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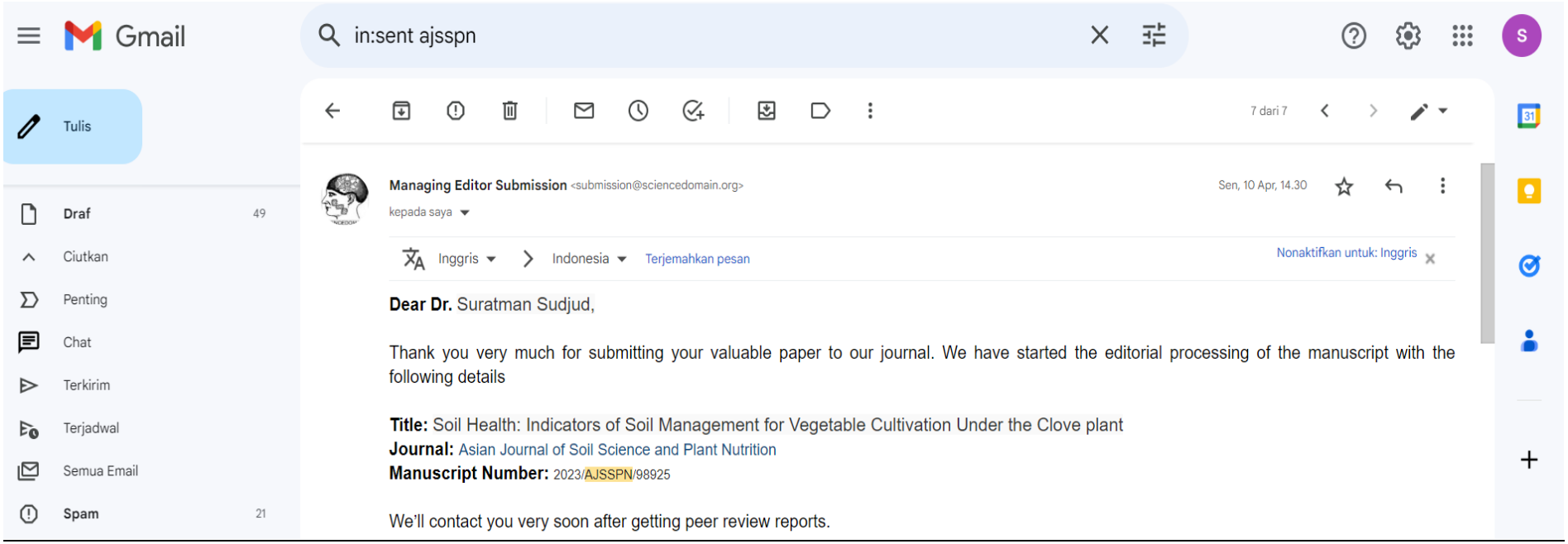

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Title: Soil Health: Indicators of Soil Management for Vegetable Cultivation Under the Clove plant
Journal: Asian Journal of Soil Science and Plant Nutrition
Manuscript Number: 2023/AJSSPN/98925

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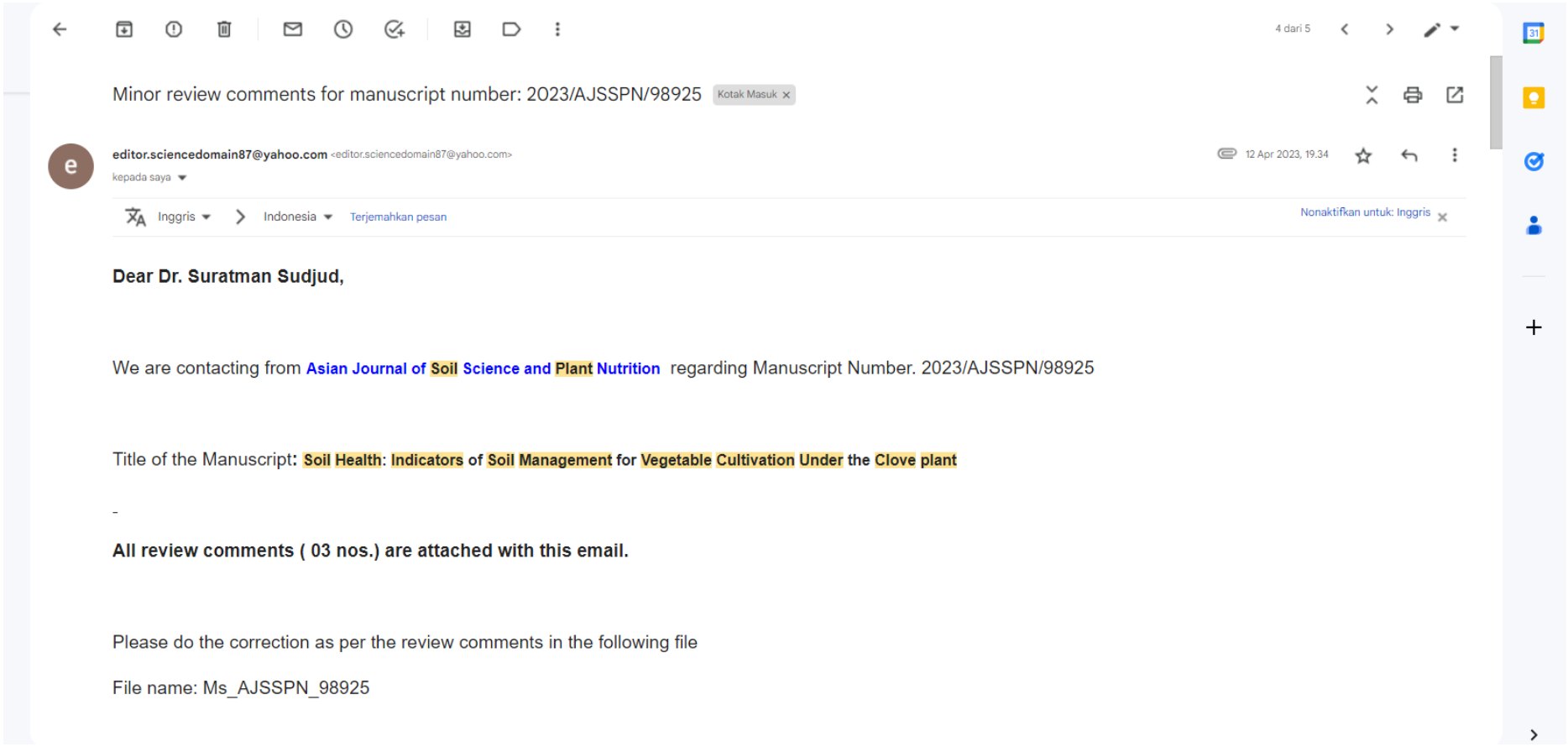

