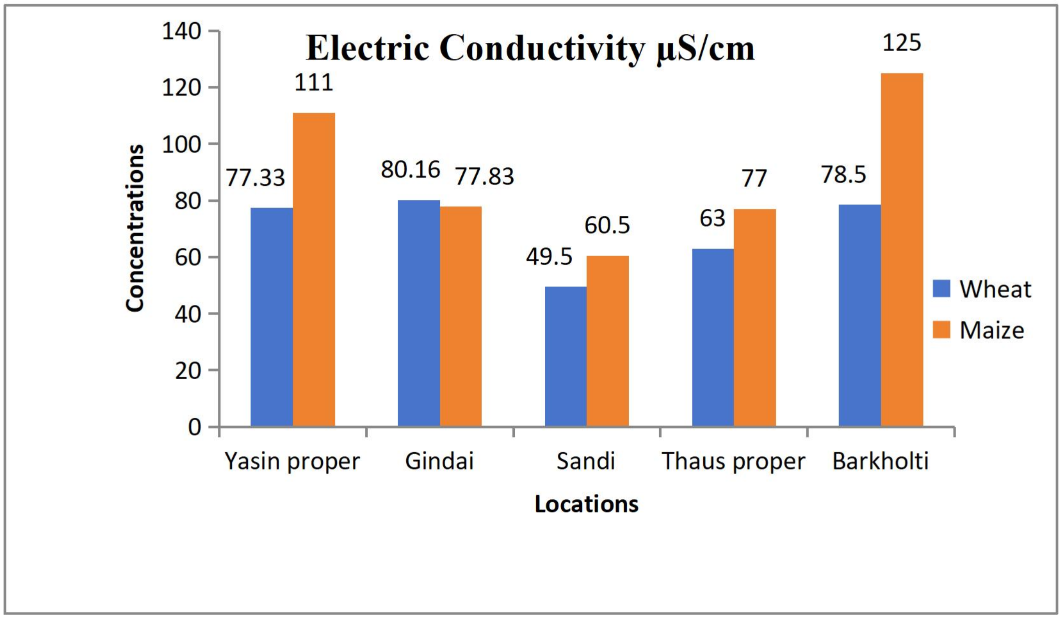

Figure 3: Mean value of EC in wheat and maize fields of Yasin.

Analysis of the soil moisture content across the Yasin Valley shows a wide variation in water retention between wheat and maize fields. The moisture levels deviated from a maximum of 30.83% to a minimum of 8.13%. As shown in the provided chart, the highest soil moisture level was recorded in the wheat fields of Gindai (30.83%), whereas the lowest values were observed in Thaus (8.13% in wheat) and Sandi (9.24% in wheat). Interestingly, while wheat fields in Gindai and Barkholti maintained higher moisture levels than maize fields, the opposite trend was noted in Yasin proper, Sandi, and Thaus, where maize fields exhibited slightly higher moisture percentages (Figure 4). These fluctuations highlight the influence of localized topography and crop-specific management practices on soil water availability within the region.

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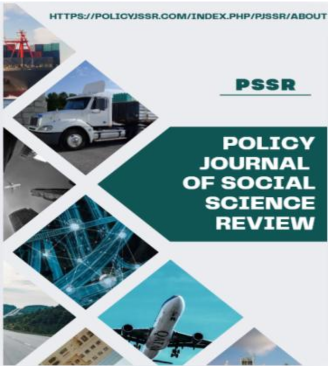

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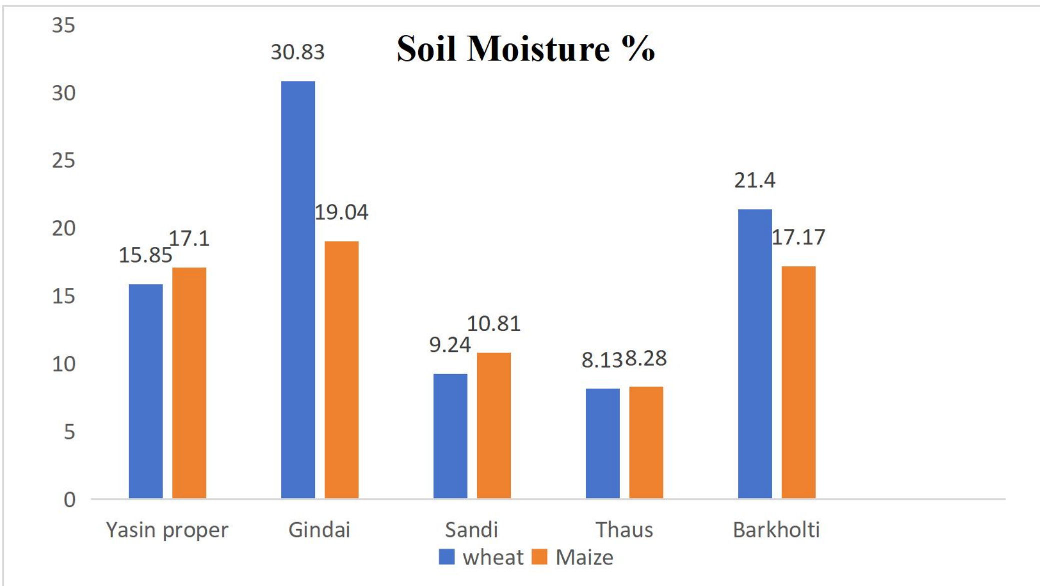

Figure 4: Mean values of soil moisture for wheat and maize fields of Yasin.

