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TABLE OF CONTENT

Typical properties of several forestry soils and cultivated soils in Bach Thong district, Bac Kan provinces

Thi Phuong Thao Vu [1*], Duc Thanh Nguyen [2]

[1] *Hanoi University of Mining and Geology, Hanoi, Vietnam*

[2]*Institute of Geography, Vietnam Academy of Sciences, Hanoi, Vietnam*

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Abstract: This article studies the soil quality of typical land use types in agriculture and forestry in Bach Thong district, Bac Kan province. Soil samples were taken on October 12-13 at 10 locations in Bach Thong district in 2023. Soil samples were analyzed for mechanical composition, pH, and organic carbon content. Analysis results show that the pH in soil samples taken in Bach Thong district usually ranges from acidic to very acidic, ranging from 3.65 to 5.32 in most soil samples. The highest organic carbon content is detected in protective forest soil samples, while lower organic carbon content values are found in productive forest soil samples. Organic carbon content in cultivated soil samples is lowest, especially in maize and rice crop samples. The acidic soil here is mainly due to sloping soil and sandy soil structure, so alkaline earth ions can easily be washed away, causing the soil to become acidic. Furthermore, organic carbon content is lower in productive forests and crop soil samples mainly due to sloping land without dense ground cover; organic carbon is easily washed away during heavy rain. Some suggestions for sustainable use of sloping land are increasing plant species diversity in afforestation, Cultivation along contour lines, and intercropping with the diversity of plants on sloping land to preserve soil to avoid erosion and washing away when heavy rain occurs.

Keywords: Contour lines; intercropping; organic carbon; productive forest; protective forest.

1. Introduction

Land is a valuable resource, one

* Corresponding author: Vu Thi Phuong Thao
Email address: Vuthiphuongthao@vnu.edu.vn

of the great resources for the country's economic development, especially in an agricultural country like Vietnam. Using land sustainably, economically, and effectively has become an important strategy affirmed by the Vietnamese government [1]. It is essential for the survival and growth of humanity because soil resources are inherently limited, and cultivable soil is even less. The soil quality depends in part on its inherent soil quality, which is determined by factors such as its parent material and topography, and also on its dynamic properties that management can change under a particular land use [2]

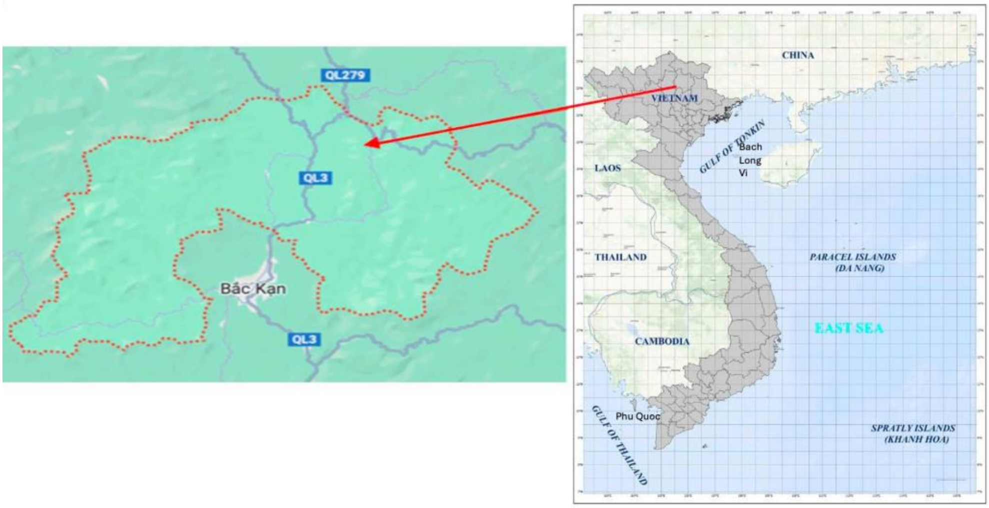

Figure 1. The geographic location of Bach Thong district - Bac Kan province.

