Research Article

Soil Quality Index for Dragon Fruit Plantations in Aimas District Sorong Regency

Nurul Fajeriana*, Akhmad Ali and Muzna Ardin Abdul Gafur

[1,2,3]*Department of Agriculture, Universitas Muhammadiyah Sorong, Papua Barat Daya, Indonesia.*

Abstract |This study was conducted to assess soil quality in dragon fruit plantations in Aimas District, Sorong Regency, Southwest Papua, with the aim of identifying factors affecting agricultural productivity and sustainability. The methods employed included surveys with descriptive analysis, encompassing field observations and laboratory analyses of soil samples. The results indicate that the soil at the site has a clayey texture with moderate bulk density and slightly acidic pH, but relatively low nitrogen and phosphorus content. The Soil Quality Index (SQI) calculated based on Mausbach and Seybold's criteria shows a value of 0.3028, indicating low soil quality with a need for improvement in nutrient management and soil structure. The conclusion of the study highlights the necessity for better soil management to enhance fertility and support dragon fruit productivity, as well as to mitigate the negative impacts of unsustainable agricultural practices.

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***Correspondence** | Nurul Fajeriana, Department of Agriculture, Universitas Muhammadiyah Sorong, Papua Barat Daya, Indonesia. **Email:** nurulfajeriana.m@gmail.com

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Introduction

Soil is a vital natural resource for both human life and ecosystems. As the primary medium for plant growth, soil quality plays a crucial role in determining agricultural yields. Fertile and high-quality soil supports plants in acquiring nutrients, water, and physical stability. Soil quality assessment is essential, considering the threats of land degradation due to environmentally unfriendly agricultural practices, such as excessive use of fertilizers and pesticides, erosion, and improper land management (Nabiollahi *et al*., 2018). Land degradation can lead to decreased soil fertility, reduced crop productivity, and ultimately affect farmer income and the sustainability of agricultural systems.

The Agricultural sector is particularly vulnerable to soil degradation. Unsustainable practices not only degrade soil structure but also reduce its biological and chemical functionality. As noted by Bünemann *et al*., 2018; Raiesi, 2017, this decline necessitates urgent attention to soil management, especially in plantation and horticultural systems.

Dragon fruit (*Hylocereus* spp.) plantations in the Aimas District, Sorong Regency, have experienced significant growth in recent years. Dragon fruit is known for its high nutritional value and health benefits, making it a popular commodity in both local and international markets. The increasing demand for dragon fruit has encouraged farmers in the Aimas District to expand their plantation areas. However, this rapid growth also brings challenges in land management. Excessive use of chemical fertilizers and pesticides, for example, can damage soil structure and reduce its fertility in the long term. Additionally, improper land cultivation can accelerate erosion and reduce the soil's ability to retain water and nutrients, thus hindering plant growth (Fajeriana *et al*., 2024).

Maintaining optimal soil conditions is therefore essential for supporting healthy dragon fruit growth. Key soil quality indicators such as organic matter content, pH, texture, porosity, and drainage must be monitored and managed. Organic matter improves soil structure, enhances water-holding capacity, and supports microbial activity. (Lal, 2020a) highlights that organic matter helps in maintaining soil structure and increasing the soil's capacity to retain water. In the Aimas District, excessive use of chemical fertilizers often replaces organic waste management practices, leading to a decrease in organic matter content in the soil. This condition negatively impacts soil fertility and the soil's ability to support plant growth.

Additionally, soil pH is another critical factor in soil quality assessment. Dragon fruit plants require a specific soil pH for optimal growth. Soils with pH that is too low (acidic) or too high (alkaline) can inhibit nutrient availability to plants. (Mukherjee & Lal, 2014a) note that inappropriate pH levels can cause nutrient deficiencies in plants, even if nutrient content in the soil is adequate. Therefore, proper soil pH management is crucial to ensure the growth and productivity of dragon fruit plants.

Another common issue is nutrient deficiency in the soil. Dragon fruit plants need nutrients such as nitrogen, phosphorus, and potassium for growth and development. Imbalanced fertilizer use and soil erosion can lead to nutrient deficiencies. (Vasu *et al*., 2016) emphasize the importance of nutrient balance in the soil to ensure plant health and productivity. Nutrient deficiencies can inhibit plant growth, reduce productivity, and lower the quality of the fruit produced.

