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Research Paper

Precision of NPK Fertilizer for Swampy Rice Based on In Situ Soil Nutrient Analysis in South Sumatra, Indonesia

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Abstract
Precision of fertilizer is an approach that directs the use of fertilizers in a rational, efficient, and targeted manner, so that plants obtain sufficient nutrients for optimal growth without causing waste or negative impacts on the environment. This study aims to determining the doses of N, P, and K fertilizers that are appropriate for swampland by implementing a site-specific fertilization approach using in situ soil analysis. This research used a systematic method with 15 sample points, Soil sampling was conducted using a composite method and soil drilling with soil depth of 0-30 cm. The parameters observed were N-total, P-available, k-exchangeable, soil pH, and C-organic. The study found that the soil in Ulak Bedil Village exhibited highly acidic conditions (pH 3.80–4.47), with varied nutrient availability. Based on soil N, P, and K analysis and rice plant nutrient requirements, site-specific fertilizer recommendations were determined. The recommended fertilizer doses are 91.30 $\mathrm{kg\,ha^{-1}}$ for urea, 31.03 $\mathrm{kg\,ha^{-1}}$ for SP-36, and 109.65 $\mathrm{kg\,ha^{-1}}$ for KCl. This research provides a practical guideline for the application of site-specific fertilization to rice cultivation in swampland, in order to increase yields while reducing negative impacts on the environment.

Keywords
Site-specific fertilization; Swamp rice; Soil nutrient analysis; NPK management

1. INTRODUCTION

Rice is a commodity of rice producing food crop that has an important role in the Indonesian economy. As a staple food, rice is very difficult to replace by other foodstuffs (Donggulo et al., 2017). This swamp has considerable potential and can be utilized as productive agricultural land (Langai et al., 2024). The 2.0 million hectares of swampland in South Sumatra could be developed for rice (Syahri and Somantri, 2013). In 2023, Indonesia produced 53.63 million tons of paddy, according to BPS data. This was a 1.12 million ton (2.05%) reduction from the 54.75 million tons produced in 2022. Around 30.90 million tons of rice were produced in 2023 for the population's food consumption, which is 645.09 thousand tons less or 2.05 percent less than the 31.54 million tons produced in 2022. The village of Ulak Bedil is situated in the Ogan Ilir Regency's Indralaya District in South Sumatra. However, according to BPS statistics from South Sumatra Province, particularly Ogan Ilir Regency, rice output in 2023 was 101,395 tons, which was 3,532 tons less than the 104,927 tons produced in 2022.

The lack of information about the soil properties or characteristics is one of the obstacles in crop production efforts, which leads to suboptimal production results. In agricultural land management, it is important to observe the characteristics of the soil as a medium that provides the needs of plants, especially their nutritional needs. If nutrient needs are met without knowing the status of nutrients in the soil, it can lead to nutrient deficiencies and excesses, impact soil degradation, and cause dependence on organic matter or certain nutrients that can lead to plant poisoning (Jawang, 2021). The condition of the land greatly affects crop productivity. Plants can't produce optimally if there are limiting factors such as low soil fertility (Mahbub et al., 2023). Decreased soil fertility can be a factor affecting productivity, so the addition of nutrients through fertilization is essential to achieve profitable agricultural production (Agoesdy et al., 2019). However, the nutrient in each area in a rice field is not always the same. Therefore, fertilizer needs can vary, both in terms of amount, application time, and location of use (Virgawati et al., 2014). Fertilization is the addition of nutrients to the soil to increase fertility. However, excessive fertilizer use can reduce efficiency and damage environmental quality. Thus, balanced fertilization is very important in agricultural production (Suarjana et al., 2015). The balanced fertilization aims to supply sufficient nutrients during plant growth so that agricultural crop production is optimum (Supriatin et al., 2023).

