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Study of Chemical Characteristics and Physical Properties in Various Used of Village Agricultural Land Labang, Labang District, Bangkalan Regency

Natasya Putri Reka Arsita, Rossyda Priyadarshini(*), Purwadi Purwadi

Departement of Agrotechnology, Faculty of Agriculture,
Pembangunan Nasional "Veteran" Jawa Timur University,
Raya Rungkut Madya No. 1, Surabaya 60294, East Java, Indonesia

***Corresponding Author:** rossyda_p@upnjatim.ac.id

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Abstract

Background: *Diverse land uses influence soil physical and chemical properties, which subsequently affects agricultural productivity. This study aimed to analyze the effect of different land uses on soil characteristics and determine the land use with the best soil quality in Labang Village, Labang District, Bangkalan Regency.* **Methodology:** *A survey method with purposive sampling was applied to three land-use types: paddy fields, dry land, and mixed gardens. Soil samples were collected at two depths (0–20 cm and 20–40 cm) from four sampling points in each land-use type, resulting in 24 samples. Parameters analyzed included soil texture, water content, bulk density, specific gravity, pH, organic carbon, cation exchange capacity (CEC), and total nitrogen. Data were analyzed using ANOVA in a Randomized Block Design followed by Duncan's test.* **Findings:** *The results showed that land use significantly affected pH, total nitrogen, clay, silt, and organic carbon, but had no significant effect on bulk density and sand content. Mixed garden land exhibited the best soil quality, characterized by higher organic carbon, nitrogen, and CEC, as well as lower bulk density and better water retention. These conditions are attributed to diverse vegetation that contributes greater organic matter through litter input. Therefore, mixed gardens are considered more effective in maintaining soil quality and supporting plant growth than other land-use types.* **Contribution:** *This study provides baseline information for sustainable land management in the Entisol–Inceptisol areas of Labang Village*

Keywords: *Entisols; Inceptisols; Land Use; Soil Physical Properties; Soil Chemical Properties*

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INTRODUCTION

Soil is the main factor in agricultural systems, acting as a growing medium and providing nutrients for plants (Nengsih, 2015). Land productivity is determined by soil quality, which can be seen from its physical and chemical characteristics (Basuki et al., 2023). Physical characteristics of soil, such as bulk density, specific gravity, water content, and texture, influence its ability to provide root growth space, water availability, and aeration (Pasaribu et al., 2023). Chemical characteristics, such as nitrogen (N) content, organic carbon (C-organic), cation exchange capacity (CEC), and soil pH, also play a role in determining the availability and balance of nutrients needed by plants (Sainju & Liptzin, 2022).

Land use changes that ignore conservation principles can increase soil degradation through reduced organic matter content, increased soil compaction, and reduced water and nutrient retention. These conditions can degrade soil quality, inhibiting plant growth and reducing agricultural production (Salam, 2020). Intensively managed agricultural land tends to experience a decrease in organic carbon content and cation exchange capacity compared to land with permanent vegetation or agroforestry systems (Wijaya, 2024). In addition, changes in land cover also affect soil structure, porosity, and water infiltration capacity which play a role in providing water for plants (Endang et al., 2024). Thus, the condition of soil quality is greatly influenced by the type of land use applied.

Good soil quality is one factor supporting agricultural productivity. Soil with a high organic content, appropriate pH, good cation exchange capacity, and a structure that supports root development will increase the efficiency of plant water and nutrient absorption (Wismaria & Dermawan, 2026). The decline in soil quality due to changes in land use causes low crop productivity and a reduction in agricultural systems (Wahyunto & Dariah, 2014). Therefore, studies on the relationship between land use and soil characteristics are important to understand soil fertility conditions and support land management.

Labang Village, Labang District, Bangkalan Regency, is an area where the majority of the population relies on agriculture for their livelihood. The soil types in this area are predominantly Entisols and Inceptisols. Entisols have varying base saturation, a pH ranging from acidic to neutral to alkaline, low organic matter content, low nutrient content (N, P, K), and a clay texture (Tuas et al., 2022). The characteristics of Inceptisols indicate that the soil solum is quite thick, ranging from 1-2 meters (Elfarisna et al., 2024). Inceptisols texture consists of dust, dusty clay, and loam, with a crumbly soil structure, indicating that this soil can be well cultivated for agriculture (Muslim et al., 2020). The soil consistency tends to be loose and usually has adequate air circulation, with a pH ranging from 5.0 to 7.0 (Muyassir et al., 2012).

