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Research Article

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Soil nutrient status under various land use systems in Padampur, Chitwan of Nepal

Krishna Bohara[1] and Prakash Khanal[2]
[1]*Nepal Polytechnic Institute, Bharatpur, Chitwan, Nepal*
[2]*Institute of Agriculture and Animal Science, Prithu Technical College, Lamahi, Dang Deukhuri, Nepal*
Corresponding author e-mail: prakash.khanal744@gmail.com
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ABSTRACT
Various land systems show various soil properties and understanding the variation in soil properties within farmland use is essential. Thus, the study was conducted from July 2019 to September 2019 in Padampur, Chitwan of Nepal to examine the soil nutrient conditions of various land use systems by designing in Randomized Complete Block Design. Different land use systems silvipasture, forest land, fodder land, low land, upland and grass land were taken to conduct a study and each land system was replicated four times in different fields. Different land systems showed very low, low and medium total nitrogen content, high and very high available phosphorus, low and high potassium content, very low organic matter and neutral to alkaline pH. Among various land use systems, grass land had the highest total nitrogen percentage (0.11%) and fodder land recorded the highest available phosphorus (120.10 kg/ha). Further, the highest potassium content (134.59 kg/ha) was obtained in low land, forest land recorded the highest soil organic matter (0.31%) and the highest pH (7.94) was obtained in silvipasture.
Keywords: nutrient, soil, land.

INTRODUCTION
Soil is a mixture of organic matter, minerals, gases, liquids and different organisms which serve as a natural medium for the growth of land plants. Soil fertility means the ability of the soil to supply balanced essential nutrients to support the proper plants' growth. For sustainable food production in agro-ecosystem soil nutrient is vital (Khan et al., 2017).
The combined effect of biological, physical, and chemical activities over time causes variation in soil properties in different spatial areas (Santra et al., 2008). Soil properties may also differ within farmland or at the landscape scale (Corwin et al., 2003; McBratney and Pringle, 1997; Mouazen et al., 2003). Soil properties are also affected by various land use and management activities (Spurgeon et al., 2013). Production problems associated with soil nutrients can be determined by knowing the variation in soil properties within farmland use (Panday et al., 2019). It is essential to provide various remedies for optimal production and suitable land use management practices (Panday et al., 2018). The judgment of soil fertility is a basic decision-making tool to impose suitable nutrient management strategies (Brady and Weil, 2002). Among several, soil testing is the most used in the world for soil fertility judgment (Havlin et al., 2010). Production of agricultural soil with giant spatial variation caused by the combined effects of physical, chemical or biological processes can be enhanced through soil test-based fertility management (Goovaerts 1998). Soil testing helps to know the present fertility status and gives knowledge about the nutrient availability in soils which forms the basis for the fertilizer recommendations for enhancing crop yields and sustaining enough fertility in soils for a prolonged time (Khadka et al., 2016). Considering these facts, the study was conducted to know about the soil nutrient status of various land use systems in Padampur, Chitawan.

MATERIALS AND METHODS
Site description
The experiment was performed from July 2019 to September 2019 in Padampur of Chitwan district of Nepal. The site is located at 27.681874 ºN Latitude and 84.516976 ºE Longitude. The study area is shown in figure 1.

Treatments detail

Randomized Complete Block Design was used to design the experiment. Specific area was recognized based on the availability of land use systems. Six land use systems were taken as treatments. The land use systems were silvipasture, fodder land, low land, upland, grass land and forest land which were replicated four times at different fields.

Soil sample collection and Preparation

Composite soil samples were gathered from each study site from a 30 cm depth with the help of a screw auger as most changes are expected to occur at 30 cm depth due to long term land use and soil management practices. The four soil samples were gathered from each land use system and a total of 24 soil samples were gathered from six study sites. Collected soil samples were labeled, taken to the laboratory, was air dried in the shade, ground, sieved through a 2.0 mm sieve and stored for physical and chemical analysis. Some samples were sieved through a 0.2 mm sieve for analyzing soil organic matter.

Laboratory analysis

Soil texture, soil pH, total nitrogen, available potassium, soil organic matter (SOM) were analyzed at the soil science laboratory of the Nepal Polytechnic College of Agriculture and Veterinary Science but available phosphorus was analyzed in the Regional Soil Laboratory, Central Region, Hetauda, Government of Nepal. Laboratory methods used for the analysis of different soil fertility parameters are presented in Table 1.