Bac Kan is a highland province with a mountainous area of around 80% of the natural area; the terrain is rugged and strongly divided; flat land occupies a small area distributed into narrow strips, sandwiched between the strips, with high mountains on both sides. Most of the province's areas have steep slopes of over 15^0, and people still cultivate (growing rice and other annual crops) in areas with over 20^0. Bach Thong is in the center of Bac Kan province with geographical coordinates from $22^0$06' to $22^0$19' North latitude and from $105^0$39' to 106^0 East longitude. Fig.1 is the geographic location of Bach Thong district - Bac Kan province.

The total natural area of the

district is 54,649 ha (equal to 11.23% of the total natural area of Bac Kan province). The topography of Bach Thong district is characterized by mountainous terrain, strongly divided with steep slopes, and the hilly direction is not homogeneous. The average elevation is (400 - 700) m above sea level. The highest terrain is 1,241m high [3].

Annual cultivation on steep slopes with improper techniques and disregarding soil fertility improvement causes soil degradation. This article studied and determined the status of soil quality in some sloping land areas in Bach Thong district, Bac Kan province, along with types of land uses, thereby finding out methods to use sloping land reasonably, prevent soil erosion, limit soil degradation, protect soil fertility, and ensure sustainable sloping land use.

2. Materials and methodology

2.1. Sample location, sampling time

Soil sampling locations, purposes, and coordinates of soil sampling locations are in Table 1. Soil sampling locations are illustrated in Figure 2.

The soil of three main land use types, annual cropland use, productive forestland use, and protective forestland use, were selected for soil quality and sustainability assessment. Soil samples were taken at 10 locations in Bach Thong district in 2023, October 12-13th.

2.2. Methodology

** Sampling method*

Soil sampling procedures are by sampling standards in the " TCVN 7538-2:2005 - Soil quality - Sampling, Part 2: Sampling technical instructions " [4]. Square plots of size 10m x 10 m were set up at each corner of these squares; take 1 kg of soil, mix well from this mixed sample, and take 1 sample of topsoil with representative vegetation to ensure the specificity of the area study. Soil was taken at a depth of 0-20cm.

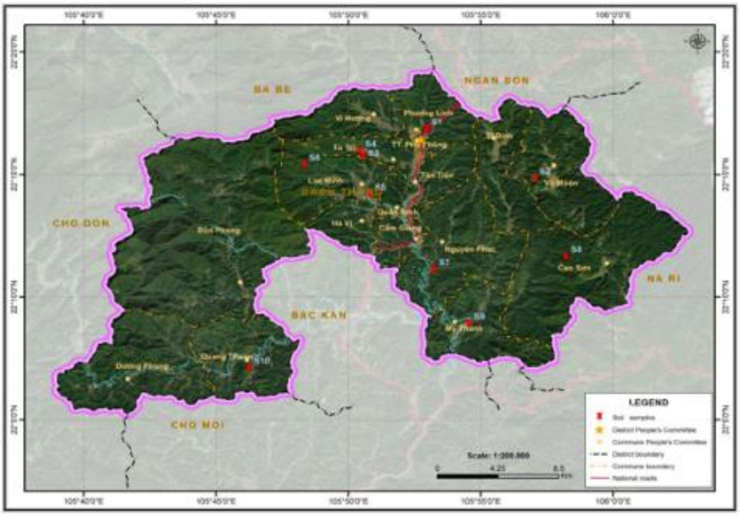

Figure 2. Soil sampling locations

* *Method of sample preservation*

Soil samples were taken for preliminary soil treatment according to TCVN 6647:2000 [5] before being transported to the Institute of Geography, Vietnam Academy of Sciences laboratory. At the laboratory, the soil samples were stored at about 2-5^{0}C and analyzed within 24 hours.

* *Method of soil sample analysis*

Soil samples were analyzed in the laboratory using the following methods: soil mechanical composition (unit %) was analyzed using TCVN 8567:2010; pH was analyzed using TCVN 5979:2007, and Organic carbon (unit %OC) was followed by TCVN 8941:2011.

3. Results and discussion

3.1. Mechanical composition and physical properties of Bach Thong district sample soils

The mechanical composition of the soil is the content of different-sized elementary particles in the soil. The mechanical composition of the soil is expressed as a percentage of the weight of arid soil. Properties of the soil, its richness, and fertility, to a large extent, depend on the composition of the soil and the size of the particles. Table 2 presents the mechanical composition of soil samples at Bach Thong district.