The agricultural sector is the primary driver in Labang District, with leading commodities such as rice, corn, peanuts, mung beans, cassava, pepper, tomatoes, shallots, and various vegetables. According to a BPS report, rice productivity in Labang District declined in 2024, with production dropping to 5,433.75 quintals from 68,633.84 quintals in 2023 (Central Statistics Agency of Bangkalan Regency, 2024). The decline in production in the region is influenced by weather, climate change, and potential land conversion.

Land productivity is greatly influenced by the physical, chemical and biological properties of the soil, which are interrelated in supporting plant growth. Various previous studies have shown that land use influences the physical and chemical characteristics of soil. Research by Rahmawati et al., (2023) reported that changes in land use can affect the distribution of texture fractions and the water-holding capacity of the soil. Multazam et al., (2025) showed that the organic matter and nutrient content of the soil differed across land use systems. However, information on variations in the physical and chemical properties of soil across various agricultural land uses in Labang Village, Labang District, Bangkalan Regency is still limited. Based on the above information, a study of soil conditions in Labang Village is needed to assess the differences in soil characteristics between rice paddies, mixed gardens, and dry fields. The results of this study are expected to provide a basis for more appropriate land management, thereby maintaining agricultural productivity.

METHODS

This research was conducted in June 2025 – August 2025 in Labang District, Bangkalan Regency, East Java Province. Geographically, Labang District is located at an altitude of 45 meters above sea level with an area of 35.23 km2 divided into 13 villages. Soil sample analysis was carried out at the Land Resources Laboratory, Faculty of Agriculture, National Development University "Veteran" East Java. The tools used in this study include sample rings, hoes, soil drills, GPS, label paper, gauze, knives, crowbars, hammers, and stationery. The materials used in this study include a 1:10,000 scale land use map, a 1:10,000 scale soil type map, a 1:15,000 slope map, a 1:15,000 sampling point map, disturbed soil samples, and undisturbed soil samples.

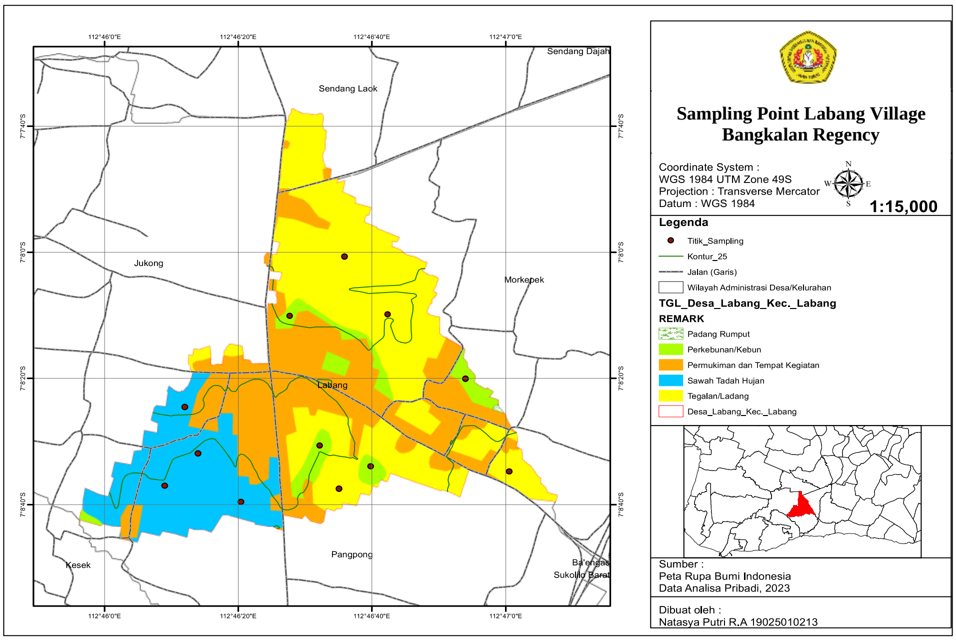


Figure 1. Map of Sampling Points in Labang Village

This study uses a survey method with the help of ArcGIS software to determine land conditions in the field, which are then used to identify sample points. Sampling in this study was carried out in rice fields, mixed gardens, and dry fields with coordinates 07° 11' 16.151" South Latitude and 113° 03' 30.387" East Longitude obtained through field GPS measurements and verification using the RBI Map (Geospatial Information Agency, 2021). Labang Village has an average temperature of around 23°C - 34°C, air humidity of 55% - 85%, with an average daily rainfall of around 35.23mm (Central Statistics Agency of Bangkalan Regency, 2020).