Table 1. Laboratory analysis techniques used to analyze different soil properties:

Parameters	Analysis techniques
Soil texture	Hydrometer method (Day, 1965)
Soil pH	pH meter method
Total nitrogen (N)	Kjeldhal distillation unit (Bremner, 1965)
Availabe phosphorus (P)	Modified Olsen bicarbonate method (Whatanabe and Olsen, 1965)
Availabe potassium (K)	Ammonium Acetate Extraction Method (Pratt, 1965)
Soil organic matter (SOM)	Wet digestion method (Walkley and Black, 1934)

Soil rating

Soil organic matter (SOM), total nitrogen, available phosphorus and available potassium were rated according to the rating chart provided by Nepal Agricultural Research Council (NARC, 2013) (Table 2). The soil pH was rated by the rating chart provided by Khatri-Chhetri (1991) (Table 3)

Table 2. Rating chart for the classification of the soil fertility status of the study sites according to NARC (2013)

Nutrient status	SOM (%)	Total N (%)	Available P (kg/ ha)	Available K (kg/ ha)
Very low	<1.00	<0.05	<5.00	<40.00
Low	1.00-2.50	0.05-0.10	5.00-12.00	40.00-80.00
Medium	2.51-5.00	0.11-0.20	13.00-25.00	81.00-120.00
High	5.00-10.00	0.21-0.40	26.00-50.00	121.00-200.00
Very high	>10.00	>0.4	>51.00	>200.00

Table 3. Rating chart for soil reaction rating of the study sites according to Khatri- Chhetri (1991)

Soil pH value	Soil reaction rating
< 6	Acidic
6.0- 7.5	Neutral
>7.5	Alkaline

Statistical analysis and data presentation

The data were coded and tabulated for computer entry. They were analyzed by descriptive and inferential statistical tools wherever possible. Different descriptive techniques like average and standard error were used to compute results. Statistical analysis was performed using Genstat. The Analysis of Variance (ANOVA) in Randomized Complete Block Design (RCBD) was used to determine the level of significance. Duncan's Multiple Range Test (DMRT) was used to examine the significant differences between treatments. The treatment means were compared at 1% and 5% levels of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Soil physical properties

Soil texture

The textures of soil samples collected from different land use systems are shown in the bar diagram (Figure 2). Silvipasture was found to be 50% loamy sand and 50% sandy loam while in forest land the content of loamy sand was 25% and sandy loam was noted to be 75%. In fodder land, sandy loam and sandy clay loam content were 50% and 50% respevtively. Similarly, in low land the content of sandy loam and sandy clay loam was 75% and 25% respectively. In upland loamy sand was found 25% and sandy loam was found 75%. And in grass land loamy sand was found to be 25% and sandy loam was found to be 75%.

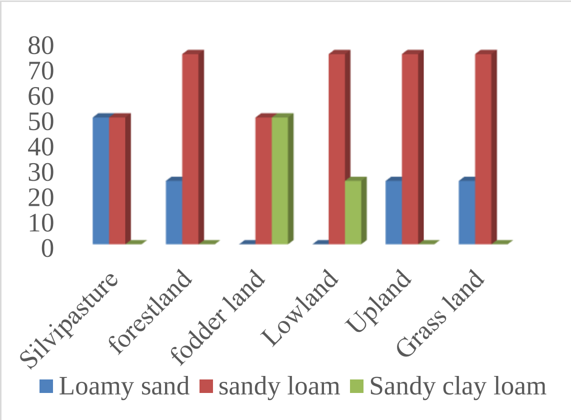

Figure 2. Soil textures of different land use systems

Soil chemical properties

Total Nitrogen (N)

The nitrogen content of the soil was not significantly affected by various land use systems (Table 4). According to the rating chart, silvipasture, forest land, low land and upland were qualified for low while grassland was qualified for medium for total nitrogen percentage. Total nitrogen percentage was the highest on grass land which was 0.11%. Similarly, total nitrogen was the lowest on fodder land which was 0.04%. The high nitrogen in grassland soil might be due to closed nutrient cycling of nutrients in such land uses because of high plant biomass. Panday et al. (2019) recorded the highest total nitrogen content in grass land as compared to other land systems. The lowest content of nitrogen in fodder land may be because in fodder land farmers usually do not apply nitrogenous fertilizers due to which the plants uptakes nitrogen which is available on soil and at the end of the season it causes less nitrogen in the soil.