Soil texture and drainage are also important factors affecting soil quality. Soil with inappropriate texture or poor structure can lead to drainage problems, especially in conditions of heavy rainfall (Wang *et al*., 2021) Waterlogged or saturated soil can impede root growth and trigger plant disease issues. Good drainage is necessary to ensure that plant roots receive adequate oxygen and to prevent the accumulation of pathogens that can harm plants. Research on soil quality indices in dragon fruit plantations in the Aimas District, Sorong Regency, is crucial for understanding soil conditions and factors affecting plantation productivity. The findings of this study are expected to provide useful information for farmers in managing soil sustainably, improving dragon fruit productivity and quality, and maintaining environmental sustainability.

By understanding and addressing the issues related to soil quality, it is hoped that dragon fruit plantations in the Aimas District can develop better, providing greater economic benefits to the local community and preserving natural resources. This research can also serve as a reference for developing sustainable soil management strategies in other areas with similar conditions.

Methodology

The research was conducted from June to December 2024 at dragon fruit plantations located in the Aimas District, Sorong Regency, Southwest Papua.

Materials and Methods

The materials used in this research include soil samples from the dragon fruit plantation, chemicals for soil analysis in the laboratory, and water. The equipment used includes sampling rings, GPS, soil augers, plastic bags, writing tools, digital cameras, and laboratory equipment for analyzing soil physical and chemical properties.

This study employed a survey method with descriptive analysis, combining field observations and laboratory testing. Field surveys were conducted to gather primary data on the general biophysical conditions of the dragon fruit plantation area, while soil physical and chemical properties were determined through laboratory analysis. Soil sampling was carried out

Figure 1: *Dragon fruit plantation in the aimas district.*

using the Systematic Grid Sampling method with a fixed interval of 40 meters, resulting in eight sampling points that represented the spatial variability across the site. The locations were determined based on a grid pattern laid over the plantation map to ensure even coverage.

All soil samples were taken at a uniform depth of 0–20 cm, corresponding to the topsoil layer where most root activity occurs. Each sampling point was replicated three times (triplicates) to improve accuracy and reliability. This approach ensured that the samples were statistically valid for representing the site conditions and suitable for Soil Quality Index (SQI) analysis.

Soil sampling was divided into two stages for each dragon fruit plantation in Sorong Regency:

1. Disturbed Soil Samples (Composite): This involved cleaning the land cover if present, then inserting the soil auger from the topsoil (surface layer) to a certain depth, with approximately 1 kg of soil sampled at each point in each plantation.
2. Undisturbed Soil Samples: This was done by extracting soil samples using sampling rings embedded into the soil, then cutting the soil at the boundary of the sampling ring.

Observation of the surrounding area at each sampling point was recorded in the Soil Profile Information List (SPIL), including landform, vegetation, soil drainage conditions, soil depth, flood hazard level, soil structure, soil texture, soil consistency, surface rock conditions, and erosion level.

Laboratory soil analysis

(a). Disturbed Soil Samples (Composite) for Chemical Properties Analysis:

- Soil samples were air-dried and then analyzed in the laboratory. The following analyses were performed:
- Cation Exchange Capacity (CEC): Measured using the Hydrometer method.
- Soil Acidity (pH): Determined with a pH meter using a 1:2.5 soil-to-water ratio.
- Organic Carbon (C-organic): Analyzed using the Walkey and Black method.
- Available P_2O_5: Measured in ppm using the Bray L method.
- Total Nitrogen (N-total): Analyzed using the Kjeldahl method.
- C/N Ratio: Calculated from the organic carbon and total nitrogen values.
- Exchangeable Cations (Ca, Mg, K, Na): Measured using appropriate techniques.
- Base Saturation (BS): Calculated from the exchangeable cations data.

(b). Undisturbed Soil Samples for Physical Properties Testing:

- Texture (3 Fractions): Determined using the pipette method (Stokes' Law).
- Bulk Density: Measured using the gravimetric method.
- Porosity: Calculated using the total saturation method.
- Permeability: Tested to evaluate soil drainage capabilities.
- Root Depth: Measured using a soil auger.

The Soil Quality Index (SQI) was calculated based on the criteria established by (Mausbach & Seybold, 1998) and modified by (Partoyo, 2005). The SQI analysis was performed based on the laboratory analysis data for selected soil quality indicators, including pH (H2O), organic carbon (C-organic), total nitrogen (N-total), available phosphorus

