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Preface

On behalf of the SEE 2021 Organizing Committee, it is our great pleasure to welcome you to the Seventh International Conference on Structure, Engineering & Environment, held at Pattaya City, Thailand, organized in conjunction with Suranaree University of Technology, Thailand, The GEOMATE International Society, Useful Plant Spread Society, Glorious International, AOI Engineering, HOJUN, JCK, CosmoWinds and Beppu Construction, Japan.

The conference covers three major themes with many specific themes including:

Advances in Building Structure
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Advances in Farm Structures

Due to COVID-19, this year we have received less submissions from different countries all over the world. The technical papers were selected from the vast number of contributions submitted after a review of the abstracts. The final papers in the proceedings have been peer reviewed rigorously and revised as necessary by the authors. It relies on the solid cooperation of numerous people to organize a conference of this size. Hence, we appreciate everyone who support as well as participate in the joint conferences.

Last but not least, we would like to express our gratitude to all the authors, session chairs, reviewers, participants, institutions and companies for their contribution to SEE 2021. We hope you enjoy the conference and find this experience inspiring and helpful in your professional field. We look forward to seeing you at our upcoming conference next year.

Best regards,

Prof. Dr. Zakaria Hossain, Chairman (General)

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ANALYSIS OF SOIL QUALITY INDEX AT POTATO PRODUCTION CENTER IN THE UPSTREAM OF LEMBANG WATERSHED

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ABSTRACT

Potato is considered as one of the primary agricultural commodities in the upstream of Lembang watershed. Rotation cropping system using shallots is occasionally adopted, due to market price influence and higher profitability. This cultivation process typically instigates soil degradation devoid of conservation measures. The land survey approach was employed as the research method, while proportional random sampling was used to select the sample. Subsequently, the soils were categorized into intact and disturbed portions to analyze the physical (texture, specific gravity, C-organic and permeability) as well as chemical (nitrogen, phosphorus, potassium, calcium, magnesium, pH, and CEC) properties, respectively, at the Soil Laboratory of Agriculture Faculty, Andalas University. These data were processed using Minitab 17 to determine the soil quality index. The results showed the existence of three primary components (PC) termed, PC1, PC2 and PC3, believed to influence the alternating index state by 80%. Furthermore, the dominant variables of these components include exchanged potassium, organic C and clay fraction texture. Based on the calculation of component factors and soil properties, the soil quality index (SQI) was classified into moderate, good and very good conditions.

Key words: soil quality index, production center areas, soil properties. conservation, degradation. potato

INTRODUCTION

Extreme exploitation of agricultural resources without considering the consequences, significantly contributes to soil quality degradation. In conventional farming systems, suitable conservation methods, including the deposition of harvest remnants are less applied. This results to the loss of several useful nutrients absorbed in the plant. Also, the rigorous application of chemical fertilizers greatly influenced certain soil properties, including pH decline and other related rapid changes. Therefore, agricultural management devoid of conservation measures triggers a decrease in terms of soil quality and environment. This circumstance continues to adversely affect productivity, eventually leading to a diminished potato grade [1]. In another study, the product quality was strongly influenced by genetic factors and soil ecosystems [2]. Meanwhile, in advanced farming, artificially engineered soil ecosystems include field, water and fertilizer management, responsible for regulating soil microenvironment. This ecosystem serves as a plant growth carrier and also provides the necessary nutrients for effective development [2], [3]. [1], further stated that without adequate cultivation control, the income from potato farming tends to decline. In several instances, farmers prefer to cultivate other commodities, including onions. This situation threatens the research location as a viable potato production base. There is a crucial need to examine the soil quality, in an effort to overcome the prevalent challenge. This property appears very essential in terms of agricultural management [5]. Soil system refers to the change in the properties and the dynamic nature of soil management is potentially due to the complex technical structure in plant cultivation. Also, the concept of soil quality is associated to effective sustainability and management, with a primary focus on contaminated land. Previous report stated that the notion of soil quality is expected to include productivity, fertility, and degradation, as well as environmental values. Therefore, by this definition, the main activity is devoted to the evaluation of a sustainable soil management system alongside the development of a related soil quality assessment. This research is aimed at determining the soil quality status for potato cultivation in various forms within the upstream of Lembang sub-watershed.