The mechanical composition of

crop soil samples (S4, S5, S9, S10) was mainly medium mechanical composition and heavy mechanical composition. Compared to the USDA textural classes of soils, these soils almost belong to loamy soils with moderately fine texture, except the S5 sample (maize growing), which belongs to loamy soils with moderately coarse texture [6].

The soil texture of productive forest soil samples consists of S1 and S2 samples, which are clay loam and sandy clay loam, respectively. These soils also belong to loamy soils with a moderately fine texture [7].

The soil texture of the protective forest soil samples (S3, S6, S7, S8) was to be two groups; the first group is sandy clay (S3, S8) belonging to clayey soils with fine texture and the second group is loam belong to loamy soils with medium texture [6]. According to Le Van Khoa, the loamy soil group is less likely to be washed away than the other soil group above [1].

Acidity is one of the critical factors that determines soil fertility. It affects the soil's physical, chemical, and biological processes and significantly impacts plant survival and growth. Most plants prefer a neutral to slightly acidic soil reaction with a pH range of 6-7 [8].

Table 1. Soil sampling locations, purposes, and coordinates of soil sampling locations

N	**Study sites**	**Signs**	**Coordinates**		**Sampling purposes**
			Latitude	**Longitude**	
1.	Phuong Linh commune	S1	22°16'50"	105°52'57"	Mixed plant productive forest soil sample with level 3 slope.
2.	Vu Muon commune	S2	22°14'50"	105°57'02"	*Manglietia conifera* productive forest soil sample with level 2 slope.
3.	Tu Tri commune	S3	22°15'44"	105°50'33"	Mixed plant protective forest soil sample with level 3 slope.
4.	Tu Tri commune	S4	22°15'56"	105°50'27"	Cassava crop soil sample with level 2 slope.

5.	Luc Binh commune	S5	22°14'10"	105°50'49"	Maize crop soil sample with level 1 slope.
6.	Luc Binh commune	S6	22°15'23"	105°48'20"	Mixed plant protective forest soil sample with level 3 slope.
7.	Nguyen Phuc commune	S7	22°11'06"	105°53'14"	Mixed bamboo plant protective forest soil sample with level 2 slope.
8.	Cao Son commune	S8	22°11'38"	105°58'13"	Mixed plant protective forest soil sample with level 3 slope.
9.	My Thanh commune	S9	22°08'54"	105°54'33"	Rice crop soil sample with level 1 slope.
10.	Quang Thuan commune	S10	22°07'05"	105°46'14"	Tangerine cultivation soil sample with level 2 slope.

Note: Level 1 slope: 0^0 - 8^0; Level 2 slope: 8^0-15^0; Level 3 slope: 15^0 - 20^0

Table 2. Mechanical composition of soil samples at Bach Thong district

Soil sample	Mechanical component			Textural class	Soil sample	Mechanical component			Textural class
	Sand	Silt	Clay			Sand	Silt	Clay	
S1	36,58	35,74	27,68	Clay loam	S6	39,86	38,10	22,04	Loam
S2	51,50	15,82	32,68	Sandy clay loam	S7	45,82	38,08	16,10	Loam
S3	43,60	14,58	41,82	Sandy clay	S8	55,10	8,34	36,56	Sandy clay
S4	49,38	15,46	35,16	Sandy clay	S9	52,50	35,98	11,52	Sandy loam
S5	66,10	14,32	19,58	Sandy loam	S10	49,48	24,12	26,40	Sandy clay loam

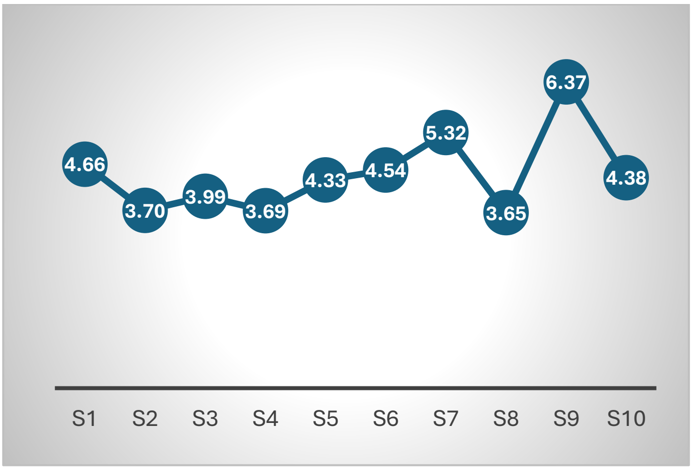

Fig. 3. pH of soil samples in Bach Thong district

The increased acidity of the soil neutralizes the activity of beneficial bacteria involved in the decomposition of peat, manure, compost, and other fertilizers. Bacteria help release nutrients found in plants in an accessible form [9].

