Evaluation of the Quality and Management of Chili Planted in Tegalweru Village, Malang, East Java, Indonesia.

Septrial Arafat, Muhammad Iqbal Fauzan*, Dian Safitri

Department of Agriculture, Faculty of Animal and Agricultural Science, Diponegoro University, Indonesia

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Abstract- Tegalweru Village is chili center production in Malang. This demand has led to the cultivation of chili plants across three growing seasons to meet the needs of partner companies. Conventional agricultural practices have reduced soil organic matter, resulting in degraded soil properties despite high yields, and have negatively impacted the agricultural ecosystem and surrounding environment. Research indicates that land in Tegalweru Village with slopes below 10% exhibits better quality in terms of water availability, pH, and soil organic matter compared to land with slopes above 30%, regardless of terracing. However, terraced land demonstrates better quality than non-terraced land. Slope does not significantly affect soil texture and structure. The suitability of land for chili cultivation in Tegalweru Village is primarily constrained by soil pH, classified as S3 suitability. To improve land quality, several methods are recommended: minimal tillage, fallow systems, moisture regime management, water conservation, soil surface conditioning for infiltration, and the use of green manure, compost, and lime.

Keywords: Land cultivation, Land survey, slope, Soil quality,

I. Introduction

Chili peppers are a significant horticultural commodity with promising market potential. In 2014, the production of fresh large chili peppers with stems was 1.075 million tons, reflecting an increase of 61.73 thousand tons, or 6.09%, compared to 2013 [1]. The cultivation of chili plants is influenced by technical and economic factors. One key technical factor is land. Land is crucial as it serves as the growth medium for plants. According to [2], soil has several functions: (1) providing a medium for root growth and development, (2) supplying primary plant needs such as water, air, and nutrients, (3) offering secondary plant needs like growth-promoting substances, hormones, vitamins, organic acids, antibiotics, and pest-deterrent toxins; enzymes that enhance nutrient availability, (4) serving as a habitat for soil biota, which can have both positive impacts (through direct or indirect involvement in providing primary and secondary plant needs) and negative impacts (as pests and disease agents).

Agricultural land management remains conventional, leading to reduced organic matter and degraded soil properties, despite high production yields. This conventional approach negatively impacts the agricultural ecosystem and the broader environment. Intensive farming systems cause soil compaction, low soil porosity, decreased ion exchange capacity, reduced water retention, diminished microbial activity, and overall reduced soil fertility [3]. Over time, intensive farming results in land degradation.

Land degradation refers to the loss or decline in land's utility or potential utility to support life, where the loss or alteration of its characteristics renders it irreplaceable by other means, effectively reducing agricultural land quality [4]. According to [5], five primary processes cause soil degradation: (1) decline in soil organic matter, (2) clay translocation, (3) deterioration of soil structure and compaction, (4) soil erosion, (5) nutrient depletion through leaching.

The relationship between slope and soil properties varies by location due to differences in soil-forming factors. Slopes typically consist of the crest, convex, concave, and foot slope segments. Steep slopes are prone to continuous erosion, resulting in shallow soils with low organic matter content and slow horizon development compared to soils in flat areas with deep groundwater [6]. Land slope is a crucial factor to consider during agricultural land preparation, planting efforts, product harvesting, and soil conservation. Sloped lands are more susceptible to disturbances or damage, especially if the slope is steep, leading to soil slippage and erosion of fertile soil layers (humus)[7].

One region in East Java where chili plants are conventionally cultivated is Tegalweru Village, Dau Subdistrict, Malang Regency. Malang Regency is a major production center for large red chili peppers, with a production volume of 21.75 thousand tons, followed by Tuban with 19.95 thousand tons, Kediri Regency with 12.77 thousand tons, and Banyuwangi with 8.08 thousand tons [8]. Optimizing chili plant production and ensuring its sustainability can be achieved through the analysis of land quality and suitability from ecological and socio-economic perspectives. Effective land management is essential to sustain chili production in Tegalweru Village, Dau, Malang.