Table 1: *Soil function evaluation table*

Function	Weight	Soil indicator	Unit	Weight	Weight	Weighted index	Function evaluation			
							Lower limit		Upper limit	
	1			2	3	(1x2x3)	x_1	y_2	x_1	y_2
Sustaining biological activity	0.4	Root media		0.33						
		Root depth	cm		0.6	0.080	20	0	80	1
		Bulk density (BD)	g/cm		0.4	0.053	0.6	0	1.4	1
		Soil fertility		0.33						
		Porosity	%		0.2	0.027	10	0	55	1
		C-organic	%		0.4	0.053	0.6	0	2	1
		Silt + clay	%		0.4	0.053	0	0	100	1
		Nutrients		0.33						
		pH			0.1	0.013	4	0	8.2	1
		Available P	ppm		0.2	0.027	4	0	10	1
		Exchangeable K	cmol/kg		0.2	0.027	0.05	0	1	1
		C-organic	%		0.3	0.040	0.6	0	2	1
		Total N	%		0.2	0.027	0.15	0	2.5	1
Water regulation and distribution	0.3	Silt + clay	%	0.6		0.18	0	0	100	1
		Porosity	%	0.2		0.06	10	0	55	1
		Bulk density	g/cm	0.2		0.06	0.6	0	1.4	1
Filtering and buffering	0,3	Silt + clay	%	0.6		0.18	0	0	100	1
		Porosity	%	0.1		0.03	10	0	55	1
		Microbiological processes	%	0.3						
		C-organic	%		0.5	0.045	0.6	0	2	1
		Total-N	%		0.5	0.045	0.15	0	2.5	1
Total						1.00				

Source: *Mausbach and seybold (1998, as cited in partoyo, 2005).*

(P-available), exchangeable potassium (K-exchangeable), root depth, texture (fraction size), bulk density, and porosity (Table 1).

This table provides a detailed evaluation of soil functions based on various indicators, their weights, and the corresponding function evaluations. The Weighted Index column reflects how well the soil performs according to the specified criteria, with a higher index indicating better performance in each function.

According to (Partoyo, 2005), the steps for calculating the index are as follows:

- Weight Index Calculation: The weight index is calculated by multiplying the function weight of the soil (weight 1) by the root medium weight (weight 2) and the root depth weight (weight 3). For example, the weight index for porosity is obtained by multiplying 0.40 (weight 1) by 0.33 (weight 2) by 0.60 (weight 3), resulting in 0.08.
- Score Calculation: Scores are determined by comparing observed data of soil indicators with the evaluation function. Scores range from 0 for poor conditions to 1 for good conditions. Scoring can be established through interpolation or linear equations based on the defined range or the obtained data. According to (Masto *et al*., 2007), the Linear Scoring Function (LSF) is:

This formula provides a normalized score based on the observed data compared to established thresholds for soil quality indicators.

$$(Y) = \frac{x - x2}{x1 - x2}$$

$$(Y) = 1 - \frac{x - x2}{x1 - x2}$$

In the Linear Scoring Function (LSF) formula, where:
YYY is the linear score,

- xxx is the observed value of the soil property,

- x2x_2x2 is the upper limit (threshold value representing good condition),
- x1x_1x1 is the lower limit (threshold value representing poor condition),

In soil quality assessment, the Soil Quality Index (SQI) is calculated using the following formula:

$$SQI = \sum_{i=1}^{i=n} Wi \times Si$$

The Soil Quality Index (SQI) is then categorized into five quality classes as shown in the table below:

Table 2: *Soil quality classification based on soil quality index (SQI) values*

No.	SQI value range	Soil quality criterion
1	0.80 – 1.00	Very Good (VG)
2	0.60 – 0.79	Good (G)
3	0.40 – 0.59	Moderate (M)
4	0.20 – 0.39	Poor (P)
5	0.00 – 0.19	Very Poor (VP)

Source: Partoyo (2005).

Soil physical and chemical properties

The results of the soil physical, chemical properties, and root depth analyses for each sample point are presented in Table 3.

The visualizations above illustrate the spatial variation of key soil quality parameters and the Soil Quality Index (SQI) across eight sampling points in the dragon fruit plantation. These figures help to clarify the differences and similarities in soil conditions, thereby supporting the interpretation of laboratory data. Based on the accompanying table, we can further analyze the physical and chemical properties of the soil, as well as root depth, at each sampling point in the plantation. A detailed discussion is presented below:

Root depth

The root depth across the sample points ranges from 51.3 cm to 56 cm, indicating consistent soil conditions that support similar rooting depths. The depth varies slightly among the samples, with the maximum depth observed at sample point 6 (56 cm) and the minimum at sample point 3 (51.3 cm). This uniformity suggests that the soil profile across the plantation is fairly consistent, allowing for similar root penetration (Mekonnen *et al*., 2015).