Location and Research Methodology

Research Location

The research location is situated in the upstream of Lembang sub-watershed, in close proximity to Talang mountain, a known active volcano in Solok regency, and also adjacent to Dibawah Lake. In addition, the sample soil containing several volcanic residues was nominated by Andisol and Inseptisol orders. This region shows a rainfall estimate of approximately 2,333 mm/year and also serves as a potato production centre in Solok. Furthermore, the research was conducted on five farmer groups, termed I, II, III, IV and V, on the basis of the land physiography. Group I and IV appeared flat, while II was described as slightly sloping. However, III and V showed a sloping pattern. These structures confirmed the sample location as a viable center for potato production.

Soil sample collecting

Field survey was employed to obtain the secondary and primary data at pre-determined locations (Figures 1, 2 and 3). The primary data involves soil sampling at several locations of the five farmer groups. This sample was acquired at a depth of 20 cm, using purposive random technique. Furthermore, the intact portions were applied to analyze the physical properties, while the disturbed samples were used to determine the chemical and biological features.

Table 1. Groups, soil types and sampling points

Location	Soil type	Soil sampling	Plan type
I	Andisol	3	Potatoes
II	Andisol	2	Potatoes
III	Inceptisol	4	Potatoes
IV	Inceptisol	2	Potatoes
V	Inceptisol	2	Potatoes

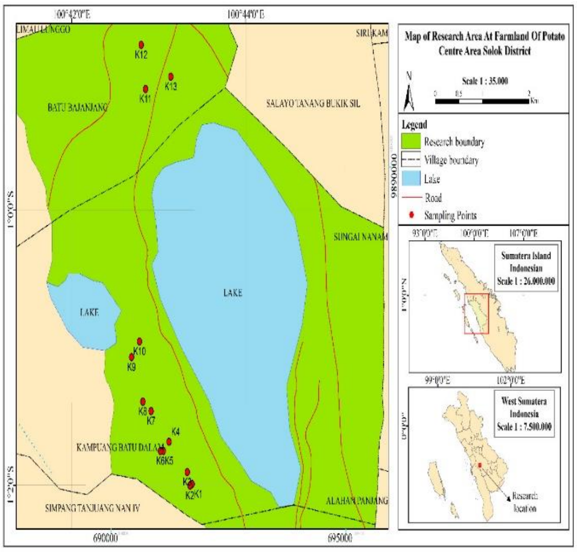

Figure 1. Research location in the potato production area at the upstream of Lembang sub-watershed, Solok regency.

Table 2. Parameters to be observed as minimum data set (MDS) for soil quality analysis in potato production areas.

Observation Variable	Variable	Method
Soil Physical Properties	Soil texture (%)	Pipette
	Bulk density (g/cm3)	Volumetric
	Total pore space (%)	Volumetric
	C-organic (%)	Walkley and black
Soil Chemical Properties	pH	pH meter
	N-Total (%)	Khjedal
	Available-P soil (ppm)	Bray II
	Ca (cmol/kg)	
	Mg (cmol/kg)	
	CEC (cmol/kg	Washing with Ammonium
	Available-K soil (cmol/kg)	Washing with Ammonium
	KB (cmol/kg)	
	DHL (electrical conductivity) µs/cm	

Figure 2. Observations on the potato plant conditions.

Figure 3. Performance of potato land.

Also, the sampling technique was conducted in four potato farmland groups around the Dibawah lake. (2) The secondary data encompassed the land conditions and the aspects of potato cultivation.

Data analysis with PCA

The preferred data analysis method was based on the lowest characteristics with optimal influence on soil quality or the minimum data set (MDS) using Minitab 17.0. Also, the MDS was generated with the principal component analysis (PCA), while the soil quality evaluation was achieved by multiplying the MDS weight and the soil analysis value, followed by the addition of scores obtained for individual land use. This data analysis value was obtained within the range of 1-5. Consequently, higher variables triggered a corresponding increase in the soil quality [7]. Furthermore, the systematic assessment of soil quality was calculated by the soil quality index (SQI) formula:

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

Description:
IKT = soil quality index
Wi = Weight factor in PC
Si = score index (soil quality indicator score).

Table 3 represents the soil quality classification after obtaining the index value.