II. MATERIALS AND METHODS

2.1. Experimental Design

This research was conducted in Tegalweru Village, Malang, East Java. The reason for choosing Tegalweru Village is its chili market, represented by PT Heinz ABC, which has encouraged many locals to start cultivating chili peppers. Laboratory analysis to support the soil survey data was conducted at the Soil Physics and Soil Chemistry Laboratory, while spatial analysis and mapping were carried out at the Pedology and Land Resource Information System Laboratory (PSISDL) Department of Land Resource Management, Brawijaya University, Malang.

Sampling points were selected by integrating land use, soil type maps, and slope maps. The observed points included representative areas: slopes of < 8%, terraced slopes of > 30%, and non-terraced slopes of > 30%, with each condition being sampled twice, resulting in a total of 6 observation points.

2.2 Measurements

Data analysis in this study utilized correlation analysis to examine the relationships between observation parameters, specifically the interrelationships between water availability, organic matter, and soil pH. The analysis was performed using Microsoft Excel.

III. RESULT AND DISCUSSION

A. Soil Texture

The soil texture in the Kd10 area is silty clay loam, as is the texture in Kd30T, which is also silty clay loam. Similarly, the soil texture in Kd30tT is silty clay loam. This consistency in texture across different slopes indicates that varying slopes do not cause differences in soil texture. In Kd10, the sand percentage is 17.634%, silt is 58.833%, and clay is 23.533%; in Kd30t, the sand percentage is 17.062%, silt is 51.343%, and clay is 31.596%; in Kd30tT, the sand percentage is 14.676%, silt is 55.461%, and clay is 29.863%. Land quality evaluation can be seen in table 1.

Table 1. Land Quality Observations in Tegalweru Village

Code	Texture (Silty Clay Loam) Sand (%)	Water Availability Silt (%)	Soil Organic Matter Clay (%)	Soil pH
Kd10	17.63	58.83	23.533	35.28
Kd30T	17.06	51.34	31.596	28.01
Kd30tT	14.67	55.46	29.863	23.40

Note: Kd10: Slope below 10%; Kd30T: Terraced slope above 30%; Kd30tT: Non-terraced slope above 30%.

According to [9], soil dominated by sand will have many macro-pores and is considered more porous. Soil dominated by silt will have meso-pores (somewhat porous), while soil dominated by clay will have many micro-pores (less porous). The more porous the soil, the easier it is for roots to penetrate and for water and air to circulate. However, it also means that water can be lost from the soil more easily, and vice versa.

B. *Water Soil availability*

Soil water availability in Tegalweru Village is considered very high. Observations show that the highest water availability is on slopes below 10%, with a percentage of 35.28%. The next highest availability is on terraced slopes above 30%, with a percentage of 28.01%. The lowest water availability is on non-terraced slopes above 30%, with a percentage of 23.4%. water soil availability can be seen in figure 1.

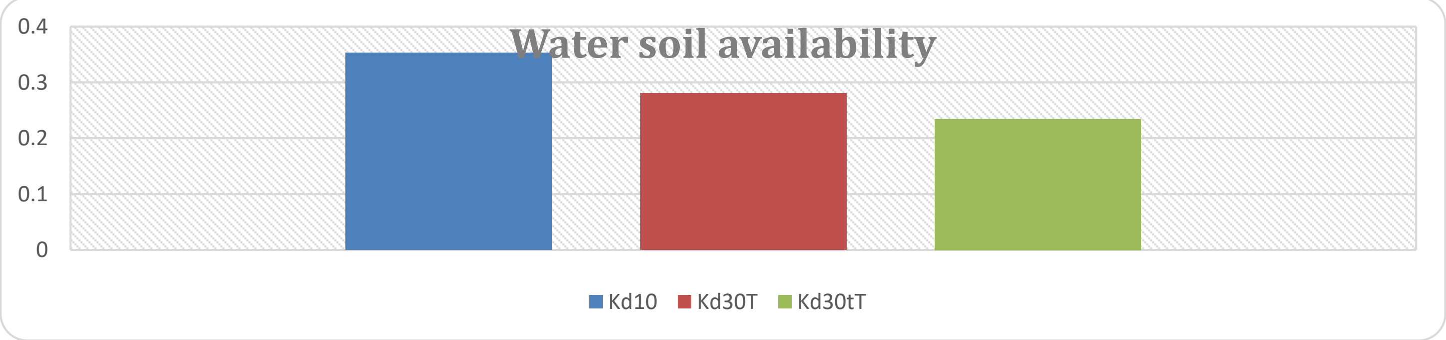

Figure 1. Water soil availability in Tegalrejo Village, Malang, East Java, Indonesia