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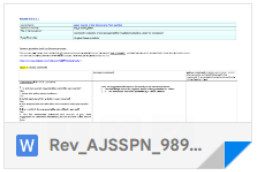

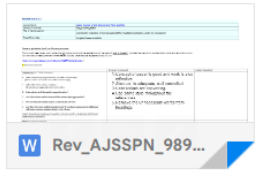

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Original Research Article
Soil Health: Indicators of Soil Management for Vegetable Cultivation ~~Under~~under the Clove plant

ABSTRACT

Low soil health indicates poor productivity and soil quality and is not optimal for supporting agricultural businesses because it will reduce the production of agricultural commodities for vegetable crop farmers in Ternate c~~C~~ity which are carried out under plantation crops. This study aims to determine the level of soil health of vegetable farms under clove plantations. Field observation methods and laboratory analysis were carried out to observe the characteristics of the land (soil and plants) which became the research variables. The drill and soil profile approach is used in observing and taking soil samples. Research data were analyzed quantitatively and qualitatively by using a scale (scoring value) and then determined the level of soil health of agricultural land in the study location. Soil variables observed were physical properties (including soil morphology), chemical properties soil, and soil biological properties. The results showed that the level of soil health on vegetable farms under clove stands in Tobololo Village was in the medium (53-58%) and high (63-67%) classes. Soil health indicators which are variables that affect the decline in the value of soil health on vegetable farms under clove stands are C-organic, base saturation, total nitrogen, and available potassium. The provision of organic matter, n~~N~~itrogen, and p~~P~~otassium fertilizers will increase base saturation as well as soil fertility and health.

Keywords: soil health indicators, soil characteristics, soil health, vegetable crops

1. INTRODUCTION (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

The increasing population of Ternate c~~C~~ity has an impact on the economic needs of farmers and consumers, especially on the need for food and vegetable consumption. The demand for vegetable production is increasing, on the one hand, clove and nutmeg farmers also need additional income to meet their daily needs, while harvesting clove flowers, seeds, and nutmeg mace takes 6 months to 1 year (Suparman et al., 2018). In addition to the need for food, the need for shelter has also increased resulting in land conversion, where productive agricultural land is used for settlements (Harini et al., 2013; Hossaimah & Subari, 2017). As a result, small and narrow lands under clove and nutmeg plantations or between gardens in clove and nutmeg plantations bordering the forest are processed into fields for cultivating food crops and vegetables. The small land area causes the number of commodities cultivated by farmers to be small but many types on one business land which are planted simultaneously or mixed in the form of *multiple cropping* or planting after harvest which is known as intercropping (relay *cropping*). Paudel, 2016) . Types of horticultural crops and vegetables that are cultivated and have business opportunities (R/C ratio and B/C ratio > 1) to be developed by farmers on Ternate Island include tomatoes (*solanum lycopersicum*), chilies (*Capsicum frustescens*), cucumbers (Cucumis *sativus*), long beans (*Vigna unguiculata sp.*), eggplant (*Solanum melongena*), kale (*Ipomoea aquatica*), spinach (*Amaranthus sp*), vegetable terubuk/ candles (*Saccharum edul*) patola or gambir, and pumpkin (Umasugi, Teapon, & Sujud, 2022).

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The island of Ternate is physiographically an archipelago, a small island with a small lowland area, and is dominated by mountains (Umasugi, Teapon, & Sudjud, 2022). This resulted in agricultural business land being generally located in hilly areas with a slope of > 8%, thus limiting farmers in planting the types of plants and cultivation techniques used. The hilly shape of the land, the small land area, and the types of plants and cultivation technology used are natural conditions and problems that exist for farmers on the slopes of Mount Gamalama, but because the land is the result of a volcanic eruption, the soil is fertile for planting various types of plants. Such land characteristics become important natural assets for the livelihoods of the people of Ternate Island (Kurniawan et al., 2023). Continuous land management will reduce soil health thereby affecting the productivity of vegetable crops cultivated under clove and nutmeg stands.

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Soil health is an indicator of land quality and productivity (Doran & Zeiss, 2000; Knight et al., 2013). The concept of soil health is the integration and optimization of soil properties that are useful for increasing land productivity, especially the main components of land, namely soil, plants, and the environment (Moebius-Clune *et al.*, 2008; Guo, 2021). Healthy soil means fertile and productive soil to be used as agricultural land for the cultivation of crops, both horticultural (vegetable) crops, food crops, and plantation crops as well as agroforestry. (Mulyono et al., 2019) . Based on these problems, this research was conducted to know the level of soil health and land productivity as well as management measures for sustainable agriculture.

2. MATERIAL AND METHODS

Ternate Island as the research location is divided into 12 land units, based on soil type, landform, and land use for vegetable crops under clove and nutmeg stands. Field and laboratory research in each land unit to collect data based on soil health indicators. Soil samples for analysis of soil properties in the laboratory are composite samples at a depth of 0-30 cm (Balitan, 2005). Soil health indicators are research variables that include soil properties, among others; soil color, soil texture, soil structure, water content, slope class, soil density, soil erosion, earthworms, soil organic matter, soil pH, salinity, nitrogen (N), P_2O_5, potassium ($K_)$ available, cation exchange capacity (CEC), base saturation (KB), and Aluminum Saturation. The properties of plants, among others; are ground cover and plant appearance (Sundermeier et al., 2004; Riwandi & Handajaningsih, 2011). Evaluation criteria for each indicator refer to the value of each element as an indicator of soil health (Balitan, 2005). The value of each indicator is used as a percentage score for soil health class based on soil performance as follows: I. 81-100% Very High (Very Fertile); II. 61-80% High (Lush); I, I, I. 41-60% Moderate (Moderately Fertile); IV. 21-40% Low (Less Fertile); V. 0-20% Very Low (Infertile) (Balitan, 2005).