The information on soil fertility on the lowland swamp in Ulak Bedil Village, Indralaya District, Ogan Ilir Regency has never been researched so that information is very limited and difficult to obtain for fertilization recommendation issues. Fertilization recommendations made today are often made without looking at field conditions. Farmers are also in the habit of fertilizing without being based on crop needs but based on economic conditions so that production can't be optimal and accelerate soil damage (Ariawan et al., 2016). Recommendations for fertilizing certain crops need to be adjusted to the level of soil fertility because each area has a different land characteristic. This difference in land characteristics requires location-specific nutrient fertilization. Location specific nutrient fertilization is a guide to the rational and efficient use of fertilizers, according to the needs of plants based on knowledge and research (Puja and Atmaja, 2018). However, more detailed information on soil nutrient conditions in paddy fields is needed. This can be done through mapping the soil nutrient content before the planting process begins. The mapping aims as a first step to identify variations in soil N, P and K contents in rice fields. This research aims to assess soil nutrient levels and determine appropriate doses of N, P and K fertilizers for lowland swamp rice fields.

2. EXPERIMENTAL SECTION

2.1 Material

The research was held from June 2024 to August 2024 in paddy fields owned by farmers in Ulak Bedil Village. At Sriwijaya University's Department of Soil Science, Laboratory of Chemistry, Biology, and Soil Fertility, Faculty of Agriculture, the chemical characteristics of the soil were analyzed. Ulak Bedil Village is located in Indralaya Sub-district, Ogan Ilir Regency, South Sumatra Province. In 2023, Indralaya Sub-district has an area of 101.22 km^2 and is located at an altitude of between 10 and 11 meters above sea level. This elevation indicates that the area is low-lying, which can affect environmental conditions such as climate and the potential for flooding. Rice fields in Ulak Bedil Village are generally lebak swamp rice fields, which are wetlands that are often inundated with water, especially during the rainy season, so they are strongly influenced by natural conditions and local water patterns. Based on the land typology classification, Ulak Bedil Village falls into the category of middle lebak swamp, which is characterized by a duration of inundation of 3 to 6 months and a water level of 100-200 cm. The cropping pattern used is the jajar legowo system, with the Inpara 3 rice variety that has resistance to waterlogging and is suitable for lebak swamp land.

This research employed a detailed survey method at a scale of 1:4,000 with a research area of 15 ha of lowland swamp land (Figure 1). Sampling determination using the systematic sampling method, namely the first point coordinate is selected with a distance of 1 hectare representing one point with a sample of 15 sample points. Tracking sample points used GPS tools. Soil sampling was conducted in a composite where each sample was drilled five times at a depth of 0-30 cm. Then, the composite soil samples were analyzed in the laboratory to determine soil pH, C-Organic, Total Nitrogen (N-Total), Available Phosphorus (P-Available) and Exchangeable K (K-dd).

2.2 Variable Observed

The soil fertility indicators analyzed in this study (pH, C-organic, total nitrogen, available phosphorus, and exchangeable potassium) as each represents a key component affecting nutrient availability and rice plant growth. Soil pH was measured using an electrometric method, C-organic was determined using the Walkley and Black method, total nitrogen was analyzed using the Kjeldahl method, available phosphorus was assessed using the Bray I method, and exchangeable potassium was extracted using NH_4OAc 1N pH 7.

Table 1. Soil Analysis Methods

Soil Fertility Indicators	Analysis Methods
Soil pH	Elektrometry
C-Organic	Walkley and Black
N-Total	Kjeldahl
P-Available	Bray I
K-exch	Extraction NH_4OAc 1 N pH 7

Source: Soil Fertility Evaluation Technical Manual from LPT (1984)

3. RESULTS AND DISCUSSION

3.1 Site description of soil sampling location

Ulak Bedil Village is located in Indralaya District, Ogan Ilir Regency, South Sumatra Province, with an area of 101.22 km^2. The region is in the lowlands with an elevation of 10-11 meters above sea level (m asl), which affects environmental conditions, such as climate and flood potential. Ulak Bedil Village's rice fields are generally lebak swamp rice fields that utilize wetlands and depend on waterlogging, especially during the rainy season. The average temperature in this location ranges from 22.69°C to 35.44°C, with annual rainfall reaching 2,218.9 mm in 2023, based on data from the BMKG Class I Climatology Station in South Sumatra. Plowing rice fields in Ulak Bedil Village is still done traditionally using buffaloes. Farmers apply the jajar legowo system planting pattern and use the Inpara 3 rice variety.