The concentration of nitrogen in the study area exhibited notable variance across different sampling sites and crop types. As shown in the figure, the mean nitrogen levels ranged from 6.03 mg/kg to 8.35 mg/kg. The highest nitrogen concentration was observed in the maize fields of Thaus proper (8.35 \mg/kg), while the lowest value was recorded in the maize fields of Yasin proper (6.03 mg/kg). Within the specific locations, nitrogen levels were higher in maize fields compared to wheat fields in Gindai, Thaus proper, and Barkholti. In contrast, wheat fields showed higher nitrogen concentrations in Yasin proper and Sandi (Figure 5). These spatial fluctuations likely reflect differences in fertilizer application, soil organic matter decomposition, and the specific nutrient uptake requirements of wheat and maize across the valley.

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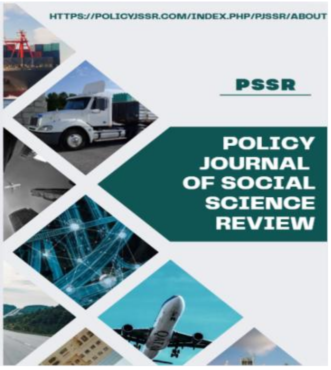

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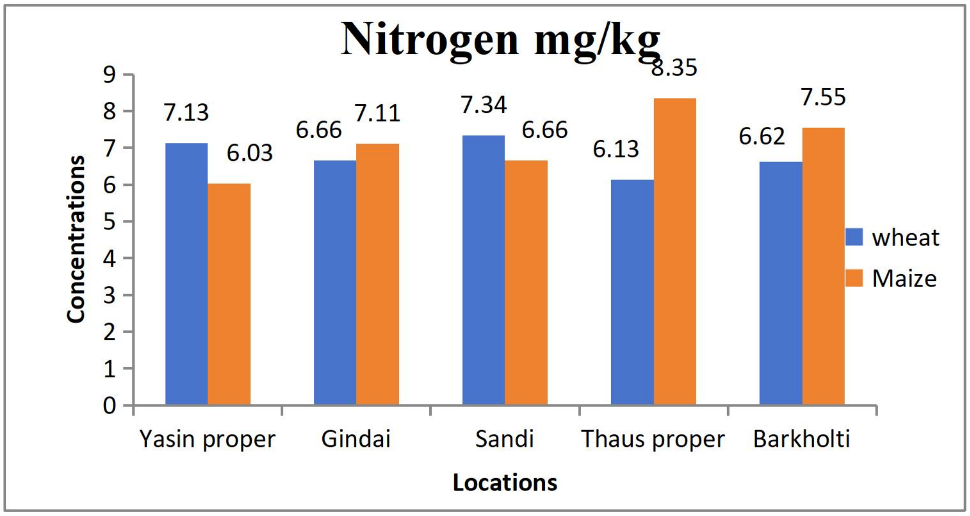

Figure 5: Mean values for Nitrogen of wheat and maize fields of Yasin.

The analysis of phosphorus concentrations across the study area revealed significant spatial variability between different locations and crop types. As illustrated in the chart, mean phosphorus levels fluctuated from a minimum of 1.29 mg/kg to a maximum of 2.76 mg/kg. The highest phosphorus concentration was recorded in the wheat fields of Gindai (2.76 mg/kg), while the lowest level was observed in the wheat fields of Yasin proper (1.29 mg/kg). In locations such as Yasin proper, Sandi, and Thaus proper, maize fields exhibited higher phosphorus levels compared to wheat. Conversely, in Gindai and Barkholti, the phosphorus concentrations were higher in wheat fields. these variations suggest that phosphorus availability is influenced by a combination of site-specific soil conditions and differing nutrient management strategies employed for wheat and maize cultivation (Figure 6).