Sampling points were determined at several land use points in Labang Village, including rice paddies, mixed gardens, and dry fields. Sampling was conducted using purposive sampling based on land use units. Each land use was represented by four sampling points as field replicates. Sampling was conducted at two depths: 0–20 cm and 20–40 cm, resulting in 24 samples used in laboratory analysis. Soil sampling was divided into two groups: intact soil and disturbed soil. Intact soil samples were taken for bulk density and specific gravity analysis. For intact soil sampling, a metal sample ring with a diameter of 5 cm and a height of 5 cm (volume ±98.17 cm^3) was used. The sample ring was pressed vertically into the soil using a hammer and support block to maintain the soil structure intact during the sampling process, while disturbed soil samples were taken by hoeing or drilling the soil layer using tools such as shovels, hoes, or soil drills for texture, pH, nitrogen, organic carbon, and other analyses. Cation Exchange Capacity (CEC). The samples are then labeled, stored in closed containers, and taken to the laboratory for analysis.

Study Procedure

Observation activities in this study include data collection conducted through direct observation of environmental conditions and the objects studied. In field observations, researchers examined the physical condition of the predetermined samples and took soil samples for analysis in the laboratory. A total of 24 soil samples were taken by taking intact soil samples and disturbed soil at depths of 0-20 cm and 20-40 cm. Intact soil sampling is undisturbed soil that is taken while maintaining its natural condition and original structure. Intact soil samples are taken using a sample ring, taken from a specific soil layer in an intact state. Disturbed soil samples are soil samples taken from a specific location, but the original soil structure has undergone changes or disturbances during the collection process. Soil samples are then analyzed according to the appropriate method for each parameter.

Table 1. Observation parameters and analysis methods

No.	Observation Parameters	Analysis Method
1.	Soil Texture	Pipette
2.	Soil Water Content	Gravimetry
3.	Content Weight	Gravimetry
4.	Specific gravity	Gravimetry
5.	C- Organic	Walkey & Black
6.	pH H2O	Potentiometry
7.	CEC	NH4OAC 1N
8.	Nitrogen available	Distillation, titration

Data Analysis

Data analysis was performed after the data obtained from all physical and chemical soil test parameters were calculated and tabulated. The statistical analysis was performed using SPSS version 26 software.analyzed using the Analysis of Variance (ANOVA) method at a 95% confidence level. If there is a significant effect, the Duncan Multiple Range Test (DMRT) at a 5% level is continued to determine the differences between treatments.

RESULTS AND DISCUSSION

Physical Characteristics

Soil Texture

Based on the results of the soil texture analysis in Labang Village presented in Table 2, it shows that the soil texture in the research area varies from dusty clay to clay.These texture variations are influenced by soil type and land use. Silty clay texture is found in rice fields and mixed gardens where the silt fraction is higher (42–50%), compared to the sand fraction (3–9%) and clay fraction (43–50%). Clay texture is found in all land uses, rice fields, mixed gardens, and dry fields. Isra et al., (2019) Soils with a silty clay texture show a better ability to retain water compared to coarse-textured soils, although their drainage is more effective when compared to fine-textured soils. Clay-dominated soils have many small pores that store water, but in this state, the water is trapped so tightly in the small pores that it is difficult for plants to absorb it. Water availability in sandy soils is the lowest (Liu et al., 2021), while clay soil has the highest water content (Alordzinu et al., 2021). Soils with fine and medium textures, such as sandy clay loam, silty clay loam, and silty loam, generally have a high capacity to store nutrients and water (Wang et al., 2022). Clay-textured soil is considered the strongest and best at resisting erosion. This is due to the highly stable aggregate properties of clay and its ability to retain more water than sandy and silt soils (Ayuningtyas et al., 2018). By knowing the soil texture accurately, soil management strategies can be adjusted to increase the efficiency of water and fertilizer use and support optimal plant growth.