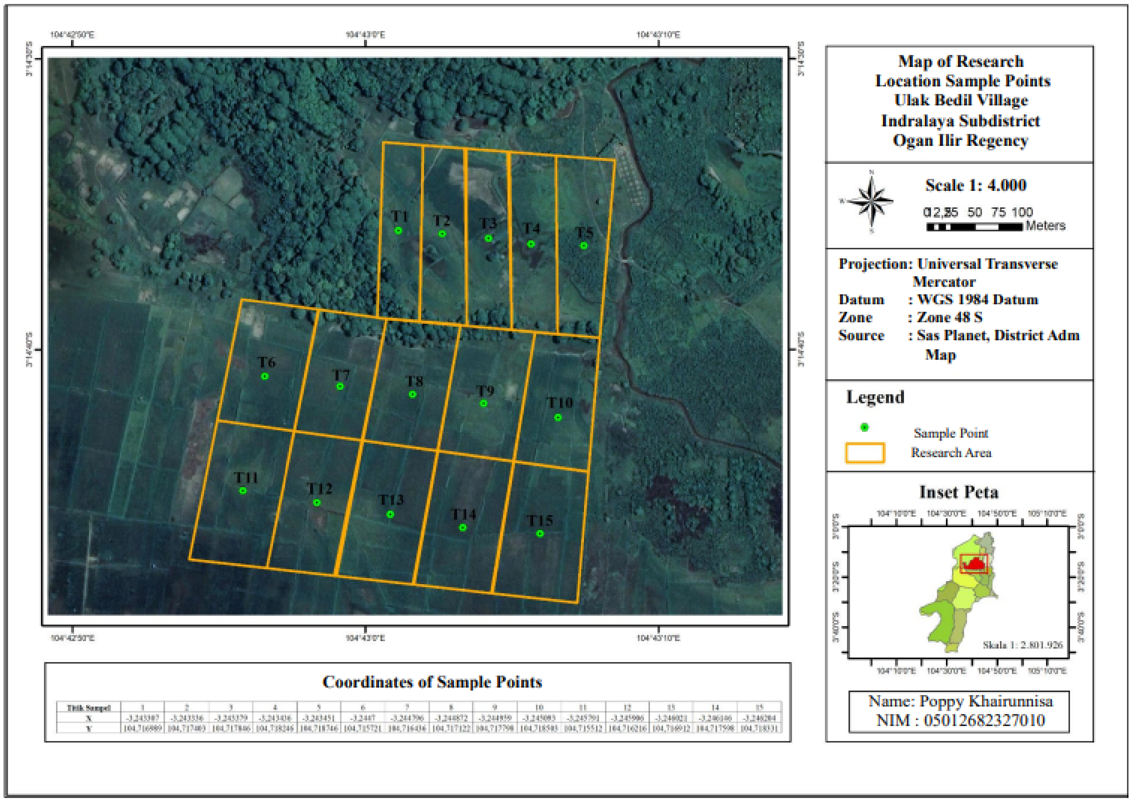

Figure 1. Map of Soil Sample Points

On lowland swamp areas, farmers can only do one planting per season, because the land is still waterlogged throughout the year.

3.2 Characteristics of Some Soil Chemical Properties of Lowland Swamp Paddy Soils

3.2.1 Soil pH

The results of soil analysis in Table 2 show that the pH of paddy field soil in the research location is in the very acidic category. Previous research by Lantoi et al. (2016) found that paddy field soils generally have a pH close to neutral, but swamp soils tend to be more acidic due to high organic matter decomposition. This is in line with our findings, where the soil pH was very acidic (3.80-4.47). The acidity of the soil at the study site is thought to be caused by high rainfall. High rainfall in the area causes nutrient leaching, so the soil naturally becomes more acidic. Soil acidity or basicity is determined by the concentration of hydrogen ions in the soil solution. Soil pH levels are important in influencing the availability of nutrients for plants (Akbar and Zainuddin, 2023).