Soil Quality	Scale	Class
Very Good (SB)	0.8 – 1	1
Good (B)	0.6 – 0.79	2
Moderate (S)	0.35 – 0.59	3
Low (R)	0.20 – 0.34	4
Very Low (SR)	0 – 0.19	5

RESULT AND DISCUSSION

Soil properties

Table 4 represents the analysis of the physical, chemical and biological soil properties. This depiction also indicate a relative satisfactory criteria for these characteritics, including pH, C-organic, phosphorus, CEC and K-dd. Based on Table 5, the research location showed a soil dominance with dusty loam texture and crumb structure, as well as high suitability for potato cultivation. Table 6 shows the soil fertility status was based on soil characteristics variables, including C-organic, phosphorus, potassium, CEC, and K-dd, ranging from low to high. This demonstrates a high ability as a cultivation medium and provides root nutrients. In a sustainable carrying capacity, the plants tend to develop optimally. Based on the key variables, soil fertility status, termed C-organic appeared relatively high, due to a value above 2%. This condition also resulted from excessive application of organic fertilizers e.g manure. [8]. According to Cation exchange capacity (CEC) refers to a major soil chemical properties closely related to plant nutrient availability and also serves as a fertility indicator. This parameter describes the potentials of clay to bind and exchange cations depending on the clay content and types as well as the organic matter. Furthermore, CEC also defines the soil cations, including Ca, Mg, and Na. These elements are exchanged or absorbed by plant roots.

In determining the extent of dominant soil properties, the quality index is evaluated from the principal component analysis (PCA) results (Tables 7 and 8). As a consequence, three primary components, termed PC1, PC2 and PC3 occurred as the factors in evaluating the diversity of soil quality indices.

Table 4. Biophysical properties of research soil from potato production centers

Sampling	pH	C-org	N	C/N	P	KTK	K-dd	Ca	Mg	Kj.KB	DHL	Pasir	Debu	Liat
		(%)	(%)		(ppm)	cmol/kg				%	µs/cm	%		
1	3,7	6,94	1,32	5,26	479,16	61,33	0,26	3,22	0,47	6,75	86,4	6,26	68,86	24,84
2	4,85	7,08	0,83	8,53	11,6	54,52	0,16	0,96	0,11	2,57	66,4	13,07	70,1	16,7
3	5,89	4,45	1,2	3,71	64,73	41,79	0,53	6,02	0,51	17,37	53,9	20,58	57,87	18,26
4	5,1	6,99	1,41	4,96	8,12	43,22	0,29	0,8	0,15	3,22	70,4	7,91	62,94	26,1
5	5,58	8,31	0,99	8,39	31,21	37,68	0,6	3,05	0,21	10,59	50,2	11,66	62,48	22,23
6	5,47	9,26	0,59	15,53	25,75	37,4	0,19	1,92	0,32	7,65	27,5	16,07	57,83	33,25
7	4,3	7,56	1,4	5,4	47,35	46,22	0,32	1,24	0,27	4,24	188,3	8,82	61,52	23,9
8	5,16	9,9	0,96	10,31	14,82	36,55	0,55	1,37	0,23	6,01	66,6	14,58	51,51	23,9
9	5,8	10,18	0,55	18,51	9,36	31,24	0,51	3,93	0,38	15,65	58,2	25,5	66,48	8,02
10	5,67	9,4	0,72	13,06	7,87	43,03	0,51	2,96	0,41	9,46	51,9	17,39	67,44	15,17
11	7,11	11,59	0,98	11,83	237,8	19,75	1,47	7,17	0,42	46,68	66,1	24,67	51,13	24,21
12	6,87	11,74	0,31	37,87	230,85	43,96	1,24	7,86	0,74	22,68	58,6	13,2	44,73	42,07
13	6,77	8,62	0,34	25,35	673,58	17,34	1,65	6,59	0,55	51,5	133,4	34,7	47,38	17,92

Table 5. Soil texture classes based on the USDA texture triangle in the potato production area.

Sampling	Sand	Dust	Clay	Texture class
1	6.26	68.86	24.84	Silt loam
2	13.07	70.1	16.7	Silt loam
3	20.58	57.87	18.26	Silt loam
4	7.91	62.94	26.1	Silt loam
5	11.66	62.48	22.23	Silt loam
6	16.07	57.83	33.25	Silty clay loam
7	8.82	61.52	23.9	Silt loam
8	14.58	51.51	23.9	Silt loam
9	25.5	66.48	8.02	Silt loam
10	17.39	67.44	15.17	Silt loam
11	24.67	51.13	24.21	Silt loam
12	13.2	44.73	42.07	Silty clay
13	34.7	47.38	17.92	Clay loam