Soil Fill Weight, Soil Specific Gravity

Bulk density is related to soil density. The higher the bulk density, the denser the soil, making it difficult for water and plant roots to penetrate (Nurilmi et al., 2017). Based on the analysis results in Table 3, the BI value for dry land was 1.25 g/cm³, mixed gardens 1.32 g/cm³, and rice fields 1.4 g/cm³. The results of the 5% Duncan test showed the information "ns" (not significant), which means that various land uses did not have a significantly different effect on the value of soil bulk density. The highest bulk density value was found in rice field land use, while the lowest value was found in dry land. The high bulk density in rice fields indicates that the soil tends to be denser than other land uses. The high bulk density is due to the low organic content and higher soil cultivation intensity so that the soil pore space is reduced. Conversely, dry land has a lower bulk density because the soil condition is looser due to inundation and higher water content.

A low bulk density indicates looser soil with good porosity, which supports optimal soil aeration and water infiltration for plant growth. A low pore count can increase soil weight, resulting in a slower infiltration rate (Safitri et al., 2024). Variations in bulk density values at various locations indicate differences in the physical properties of the soil which are influenced by soil texture, organic matter content, and density level.

Table 2. Soil Texture Laboratory Analysis Results

Land Use	Fraction (%)			Texture
	Sand	Dust	Look	
Rice Field I (0-20 cm)	8	49	43	Dusty Clay
Rice Field I (20-40 cm)	7	50	43	Dusty Clay
Rice Field II (0-20 cm)	3	37	60	Clay
Rice Field II (20-40 cm)	2	38	60	Clay
Rice Fields III (0-20 cm)	9	42	49	Dusty Clay
Rice Fields III (20-40 cm)	5	45	50	Dusty Clay
Rice Field IV (0-20 cm)	4	47	49	Dusty Clay
Rice Field IV (20-40 cm)	3	49	48	Dusty Clay
Mixed Garden I (0-20 cm)	8	49	43	Dusty Clay
Mixed Garden I (20-40 cm)	4	47	49	Dusty Clay
Mixed Garden II (0-20 cm)	4	32	64	Clay
Mixed Garden II (20-40 cm)	9	29	62	Clay
Mixed Garden III (0-20 cm)	2	36	62	Clay
Mixed Garden III (20-40 cm)	7	24	69	Clay
Mixed Garden IV (0-20 cm)	4	32	64	Clay
Mixed Garden IV (20-40 cm)	7	27	67	Clay
Dry Land I (0-20 cm)	7	34	59	Clay
Dry Land I (20-40 cm)	9	42	49	Clay
Dry Land II (0-20 cm)	6	32	62	Clay
Dry Land II (20-40 cm)	7	23	70	Clay
Dry Land III (0-20 cm)	6	32	62	Clay
Dry Land III (20-40 cm)	7	26	67	Clay
Dry Land IV (0-20 cm)	6	33	61	Clay
Dry Land IV (20-40 cm)	8	26	66	Clay

Source: (Sarwono, 2003)

Table 3. Analysis of Bulk Density and Specific Gravity of Soil in Various Land Uses

Land Use	Content Weight (g/cm³)	Specific gravity (g/cm³)
Ricefield	1.4	2.40
Mixed Garden	1.32	2.32
Dry Land	1.25	2.13

Source: (Rai et al., 2017)

Particle density is directly related to soil volumetric density. When soil has a high particle density, its volumetric density is also high. Based on the specific gravity analysis results in Table 3, the highest particle density value was found in rice fields, at 2.40.g/cm³, while the lowest value was found in dryland, at 2.13 g/cm³. Land use with higher particle density is caused by intensive land cultivation, which reduces organic matter content.In soil conditions like this, plant roots will have difficulty penetrating the soil (Gong et al., 2023). Organic matter has a large influence on the weight density of particles in soil. If the organic matter content in the soil increases, the weight density value of the soil particles will decrease (Handayani & Al Ikhsan Amri, 2014). The low soil volume weight value obtained on the soil surface after processing occurs because the soil becomes looser (Agus et al., 2016). High soil specific gravity can inhibit plant growth, so additional organic material is required (Chang, 2003).

Soil Water Content

Differences in soil water content at each sample point indicate variations in the physical condition of the soil in agricultural land in Labang Village. Based on the results of the soil water content analysis in Table 4, differences between land uses are evident. Paddy fields have a soil water content of 3.07%, mixed gardens 4.15%, and dry fields 7.32%. All three land uses are categorized as very dry. This indicates that the soil at the study site has a low water retention capacity, thus limiting water availability for plants. Khoirunisa et al., (2021) Soil water content is the amount of water contained in the soil, measured by dry weight.