Low soil pH indicates the dominance of hydrogen ions (H+), which can come from the decomposition of organic matter left over from rice plants or from the subsoil layer containing aluminum (Al) and iron (Fe). Rice paddy soils generally have a pH close to neutral, but drainage can lower the pH due to oxidation processes that increase the concentration of H+ ions and soil acidity. Pyrite (FeS_2) compounds, which are stable under flooded conditions, release large amounts of H+ ions when oxidized by drainage, especially during land reclamation (Syachroni, 2019).

3.2.2 C-Organic of Soil

The results of analysis C-organic paddy soil in the research location ranged from 3.53% to 7.42% with low to very high criteria (Table 2). C-organic functions as an indicator to determine the quality of organic matter which is closely related to the level of soil decomposition (Simatupang et al., 2018). Organic matter is considered very low if the content is below 2% and low if more than that. Content of between 2-10% has a significant contribution to soil fertility (Nurrohman et al., 2018). Mulyawan et al. (2023) stated that topography affects the availability of organic matter. In middle land, which is lower than shallow land, C-organic levels are more easily lost due to flooding.

3.2.3 N-Total of Soil

Based on the Table 2, it is known that the total N of the soil at the study site ranges from 0.16% to 0.39%, which is classified as low to medium. Research by Wijaya and Budianta (2023) also revealed that N-Total levels in the paddy soil of Marga Cinta Village, East Ogan Komering Ulu Regency, ranged from 0.05-0.21%, which is included in

Table 2. Analysis Results of Chemical Properties of Lowland Swamp Soil

Sample	Variables observed				
	pH H_20	C-Organic (%)	N-total (%)	P-available ($mg\,kg^{-1}$)	K-exch ($cmol\,kg^{-1}$)
T1	$4{,}10^{VA}$	$4{,}40^{H}$	$0{,}23^{M}$	$4{,}50^{VL}$	$0{,}96^{H}$
T2	$4{,}47^{VA}$	$6{,}39^{VH}$	$0{,}35^{M}$	$22{,}19^{M}$	$1{,}28^{VH}$
T3	$4{,}01^{VA}$	$4{,}13^{H}$	$0{,}21^{L}$	$12{,}05^{L}$	$0{,}26^{L}$
T4	$4{,}20^{VA}$	$6{,}47^{VH}$	$0{,}39^{M}$	$4{,}06^{VL}$	$0{,}38^{M}$
T5	$3{,}80^{VA}$	$3{,}59^{H}$	$0{,}19^{L}$	$4{,}79^{VL}$	$0{,}26^{L}$
T6	$3{,}85^{VA}$	$5{,}62^{VH}$	$0{,}26^{M}$	$22{,}07^{M}$	$0{,}26^{L}$
T7	$3{,}92^{VA}$	$6{,}09^{VH}$	$0{,}28^{M}$	$20{,}19^{M}$	$0{,}32^{M}$
T8	$3{,}94^{VA}$	$4{,}29^{H}$	$0{,}16^{L}$	$20{,}92^{M}$	$0{,}26^{L}$
T9	$4{,}16^{VA}$	$6{,}47^{VH}$	$0{,}17^{L}$	$6{,}38^{VL}$	$0{,}38^{M}$
T10	$3{,}97^{VA}$	$7{,}42^{VH}$	$0{,}28^{M}$	$2{,}47^{VL}$	$0{,}45^{M}$
T11	$3{,}62^{VA}$	$6{,}08^{VH}$	$0{,}24^{M}$	$3{,}77^{VL}$	$0{,}38^{M}$
T12	$4{,}05^{VA}$	$3{,}52^{H}$	$0{,}16^{L}$	$1{,}16^{VL}$	$0{,}32^{M}$
T13	$3{,}91^{VA}$	$3{,}67^{H}$	$0{,}17^{L}$	$0{,}73^{VL}$	$0{,}51^{M}$
T14	$3{,}89^{VA}$	$5{,}46^{VH}$	$0{,}31^{M}$	$7{,}55^{VL}$	$0{,}45^{M}$
T15	$4{,}02^{VA}$	$5{,}15^{VH}$	$0{,}22^{L}$	$22{,}50^{M}$	$0{,}45^{M}$

(L) Low; (M) Medium; (VA) Very Acid; (VL) Very Low; (VH) Very High; (H) High
Soil Chemical Properties Assessment Criteria Based on LPT (1983)

the very low to moderate category. Manurung et al. (2017) stated that total nitrogen is the total amount of nitrogen in the soil, both in the form available to plants and as organic compounds that have not been fully decomposed. The soil N-total distribution map is shown in Figure 2.