The cause of the acidic soil here is mainly due to the sloping soil and sandy soil structure, so alkaline earth ions can easily be washed away, causing the soil to become acidic. S9 sample- Rice crop soil sample with level 1 slope (<8°) located at the down of the mountain, so it retains more alkaline earth ions, resulting in less soil erosion.

3.2. Nutrient composition in Bach Thong district sample soils

Vietnam is located in a tropical climate; high temperatures and relatively high humidity cause the organic carbon mineralization process to take place vigorously, so the organic carbon content in soil is often poor, especially for long cultivation without organic fertilizers [10]. Comparing the organic carbon content in this study to the result of some other authors cultivating on sloping land [11,12], it is found that the organic carbon content in Bach Thong's soil belongs to the type of soil from poor to reasonably good. Organic matter is a unique component in almost all soil and is one of the most important indicators of soil fertility. In any ecosystem, steady-state organic carbon content is reached when carbon inputs to the soil match losses through respiration, leaching, and erosion. Analysis results show that organic carbon in arable soil ranges from 2,77 to 4,38%, the lowest in maize crop soil, higher in rice growing soil (3,41%), tangerine cultivation soil (4,38%) while the highest value in cassava soil (4,86%). This can be explained in the soil where corn and rice are grown in monoculture; the cultivating time is short; each year, there are 3 to 4 corn crops or two rice crops, the soil is continuously plowed, and there is no time to rest.

Meanwhile, cassava is an annual crop planted at the beginning and harvested at the end of the year. The soil rests around two months after each crop. The resting time is in the dry season when it rarely rains. Therefore, the soil is less affected by the rain. Furthermore, cassava is planted densely and along contour lines; the ability of cassava fields to retain soil and nutrients is much better than that of corn and rice fields. Farming on the contour reduces sheet and rill erosion and the resulting sediment deposition at the foot of the slope or off-site. It can increase water infiltration, thereby reducing the transport of nutrients and organics to surface water and increasing water storage in the soil profile [2,13]. Besides, in tangerine fields, tangerine trees are planted over time, year after year with dense bushes of grass under the ground such as *Brachiaria ruziziensis, Chrysopogon zizanioides, Panicum Maximum,…*, with strong roots improve the soil's physical properties, reduce acidity and increase the ability to hold Organic carbon in the soil by breaking down the solid soil layer, making the soil more porous and absorbent. The deep roots will take advantage of nutrients in the soil layers to create large biomass for soil protection, erosion prevention, and soil improvement and for producing on-site covering materials [8,14]. Fig. 4 presents the organic carbon in soil samples in Bach Thong district.

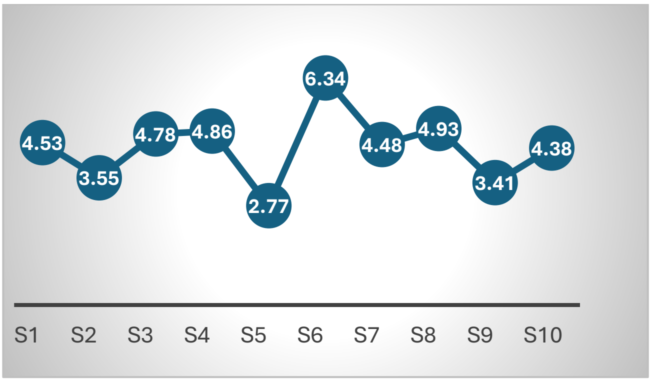

Fig. 4. Organic carbon (%) in soil samples in Bach Thong district soil samples

Organic carbon in productive forest soil samples (S1, S2) were 4,53% and 3,55% respectively. The S1 soil sample was from mixed plant productive forest soil with a level 3 slope, while the S2 soil sample was from manglietia conifera productive forest soil with a level 2 slope. The higher slope but more tree species diversity with dense aboveground tree layers caused the organic carbon retained in sample S1 to be higher than in sample S2. This demonstrates the significance of diverse tree layers and plant species for soil sustainability in storing organic carbon. This result is consistent with many cultivating studies on sloping soil [2,7, 8, 11].