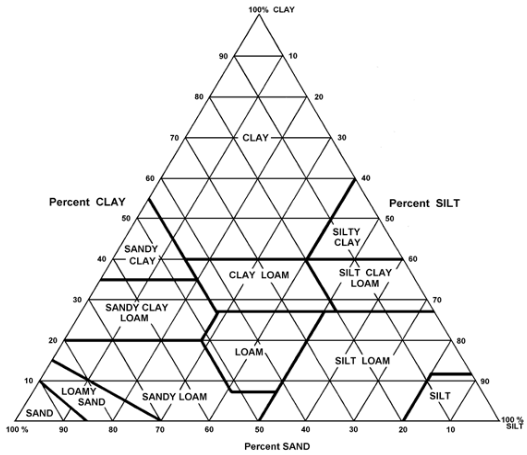

Figure 2. Soil Texture Triangle (USDA).

Table 6. Soil fertility status based on key variables of fertility in potato production centers in the upstream of Lembang sub-watershed.

Sample	C-org (%)	P (ppm)	CEC cmo/kg	K-dd cmol/kg	Kj.KB %	Fertility Status
1	6.94 st	479.16 st	61.33 st	0.26 rd	6.75 sr	t
2	7.08 st	11.6 st	54.52 st	0.16 rd	2.57 sr	t
3	4.45 t	64.73 st	41.79 st	0.53 t	17.37 sr	sd
4	6.99 st	8.12 r	43.22 st	0.29 sd	3.22 sr	sd
5	8.31 st	31.21 t	37.68 t	0.6 t	10.59 sr	t
6	9.26 st	25.75 sd	37.4 t	0.19 r	7.65 sr	sd
7	7.56 st	47.35 st	46.22 st	0.32 sd	4.24 sr	sd
8	9.9 st	14.82 rd	36.55 t	0.55 sd	6.01 sr	r
9	10.18 st	9.36 sr	31.24 t	0.51 sd	15.65 sr	r
10	9.4 st	7.87 sr	43.03 st	0.51 sd	9.46 sr	sd
11	11.59 st	237.8 st	19.75 sd	1.47 st	46.68 sd	t
12	11.74 st	230.85 st	43.96 st	1.24 st	22.68 r	t
13	8.62 st	673.58 st	17.34 sd	1.65 st	51.5 t	t

Description: r = low, sr = very low, sd = moderate, t = high, st = very high.

Principal Component Analysis (PCA)

Table 7. The results of the eigenvalue calculation on the soil biophysical property variable in the potato production centre in the upstream of Lembang sub-watershed.

Eigenvalue	7.4477	1.9673	1.7146	0.9875	0.8250	0.3841	0.3671	0.1526	0.0800	0.0417
Proportion	0.532	0.141	0.122	0.071	0.059	0.027	0.026	0.011	0.006	0.003
Cumulative	0.532	0.673	0.795	0.866	0.924	0.952	0.978	0.989	0.995	0.998

Table 7 represents the eigenvalues from PCA analysis and indicates the influence of a variable on soil characteristics. The determining factor is retained in the model with values above 1, but absent at estimates below 1. Also, the eigenvalue expresses the element contributing to the variance in the entire variables. However, only factors with variance greater than 1 are included, while no importance is attached to values less than 1, as the original variable has been standardized. This means the average is 0 and the variance is 1 [9].

The soil analysis data obtained three factors (PC), termed PC1, PC2 and PC3, with eigenvalues above 1. Each PC describes a certain amount of variation (%) in the total data set needed to generate a value for the selected variable. Also, three factors significantly influence the soil quality index. The first, PC1, obtained an eigenvalue of 7.44%, with a 53.2% proportion of influence on variables, including pH and K-dd. Subsequently, the second factor, PC2, attained an eigenvalue of 19.67%, with C-org, C/N ratio, CEC and clay fraction content. These parameters were used to determine the soil quality at 14.1%. Meanwhile, the third factor, PC3, showed an eigenvalue of 17.14 %, comprising phosphorus (P) and DHL. Furthermore, the three factors, PC1, PC2 and PC3, contributed to the overall cumulative variance of approximately 80%. This result indicates the variables of components 1, 2 and 3 were able to separately comprehend the influence on the soil quality diversity.