Table 1. Assessment criteria and soil health indicator scores

Number	Land Property	(score 1)	(score 2)	(score 3)	(score 4)	(score 5)
1	Soil color*&****	red, gray, greenish gray	yellow, reddish yellow, yellowish red	Yellowish brown, reddish brown	dark brown to very dark brown	black
2	Water content *&****	<10%,>80%	10-20%, 70-80%	20-30%, 60-70%	30-40%, 50-60%	40-50%
3	Slope*	>30%	15-30%	8-15%	3-8%	0-3%

4	Soil texture*&****	S, C	LS, SC, SiC	SL, SCL	Si, SiCL, CL	L, SiL
5	Soil structure*&****	Details	plate	Pole, prism	cubes/clumps	Crumbs, granules
6	Organic matter (C-organic)**	none (<1)	a little (1-2)	enough (2-3)	many (3-5)	very much (>5)
7	pH (H20)**	<4,5	4.5-5.5	7.6-8.5	5,5-6	6-7,5
8	CEC (cmol (+)kg $^{-1}$)**	<5	5,1-6,9	7.0-24	25-40	>40
9	Basic sSaturation (KB)**	<20	20-40	41-60	61-80	>80
10	Al saturation (%)* *	<5	5.0-10	10,1-20	21-40	>40
11	Total nitrogen (%)* *	<0.1	0.1-0.2	0.2-0.5	0.5-0.75	>0.75
12	Phosphorus/P_2O_5 (ppm)**	<4	5.0-7	8.0-10	11.0-15	>15
13	Available potassium (cmol (+)kg $^{-1}$	<0.1	0.1-0.3	0.4-0.5	0.6-1.0	>1.0
14	Salinity (dS /m)**	<1	1-2.0	2,1-3	3,1-4	>4
15	Earthworms***	none (0)	little, wormhole shit (1-2	enough, wormhole shit (3,5)	Lots of wormhole shit (6-9)	Aabundant wormhole excrement (≥ 10)
16	Groundcover plants***	<45%	45-64%	65-74%	75-99%	100%
17	Avalanche***	big moat	small ditch	channel	sheet	No erosion
18	Soil density***	hard, dense, very poor root penetration	hard, solid	Firm, limited root penetration	leave	Ffree root penetration
19	Plant appearance***	white leaves, stunted, elemental stress	dwarf, elemental stress	moderate growth, slight elemental stress	green leaf stress-free element	Ggreen leaves, normal growth, free from elemental pressure

*Source: * Riwandi & Handajaningsih (2011) ; ** (Balitan, 2005) ; *** Sundermeier et al. (2004) ; **** Research modification*

3. RESULTS AND DISCUSSION

3.1 Climatic Condition

The climate classification according to Schmidt and Ferguson (1951) is classified as a wet climate type (B) with an average dry month (SW < 60 mm) of 2.1 months and an average wet month (BB > 100 mm) of 9.1 months. . with a Q index of 23.1 %. The wet climate type (B) is usually covered with tropical rainforest vegetation. Agro-climatic zone according to Oldeman *eat.* al., (1980) classified it as zone C2 with an average dry month (BK <100 mm) of 3 months

and an average wet month (BK > 200 mm) of 6 months. According to Umasugi et al. (2021), the monthly average rainfall on Ternate Island ranges from 115.6 mm to 263.5 mm with an annual rainfall of 2,233 mm/year. Rainy days range from 12 to 20 days with an average of 16 days. The rainiest days in May and December are 20 days. The maximum monthly air temperature ranges from 28 .8 ºC to 31.9 ºC with an annual average of 31.1 ºC.
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Based on morphological observations and results of soil analysis, the soil in Tobololo Village is classified according to the National Soil classification system (Subardja *et al*., 2014) and is equivalent to the Soil Taxonomy classification (Soil Survey Staff, 2015) into two types of soil, namely Andosol (*Andisol*s) and Cambisol (*Inceptisol*s).

The landscape resulting from the mapping is dominated by the lower volcanic slopes (V115) with a total area of 223.9 ha (67.1%). Based on the mapping results, the proportion of geological formations in Tobololo Village appears to be dominated by Old Lava Deposits (Gmlt) covering an area of 194.9 ha (58.4%) with lapilli tuff as the constituent rock. Lapilli tuff is a pyroclastic material resulting from the eruption of Mount Gamalama which consists of chunks of andesite rock to andesite basalt arranged in a matrix of sand and volcanic ash (Umasugi & Kamaluddin, 2015; Hadun et al., 2016). Furthermore, according to Sudjud & Hadun (2018), vegetable cropland is very suitable (S1) to be developed on flat land (0-3%) to slightly sloping (8-15%). Whereas on sloping land (15-30%) to very steep (> 65%) land conditions are not suitable for the development of vegetable crops. Development of vegetable crops on sloping land (15-30%) to very steep (> 65%) with open soil conditions can lead to increased soil erosion and has implications for soil damage due to erosion (Shadikin Nurdin et al., 2020)

3.2 Soil Health Level

The results showed that the level of soil health on vegetable farms under clove stands in Tobololo Village was in the medium and high classes. Soil health indicators in the form of soil and plant properties affect the level of medium and high soil health or fertility on vegetable farming land.

3.2.1 Medium Class

Health (55-59%) found in SPL 3, 4, 5, 6, 7, and 8 land units. Soil and plant indicators which are variables that affect the health level of medium soil are C-organic, base saturation (KB), Nitrogen (total N), and Potassium (available K). The results of the analysis of soil health indicators for each SST are shown in Table 2.