Available soil phosphorus (P)

A significant effect of land use was observed on available soil phosphorus (Table 4). According to the rating chart, silvipasture, forest land and grassland recorded high available P while fodder land, low land and upland recorded very high available phosphorus value. Available phosphorus content of the study area differed from 120.10 kg/ha (highest) in fodder land to 32.70 kg/ha (lowest) in soils of grass land. Silvipasture, forest land and grass land did not show any significant difference in available soil phosphorus content. Further, fodder land and lowland also did not show any significant difference in available soil phosphorus content. The highest amount of available phosphorus from the fodder land might be due to a higher amount of organic matter.

Available soil potassium (K)

Significant effect was found on potassium (Table 4). According to the rating chart, lowland qualified as high while silvipasture, upland, forest land, fodder land and grass land qualified as low for available K status. The highest potassium was obtained in lowland (134.59 kg/ha) and the lowest was obtained in grass land (50.88 kg/ha). Silvipasture, forest land, fodder land, upland and grass land did not show any significant difference in available soil potassium content. The highest available K in the lowland might be due to the recycling of nutrients and by the application of external inputs in the form of fertilizers. The potassium content on fodder land and grass land was lowest in comparison to other land use systems which might be due to overgrazing, human interference, higher leaching loss of K from the soil surface, more K harvest from the soil, climate change and low external inputs. Application of acid forming fertilizers in fodder land might have caused the depletion of available K as reported by Baker et al. (1997) and Wakene (2001).

Soil organic matter (SOM)

No significant difference was found on soil organic matter by a change in land use systems (Table 4). All land use systems showed very low organic matter content. The highest soil organic matter content (0.31%) was found in forest land whereas the lowest organic matter content (0.12%) was found in silvipasture. Bista (2010), Chauhan et al. (2014), Kharal et al. (2018) also obtained high organic matter in forest land as compared to other lands. The highest organic matter in the forest land may be due to the decomposition of leaves of forest trees. According to the rating chart, all treatments showed very low soil organic matter it might be because nowadays people focus on chemical fertilizer instead of organic manure.

Soil pH

A significant difference was noticed in pH and pH values were ranged from 6.14 to 7.94 (Table 5). According to the soil pH rating suggested by Khatri-Chhetri (1991), these soil pH values can be rated as neutral and alkaline respectively. The pH value of silvipasture, forest land, fodder land, upland, grass land and low land were 7.94, 7.25, 6.76, 6.51, 6.36 and 6.14 respectively. In this study soil pH were more in silvipasture and forest land. The pH of silvipasture was found to be alkaline (7.94) which might be due to the presence of soil minerals producing sodium carbonate and sodium bicarbonate upon weathering.

CONCLUSION

From the study it was concluded that grass land had the highest total nitrogen percentage, fodder land recorded the highest available phosphorus, the highest potassium content was obtained in low land while the forest land recorded the highest soil organic matter and the highest pH was obtained in silvipasture.

Table 4. Soil chemical properties of different land use systems

Different land use systems	Total N (%)	Available P (kg/ha)	Available K (kg/ha)	SOM	pH
Silvipasture	0.06	41.80a	67.93 a	0.12	7.94c
Forest land	0.05	44.70a	67.93a	0.31	7.25bc
Fodder land	0.04	120.10c	51.26a	0.28	6.76ab
Lowland	0.05	113.60c	134.59b	0.16	6.14a
Upland	0.10	78.60b	59.59a	0.29	6.51ab
Grass land	0.11	32.70a	50.88a	0.30	6.36a
Grand mean	0.06	71.91	72.03	0.24	6.82
CV %	71.70	16.10	35.80	40.90	7.40
F test	NS	**	*	NS	**

Treatments means followed by the common letter or letters within the column are not significantly different among each other. CV = Coefficient of variation, *= Significant at P≤ 0.05, **= Significant at P≤0.01 and NS= Non-significant

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