Table 8 represents the loading matrix values from soil property analysis. A high variable estimate on PC1, in the form of potassium (K-dd) was specified at 0.345. Meanwhile, the maximum element on PC2 referred to the clay fraction, or soil texture, with a loading value of 0.565. Finally, the third parameter, PC3, represented the optimal variable as C-organic. Ultimately, the three greatest estimates were applied in the analysis of soil quality index (Table 9).

Soil quality index

Table 9 represents the soil quality indices obtained by multiplying the weight index and the score indicator. These SQI values ranged between 0.51-0.97, where a higher estimate instigates an increase in soil quality. In addition, the research location generated a scale of moderate to very good. The dominant determining factors in the sample soil quality index refer to the availability of potassium (K-exchangeable) and soil texture, including the clay fraction and organic carbon content. Several studies reported the potassium content in potassium-based fertilizer tends to increase tuber accumulation, dry matter, crude starch synthesis and dissolved vitamin C [10]. Meanwhile, the application of NPK fertilizers significantly improved the potato tuber quality. Furthermore, organic carbon matter greatly influences the soil structure, as the soil remained loose. Increasing soil organic matter enhances the physical properties and the nutrients, leading to extensive crop biomass and yield [11].

Table 8. The loading matrix value from analysis of soil biophysical properties

Variable	PC1	PC2	PC3
pH	0.328	0.020	0.228
C-org	0.222	0.295	0.232
N	-264	-0.183	-0.273
C/N	0.289	0.316	0.018
P	0.207	-0.191	-0.468
CEC	-0.276	0.265	-0.259
K-dd	0.345	-0.105	-0.106
Ca	0.319	-0.002	-0.139
Mg	0.267	0.144	-0.287
KB	0.331	-0.253	-0.071
DLH	-0.006	-0.319	-0.482
Sand	0.279	-0.364	0.239
Dust	-0.294	-0.150	0.153
clay	0.068	0.565	-0.320

The physical, chemical and biological soil properties are important considerations in determining soil quality. This is due to the very dynamic state prevalent in intensive potato farming. [12]. In addition, a significant aspect of the biophysical properties refers to organic matter. This variable serves as an essential indicator for soil health and also shows a high influence on crop yields [13].

Table 9. Soil quality index in potato production centers area

Group	S1	W1	S2	W2	S3	W3	SQI	SQI Class
	K-exchangable	Weight	Soil texture (clay fraction)	Weight	Organic carbon	Weight		
I	0.25 0.1 0.5		1 1 0.5		1 1 0.25		0.88 0.83 0.51	sb sb sd
II	0.25 0.5		1 0.75		1 0.75		0.88 0.77	sb b
III	0.25 0.5 0.5	0.345*	1 0.5 1	0.565*	1 1 1	0.232*	0.88 0.69 0.97	sb b sb
IV	0.5 0.5 0.75		1 0.5 0.5		1 1 1		0.97 0.69 0.77	sb b b
V	0.75 0.75		0.5 0.75		1 1		0.77 0.91	b sb

Description: S ; score index, W ; weights, SQI ; soil quality index, sb ; very good, b ; good, sd; medium.

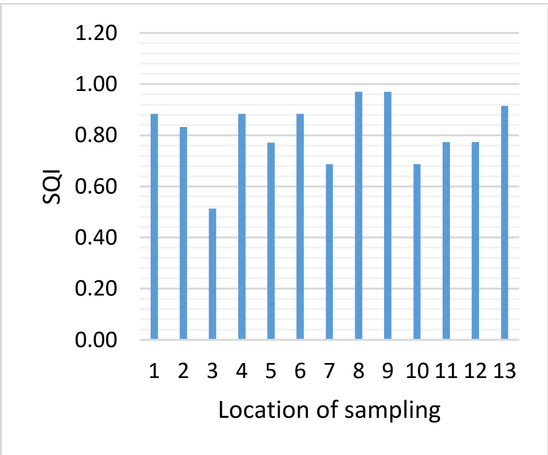

Figure 3. Histogram of SQI comparison from research location in the potato production center

Figure 4 shows the comparison of SQI between soil sample locations. Based on the histogram, the diversity of SQI in the potato production centre in the upstream of Lembang sub-watershed, Solok regency, was significantly influenced by the landform variation and land management.

CONCLUSION

Based on the results on the soil quality index in the potato production centre, the soil quality index was dominated by good and very good classes, while only one location was specified in the moderate class in soil group 1. Furthermore, the dominant factors influencing the soil quality index included the properties of potassium availability, organic C, and texture from the percentage of clay fraction.

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