Table 2. Results of analysis of soil health indicators for each SST

NO	Soil health indicator	The score for each SPL									
		1	2	3	4	5	6	7	8	9	10
1	Soil color	5	5	4	4	4	4	4	4	5	5
2	Water content (%)	4	4	5	5	4	5	5	4	5	5
3	Slope (%)	4	4	2	2	3	2	2	3	2	2
4	Soil texture	4	4	4	5	4	4	5	4	4	4
5	Soil structure	4	4	4	4	4	4	4	4	5	5
6	Organic matter (C-organic)	3	3	2	2	3	2	2	3	2	2

7	pH (H20)	5	5	5	5	5	5	5	5	4	4
8	CEC (cmol (+)kg ˉ 1)	4	4	3	3	3	3	3	3	3	3
9	Basic Saturation (KB)	2	2	2	2	2	2	2	2	2	2
10	Al saturation (%)	1	1	1	1	1	1	1	1	1	1
11	Total nitrogen (%)	2	2	2	2	2	2	2	2	2	2
12	Phosphorus/P_2O_5 (ppm)	5	5	4	4	4	4	4	4	3	3
13	Available potassium (cmol (+)kg $^{-1}$	2	2	2	2	2	2	2	2	2	2
14	Salinity (dS /m)	1	1	1	1	1	1	1	1	1	1
15	Earthworm population	2	2	2	2	1	2	2	1	3	3
16	Ground cover crops (%)	4	4	3	3	3	3	3	3	5	5
17	avalanche	4	4	3	3	2	3	3	2	5	5
18	soil compaction	5	5	5	5	4	5	5	4	5	5
19	plant appearance	4	4	4	4	3	4	4	3	5	5
	Total score	**65**	**65**	**58**	**59**	**55**	**58**	**59**	**55**	**64**	**64**

Based on the results of the analysis of soil health indicators in Table 1, the soil health level at the study site was classified as moderate at SST 3, 4, 5, 6, 7, and 8 according to the criteria for soil health and fertility. by Balitan (2005). The moderate level of soil health on vegetable farming land in Tobololo Village is generally influenced by the low availability of total N, and the percentage of base saturation in the soil. As the results of research by Irawan et al. (2022), total N and base saturation affect soil quality in coconut plantations. The availability of C-organic and available K in the soil also determines the level of soil health value. Organic matter sourced from C-organic as a source of soil nutrients will be the main variable for assessing the level of soil health on agricultural land. This is because it affects the development of soil microorganisms. In the opinion of Yulianti (2010; Mann et al., 2019), the addition of organic matter to the soil in addition to increasing soil fertility and improving the physical structure of the soil, also functions to restore the microbiological balance in the soil.

3.2.2 High Grade

Soil health levels with high value (64-65%) are found in SPL 1, 2, 9, and 10. High soil health values are because the soil surface is 100% covered with vegetation so that soil erosion does not occur and soil texture and structure are good, i.e. clay soil texture and crumb structure with loose consistency and the activity of soil organisms (earthworms) are sufficiently available. This is because there are 1-3 earthworms in each SST. Based on the research results of Umasugi, Teapon, & Ishak (2022) that the level of earthworm density in vegetable fields in Tobololo Village is moderate. The level of soil health is high but in some soil chemical properties, it is still low, especially the availability of pPotassium and the percentage of Base Saturation (KB). The high and low values of the health indicators that affect the health level of the soil for each SST in the study location are shown in Table 2. In general, the results of this study indicate that both high and moderate health levels have problems with soil chemical indicators, namely the availability of pPotassium and the level of base saturation (KB).

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4. CONCLUSIONS

Soil health level in vegetable fields under clove stands was moderate (55-59%) and high (64-65%). The results of this study indicate that both moderate and high health levels have problems with soil chemical indicators, namely the availability of potassium and nitrogen and the level of base saturation (KB). Potassium (K) and cow manure contain lots of nitrogen (N).

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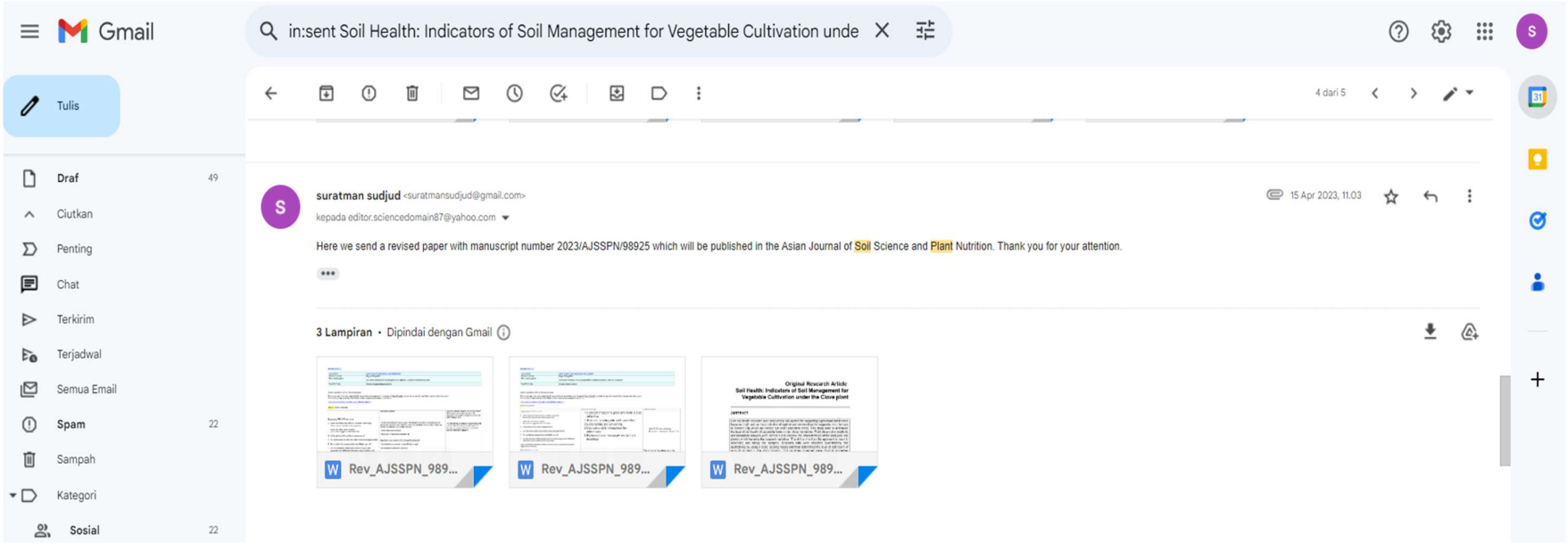
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Journal Name:	**Asian Journal of Soil Science and Plant Nutrition**
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Title of the Manuscript:	**Soil Health: Indicators of Soil Management for Vegetable Cultivation Under the Clove plant**
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Manuscript Number:	**Ms_AJSSPN_98925**
Title of the Manuscript:	**Soil Health: Indicators of Soil Management for Vegetable Cultivation Under the Clove plant**
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Original Research Article
Soil Health: Indicators of Soil Management for Vegetable Cultivation under the Clove plant

