Evaluation of Soil Fertility in Dry Climate Dry Land in Pandawai District, East Sumba Regency

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ABSTRACT

One of the suboptimal lands that have the potential to increase their productivity is dry land with a dry climate. Dry land with a dry environment can be optimized if the land's carrying capacity is known. This study aims to identify soil chemical characteristics and fertility in several lands uses in Pandawai District, East Sumba Regency. This research was conducted in May-August 2022. The research method used was field observation, while the soil fertility index method was used for determining soil fertility. The results showed that the soil's cation exchange capacity was 30.07-39.27 m.e./100g, and the base saturation value of the soil was 71.06-98.25%. The content soil P was 14.27-57.78 ppm, the content soil K was 0.25-1.24 m.e./100g, and the soil C-Organic was 0.21-2.02%. Soil fertility was in low and moderate status. Low fertility status was at sample points 4, 5, 9, 10, 11, and 12, while average fertility status was at 1, 2, 3, 6, 7, and 8. The limiting factor that causes low and moderate fertility status was organic C content.

Keywords: *Dry land, soil fertility.*

INTRODUCTION

Suboptimal land is land that has not been maximized in productivity. This land has low productivity due to internal factors such as the soil's unsupportive physical, chemical, and biological properties and extreme rainfall and temperature (1). One of the suboptimal lands that have the potential to increase productivity is dry land. Dryland or dry land is land that has never been inundated or inundated by water for some time and has an evapotranspiration rate that is greater than the amount of rainwater (2). Dryland consists of acid dry land and dry climate dry land. Indonesia's dry land with dry climates is around 13.3 million ha, and about 3 million ha is in East Nusa Tenggara (NTT) (3).

Pandawai District, East Sumba Regency, is one of the sub-districts in NTT Province, which is a dry land area with a dry climate. This area is said to have a dry environment because the average rainfall is low, 831.8 mm per year (4). In addition to precipitation, water availability is expected, ranging from 413-868 mm/year (5). Dry land in Pandawai District's dry climate is generally used to grow corn, peanuts, rainfed rice, coconut, and horticultural crops. Land in this area is still traditionally cultivated due to a lack of knowledge about the land's carrying capacity. Dry land with a dry climate can be optimized if the land's carrying capacity is known.

The steps taken to determine the carrying capacity of dry land with dry climates are by identifying the characteristics of the land. Identification activities are the first step to determining the condition and characteristics of the soil on the land. Knowledge of land characteristics, both physical, chemical, and biological, is very influential because

this land's characteristics will be decisive in supporting plant growth and development (6). The existence of knowledge of the characteristics or properties of the land can also be known as the ability of the land to support the productivity of a particular commodity. Characteristics or properties of land or soil that can be identified include physical, chemical and biological properties of the soil.

Soil chemical properties are soil properties related to nutrients for plant growth and development. The availability of nutrients in the soil is crucial for plants to produce well. In this case, soil fertility can provide a level of soil capability in the availability of nutrients in the soil for plant needs in sufficient quantities available for good production (7). Soil can be declared fertile if planted plants can grow and develop well and increase productivity. Soil fertility depends on the soil's balance of water, oxygen, and nutrients. The soil's ability level to provide plant needs for nutrients in the soil has different levels of ability. This causes the nutrient content in the soil is still very low. Of course, plant growth becomes inhibited and susceptible to pest and disease aggression (8).

The existence of this study will provide an overview of the condition of the chemical characteristics of the soil and the level of soil fertility in Pandawai District so that its management can be used optimally. Therefore, this study aims to identify soil chemical characteristics and fertility in several lands uses in Pandawai District, East Sumba Regency, East Nusa Tenggara Province.

MATERIAL AND METHODS

This research was carried out in May-August 2022 by taking samples in Pandawai District, and the observed samples were then analyzed at the Soil Chemistry Laboratory, Nusa Cendana University.

The tools used in this research are land survey equipment in the field, namely plastic, crowbar, paper labels, writing instruments, GPS (Global Positioning System), ArcView GIS 3.2, and tools used to analyze soil samples in the laboratory. The materials used are land use maps (RBI), soil samples, and chemicals used to analyze the soil.

The method used in this study is a survey method. Determination of the sampling location is done by purposive sampling (done intentionally by looking at the land use in the research location). Sampling was conducted at a 0-20 cm soil depth and in 12 different areas with 4 other land uses (plantations/gardens, irrigated rice fields, moor/fields, and shrubs) in Kelurahan/Village in Pandawai District (table 1). Soil samples were analyzed according to the method of each observation variable. The variables observed were cation exchange capacity (CEC) (1N NH4OAC pH 7), base saturation (Base Saturation/CEC*100%), C-Organic (Walkley and Black), available P (Olsen), available K (NH4OAC AAS), nitrogen is available. Soil fertility status was determined based on the criteria of the Bogor Soil Research Center (1995) by taking into account the criteria for assessing soil chemical properties (Table 2) and the combination of low, medium, and high soil fertility (Table 3). The sample analysis results are presented in tabular form and then described.