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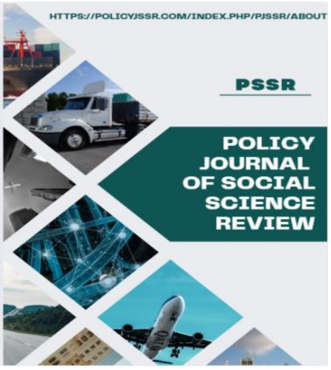
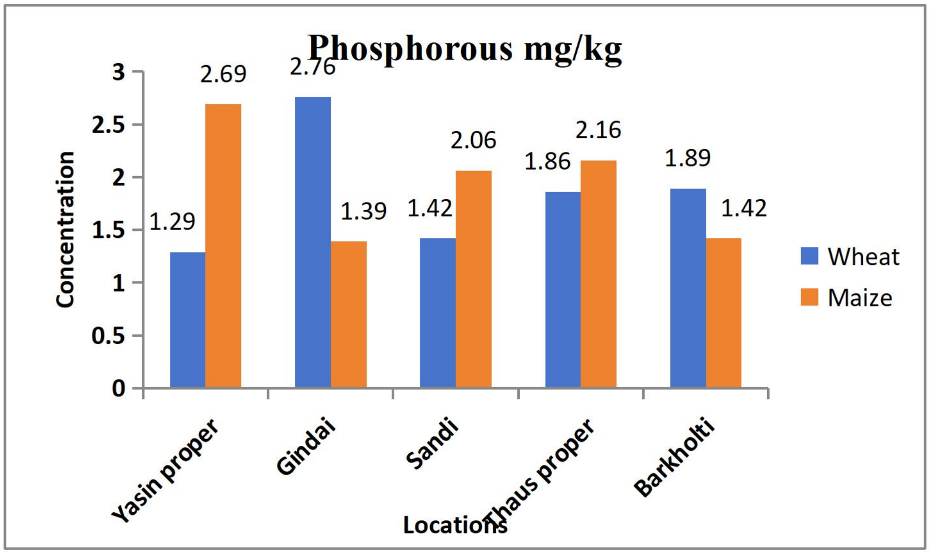

Figure 6: Mean values for Phosphorus of wheat and maize fields of Yasin.

The potassium concentrations in the study area showed distinct spatial variation across the different sampling sites. As indicated in the provided data, the mean values of potassium ranged from 81.62 ppm to 118.25 ppm. The highest concentration was recorded in the wheat fields of Sandi (118.25 ppm), while the minimum level was observed in the wheat fields of Gindai (81.62 ppm). Across the locations, potassium levels were notably higher in maize fields compared to wheat fields in Yasin proper, Gindai, and Barkholti. In contrast, wheat fields exhibited higher potassium concentrations in Sandi and Thaus proper (Figure 7). These fluctuations highlight the influence of site-specific soil characteristics and different nutrient management practices for wheat and maize cultivation in the Yasin Valley.

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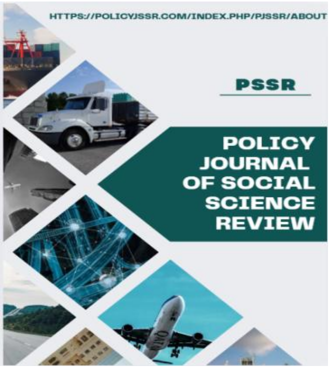

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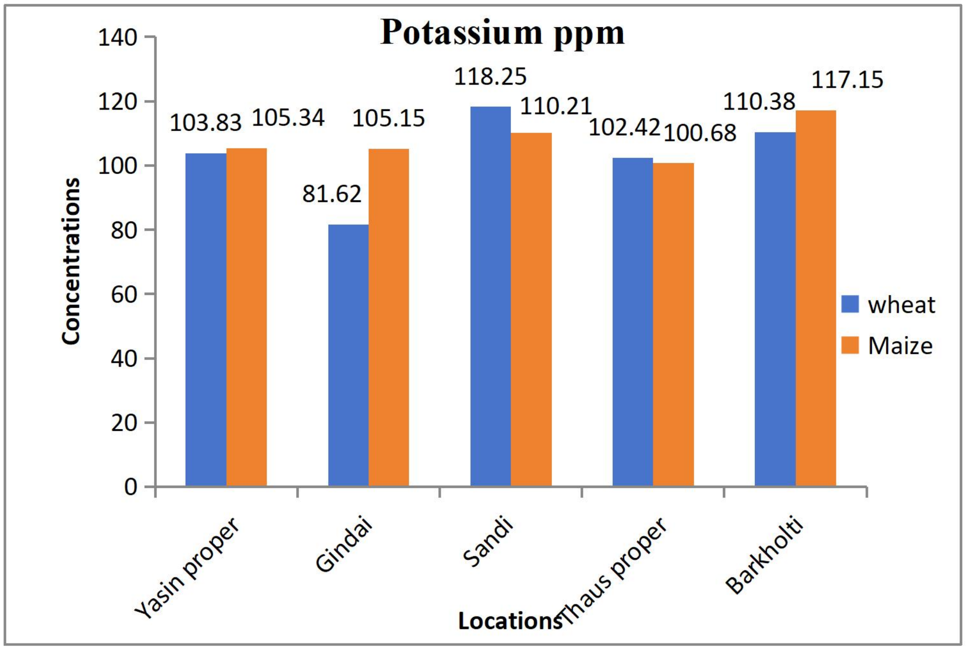

Figure 7: Mean values for Potassium at wheat and maize fields of Yasin.