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ABSTRACT

Low soil health indicates poor productivity soil optimal for supporting agricultural businesses because it will reduce the production of agricultural commodities for vegetable crop farmers in Ternate City which are carried out under plantation crops. This study aims to determine the level of soil health of vegetable farms under clove plantations. Field observation methods and laboratory analysis were carried out to observe the characteristics of the land (soil and plants) which became the research variables. The drill and soil profile approach is used in observing and taking soil samples. Research data were analyzed quantitatively and qualitatively by using a scale (scoring value) and then determined the level of soil health of agricultural land in the study location. Soil variables observed were physical properties (including soil morphology), chemical properties soil, and soil biological properties. The results showed that the level of soil health on vegetable farms under clove stands in Tobololo Village was in the medium (53-58%) and high (63-67%) classes. Soil health indicators which are variables that affect the decline in the value of soil health on vegetable farms under clove stands are C-organic, base saturation, total nitrogen, and available potassium. The provision of organic matter, nitrogen, and potassium fertilizers will increase base saturation as well as soil fertility and health.

Keywords: soil health indicators, soil characteristics, soil health, vegetable crops

1. INTRODUCTION (ARIAL, BOLD, 11 FONT, LEFT ALIGNED, CAPS)

The increasing population of Ternate city has an impact on the economic needs of farmers and consumers, especially on the need for food and vegetable consumption. The demand for vegetable production is increasing, on the one hand, clove and nutmeg farmers also need additional income to meet their daily needs, while harvesting clove flowers, seeds, and nutmeg mace takes 6 months to 1 year [1]. In addition to the need for food, the need for shelter has also increased resulting in land conversion, where productive agricultural land is used for settlements [2]; [3]. As a result, small and narrow lands under clove and nutmeg plantations or between gardens in clove and nutmeg plantations bordering the forest are pr ocessed into fields for cultivating food crops and vegetables. The small land area causes the number of commodities cultivated by farmers to be small but many types on one business land which are planted simultaneously or mixed in the form of *multiple cropping* or planting after harvest which is known as intercropping (relay *cropping*) [4]. Types of horticultural crops and vegetables that are cultivated and have business opportunities (R/C ratio and B/C ratio>1) to be developed by farmers on Ternate Island include tomatoes *(Solanum lycopersicum)*, chilies *(Capsicum frustescens)*, cucumbers *(*Cucumis *sativus*), long beans (*Vigna unguiculata sp*), eggplant (*Solanum melongena*), kale (*Ipomoea aquatica*), spinach (*Amaranthus sp*), vegetable terubuk/candles (*Saccharum edul*), and pumpkin [5].

The island of Ternate is physiographically an archipelago, a small island with a small lowland area, and is dominated by mountains. This resulted in agricultural business land being

generally located in hilly areas with a slope of > 8%, thus limiting farmers in planting the types of plants and cultivation techniques used. The hilly shape of the land, the small land area, and the types of plants and cultivation technology used are natural conditions and problems that exist for farmers on the slopes of Mount Gamalama, but because the land is the result of a volcanic eruption, the soil is fertile for planting various types of plants. Such land characteristics become important natural assets for the livelihoods of the people of Ternate Island [6]. Continuous land management will reduce soil health thereby affecting the productivity of vegetable crops cultivated under clove and nutmeg stands.

Soil health is an indicator of land quality and productivity [7]; [8]. The concept of soil health is the integration and optimization of soil properties that are useful for increasing land productivity, especially the main components of land, namely soil, plants, and the environment [9]; [10]. Healthy soil means fertile and productive soil to be used as agricultural land for the cultivation of crops, both horticultural (vegetable) crops, food crops, and plantation crops as well as agroforestry [11]. Based on these problems, this research was conducted to know the level of soil health and land productivity as well as management measures for sustainable agriculture.

2. MATERIAL AND METHODS

Ternate Island as the research location is divided into 12 land units, based on soil type, landform, and land use for vegetable crops under clove and nutmeg stands. Field and laboratory research in each land unit to collect data based on soil health indicators. Soil samples for analysis of soil properties in the laboratory are composite samples at a depth of 0-30 cm [12]. Soil health indicators are research variables that include soil properties, among others; soil color, soil texture, soil structure, water content, slope class, soil density, soil erosion, earthworms, soil organic matter, soil pH, salinity, nitrogen (N), Phosphorus (P_2O_5), potassium (K) available, cation exchange capacity (CEC), base saturation (BS), and aluminum saturation. The properties of plants, among others; are ground cover and plant appearance [13]; [14]. Evaluation criteria for each indicator refer to the value of each element as an indicator of soil health [12]. The value of each indicator is used as a percentage score for soil health class based on soil performance as follows: I. 81-100% Very High (Very Fertile); II. 61-80% High (Lush); III. 41-60% Moderate (Moderately Fertile); IV. 21-40% Low (Less Fertile); V. 0-20% Very Low (Infertile) [12].

Table 1. Assessment criteria and soil health indicator scores

Number	Land Property	(score 1)	(score 2)	(score 3)	(score 4)	(score 5)
1	Soil color*&****	red, gray, greenish gray	yellow, reddish yellow, yellowish red	Yellowish brown, reddish brown	dark brown to very dark brown	black
2	Water content *&****	<10%,>80%	10-20%, 70-80%	20-30%, 60-70%	30-40%, 50-60%	40-50%
3	Slope*	>30%	15-30%	8-15%	3-8%	0-3%
4	Soil texture*&****	S, C	LS, SC, SiC	SL, SCL	Si, SiCL, CL	L, SiL
5	Soil structure*&****	Details	plate	Pole, prism	cubes/clumps	Crumbs, granules
6	Organic matter (C-organic)**	none (<1)	a little (1-2)	enough (2-3)	many (3-5)	very much (>5)