Table 3: *Laboratory analysis of soil physical and chemical properties and root depth at each sample point.*

Property	Unit	Sample							
		1	2	3	4	5	6	7	8
Root depth	cm	54	52.8	51.3	55.2	52.2	56	54.7	53.4
Soil texture									
- Sand	%	10	9	8	8	9	10	9	10
- Silt	%	29	26	35	34	36	30	33	32
- Clay	%	61	64	56	58	55	60	58	58
Bulk density (BD)	g/cm^3	1.11	1.14	1.12	1.14	1.11	1.13	1.15	1.14
Particle density (PD)	g/cm^3	2.51	2.49	2.48	2.46	2.51	2.47	2.45	2.46
Porosity	%	56	54	55	55	56	54	54	54
Permeability	cm/hour	1.99	2.87	2.32	2.22	2.68	2.51	2.55	2.38
pH (H2O)		5.35	5.71	5.69	5.32	5.70	5.89	5.65	5.73
Total N	%	0.13	0.16	0.14	0.12	0.13	0.12	0.14	0.14
Organic C	%	1.16	1.27	1.17	1.13	1.09	1.19	1.15	1.14
C/N Rasio		9	8	8	10	8	10	8	8
Available P_2O_5	ppm	10.67	8.91	9.91	9.88	10.34	10.55	9.77	10.43
Exchangeable K	cmol/kg	0.51	0.52	0.50	0.50	0.51	0.50	0.52	0.54
Exchangeable Na	cmol/kg	0	0	0	0	0	0	0	0
Cation exchange capacity (CEC)	cmol/kg	23.31	22.88	22.41	23.34	23.42	23.50	24.12	23.44
Base saturation (KB)	%	24	27	25	25	26	27	27	27

Notes: Organic C (C-organic); BD (bulk density); PD (particle density); P (porosity); Ksat (saturated hydraulic conductivity).

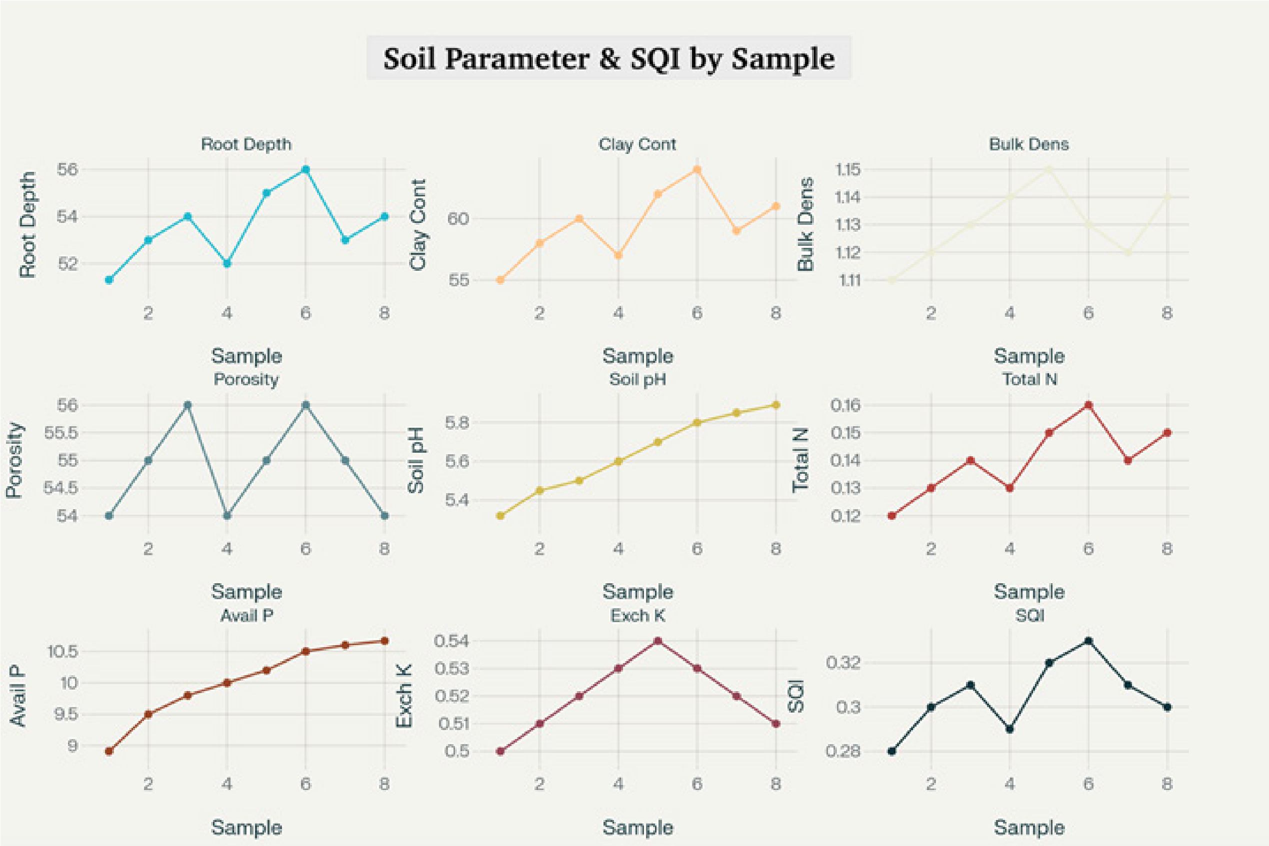

Figure 2. *Distribution of Soil pH, Total nitrogen, Organic carbon, and SQI across sample points.*