Influence of altitudinal variation on soils physical-chemical characteristics:

The data presented in **Figure** 8 demonstrates that altitudinal variation has a negligible impact on the physico-chemical properties of soil across the investigated wheat cultivation sites. Analysis of the nutrient profile reveals that nitrate (NO_3) concentrations were most prominent in Gindai Village, followed by Yasin and Barkulti. Conversely, phosphorous (P) levels remained consistently low across all elevations, while potassium (K) was found in high abundance throughout the study area, peaking at Sandi and Barkulti. Furthermore, secondary parameters such as soil pH remained stable across the altitudinal gradient, whereas electrical conductivity (EC) and moisture content exhibited localized fluctuations without a direct linear correlation to increasing altitude.

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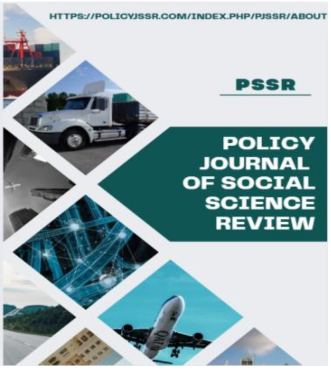

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ISSN Online:3006-4635

ISSN Print: 3006-4627

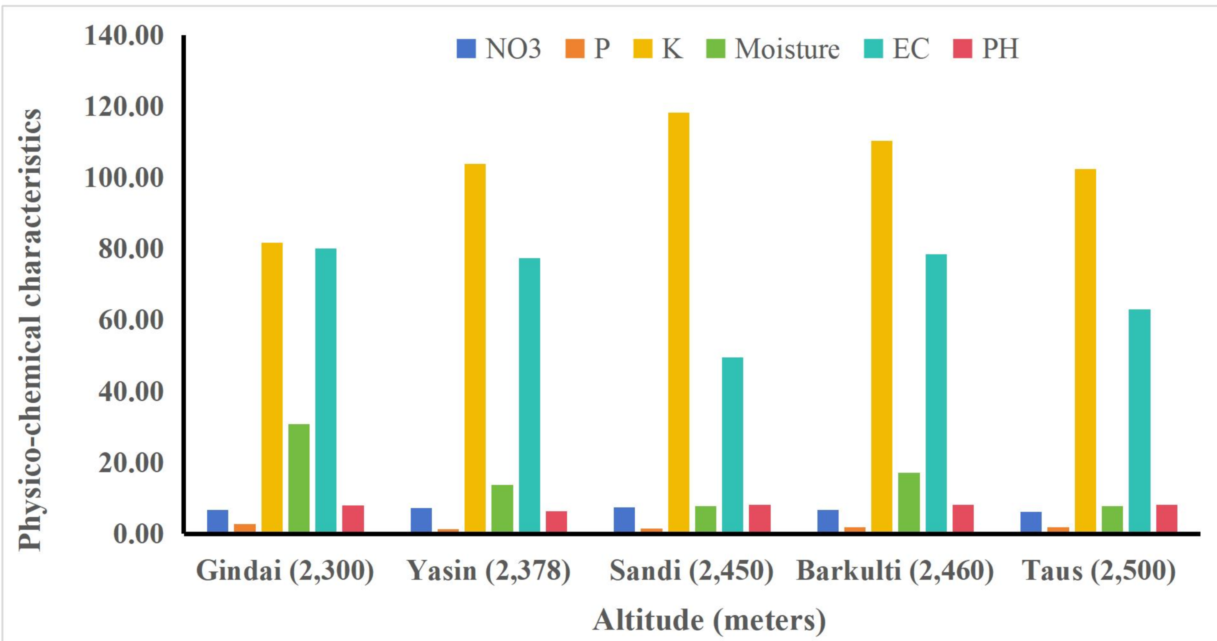

Figure 8: Altitudinal variation of physico-chemical characteristics of wheat crop fields in the study area.

Analysis of the soil profiles in maize cultivation fields, as illustrated in Figure 9, reveals that Electrical Conductivity (EC) and Potassium (K) are the most dominant physico-chemical parameters across the altitudinal gradient. In Barkulti and Yasin, EC values were the most prominent, whereas in Gindai, Sandi, and Taus, Potassium concentrations exceeded EC levels. A general inverse relationship was observed between elevation and soil moisture, with moisture content trending downward as altitude increased. In contrast, variables such as soil pH and nitrate (N_3) concentrations remained relatively stable across all study sites. Notably, phosphorous (P) levels were consistently minimal at all sampled locations, indicating a widespread deficiency regardless of elevation.

