Nutrients Variability in Soils of the Hill-Valley Transect of NPI Farmlands in Chitwan

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Abstract

Based on landscape position, soils in plain areas are generally considered to be more fertile than those in adjoining sloping areas of Nepal. This article compares the soil fertility of upland crop areas to those of lowland crop areas of Bharatpur municipality of Chitwan district using soil data from Nepal Polytechnic Institute (NPI). The study employed a rapid test method to analyze surface soil samples for pH, organic matter and available nitrogen, phosphorus, and potassium content. In contrast to the widely held notion, results of soil test in the upland area of Kabilash exhibited superior fertility in most parameters when compared to those in the southern plain areas. Therefore, further and detailed study is warranted to validate the results in the study area.

Introduction

The published literature maintains that there is a general trend for mountain soils to be less developed and shallower than soil on areas of lower slopes and on plains (Egli and Poulenard, 2017). Although the fertility of a soil formed at a site will also depend on the parent material and other soil forming factors (Gray and Murphy,1999). A question we raise is why subsistence agriculture in these mountains have been able to support rural livelihood for long remains a matter of investigation in this study. We hypothesize that landscape position plays a decisive role in soils-making and subsequent choices of land-uses in this region. This paper presents an insight into the effect of landscape position on soil types affecting the choices of land-uses in a peculiar Hill-Valley system of Chitwan district of Nepal. Since this is a preliminary part of the longer-term project, here we limited our presentation to the results of initial data analysis.

Materials and methods

A transect study was carried out in a subtropical humid region (Hyperthermic soil temperature and mesic to aquic soil moisture regimes) of Chitwan district, Nepal in 2022. Surface (0-15 cm) and sub-surface (15-30 cm) soil samples were collected from agricultural areas of the region

representing hill (500 m, amsl) and plain (200 m, amsl) areas in the N-S transect. The sampled areas belong to the land of NPI. Each of the hill and plain areas were divided into three sampling zones (upper, middle and lower zones). Composite soil samples from three replications for surface and sub-surface soils drawn separately were analyzed for soil pH and major plant nutrients (available N, P and K) and results interpreted as high, medium, and low. Facility available at the NPI soil laboratory was used for chemical analysis. Subsidiary data on biophysical conditions such as aspect, soil depth, soil texture, rock types, natural vegetation, land-use and cropping systems were also used for further data interpretation.

Results and discussion

Table 1 shows how the selected parameters varied along hill-plain transect for both surface and sub-surface soils. Differences in selected properties were more distinct in the surfaces of the transect than in the sub-surface soils; and interestingly, surface soils in the hilly areas exhibited greater availability of N, P and K elements and appear to have more favorable soil pH for crop growth than in the surface soils of the plain area. This means that in comparison to the plain areas, hilly farmlands despite shallower soils, exhibit superiority in terms of soil pH and availability of major plant nutrients allowing farmers greater choices to put their lands to multiple land-uses. Weil and Brady (2017) attributed such differences in soil between hills and valley floors mainly to the process of origin, and their morphological and chemical properties.

Soil management also appears to be the prominent factor especially for N and P levels because the farmers plow the land and return into the soil resides of short-cycled crops, grasses, leaf litters and animal manures in relatively short time intervals which is more common in the hilly areas. This can explain the higher N levels in the hill soils. Availability of these nutrient elements is also influenced by the type of rocks and clay mineralogy. Rapid weathering and release of basic cations is a continuous phenomenon occurring in soils in these hills and mountains and so higher K in hill soils as the rocks are closer to the shallower soils. This process keeps soil younger in hilly areas which in turn help maintain soil fertility. These three should be the major factors explaining why selected nutrient elements under study were found in higher amounts in this hilly region than in the soils of the valley floor.

Table 1: Soil acidity and availability of major nutrients in soils samples of two contrasting agro-ecological sites of Chitwan District, Nepal.

Region	Location	Acidity (pH)	Available N	Available P	Available K
Hilly area	….……Surface soils……..				
	Upper	Neutral (6.6)	High	Medium	High
	Middle	Slightly acid (6.1)	High	High	High
	Lower	Neutral (7.0)	High	High	High
Plain area	Loc. 1	Strong acid (5.1)	Low	High	Medium
	Loc. 2	Medium acid (5.8)	Low	High	Medium
	Loc. 3	Slightly acid (6.3)	Low	High	Low
	…….Sub-surface soils……..				
Hilly area	Upper	Neutral (6.6)	Low	Low	High
	Middle	Neutral (6.7)	Medium	High	High
	Lower	Neutral (7.0)	High	High	Medium
Plain Area	Loc. 1	Strong acid (5.1)	Low	High	Low
	Loc. 2	Medium acid (5.8)	Low	High	Medium
	Loc. 3	Slightly acid (6.3)	Low	High	Low

Tools used to interpret soil samples for available N, P, and K: Soil Testing Kit Box and pH by electrode method

Conclusion

Although detailed analysis is awaited, research results of initial phase indicates that rich natural biodiversity and younger soils have combined to result in more favorable soil conditions for multiple land-uses in the upstream hilly terrains while soil properties are changing due to urban effects in the downstream plain areas. The detail future investigation will explore other drivers of change and issues linked to the soil fertility and sustainability.

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