Organic carbon in protective forest soil samples (S4, S6, S7, S8) were ranged from 4,48 to 6,34%. The highest organic carbon value was from mixed protection forests with a diversity of tree species formed from several forest layers with high stories consisting of timber trees such as *Chukrasia Tabularis*, *Fructus canarii*, *manglietia conifers,…* more than five years old were left over after forest exploitations five years ago, midstory trees with dense shrubs and grass layer in the surface layer. Humidity in this area is generally relatively high. High organic carbon content was detected with remaining protective forest soil samples but significantly lower than the S6 sample. Noticed an apparent reduction in the biodiversity of tree species in these forests. The lowest Organic carbon value was in a soil sample of mixed protection forests (S7) with mainly Bambusaceae family such as *Chimonoc alamus Avensis*, a few groups of grass growing on the ground, *Arundo donax L*, ... Lowest plant species diversity were discovered in this forest compare to another protective forest in this study. Due to illegal human exploitation, valuable wood trees were almost gone.

It was found that protective forest soil has an advantage over productive forest soil and cultivated soil because of plant diversity and forest layer diversity. However, the slope of the protective forest (level 3 slope) is higher than the slope of the productive forest (level 2 slope). The characteristics of these protective forests create high humidity in the forest, causing organic carbon to form. The soil here is reddish yellow mountain organic carbon. Thus, plant diversity once again proves its essential role in the soil formation process and is a determining factor in organic carbon richness in the soil.

3.3. Some proposals to improve and protect sloping land

Many human activities should be implemented to increase the soil's ability to support forestry and agricultural production in the long term and benefit soil properties. The implementation of traditional methods has been observed, and it has also demonstrated remarkable effectiveness. Protecting sloping soil in forests and cultivating land by intercropping and increasing surface cover with strong and thick root system plants such as grasses (*Brachiaria ruziziensis, Chrysopogon zizanioides, Panicum Maximum,...*), legumes (*Leucaena leucocephala, Arachis pintoi, Cajanus cajan (L.) Millsp, Fructus Gleditschiae, Cassia siamea Lam.,...*),... get a good result in soil improvement that has been proven in this study and other experiments [3,11]. Plants with strong roots will improve the soil's physical properties, reduce acidity, and increase the ability to hold Organic carbon in the soil by breaking down the solid soil layer, making the soil more porous and absorbent. The deep roots will take advantage of nutrients in the soil layers to create large biomass for soil protection, erosion prevention, and soil improvement and for producing on-site covering materials. The amount and intensity of rainfall can influence the effectiveness of surface cover, but an increase in surface cover effectively reduces soil loss. These trends indicate that adequate surface cover is necessary to protect soil from erosion [15]. Besides, protecting and improving sloping soil in forests and cultivated land by cultivating trees along contour lines. Farming on the contour reduces sheet and rill erosion and the resulting sediment deposition at the foot of the slope or off-site. It can increase water infiltration, thereby reducing the transport of nutrients and organics to surface water and increasing water storage in the soil profile [2, 13]. It can also improve and protect sloping soil in forests and cultivated land by intercropping with nitrogen-fixing Legumes.

Legumes can form a symbiotic relationship with nitrogen-fixing soil bacteria called rhizobia. This symbiosis results in the formation of nodules on the plant root, within which the bacteria can convert N2 into NH3, which the plant can use. Only a few organisms that contain the genetic information needed to synthesize the enzyme nitrogenase possess the ability to convert gaseous N_2 into NH_3, which can then be biochemically modified to generate different organic forms of nitrogen [10]. In addition to providing bio-fertilizers, legumes cover crops and reduce soil erosion and leaching, as well as organic matter in the arable soil layer. Legumes help main crops grow healthier, more productive, and better withstand weather activities [16]. When rain comes, runoff is greater from mono-cropping plots than inter-cropping plots, whereas soil losses are significantly more significant from monocropping plots than intercropping plots [2, 11, 12]. Therefore, intercropping rows of legumes with main crops will be an excellent solution to help prevent erosion and nutrient leaching on sloping land.