DOI: https://doi.org/10.5281/zenodo.20058071

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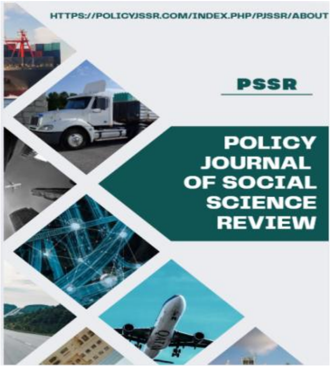

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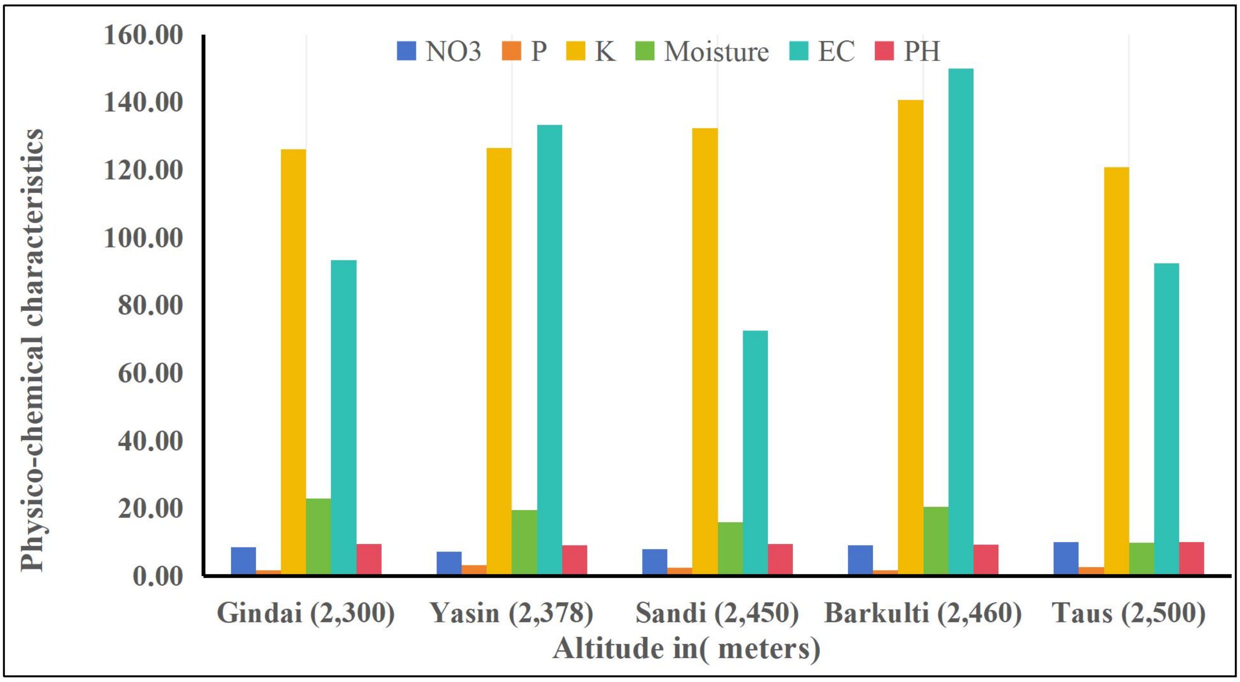
ISSN Online:3006-4635

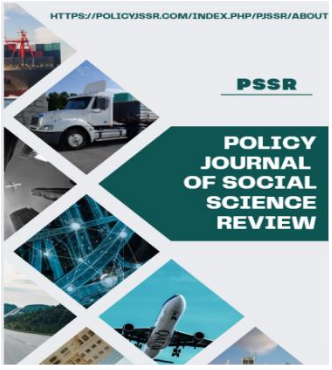
ISSN Print: 3006-4627



Discussion

The availability of nutrients to plants is determined by the pH of the soil, which indicates acidity and alkalinity (Begum *et al.*, 2009). In comparison to neutral and alkaline soils, slightly acidic soils contain the majority of soil nutrients. The majority of nutrients are found in soils with a pH of 5.5 to 6.5. According to Gowthamchand, et al. (2023) soil pH increased with depth due to substantial leaching. The mean values of maize and wheat soil pH indicated little variance in different sites of Yasin, with pH ranging from 8.08 to 7.50 for maize fields and somewhat basic for wheat fields. This minor variance could be caused by soluble salts, altered nitrogen cycling, and varied vegetation (Begum *et al.*, 2019). Because of the source from which they are created, alkaline soils usually have a pH shift. Soil moisture is important indicator to show fertility of the soil. This study shows that there is variation of soil moisture in different fields of Yasin valley .The highest water holding capacity was found in Gindai this is because of fertile soil or soil texture of that area. Whereas Thaus having less water holding capacity due to infertile condition of the soil.