The highest water content was found in dryland areas, at 7.32%, while the lowest was found in rice paddies, at 3.07%. Low soil water content can be influenced by several factors, including soil texture, organic matter content, ambient temperature, and the soil's low water-retention capacity. Soils with low organic matter content tend to have low porosity and water-holding capacity, resulting in faster water loss through evaporation.

Table 4. Water Content Analysis Results

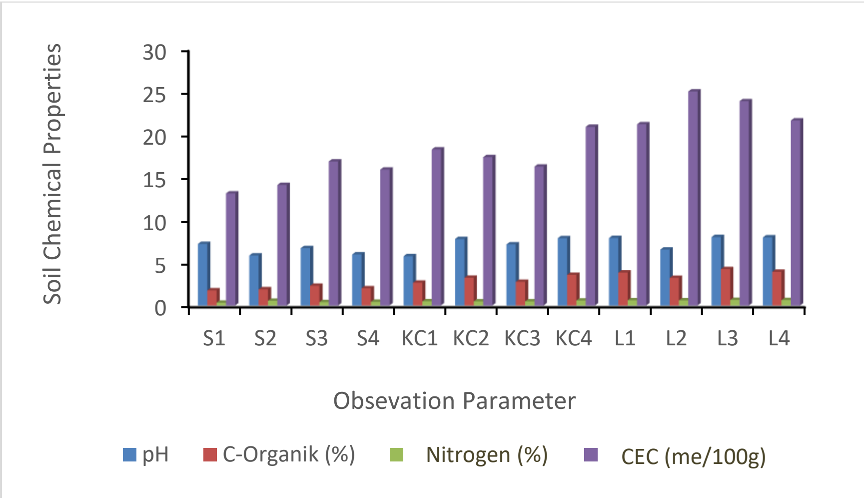
Land Use	Water content %	Criteria
Ricefield	3.07	Very Dry
Mixed Garden	4.15	Very Dry
Dry Land	7.32	Very Dry

Source: (Sarwono, 2003)

Very dry soil conditions can impact nutrient availability. Water acts as a solvent and transport medium for nutrients to plant roots. If the water content is low, the process of nutrient dissolution and absorption is less than optimal. Furthermore, soil microorganism activity also decreases because microorganisms require moist conditions to decompose organic matter and mineralize nutrients. As a result, fewer nutrients are available to plants. In rice fields, which are generally associated with flooded conditions, low water content indicates that the land was dry at the time of sampling or that water management was less than optimal. Meanwhile, dryland areas have higher water content than other land uses due to the possibility of vegetation cover or slightly better accumulation of organic matter, which is able to maintain soil moisture. The results of this study indicate that the soil water content in Labang Village is relatively low, requiring soil management efforts that can increase the soil's water retention capacity, such as the addition of organic matter, the use of mulch, and better irrigation management to support agricultural productivity.

Characteristics of Soil Chemical Properties

The chemical properties of soil are related to the composition of chemical elements, soil reaction (pH), soil cation exchange capacity (CEC), and organic carbon (Saputri, 2020).



Picture 2. Results of Soil Chemical Properties Analysis

Table 5. Criteria Soil Chemical Properties Assessment from PPT Bogor (Soil Research Center, 1995)

No.	Chemical Properties	Mark	Criteria
1	Cation Exchange Capacity (CEC)	>40	Very High (ST)
		25-40	Height (T)
		17-24	Medium (S)
		5-16	Low (R)
		<5	Very Low (SR)
2	Baasah's Boredom	>70	Very High (ST)
		51-70	Height (T)
		36-50	Medium (S)
		20-35	Low (R)
		<20	Very Low (SR)
3	Nitrogen	>0.75	Very High (ST)
		0.51-0.75	Height (T)
		0.21-0.50	Medium (S)
		0.10-0.20	Low (R)
		<0.10	Very Low (SR)