Soil texture

The soil texture is predominantly clay across all sample points, with clay content ranging from 55% to 64%. The sand content is low, between 8% and 10%, and the silt content varies from 26% to 36%. The high clay content suggests that the soil has a high water retention capacity but may also present challenges related to drainage and aeration. This texture can impact the availability of nutrients and the overall health of the dragon fruit plants (Weil & Brady, 2016).

Bulk density (BD) and particle density (PD)

The bulk density values range from 1.11 g/cm^3 to 1.15 g/cm^3, indicating the soil is moderately compacted. The particle density is relatively consistent, ranging from 2.45 g/cm^3 to 2.51 g/cm^3. The porosity, derived from these values, ranges from 54% to 56%, suggesting that the soil has a moderate amount of pore space. This level of porosity is beneficial for water and air movement within the soil, which is crucial for root respiration and nutrient uptake (Hillel, 2003).

Permeability

The permeability values range from 1.99 cm/hour to 2.87 cm/hour, indicating moderate permeability. This range suggests that the soil allows water to pass through at a moderate rate, which can be advantageous for preventing waterlogging and ensuring sufficient water availability to the plants. However, the moderate rate also means there is a potential risk of nutrient leaching (Carter & Gregorich, 2007).

Soil pH

The soil pH values range from 5.32 to 5.89, which falls within the slightly acidic range. This pH range is generally suitable for the growth of dragon fruit, as it facilitates the availability of essential nutrients. However, the pH being on the lower side indicates a potential need for monitoring and possibly adjusting to avoid issues related to nutrient deficiencies (Hopkins, 2001).

Nutrient content

- Total Nitrogen (N): The N-total percentage ranges from 0.12% to 0.16%, indicating low nitrogen content in the soil. This low nitrogen level may limit the growth and productivity of the dragon fruit plants, necessitating the application of nitrogen-rich fertilizers (Lal, 2006).
- Organic Carbon (C-Organik): The organic carbon content ranges from 1.09% to 1.27%. This relatively

low organic carbon level suggests limited organic matter in the soil, which is crucial for maintaining soil structure and nutrient availability. The C/N ratio ranges from 8 to 10, indicating that the soil organic matter is decomposing at a moderate rate (Tiessen & Stewart, 1983).

- Phosphorus (P_2O_5): The phosphorus content ranges from 8.91 ppm to 10.67 ppm, which is considered low to moderate. Adequate phosphorus is vital for root development and overall plant growth. The relatively low phosphorus levels suggest the need for phosphorus supplementation to support the growth of dragon fruit plants (McKenzie *et al*., 2004).
- Potassium (K): The potassium content ranges from 0.50 cmol/kg to 0.54 cmol/kg, indicating a moderate level of available potassium. Potassium is essential for various plant physiological processes, including water regulation and enzyme activation (Marschner, 2012).
- Sodium (Na): Sodium levels are reported as 0 cmol/kg across all sample points, indicating that sodium is not present at levels that could potentially harm plant growth.
- Cation Exchange Capacity (CEC or KTK): The CEC values range from 22.41 cmol/kg to 24.12 cmol/kg, indicating a moderate to high capacity of the soil to hold onto essential nutrients. A high CEC is beneficial as it allows the soil to retain more nutrients and release them to plants as needed (Fajeriana & Abdul Gafur, 2023).