RESULT

The results of laboratory tests on 12 soil samples on dry land with dry climates in Pandawai District showed that the CEC value of the soil ranged from 30.07-39.27 m.e./100g, while the KB value of the soil ranged from 71.06-98.25%. Soil P content in the study area ranged from 14.27-57.78 ppm, soil K went from 0.25-1.24 m.e./100g,

and soil C-Organic content from the study site was 0.21-2.02% (Table 4).

Low and moderate fertility statuses were obtained based on the criteria for the chemical properties of the soil and the criteria for determining the soil fertility status. Based on 12 sampling points, fertility status was low at sample points 4, 5, 9, 10, 11, and 12, while fertility status was moderate at sample points 1, 2, 3, 6, 7, and 8 (Table 5).

Table 1. Soil sampling points

Sample point	Coordinate	Land Use	Village
1	120.39; -9.69	Estate	Watumbaka
2	120.45; -9.63	Estate	Palekahembi
3	120.54; -9.69	Estate	Kadumbul
4	120.33; -9.62	Ricefield	Kawangu
5	120.32; -9.68	Ricefield	Kawangu
6	120.39; -9.78	Ricefield	Moubokul
7	120.56; -9.71	Shrubs	Kadumbul
8	120.33; -9.73	Shrubs	Kambata Tana
9	120.39; -9.83	Shrubs	Moubokul
10	120.37; -9.65	Field	Kawangu
11	120.42; -9.64	Field	Watumbaka
12	120.48; -9.65	Field	Palekahembi

Table 2. Criteria for assessing soil chemical properties

Soil Parameter	Very Low (VR)	Low (L)	Medium (M)	High (H)	Very High (VH)
CEC (me/100 g)	<5	5-16	17-24	25-40	>40
Base Saturation (%)	<20	21-35	36-50	51-70	>70
P2O5 (ppm)	<10	10-25	26-45	46-60	>60
K-dd (me/100 g)	<0,1	0,1-0,5		0,6-1,0	>1,0
C Organic (%)	<1,00	1,0-2,0	2,1-3,0	3,1-5,0	>5,0

Source: (9)

Table 3. Combination of soil fertility levels

No	CEC	Base Saturation	P2O5, K-dd, C-organic	Fertility Status
1	H	H	≥2 H without R	High
2	H	H	≥2 H with R	Medium
3	H	H	≥2 M without R	High
4	H	H	≥2 M with R	Medium
5	H	H	H>M>R	Medium
6	H	H	≥2 L with H	Medium
7	H	H	≥2 L with S	Low
8	H	M	≥2 H without R	High
9	H	M	≥2 H with R	Medium
10	H	M	≥2 M	Medium
11	H	M	Other Combination	Low
12	H	L	≥2 H without R	Medium
13	H	L	≥2 M without R	Low
14	H	L	Other Combination	Low
15	M	H	≥2 H without R	Medium
16	M	H	≥2 M without R	Medium
17	M	H	Other Combination	Low

18	M	M	≥2 H without R	Medium
19	M	M	≥2 M without R	Medium
20	M	M	Other Combination	Low
21	M	L	3 H	Medium
22	M	L	Other Combination	Low
23	L	H	≥2 H without R	Medium
24	L	H	≥2 H with R	Low
25	L	H	≥2 M without R	Medium
26	L	H	Other Combination	Low
27	L	M	≥2 H without R	Medium
28	L	M	Other Combination	Low
29	L	L	All Combination	Low
30	VR	H,M,L	All Combination	Very Low

Source: (9)

Table 4. The results of the analysis of soil chemical properties in Pandawai District

Sampel	CEC (me/100g)	BS (%)	P_2O_5 (ppm)	K-dd (me/100g)	C Organic (%)
1	34,56^{H}	72,72^{VH}	41,76^{H}	0,89^{H}	0,69^{VL}
2	38,62^{H}	93,76^{VH}	38,92^{M}	0,78^{H}	0,42^{VL}
3	39,07^{H}	94,05^{VH}	57,78^{H}	1,24^{VH}	1,78^{L}
4	35,15^{H}	81,32^{VH}	14,51^{L}	0,25^{L}	1,83^{L}
5	39,20^{H}	97,25^{VH}	14,27^{L}	0,28^{L}	0,73^{VL}
6	34,77^{H}	71,69^{VH}	53,79^{H}	0,69^{H}	1,56^{L}
7	36,54^{H}	78,62^{VH}	59,92^{H}	0,85^{H}	1,24^{L}
8	36,06^{H}	78,41^{VH}	46,41^{H}	0,64^{H}	1,29^{L}
9	31,93^{H}	71,14^{VH}	16,89^{L}	0,42^{L}	0,21^{VL}
10	34,54^{H}	73,19^{VH}	21,31^{M}	0,34^{L}	1,43^{L}
11	30,07^{H}	71,06^{VH}	15,35^{L}	0,29^{L}	2,02^{M}
12	39,27^{H}	96,60^{VH}	14,25^{L}	0,25^{L}	0,51^{VL}