7	pH (H20)**	<4,5	4.5-5.5	7.6-8.5	5,5-6	6-7,5
8	CEC (cmol (+)kg $^{-1}$)**	<5	5,1-6,9	7.0-24	25-40	>40
9	Basic saturation (KB)**	<20	20-40	41-60	61-80	>80
10	Al saturation (%)* *	<5	5.0-10	10,1-20	21-40	>40
11	Total nitrogen (%)* *	<0.1	0.1-0.2	0.2-0.5	0.5-0.75	>0.75
12	Phosphorus/P_2O_5 (ppm)**	<4	5.0-7	8.0-10	11.0-15	>15
13	Available potassium (cmol (+)kg $^{-1}$	<0.1	0.1-0.3	0.4-0.5	0.6-1.0	>1.0
14	Salinity (dS /m)**	<1	1-2.0	2,1-3	3,1-4	>4
15	Earthworms***	none (0)	little, wormhole shit (1-2)	enough, wormhole shit (3-5)	Lots of wormhole shit (6-9)	Abundant wormhole excrement (≥10)
16	Groundcover plants***	<45%	45-64%	65-74%	75-99%	100%
17	Avalanche***	big moat	small ditch	channel	sheet	No erosion
18	Soil density***	hard, dense, very poor root penetration	hard, solid	Firm, limited root penetration	leave	Free root penetration
19	Plant appearance***	white leaves, stunted, elemental stress	dwarf, elemental stress	moderate growth, slight elemental stress	green leaf stress-free element	Green leaves, normal growth, free from elemental pressure

Source: *[14]*;* **[12]*;* *** [13]*;* **** *Research modification*

3. RESULTS AND DISCUSSION

3.1 Climatic Condition

The climate classification according to Schmidt and Ferguson (1951) is classified as a wet climate type (B) with an average dry month (SW < 60 mm) of 2.1 months and an average wet month (BB > 100 mm) of 9.1 months. with a Q index of 23.1 %. The wet climate type (B) is usually covered with tropical rainforest vegetation. Agro-climatic zone according to Oldeman e*t al*. (1980) classified it as zone C2 with an average dry month (BK <100 mm) of 3 months and an average wet month (BK > 200 mm) of 6 months. According to [15], the monthly average rainfall on Ternate Island ranges from 115.6 mm to 263.5 mm with an annual rainfall of 2,233 mm/year. Rainy days range from 12 to 20 days with an average of 16 days. The rainiest days in May and December are 20 days. The maximum monthly air temperature ranges from 28 .8 ^{o}C to 31.9 ^{o}C with an annual average of 31.1 ^{o}C.

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Based on morphological observations and results of soil analysis, the soil in Tobololo Village is classified according to the National Soil classification system and is equivalent to the Soil Taxonomy classification [16] into two types of soil, namely Andosol (*Andisols*) and Cambisol (*Inceptisols*).

The landscape resulting from the mapping is dominated by the lower volcanic slopes (V115) with a total area of 223.9 ha (67.1%). Based on the mapping results, the proportion of geological formations in Tobololo Village appears to be dominated by Old Lava Deposits (Gmlt) covering an area of 194.9 ha (58.4%) with lapilli tuff as the constituent rock. Lapilli tuff is a pyroclastic material resulting from the eruption of Mount Gamalama which consists of chunks of andesite rock to andesite basalt arranged in a matrix of sand and volcanic ash [17] [17];[18]. Furthermore, according to [19], vegetable cropland is very suitable (S1) to be developed on flat land (0-3%) to slightly sloping (8-15%). Whereas on sloping land (15-30%) to very steep (> 65%) land conditions are not suitable for the development of vegetable crops. Development of vegetable crops on sloping land (15-30%) to very steep (> 65%) with open soil conditions can lead to increased soil erosion and has implications for soil damage due to erosion [20].

3.2 Soil Health Level

The results showed that the level of soil health on vegetable farms under clove stands in Tobololo Village was in the medium and high classes. Soil health indicators in the form of soil and plant properties affect the level of medium and high soil health or fertility on vegetable farming land.

3.2.1 Medium Class

Health (55-59%) found in SPL 3, 4, 5, 6, 7, and 8 land units. Soil and plant indicators which are variables that affect the health level of medium soil are C-organic, base saturation (KB), Nitrogen (total N), and Potassium (available K). The results of the analysis of soil health indicators for each SST are shown in Table 2.

Table 2. Results of analysis of soil health indicators for each SST

NO	Soil health indicator	The score for each SPL									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Soil color	5	5	4	4	4	4	4	4	5	5
2	Water content (%)	4	4	5	5	4	5	5	4	5	5
3	Slope (%)	4	4	2	2	3	2	2	3	2	2
4	Soil texture	4	4	4	5	4	4	5	4	4	4
5	Soil structure	4	4	4	4	4	4	4	4	5	5
6	Organic matter (C-organic)	3	3	2	2	3	2	2	3	2	2
7	pH (H20)	5	5	5	5	5	5	5	5	4	4
8	CEC (cmol (+)kg $^{-}$1)	4	4	3	3	3	3	3	3	3	3
9	Basic Saturation (KB)	2	2	2	2	2	2	2	2	2	2
10	Al saturation (%)	1	1	1	1	1	1	1	1	1	1
11	Total nitrogen (%)	2	2	2	2	2	2	2	2	2	2

12	Phosphorus/P_2O_5 (ppm)	5	5	4	4	4	4	4	4	3	3
13	Available potassium (cmol (+)kg^{-1}	2	2	2	2	2	2	2	2	2	2
14	Salinity (dS /m)	1	1	1	1	1	1	1	1	1	1
15	Earthworm population	2	2	2	2	1	2	2	1	3	3
16	Ground cover crops (%)	4	4	3	3	3	3	3	3	5	5
17	Avalanche	4	4	3	3	2	3	3	2	5	5
18	soil compaction	5	5	5	5	4	5	5	4	5	5
19	plant appearance	4	4	4	4	3	4	4	3	5	5
	Total score	**65**	**65**	**58**	**59**	**55**	**58**	**59**	**55**	**64**	**64**

Based on the results of the analysis of soil health indicators in Table 1, the soil health level at the study site was classified as moderate at SST 3, 4, 5, 6, 7, and 8 according to the criteria for soil health and fertility by [12]. The moderate level of soil health on vegetable farming land in Tobololo Village is generally influenced by the low availability of total N, and the percentage of base saturation in the soil. As the results of research by [21], total N and base saturation affect soil quality in coconut plantations. The availability of C-organic and available K in the soil also determines the level of soil health value. Organic matter sourced from C-organic as a source of soil nutrients will be the main variable for assessing the level of soil health on agricultural land. This is because it affects the development of soil microorganisms. In the opinion of [22]; [23], the addition of organic matter to the soil in addition to increasing soil fertility and improving the physical structure of the soil, also functions to restore the microbiological balance in the soil.