Soil electrical conductivity (EC) is a measure of different salts in soil that affect crop yields and is an essential indicator of soil health (USDA-NRCS, 2022). Mean Soil EC in maize fields of different villages wash higher than the wheat fields. The reason why there is more EC in maize than wheat is because of chemical fertilizers or other organic matters present in the maize field. In agriculture, nitrogen is applied in the form of



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ISSN Print: 3006-4627

ammonium nitrate, often known as commercial fertilizer. It is a significant indicator that is used to assess soil fertility (Ge *et al.*, 2013). Decay and accumulation of leaf litter of crops and application of commercial fertilizers and animal manure resulted in high fertility of soil. As both fields fall in the medium category of the soil but in Gindai the concentration of nitrogen in maize fields is higher than the wheat fields this is due to adding of more commercial fertilizers and or of different cropping system. The highest quantity of SOC and nitrogen is stored in forests and grasslands (Paltineanu *et al.*, 2024). Ishaq *et al* (2015) discovered increased NO_3-N levels in the agriculture soil of Hunza's Altit valley. Natural catastrophes have a substantial impact on soil macronutrients (Ali *et al.*, 2014).

Phosphorus builds on the surface of the soil in cultivated lands as a result of fertilizer use. The use of commercial fertilizers is one of the main reasons for greater accessible phosphorus (Av.P) values in agriculture (Ishaq *et al.*, 2015). Wheat fields have a greater Phosphorus concentration than maize fields. The application of synthetic fertilizers and some organic fertilizers, such as compost and animal manure, has resulted in a sufficient amount of Av.P in wheat fields. While in Barkholti there is less phosphorus in wheat than maize. This is because after cultivation of wheat, the soils become more fertile and due to decay of leave litter and organic matter the concentration of phosphorus is higher in maize field. The results of the fertility level in several Yasin farmed fields demonstrated that the soil fertility is in the middle category. The usage of fertilizers has resulted in a slightly greater potassium concentration in wheat fields. Results of the altitudinal variations showed that in both maize and wheat fields the concentration of phosphorus and nitrogen increases with increasing altitudes .This is due to using of compost and organic fertilizers or the people of the area use wood ash during cultivation which increases the concentration of potassium. Soil moisture is another factor which retains potassium in the soil. There is no much variation of nutrients found in the fields of maize and wheat it may be due to less difference of altitudes between the points. Presence of nutrients also increases the electric conductivity in the soils of high altitudes. Soil moisture showed decreasing trend along the altitudinal variation. But according to some researcher's soil moisture increases with increasing altitudes but in this case due to weathered rocks or immature and porous soil of the area the soil has less ability to retain moisture in the soil. pH showed a constant value in all the points. According to researchers the nutrients decreased along the altitudes but in some cases due to accumulation of nutrients in some plain fields from high hills theses altitudes showed high nutrients values.The presence of nutrients in soil is controlled by soil texture, and its water holding capacity is also influenced by it (Hussain *et al.*, 2021). In Gilgit Baltistan, soil texture ranged from silt to silt loam, (Ali *et al.*, 2014; Ishaq *et al.*, 2015; Hussain *et al.*, 2021).

Altitudinal gradients play a critical role in modulating soil nutrient dynamics (Sun et al., 2025; Parakash et al., 2025). The altitude is a primary determinant of nutrient dynamics in the Karakoram. These high-elevation ecosystems are significant reservoirs of carbon and nitrogen, but their distribution is highly non-uniform and sensitive to the

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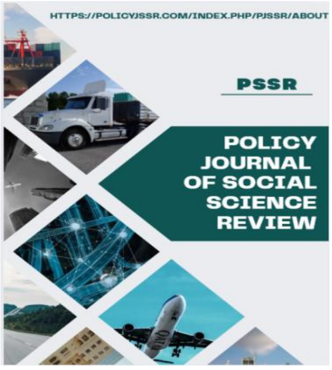

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ISSN Online:3006-4635

ISSN Print: 3006-4627

specific climatic conditions found at different altitudinal belts (Shedayi et al., 2016).

In Yasin Valley, nitrogen and phosphorus concentrations demonstrate an increasing trend with altitude. This pattern is likely driven by the localized use of compost, organic fertilizers, and wood ash, the latter being a traditional practice that significantly boosts potassium levels at higher elevations. Soil moisture, however, follows a decreasing trend with increasing altitude in this study area.

While some researchers suggest that moisture typically increases with elevation due to lower temperatures (Yan e al., 2024), the weathered, immature, and porous nature of the rocks in Yasin leads to poor moisture retention. Furthermore, while global trends often show a decrease in nutrients at higher altitudes, localized accumulation in plain fields from higher slopes can result in elevated nutrient values at certain high-altitude points.