On steep slopes, water tends to run off more quickly and has less opportunity to infiltrate the soil compared to gentler slopes. Soils on steep slopes also tend to have different physical characteristics (notably higher clay content) due to erosion from previous years [10].

The differences in slope also lead to variations in water availability for plants, which affects vegetation growth in those areas and, consequently, influences soil formation processes.

C. *Soil Organic Matter*

The organic matter content in land with slopes below 10% is 1.89%, indicating higher organic matter availability compared to terraced slopes above 30%, which have an organic matter content of 1.64%, and non-terraced slopes above 30%, which have an organic matter content of only 0.54%. This shows that land slope also impacts the availability of soil organic matter. Soil organic availability can be seen in figure 2.

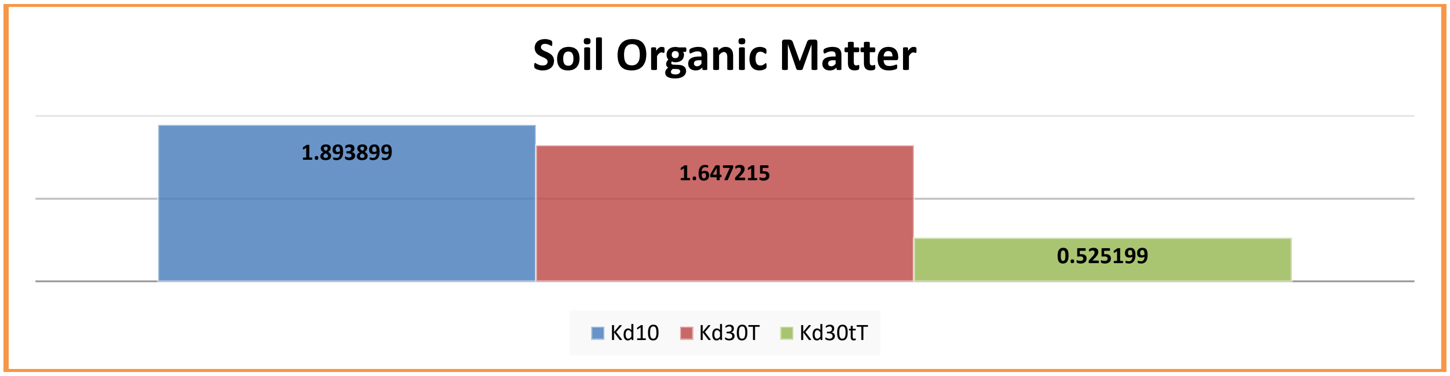

Figure 2. Soil organic matter in Tegalrejo Village, Malang, East Java, Indonesia

The relationship between slope and soil properties is not always the same in all locations. This is because the characteristics of soil-forming factors differ in each place. Slopes typically consist of the crest, convex section, concave section, and foot slope. In steeply sloped areas, continuous erosion occurs, resulting in shallow soils, low organic matter content, and slow horizon development compared to flat areas with deep groundwater [6].

Land slope is a crucial factor to consider during agricultural land preparation, cultivation efforts, product harvesting, and land conservation. Sloped land is more susceptible to disturbance or damage, especially if the slope is steep. This can lead to issues such as soil slippage and the washing away of fertile soil layers (humus)[7].

D. *Soil pH*

The soil pH condition on land with a slope of less than 10% is the highest, at pH = 5.4. Next is the land with slopes greater than 30% that are terraced, with a soil pH of 5.03. The lowest soil pH is found on land with slopes greater than 30% without terraces, with a pH value of 3.94. This indicates that land slope also impacts soil pH. Soil pH can be seen in figure 3.