3.2.2 High Grade

Soil health levels with high value (64-65%) are found in SPL 1, 2, 9, and 10. High soil health values are because the soil surface is 100% covered with vegetation so that soil erosion does not occur and soil texture and structure are good, i.e. clay soil texture and crumb structure with loose consistency and the activity of soil organisms (earthworms) are sufficiently available. This is because there are 1-3 earthworms in each SST. Based on the research results of [24] that the level of earthworm density in vegetable fields in Tobololo Village is moderate. The level of soil health is high but in some soil chemical properties, it is still low, especially the availability of potassium and the percentage of Base Saturation (KB). The high and low values of the health indicators that affect the health level of the soil for each SST in the study location are shown in Table 2. In general, the results of this study indicate that both high and moderate health levels have problems with soil chemical indicators, namely the availability of potassium and the level of base saturation (BS).

4. CONCLUSIONS

Soil health level in vegetable fields under clove stands was moderate (55-59%) and high (64-65%). The results of this study indicate that both moderate and high health levels have problems with soil chemical indicators, namely the availability of potassium and nitrogen and the level of base saturation (KB). Potassium (K) and cow manure contain lots of nitrogen (N).

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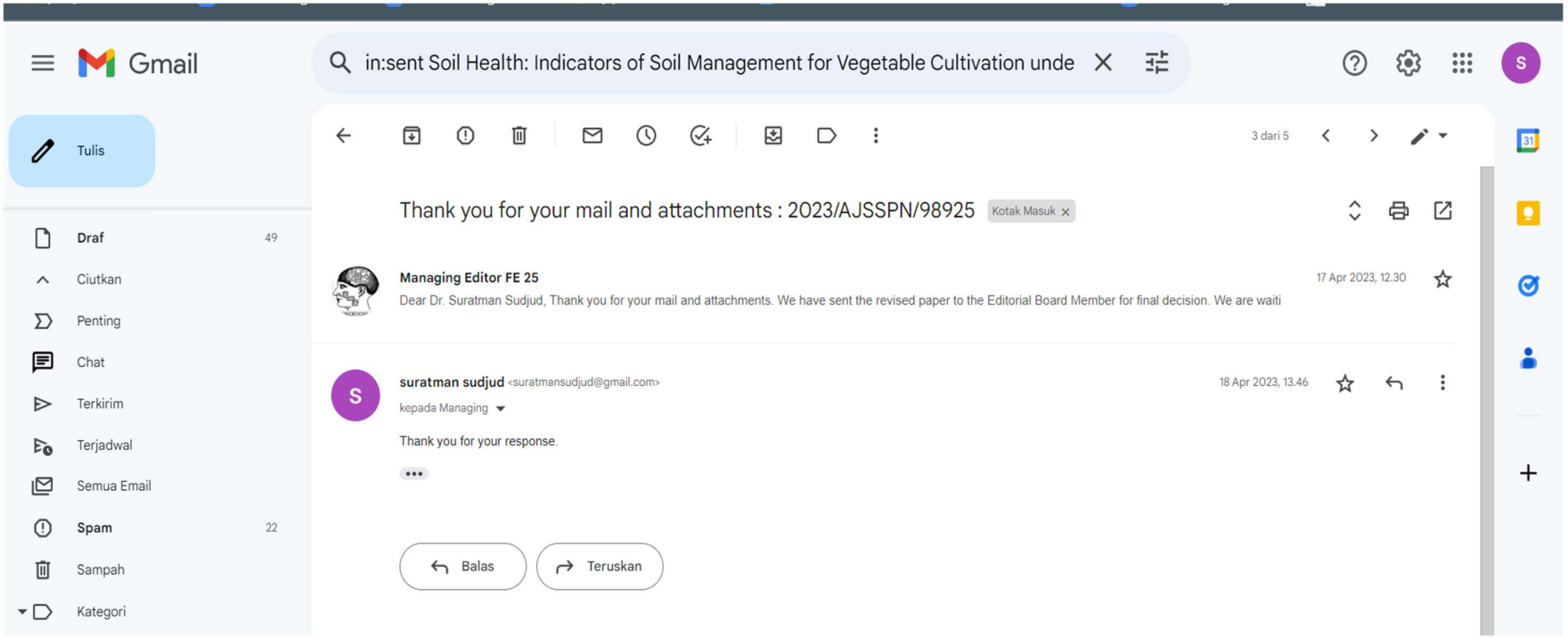
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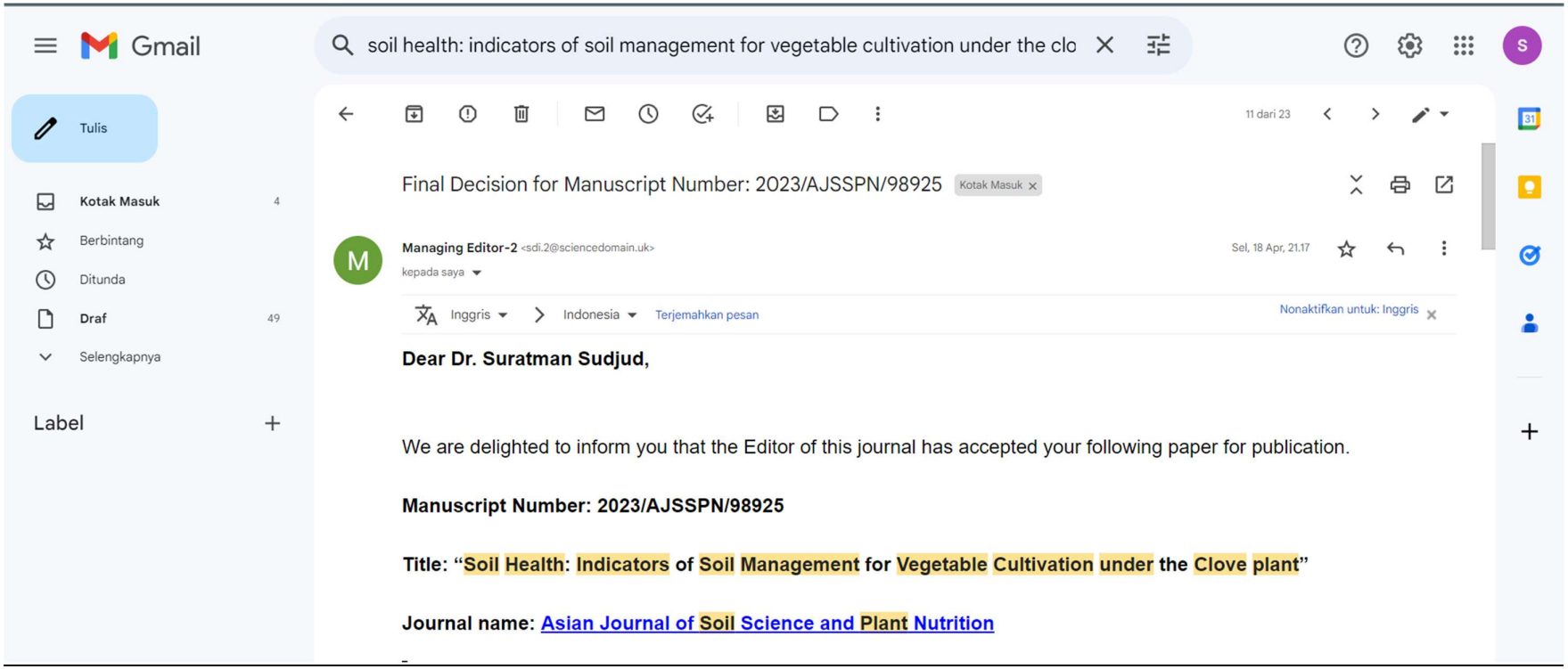