Conclusion

The current study demonstrates that the soil across both wheat and maize cultivation systems in the Yasin Valley maintains a neutral to slightly alkaline character, which is conducive to general nutrient availability in high-altitude environments. While macronutrient levels were found to be within satisfactory ranges for cereal production, their distribution exhibited significant variability between the two cropping systems. Specifically, maize fields displayed higher concentrations of available phosphorus (Av.P) and exchangeable potassium (Ex.K), likely driven by the intensive application of organic amendments and commercial fertilizers. Conversely, wheat fields maintained marginally higher soil moisture levels, reflecting differences in irrigation requirements and crop-specific water-holding capacities.

A notable finding of this research is the lack of significant variance in soil characteristics across altitudinal gradients. This homogeneity suggests that local management practices, specifically the traditional application of wood ash and natural organic fertilizers, serve as a stabilizing factor that overrides the typical effects of elevation on soil chemistry. These results provide a critical baseline for local farmers to implement site-specific nutrient management, ensuring that fertilizer application is optimized to address localized deficiencies and maximize crop yields.

Given the harsh climatic conditions and the fragile nature of high-mountain agro-ecosystems, there is a profound need for continued research into the long-term effects of land-use changes on soil health. To enhance soil quality and ensure sustainable productivity, it is recommended that farmers adopt diversified cropping strategies. Intercropping wheat with legumes or root crops (e.g., lentils, carrots, or garlic) in standardized strip patterns can provide multiple socio-economic benefits. Although such practices may lead to a marginal reduction in primary grain yields, the additional harvest from intercrops typically compensates for these losses. Furthermore, the integration of cover-cropping (utilizing species such as alfalfa, mustard, or buckwheat) and the adoption of bio-fertilizers are essential techniques for mitigating soil erosion, improving organic matter content, and ensuring the long-term resilience of the agricultural landscape in Gilgit-Baltistan.

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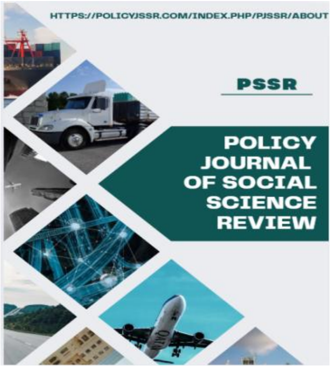


Policy Journal of Social Science Review

ISSN Online:3006-4635

ISSN Print: 3006-4627

References

Abdul Aziz, M., Abbasi, A. M., Ullah, Z., & Pieroni, A. (2020). Shared but threatened: The heritage of wild food plant gathering among different linguistic and religious groups in the Ishkoman and Yasin Valleys, North Pakistan. *Foods*, *9*(5), 601.

Begum, F., Alam, M., Mumtaz, S., Ali, M., Wafee, S., Khan, M. Z., & Khan, A. (2019). Soil Quality Variation under Different Land Use Types in Haramosh Valley, Gilgit, Pakistan. *International Journal of Economic and Environmental Geology*, *10*(2), 32-37.

Begum, F., Bajracharya, R. M., Sharma, S., & Situala, B. K. (2009). Land Use Effects On Soil Quality Indicators In The Mid-Hills Of Central Nepal. In International Conference on Emerging Technologies in Environmental Science and Engineering. Aligarh Muslim University, Aligarh, India (pp. 488-495).

Bone, J., Head, M., Barraclough, D., Archer, M., Scheib, C., Flight, D., & Voulvoulis, N. (2010). Soil quality assessment under emerging regulatory requirements. Environment International, 36(6), 609-622.

Erkossa, T., Wudneh, A., Desalegn, B., & Taye, G. (2022). Linking soil erosion to on-site financial cost: lessons from watersheds in the Blue Nile basin. *Solid Earth*, 6(2), 765-774.

Gabele, L. M., Sieber, P., Liu, L., & Seneviratne, S. I. (2025). Soil moisture-induced changes in land carbon sink projections in CMIP6. *EGUsphere*, *2025*, 1-23.

Ge, T., Li, B., Zhu, Z., Hu, Y., Yuan, H., Dorodnikov, M., & Kuzyakov, Y. (2017). Rice rhizodeposition and its utilization by microbial groups depends on N fertilization. Biology and Fertility of Soils, 53(1), 37-48.

hamchand, Dhaliwal, S. S., Sharma, V., Verma, G., Singh, J., & Kaur, M. (2023). Variation of physico-chemical properties among different soil orders under different land use systems of the Majha Region in North-Western India. *Sustainability*, *15*(6), 4779.

ıin, A., Ali, H., Begum, F., Hussain, A., Khan, M. Z., Guan, Y., & Hussain, K. (2021). Mapping of Soil Properties under Different Land Uses in Lesser Karakoram Range, Pakistan. Polish Journal of Environmental Studies, 30(2).