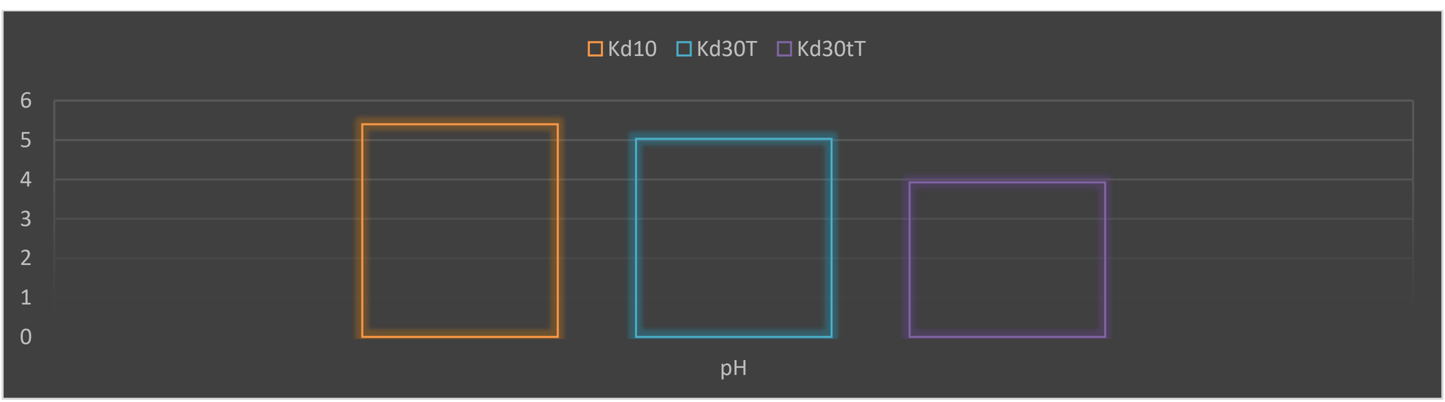

Figure 3. Soil pH in Tegalrejo Village, Malang, East Java, Indonesia

A thick A horizon is generally found on concave slopes or flat areas, while the thinnest A horizon is on convex slopes. Water usually seeps from the upper slopes to the foot slopes. Additionally, groundwater tends to be shallower at the foot of slopes, making the soil wetter compared to the upper slopes. The soil color is generally redder in sloped areas than in flat areas. In the foot slopes and valleys, the soil color often turns gray or grayish with red spots due to more frequent waterlogging. The degree of horizon development in convex areas is generally lower than in concave areas because erosion is stronger. In the foot slopes and valleys, horizon development can be hindered by frequent new deposits from materials originating from the upper slopes. Leaching and base cation movement are more intensive in sloped areas where base cations are deposited at the foot slopes along with seepage water, resulting in higher soil pH at the foot slopes compared to the upper slopes. The influence of slope on the properties of soil parent material can be seen in hilly areas, where the hills are usually composed of coarser materials while the valleys consist of finer materials [6].

IV. CONCLUSION

Based on the research results and discussion, the conclusions are as follows: Land in Tegalweru Village with slopes below 10% has better quality in terms of water availability, pH, and soil organic matter compared to land with slopes above 30%, whether terraced or non-terraced. However, terraced land is of better quality than non-terraced land. Slope does not significantly impact soil texture and structure. The suitability of land for chili cultivation in Tegalweru Village is constrained by soil pH, classified as S3 suitability. Several methods to improve land quality include minimal tillage, fallow systems, moisture regime management, water conservation, conditioning of the soil surface for infiltration, and the use of green manure, compost, and lime.

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AUTHORS

First Author – Septrial Arafat, writing the manuscript, septrialarafat@lecturer.undip.ac.id.
Second Author – Muhammad Iqbal Fauzan, conception and data collection muhammadiqbalfauzan@lecturer.undip.ac.id.
Third Author – Dian Safitri, writing the manuscript, diansafitri@lecturer.undip.ac.id.
Correspondence Author – Muhammad Iqbal Fauzan, muhammadiqbalfauzan@lecturer.undip.ac.id.