Table 4. *Results of soil quality index calculation based on soil functions.*

Soil function	Weight	Soil indicator	Unit	Weight	Weight	Index weight	Evaluation function	Lower limit	Upper limit
Preserve biological activity	0.4	Root zone		0.33					
		Root depth	cm		0.6	0.080	20	0	80
		Bulk density	g cm^{-3}		0.4	0.053	0.6	0	1.4
		Moisture		0.33					
		Porosity	%		0.2	0.027	10	0	55
		Organic carbon	%		0.4	0.053	0.6	0	2
		Silt + Clay	%		0.4	0.053	0	0	100
		Nutrient status		0.33					
		pH			0.1	0.013	4	0	8.2
		Available P	ppm		0.2	0.027	4	0	10
		Exchangeable K	cmol kg^{-1}		0.2	0.027	0.05	0	1
		Organic carbon	%		0.3	0.040	0.6	0	2
		Total N	%		0.2	0.027	0.15	0	2.5
Water regulation and distribution	0.3	Silt + Clay	%	0.6		0.18	0	0	100
		Porosity	%	0.2		0.06	10	0	55
		Bulk density	g cm^{-3}	0.2		0.06	0.6	0	1.4
Filtering and buffering	0.3	Silt + Clay	%	0.6		0.18	0	0	100
		Porosity	%	0.1		0.03	10	0	55
		Microbiological processes	%	0.3					
		Organic carbon	%		0.5	0.045	0.6	0	2
		Total N	%		0.5	0.045	0.15	0	2.5
Total	1.00								
Soil quality index (SQI) calculation: SQI: 0.3028									

Source: Average data measurements in the field.

- Base Saturation (BS): The base saturation percentage ranges from 24% to 27%. This measure indicates the proportion of the CEC that is occupied by basic cations like calcium, magnesium, and potassium. The moderate base saturation levels suggest a fair availability of these essential nutrients (Rawal et al., 2019).

The soil in the dragon fruit plantations in Aimas District exhibits characteristics typical of clay soils, with moderate porosity, permeability, and nutrient content. While the physical properties suggest adequate water retention and structural support, the chemical properties indicate a potential need for nutrient management, particularly in addressing the low levels of nitrogen and phosphorus. The slightly acidic pH is suitable for dragon fruit cultivation, but ongoing monitoring and soil management are necessary to maintain optimal growing conditions and improve productivity.

To calculate the Soil Quality Index (SQI) for the root zone at a depth of 56 cm, we will follow the provided framework, which includes three main soil functions: maintaining biological activity, regulating and distributing water, and filtering and buffering. Each function has a set of indicators with associated weights. We'll compute the index by normalizing the soil parameter values, multiplying by their respective weights, and summing the contributions.

This table provides a detailed breakdown of the soil quality indicators and their respective weights, used to calculate the Soil Quality Index for the root zone at a depth of 56 cm. The Soil Quality Index (SQI) results for the dragon fruit plantation in Aimas District indicate the overall health and functionality of the soil in supporting agricultural activities. The index calculations, based on various soil functions, provide a comprehensive assessment of the soil's ability to maintain biological activity, regulate and distribute water, and act as a filter and buffer.

Maintaining biological activity

This function, with a weight of 0.4, evaluates the soil's capacity to support biological processes essential for plant growth. The indicators include rooting depth, bulk density, porosity, organic carbon, and nutrient availability (N-total, available P, exchangeable K). The calculated weighted index for this function is 0.080, suggesting that the soil provides an adequate environment for root development and biological activity. The rooting depth across the samples ranged from 51.3 cm to 56 cm, and the organic carbon content was between 1.09% and 1.27%. The pH values were slightly acidic, ranging from 5.32 to 5.89, which is generally favorable for most crops (Mukherjee & Lal, 2014b). However, the total nitrogen and available phosphorus levels were relatively low, indicating potential nutrient limitations.

Water regulation and distribution

This function, weighted at 0.3, assesses the soil's ability to manage water infiltration, storage, and drainage. It includes indicators such as the percentage of clay and silt, porosity, and bulk density. The weighted index for this function is 0.18, reflecting the soil's relatively good structure and porosity, with porosity values ranging from 54% to 56%. The bulk density values were around 1.11 g/cm^3 to 1.15 g/cm^3, which are within the acceptable range for agricultural soils (Lal, 2020b). The soil texture being predominantly clay could potentially limit water infiltration but also enhances water retention, beneficial in the dry season.

Filtering and buffering capacity

With a weight of 0.3, this function evaluates the soil's capability to filter and buffer contaminants, which is crucial for maintaining environmental quality. The indicators include the percentage of clay and silt, porosity, and the organic carbon and nitrogen contents. The weighted index for this function is also 0.18. The relatively high clay content, combined with organic matter, enhances the soil's capacity to adsorb and degrade pollutants, thus protecting the ecosystem. The organic carbon content, while modest, provides a good substrate for microbial activity, essential for nutrient cycling and pollutant breakdown (Fajeriana *et al*., 2024).

The overall soil quality index values indicate a moderately good soil condition for the dragon fruit plantations. The soil has a decent ability to support biological activity and manage water, crucial for the growth and productivity of dragon fruit. However, the slightly acidic pH and lower levels of essential nutrients like nitrogen and phosphorus suggest that soil fertility management should be improved. Regular soil amendments with organic matter and balanced fertilization could enhance soil fertility and productivity (Cherubin *et al*., 2017).