, S., Begum, F., Ali, K., Ahmed, S., Ali, S., Ali, H., & Ali, S. (2015). Soil quality assessment using selected physico-chemical indicators in Altit Hunza, Gilgit-Baltistan. J Biodiv Environ Sci, 6, 454-459.

. S., Datta, A., Sharma, P. C., Kumar, V., Yadav, A. K., Choudhary, M., & McDonald, A. (2018). Assessing soil properties and nutrient availability under conservation agriculture practices in a reclaimed sodic soil in cereal-based systems of North-West India. Archives of Agronomy and Soil Science, 64(4), 531-545.

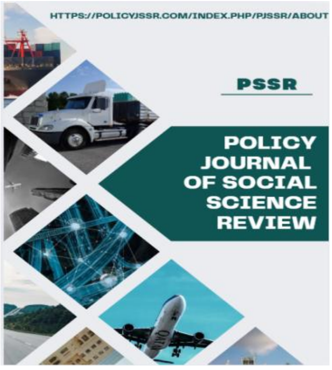
, J. B. (2001). *Laboratory guide for conducting soil tests and plant analysis* (No. BOOK). CRC press.

nat Ali, K. A., Farida Begum, F. B., Sultan Ishaq, S. I., Sher Ahmed, S. A., Durrani, S. A., Shaukat Ali, S. A., ... & Iqtidar Hussain, I. H. (2014). Assessment of impact of Attabad disaster on soil physico-chemical properties of Upper Hunza, Gilgit-Baltistan.

ueh, B. T., Fokeng, R. M., & Tume, S. J. (2021). Effects of Land Cover/Use Change and Altitude on Soil NPK Nutrients in Selected

DOI: https://doi.org/10.5281/zenodo.20058071

Volume. 4, issue No. 5 (2026)



Policy Journal of Social Science Review

ISSN Online:3006-4635

ISSN Print: 3006-4627

areas in the North West Region of Cameroon. Advances in Environmental and Engineering Research, 2(4), 1-1.

McLean, E. O. (1983). Soil pH and lime requirement. Methods of soil analysis: Part 2 Chemical and microbiological properties, 9, 199-224.

Nadler, A. (2005). Methodologies and the practical aspects of the bulk soil EC (σa)—soil solution EC (σw) relations. Advances in Agronomy, 88, 273-312.

Paltineanu, C., Dumitru, S., Vizitiu, O., Mocanu, V., Lăcătusu, A. R., Ion, S., & Domnariu, H. (2024). Soil organic carbon and total nitrogen stocks related to land use and basic environmental properties– assessment of soil carbon sequestration potential in different ecosystems. *Catena*, *246*, 108435.

Prakash, P., Kumar, P., Bishist, R., Kumar, P., & Singh, R. (2025). Impact of altitudinal gradients on composition, biomass and soil nutrients of Cedrus deodara forests in the Northwestern Himalaya. *Trees, forests and people*, 100937.

Rayment, G. E., & Higginson, F. R. (1992). Australian laboratory handbook of soil and water chemical methods. Inkata Press Pty Ltd.

Razaq, M., Zhang, P., & Shen, H. L. (2017). Influence of nitrogen and phosphorous on the growth and root morphology of Acer mono. PloS one, 12(2), e0171321.

ı, Z. M. (2018). Mineral fertilizers and plant growth retardants: Its effects on cottonseed yield; its quality and contents. Cogent Biology, 4(1), 1459010.

ıyi, A. A., Xu, M., Naseer, I., & Khan, B. *Altitudinal gradients of soil and vegetation carbon and nitrogen in a high altitude nature reserve of Karakoram ranges. SpringerPlus. 2016; 5: 320.*

J., Li, H., JianJi, G., He, Y., Xu, L., Zhang, L., ... & Wang, H. (2025). Influence of altitudinal zones on soil nutrient dynamics and fertility constraints in agricultural terrains of Yunnan, China. *Scientific Reports*, *15*(1), 43452.

A-NRCS (2022). Inherent Factors Affecting Soil EC (Soil Health – Electrical Conductivity). NRCS Soil Health Fact Sheet. Available at: https://www.nrcs.usda.gov/sites/default/files/202210/Soil%20Electrical%20Conductivity%20Educators.pdf

J., Tong, M., Liu, J., Li, J., & Li, H. (2024). Temperature and moisture sensitivities of soil respiration vary along elevation gradients: An analysis from long-term field observations. *Science of the Total Environment*, *912*, 169150.

ɔza, R., Acosta, J. A., Bastida, F., Domínguez, S. G., Toledo, D. M., & Faz, A. (2015). Identification of sensitive indicators to assess the interrelationship between soil quality, management practices and human health. Soil, 1(1), 173-185