4. Conclusion

Soil samples collected from Bach Thong district show that the medium dominates mechanical composition in crop soil samples, while in forest soil samples, heavy mechanical composition is dominant. pH often ranges from acidic to very acidic, fluctuating from 3,65 to 5,32. The cause of the acidic soil here is mainly due to the sloping soil and sandy soil structure, so alkaline earth ions can easily be washed away, causing the soil to become acidic. It is found that the organic carbon content in Bach Thong's cultivated soil belongs to the soil with fairly good organic carbon content in forest soil samples. The highest organic carbon content is detected in protective forest soil samples, while lower organic carbon content values are found in productive forest soil samples. Organic carbon content in crop soil samples is the lowest. High organic carbon values were discovered from land use with the diversity of tree species through higher slopes. Thus, plant diversity plays a vital role in soil formation and is a decisive factor in the richness of organic carbon in Bach Thong district, Bac Kan province.

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References:

1. Le Van Khoa. Soil and environment. Education publisher, (2000).
2. Pierce, F.J. and W.E. Larson. 1993. Developing criteria to evaluate sustainable land management. p. 7-14. In: J.M. Kimble (ed.) Proceedings of the Eighth International Soil Management Workshop: Utilization of Soil Survey Information for Sustainable Land Use. (1993). USDA Soil Conservation Service, National Soil Survey Center, Lincoln, NE.
3. J.C. Castella, Dinh Quang Dang. Doi Moi in the mountains: Land use changes and farmers' livelihood strategies in Bac Kan province, Vietnam, The Agricultural Publishing House, (2002).
4. Ministry of Science and Technology TCVN 7538-2:2005 - Soil quality - Sampling, Part 2: Sampling technical instructions, (2005).
5. Ministry of Science and Technology, TCVN 6647:2000 (ISO 11464:1994) - Soil quality - Preliminary treatment of soil for testing, (1994).
6. T.Phien, N. T. Siem. Sustainable

farming on sloping land in Vietnam. Agriculture Publishing House, Hanoi, (1998).

7. USDA. Soil survey manual. Soil Survey Soil Conservation Service Volume Handbook 18, U.S. Department of Agriculture, (2017).
8. K. Zoljargal., D. Ikhbayar, T. Purevdorj. Effect of land use on soil organic carbon fractions. Mongolian Journal of Geography and Geoecology, Volume 43, (2022).
9. V.F. Valkov, K.S. Kazeev, S.I. Kolesnikov. Soil science. Publishing and Bookselling Center Mart, Moscow, (2004).
10. Vietnam Soil Science Association, Vietnamese Soil. Agriculture Publishing House, Hanoi, (2000).
11. T. Higashide. Soilless Culture on Sloping Land. Japanese Journal of Plant Science, (2007).
12. T. B. H. Nguyen and T. T. T. Nguyen. "Evaluating the efficiency of agricultural land use types in Yen Phuc commune, Van Quan district, Lang Son province" (in Vietnamese), Journal of Science and Technology, vol. 179, (2018), pp. 181-186.
17.
13. Damasa Magcale-Macandog B., Ranola F. M., Roberto Ran˜ola Jr. F., Princess Alma Ani B., Nin Vidal B, Enhancing the food security of upland farming households through agroforestry in Claveria, Misamis Oriental, Philippines. Agroforest system journal, (2010).
14. and nutrient losses by water erosion under mono-cropping and legume inter-cropping on sloping land. Pakistan Journal of Agricultural Research, (2007).
15. J.S. Pate, Transport and partitioning of nitrogenous solutes. Annual Review of Plant Biology, 31, (1980), pp. 312-340.
16. A. Broghammer, L. Krusell, M. Blaise, J. Sauer, J. T. Sullivan, N. MaolanonLegume receptors perceive the rhizobial lipochitin oligosaccharide signal molecules by direct binding. Proceedings of the National Academy of Sciences, (2012). U.S.A. 109, 13859-13864

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