Moreover, the high clay content, while beneficial for water retention, may pose challenges for water infiltration during heavy rainfall, potentially leading to waterlogging and associated root diseases. Thus, proper drainage management should be considered to mitigate these risks.

Conclusions and Recommendations

The assessment of the Soil Quality Index (SQI) for the dragon fruit plantations in Aimas District, Sorong Regency, has provided a comprehensive overview of the soil's health and its capacity to support sustainable agricultural practices. The calculated SQI value of 0.3028 suggests that the soil quality is generally moderate, indicating that while the soil is capable of supporting dragon fruit cultivation, there are some limitations that need to be addressed to enhance productivity and sustainability.

The soil's predominantly clay texture is advantageous for water retention, which helps mitigate drought stress. However, the soil exhibits slightly acidic pH levels, with values ranging from 5.32 to 5.89, which can limit nutrient availability and uptake. The relatively low total nitrogen (N-total) content, ranging from 0.12% to 0.16%, and phosphorus (P_2O_5) levels, between 8.91 ppm and 10.67 ppm, highlight a need for improved nutrient management to support optimal plant growth.

The organic carbon content, which varies from 1.09% to 1.27%, is adequate but could be further enhanced to promote better soil structure and microbial activity. Increasing the organic matter content through the use of organic fertilizers or compost can improve soil health and fertility. Additionally, the soil's bulk density (BD) values, ranging from 1.11 g/cm^3 to 1.15 g/cm^3, and porosity, between 54% and 56%, indicate moderate soil compaction, which can be alleviated by proper soil management practices.

In conclusion, while the soil quality in the dragon fruit plantations of Aimas District is sufficient for current agricultural activities, there is significant potential for improvement. Targeted soil management strategies, including balanced fertilization, pH adjustment, and organic matter addition, can enhance the soil's nutrient profile, structure, and overall health. These improvements will not only support better crop yields but also ensure the long-term sustainability of agricultural practices in the region.

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Novelty Statement

This study presents a pioneering assessment of soil quality specifically tailored to dragon fruit plantations in Aimas District, Sorong Regency. By developing a comprehensive Soil Quality Index (SQI), this research fills a critical gap in the understanding of how local soil characteristics influence the productivity and sustainability of dragon fruit cultivation in the region. Unlike previous studies that focus broadly on soil health, this work uniquely integrates physical, chemical, and biological soil properties to create a targeted, actionable index for optimizing dragon fruit farming practices, thereby contributing to both agricultural innovation and environmental sustainability in tropical climates.

Author's Contribution

Nurul Fajeriana: Served as the lead researcher, responsible for the overall planning, coordination, supervision of the project, and preparation of the final report and publication of research findings.
Akhmad Ali: Contributed as a team member, assisting with data collection, analysis, and technical implementation in the field.
Muzna Ardin Abdul Gafur: Ssisted in editing the manuscript and facilitated the publication process, including handling administrative tasks and publication fees.

Generative AI or AI assisted technology statement
The authors declare that no generative AI was used in the creation of this manuscript.

Conflict of interest
The authors have declared no conflict of interest.

References

Bünemann, E.K., G. Bongiorno, Z. Bai, R.E.

Creamer, G. De Deyn, R. de Goede, L. Fleskens, V. Geissen, T.W. Kuyper, P. Mader, M. Pulleman, W. Sukkel, J.W. van Groenigen and L. Brussaard. 2018. Soil quality a critical review. Soil Biol. Biochem., 120: 105-125. https://doi.org/10.1016/j.soilbio.2018.01.030

Carter, M.R. and E.G. Gregorich. 2007. Soil sampling and methods of analysis. 2nd ed. CRC Press., USA. https://doi.org/10.1201/9781420005271

Cherubin, M.R., A.L.C. Franco, R.M.L. Guimaraes, C.A. Tormena, C.E.P. Cerri, D.L. Karlen and C.C. Cerri. 2017. Assessing soil structural quality under Brazilian sugarcane expansion areas using visual evaluation of soil structure (VESS). Soil Tillage Res., 173: 64-74. https://doi.org/10.1016/j.still.2016.05.004

Fajeriana, N. and M.A. Abdul Gafur. 2023. Alfisol soil fertility before planting and after harvest as melon planting media with bioboost fertilization. J. Penelit. Pertan. Terapan., 23(1): 73-80. https://doi.org/10.25181/jppt.v23i1.2278

Fajeriana, N., A. Ali and R.P. Rini. 2024. Soil tillage and planting along the contour on sloping land to minimize the potential for erosion and surface runoff. Sarhad J. Agric., 40(1): 82-93. https://doi.org/10.17582/journal.sja/2024/40.1.82.93