Table 5. Soil fertility status in Pandawai District

Sampel	Variabel kesuburan	Kriteria kesuburan	Status Kesuburan Tanah
1	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; High; High; Very Low	Medium
2	CEC; Base Saturation P_2O_5; K-dd; C-organic	High; Very High; Medium; High; Very Low	Medium
3	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; High; High; Low	Medium
4	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; Low; Low; Low	Low
5	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; Low; Low; Very Low	Low
6	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; High; High; Low	Medium
7	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; High; High; Low	Medium
8	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; High; High; Low	Medium
9	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; Low; Low; Very Low	Low

10	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; Medium; Low; Very Low	Low
11	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; Low; Low; Medium	Low
12	CEC; Base Saturation; P_2O_5; K-dd; C-organic	High; Very High; Low; Low; Very Low	Low

DISCUSSION

Soil chemical properties

Cation Exchange Capacity (CEC) is the essential soil chemical property that affects nutrient availability and retention in the soil (10). CEC is the capacity or ability of the soil to absorb and release cations expressed as the total exchangeable cations per 100 grams of soil defined in milliequivalents, abbreviated m.e. (m.e./100g or in its international unit Cmolc/kg) (11). CEC in the research area is classified as high. The research conducted in the dry land area of Central Sumba Regency is in line with the criteria for high-status CEC (Jawang, 2021). CEC's high and low values can be influenced by soil texture and organic matter. Soils with higher clay and high organic matter content have a higher CEC value than soils with low clay (sandy soil) and low organic matter content (11).

Base saturation (BS) has an essential role in soil fertility. It compares the number of base cations in the soil that can be exchanged by cation exchange capacity to determine the nutrients in the soil needed by plants (12). The results showed that the condition of family planning in the soil was very high. The high content of base saturation indicates that the base cation content is still very sufficient for plant needs for nutrients (13).

Phosphorus is an element of soil P that can be dissolved in water, and citric acid, with P that is dissolved in water, is an element of P that plants can absorb. Factors that affect the availability of P in the soil are organic C, soil pH, Fe, Al, Ca content, and soil physical characteristics (14). Based on the research results, the percentage of soil P content showed that the P condition was low to high. The results showed that in several research locations, the P content was low, so it needed adding P elements. P nutrients could be increased by adding organic matter and phosphate fertilizers (15).

Potassium is a macronutrient needed by plants such as N and P. Soil potassium is in a balanced form, namely mineral, fixed, exchangeable, and dissolved in water (14). Based on the soil sample test results, the percentage of soil K content shows that the K condition is in a low to high status. The results show that the K content in several research locations is low, so it requires adding K elements. K nutrients are needed and absorbed by plants so that in areas with low K conditions, inputs in organic matter and potassium fertilizer can be added (15).

Soil organic carbon consists of soil microbes, including bacteria and fungi, decomposed organic residues from root plant tissue (rhizome), and plant, animal, animal waste, and humus tissue. The amount of soil organic carbon results from the ecosystem's interaction of processes, especially photosynthesis, respiration, and decomposition (16). The results of laboratory tests, C-organic belongs to the very low to the middle class. Research in Lewa Tidahu District dryland areas, East Sumba Regency, also shows that the C-organic content is common to high criteria (17). This happens because dry land areas experience high heating, causing high evapotranspiration, so some elements will be carried away with evapotranspiration water (18). The low content of organic C

can be increased by adding organic matter such as crop residues and animal manure (manure).

Soil fertility status

Soil fertility can support plant growth from various components in the soil. Soil fertility status is one of the conditions or conditions of the soil that describes the fertile or infertile soil in a specific place which can be assessed based on the criteria for soil chemical properties and the criteria for determining soil fertility status based on PPT (1995) (19). Based on the analysis of 12 sample points at the study site, low and moderate fertility statuses were obtained. Research conducted in Umbu Pabal Selatan Village, Central Sumba Regency, found that the soil fertility of rainfed rice fields was low, medium, and high (14). Soil fertility status in the study area is classified as low and moderate due to the limiting factor, namely the organic C-value, which is mainly deficient. One of the actions that can be used to reduce the limiting factor of soil fertility is by adding organic matter through fertilization which can be obtained from crop residues as well as manure and compost (20).

CONCLUSION

The results showed that the CEC value was classified as high (30.07-39.27 m.e./100g), and the KB in the soil was very high (71.06-98.25 %). The soil P and K content percentage showed that the P condition was in low to high status (P = 14.27-57.78 ppm and K = 0.25-1.24 m.e./100g). The C-organic content of the soil is classified as very low to moderate (0.21-2.02%). Based on the chemical properties of the soil and the criteria for determining the soil fertility status, the soil in the study area has low and moderate soil fertility status. Low fertility status at sample points 4, 5, 9, 10, 11, and 12, while average fertility status at 1, 2, 3, 6, 7, and 8. The limiting factor that causes low and moderate fertility status is low fertility. C-organic.

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