No.	Chemical Properties	Mark	Criteria
4	P-Available	>60	Very High (ST)
		41-60	High (T)
		21-40	Medium (S)
		10-20	Low (R)
		<10	Very Low (SR)
5	K-Available	>60	Very High (ST)
		41-60	High (T)
		21-40	Medium (S)
		10-20	Low (R)
		<10	Very Low (SR)
6	pH	>8.5	Alkalis (A)
		7.6-8.5	Slightly Alkaline (AA)
		6.6-7.5	Neutral (N)
		4.5-5.5	A bit sour (AM)
		<4.5	Sour (M)
7	C-Organic	>5.00	Very High (ST)
		3.01-5.00	High (T)
		2.01-3.00	Medium (S)
		1.00-2.00	Low (R)
		<1.00	Very Low (SR)

Organic Materials

Organic matter has a significant influence on the soil's capacity to support plant growth (Manan, 2016). If the amount of organic material in the soil decreases, the soil's ability to support crop yields will also decrease (Omposunggu et al., 2015). Based on the results of the C-Organic analysis in Table 5, the soil organic content in Labang Village is classified as low to high. Paddy fields have a lower C-organic content of 1.98% compared to mixed gardens at 3.05% and the highest in dry land at 3.81%. Based on the Duncan test, the three land uses are significantly different. The high of C-organic content in dry land indicates that the land has better organic matter accumulation than other land uses. This is related to the return of crop residues such as straw to the soil and moist soil conditions that slow the decomposition of organic matter.

Table 6. C – Organic Analysis Results

Land Use	C – Organic (%)	Criteria
Ricefield	1.98	Low
Mixed Garden	3.05	High
Dry Land	3.81	High

Note: Criteria refers to (Sarwono, 2003)

The low organic carbon content in rice fields indicates the need for regular addition of organic matter to improve the physical and chemical characteristics of the soil. Organic matter affects the soil's ability to retain water. The organic carbon (C) content considered optimal and suitable for soil fertility is high to very high, with the requirement being >2.51% to >3.50%. Murtilaksono & Wahyuni (2004) Soil with a high organic content indicates fertile soil, supporting water availability for plants, maintaining fertility, and supporting microbial activity. It can be seen that the highest water-holding capacity of the soil is found in dry fields.

Cation Exchange Capacity (CEC)

CEC is the soil's ability to store and exchange cations used by plants, for example calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), and sodium (Na^{+}) (Faery et al., 2024). Soil colloids are able to absorb and exchange various cations, including Ca, Mg, K, Na, NH4, Al, Fe, and H (Putri et al., 2019). Low soil cation exchange capacity can be improved by adding organic materials, such as compost or animal manure (Suryani, 2014).

Based on the results of the CEC analysis in Table 6, it is known that the lowest CEC value in rice fields is 14.98 cmol/kg, which is considered low, while mixed gardens have 18.18 cmol/kg, and the highest CEC value in dryland is 22.95 cmol/kg, which is considered medium. These results indicate differences in the soil's ability to retain and provide nutrients across different land uses. The high CEC value in dryland indicates that the soil has a better ability to retain cationic nutrients such as potassium^{+}, Ca^{2+}, Mg^{2+}, and NH_4^{+}so that nutrients are not easily leached. On the other hand, a low CEC value in paddy fields indicates that the soil's ability to bind nutrients is relatively lower so that the soil is more susceptible to nutrient loss due to leaching.

Table 7. CEC Analysis Results

Land Use	CEC (cmol/kg)	Criteria
Ricefield	14.98	Low
Mixed Garden	18.18	Medium
Dry Land	22.95	Medium

Note: Criteria refers to (Sarwono, 2003)

Differences in CEC values are influenced by several factors, particularly the organic matter content and clay fraction of the soil. Soils with high organic matter content generally have higher CECs because organic matter has a large negative charge that can bind cations. Furthermore, soil texture also affects CEC values, with finer-textured soils with high clay content tending to have higher CECs than sandy soils. Moderate CEC values in mixed gardens and dry fields indicate that both land uses have better soil fertility than rice paddies. The higher the CEC value, the better the soil's ability to provide nutrients to plants. This condition supports plant growth because nutrients can be available longer in the soil and are not easily lost. The results of the study indicate that land use influences soil CEC values. Land with higher organic matter content tends to have better CEC values, thereby increasing the soil's capacity to store and provide nutrients to plants.

pH

Soil pH is a condition where there is a relationship between elements or materials contained in the soil, soil has several pH values which are classified into acidic, neutral and alkaline (Novia, 2021). Based on the results of soil pH analysis for various land uses, the pH value for rice fields was 6.43, which is considered slightly acidic. This is thought to be influenced by the frequently flooded land conditions and the continuous use of inorganic fertilizers. Long-term use of fertilizers such as urea can increase the concentration of H+ ions.$^{+}$in the soil, causing it to become more acidic. Furthermore, the leaching of alkaline elements due to flooding can also lower the soil pH. The pH value of mixed garden land is 7.13, which is neutral, indicating that the soil in mixed gardens has a fairly good level of fertility because nutrients are more readily available.