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Dear Dr. Suratman Sudjud,

We are delighted to inform you that the Editor of this journal has accepted your following paper for publication.

Manuscript Number: 2023/AJSSPN/98925

Title: "Soil Health: Indicators of Soil Management for Vegetable Cultivation under the Clove plant"

Journal name: Asian Journal of Soil Science and Plant Nutrition

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F. No. SDI/ AJSSPN/23/22272
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Subject: Final decision of review process for (Manuscript Number. 2023/AJSSPN/98925) submitted in Asian Journal of Soil Science and Plant Nutrition

Dear Colleague,

We are pleased to inform that peer review process and editorial review process have been completed for your following manuscript

Manuscript Number: 2023/AJSSPN/98925

Title: "Soil Health: Indicators of Soil Management for Vegetable Cultivation under the Clove Plant"

Author(s): Buhari Umasugi,Amiruddin Teapon,Suratman Sudjud,Gunawan Hartono

We are ready with the final decision. We are happy to inform you that your manuscript is officially accepted for publication in Asian Journal of Soil Science and Plant Nutrition

Once your manuscript is moved to publishing, our production editor will keep you informed of your article's progress in the production process. You will also receive a galley proof of your manuscript for final review. We're excited to move forward with your submission. Please feel free to email me with any questions.

Thank you for submitting your paper.

Thanking you.

Dr. M. Basu
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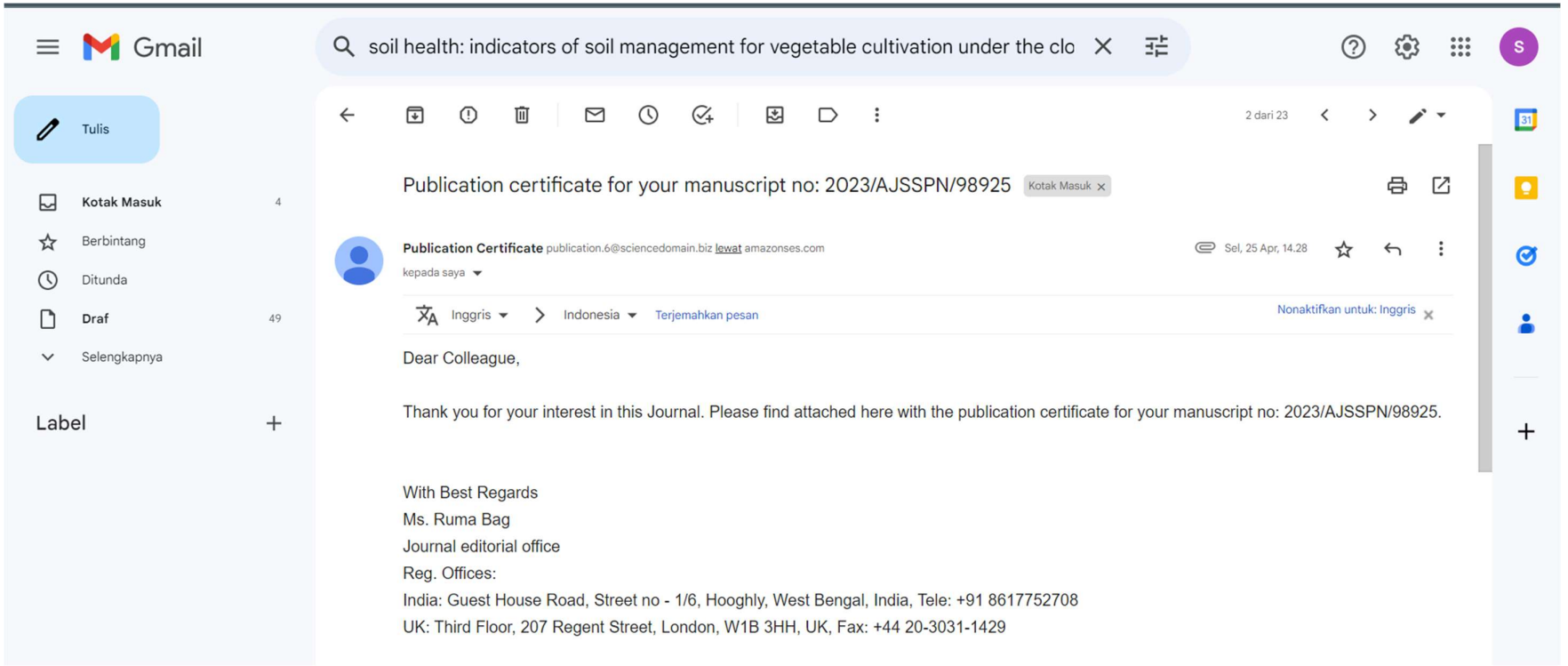
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