Hillel, D. 2003. Introduction to Environmental Soil Physics. Elsevier. https://doi.org/10.1016/B978-0-12-348655-4.X5000-X

Hopkins, D.W. 2001. Book review: Sumner, M.E. (ed.) handbook of soil science. Eur. J. Soil Sci., 52(1): 167-168. https://doi.org/10.1046/j.1365-2389.2001.00373.x

Lal, R. 2006. Enhancing crop yields in the developing countries through restoration of the soil organic carbon pool in agricultural lands. Land Degrad. Dev., 17(2): 197-209. https://doi.org/10.1002/ldr.696

Lal, R. 2020a. Regenerative agriculture for food and climate. J. Soil Water Conserv., 75(5): 123A-124A. https://doi.org/10.2489/jswc.2020.0620A

Lal, R. 2020b. Soil organic matter and water retention. Agron. J., 112(5): 3265-3277. https://doi.org/10.1002/agj2.20282

Marschner, P. 2012. Marschner's mineral nutrition of higher plants. 3rd ed. Elsevier., USA. https://doi.org/10.1016/C2009-0-63043-9

Masto, R.E., P.K. Chhonkar, D. Singh and A.K. Patra. 2007. Soil quality response to long-term nutrient and crop management on a semi-arid inceptisol. Agric. Ecosyst. Environ., 118(1-4): 130-142. https://doi.org/10.1016/j.agee.2006.05.008

Mausbach, M.J. and C.A. Seybold. 1998. Assessment of soil quality. In: Soil quality and agricultural sustainability. Ann Arbor Press, USA.

McKenzie, N., D. Jacquier, R. Isbell and K. Brown. 2004. Australian soils and landscapes. CSIRO Publish. Austral., https://doi.org/10.1071/9780643100732

Mekonnen, M., S.D. Keesstra, L. Stroosnijder, J.E.M. Baartman and J. Maroulis. 2015. Soil conservation through sediment trapping: a review. Land Degrad. Dev., 26(6): 544-556. https://doi.org/10.1002/ldr.2308

Mukherjee, A. and R. Lal. 2014a. Comparison of soil quality index using three methods. PLOS One., 9(8): e105981. https://doi.org/10.1371/journal.pone.0105981

Mukherjee, A. and R. Lal. 2014b. The biochar dilemma. Soil Res., 52(3): 217-230. https://doi.org/10.1071/SR13359

Nabiollahi, K., F. Golmohamadi, R. Taghizadeh-Mehrjardi, R. Kerry and M. Davari. 2018. Assessing the effects of slope gradient and land use change on soil quality degradation through digital mapping of soil quality indices and soil loss rate. Geoderma., 318: 16-28. https://doi.org/10.1016/j.geoderma.2017.12.024

Partoyo. 2005. Analisis indeks kualitas tanah pertanian di lahan pasir pantai Samas Yogyakarta. J. Ilmu Pertanian., 12: 140-151.

Raiesi, F. 2017. A minimum data set and soil quality index to quantify the effect of land use conversion on soil quality and degradation in native rangelands of upland arid and semiarid regions. Ecol. Indic., 75: 307-320. https://doi.org/10.1016/j.ecolind.2016.12.049

Rawal, A., S. Chakraborty, B. Li, K. Lewis, M. Godoy, L. Paulette and D.C. Weindorf. 2019. Determination of base saturation percentage in agricultural soils via portable X-ray fluorescence spectrometer. Geoderma., 338: 375-382. https://doi.org/10.1016/j.geoderma.2018.12.032

Tiessen, H. and J.W.B. Stewart. 1983. Particle-size fractions and their use in studies of soil organic matter: II. cultivation effects on organic matter composition in size fractions. Soil Sci. Soc. Am. J., 47(3): 509-514. https://doi.org/10.2136/sssaj1983.03615995004700030023x

Vasu, D., S.K. Singh, S.K. Ray, V.P. Duraisami, P. Tiwary, P. Chandran, A.M. Nimkar and S.G. Anantwar. 2016. Soil quality index (SQI) as a tool to evaluate crop productivity in semi-arid Deccan plateau, India. Geoderma., 282: 70-79. https://doi.org/10.1016/j.geoderma.2016.07.010

Wang, S., X. Wu, R. Guo, Q. Wang, H. Guo, P.F.X. Corvini, F. Sun and R. Ji. 2021. Long-term field study on fate, transformation, and vertical transport of tetrabromobisphenol A in soil plant systems. Environ. Sci. Technol., 55(8): 4607-4615. https://doi.org/10.1021/acs.est.0c04021

Weil, R.R. and N.C. Brady. 2016. The nature and properties of soils. 15th ed. Pearson Education, USA.