Meanwhile, dryland land has the highest pH value, at 7.59, which is slightly alkaline. This difference in pH values indicates that land use influences soil acidity. The high pH value in dryland land can be influenced by low base leaching and the accumulation of base cations such as Ca, Mg, K, and Na in the soil. Furthermore, intensive soil cultivation and more open land conditions can also influence changes in soil reaction to become more alkaline. Differences in pH values across various land uses indicate that land management activities, fertilizer use, organic matter content, and environmental conditions play a significant role in determining soil acidity. Soil pH values ranging from slightly acidic to neutral generally still support plant growth because most nutrients are optimally available under these conditions.

Table 8. pH Analysis Results

Land Use	pH	Criteria
Ricefield	6.43	A bit sour
Mixed Garden	7.13	Neutral
Dry Land	7.59	Slightly alkaline

Note: Criteria refers to (Sarwono, 2003)

Nitrogen

Nitrogen is a macronutrient that is crucial in the growth process of plants because it is one of the components that make up plant cells (Rahmadani et al., 2020). Nitrogen, potassium, and phosphorus are vital components for plant growth (Putra et al., 2022). The loss of any of these elements can result in a decrease in crop yields (Fageria, 2016). In submerged soils, the majority of nitrogen is available in the form of ammonium ($NH4\ +$), because nitrate (NO3-) is easily lost due to the denitrification and leaching processes, while the amount taken up by plants is also quite large (Das et al., 2022). Ammonium introduced into the soil as fertilizer is able to increase the amount of total Nitrogen in the soil, where it is quickly absorbed by the soil cation exchange complex (Lumbanraja et al., 2019).

The results of the analysis of variance (ANOVA) show that land use has a very significant effect on soil nitrogen content in Labang Village. This is indicated by a significance value of 0.000 ($p<0.01$), thus It can be concluded that differences in land use significantly influence soil nitrogen content. Based on Duncan's further tests, the highest nitrogen content was found in dryland areas, at 0.6129%. The high nitrogen content in dryland areas is thought to be due to the higher accumulation of organic matter compared to other land uses. High nitrogen content indicates better soil fertility. In mixed garden soils, the nitrogen content is moderate at 0.4986%. This condition is influenced by the presence of diverse vegetation, so that plant litter that falls to the soil surface can increase the soil's organic matter. However, the process of nutrient absorption by various types of plants is also quite high, so the nitrogen content is not as high as in dryland. Meanwhile, the lowest nitrogen content was found in rice fields at 0.3745%. The low nitrogen content in rice fields is caused by leaching and denitrification processes due to frequently waterlogged soil conditions. Under anaerobic conditions, nitrogen is easily lost to the atmosphere in the form of gas, so its availability in the soil is lower. In addition, the intensity of land cultivation and the continuous use of chemical fertilizers without balancing the addition of organic matter also causes a decrease in soil nitrogen content.

Table 9. Nitrogen Laboratory Analysis Results

Land Use	Nitrogen	Criteria
Ricefield	0.374	Medium
Mixed Garden	0.498	Medium
Dry Land	0.612	High

Note: Criteria refers to (Sarwono, 2003)

The Effect of Land Use on the Physical and Chemical Characteristics of Soil

Based on the results of the Duncan test at a 5% level, land use has different effects on several physical and chemical characteristics of the soil. Parameters that show significant effects include actual pH, nitrogen, organic C, dust fraction, and clay fraction, while bulk density and sand fraction show no significant effects. The highest soil pH value is found in dry land use, namely 7.5975 and is significantly different from rice fields at 6.4325, while mixed gardens have a pH value of 7.1363 which is not significantly different from both. This indicates that dry land use tends to have more neutral to slightly alkaline soil conditions than rice fields.

In terms of nitrogen, dry land has the highest content at 0.6129%, followed by mixed gardens at 0.4986%, and rice fields at 0.3745%. Duncan's test results show that the three land uses are significantly different from each other. The high nitrogen content in dry land is thought to be influenced by the accumulation of organic matter and different land management activities. The C-organic parameter also shows a very significant difference between land uses. Dry land has the highest C-organic content at 3.8100%, followed by mixed gardens at 3.0563%, and rice fields at 1.9838%. The high of C-organic content in dry land and mixed gardens indicates a higher addition of litter and organic matter compared to rice fields.

In terms of soil physical properties, the bulk density parameter did not show a significant effect between land uses, although the highest value was found in dry fields at 1.4102 g/cm³ and the lowest in rice fields at 1.2577 g/cm³. This indicates that differences in land use have not significantly changed the level of soil density. The sand fraction also did not differ significantly between land uses with a range of values 5.125–

7.000%. The silt and clay fractions showed significant differences. The highest silt fraction was found in dry fields at 44.625% and was significantly different from rice fields and mixed gardens. The highest clay fraction was found in dry fields at 62.000% and mixed gardens at 60.000%, both of which were significantly different from rice fields at 50.250%. Dry land use showed the highest soil characteristics in most soil chemical parameters, namely pH, nitrogen, and organic carbon. In addition, dry fields also had higher silt and clay content compared to other land uses.

Table 10. Duncan's Advanced Test

Land Use	Parameter						
	Actual pH	Content Weight	Nitrogen	C-Organic	Sand	Silt	Clay
Ricefield	6.4325a	1.2577a	0.3745a	1.9838a	5.125a	31.000a	50.250a
Mixed Garden	7.1363ab	1.3219a	0.4986b	3.0563b	5.500a	34.500a	60.000b
Dry Land	7.5975b	1.4102a	0.6129c	3.8100c	7.000a	44.625b	62.000b
Duncan 5%	*	ns	**	**	ns	*	*

Description: * (significantly different), ** (very significant), ns (not significantly different). Numbers followed by the same letter are not significantly different at the 5% level.

Land use affects soil conditions because each plot of land has a different management system, vegetation, and processing intensity. Land use has a greater influence on soil chemical properties than on physical properties. Chemical parameters such as pH, nitrogen, and organic carbon experience significant to very significant changes due to differences in land management. Meanwhile, physical soil properties such as bulk density and sand fraction tend to experience no significant changes. This indicates that land use activities affect soil chemical conditions more rapidly than physical characteristics. Thus, land use has been shown to influence the physical and chemical characteristics of soil in Labang Village.

The Most Appropriate Land Use Pattern to Improve Land Productivity

The best land use patterns for maintaining soil quality are dry fields and mixed gardens. Both of these land uses have higher nitrogen and organic carbon content than rice paddies. Mixed gardens can increase the activity of soil microorganisms that play a role in the decomposition of organic matter. Meanwhile, dry fields have high fertility levels, but if managed without attention to soil conservation, they have the potential to experience long-term soil quality decline. Several efforts can be made to increase agricultural land productivity in Labang village, including the addition of organic materials such as compost and manure, the implementation of mixed cropping patterns or crop rotation, reducing excessive use of chemical fertilizers, proper irrigation management in rice paddies, and the application of soil conservation techniques to reduce erosion and nutrient loss. With proper management, the physical and chemical characteristics of the soil in Labang Village can be maintained, thereby supporting agricultural productivity.

CONCLUSION

Based on the research results, it can be concluded that differences in land use have an impact on several physical and chemical properties of the soil. The use of mixed garden land showed the best soil characteristics (physical and chemical soil) compared to other land uses. The results of the ANOVA test showed that land use had a significant effect on soil pH (Sig.= 0.016), nitrogen (Sig.= 0.000), organic C (Sig.= 0.000), bulk density (Sig.= 0.000), soil water content (Sig.= 0.000), sand fraction (Sig.= 0.000), silt (Sig.= 0.000), and clay (Sig.= 0.000), while the specific gravity and CEC parameters did not show significant differences (Sig. > 0.05). The use of mixed garden land showed the best soil characteristics compared to other land uses, indicated by higher organic C, nitrogen, and CEC contents as well as better soil physical conditions such as lower bulk density and higher water content. The results of this study indicate that appropriate land use selection and management play a crucial role in maintaining and improving soil quality. Therefore, land use systems such as mixed gardens can be considered as an alternative agricultural land management method to maintain soil fertility, increase nutrient availability, and support agricultural productivity in Labang Village, Labang District, Bangkalan Regency.

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