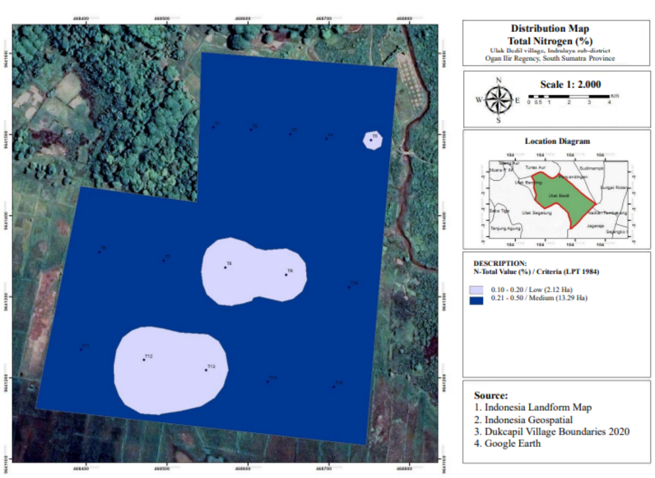

Figure 2. Map of Soil N-Total Distribution

The variation of nitrogen content in soil is determined by several factors, such as climate, vegetation, topography, physical and chemical properties (Nospagiarti et al., 2020). In line with the statement (Yuliani et al., 2017) which states that, variations in soil nitrogen content are influenced by topography, climate, and slope. The process of erosion, leaching, and nutrient removal through harvesting also contributes to differences in nitrogen levels. High surface flow and erosion accelerate nutrient loss from the nutrient-rich topsoil.

3.2.4 Soil P-Available

Based on Table 2, the P-available in the research location, shows that the average soil sample analyzed falls into the very low to medium category with a range of values between 2.47 $mg\,kg^{-1}$ to 22.50 $mg\,kg^{-1}$. The available P nutrient content of the soil was obtained through laboratory analysis using the Bray 1 analysis method. The results of the soil P-available distribution map can be seen in Figure 3.

The very low availability of phosphorus (P) in the soil for plants is also influenced by soil pH (Agustina et al., 2020). Research conducted by Latifa et al. (2023) also revealed that the levels of P-available in the paddy soil of Talang Padang Village, Talang Padang District, were included in the very low to medium category, with values

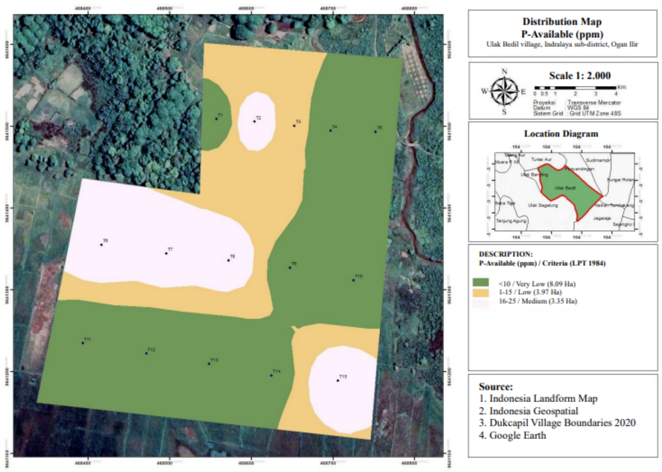

Figure 3. Map of soil P-Available distribution

ranging from 7.35 $mg\,kg^{-1}$ to 22.83 $mg\,kg^{-1}$. According to Zainuddin et al. (2019), the availability of phosphorus (P) in soil is influenced by the content of organic matter which plays a role in regulating the ability of soil to absorb P nutrients. Soils with high levels of organic matter tend to have low levels of P absorption, while soils with low levels of organic matter usually show higher levels of P absorption.

3.2.5 K-exchangeability of Soil

Based on Table 2, the K-dd in the research area soil analyzed in the laboratory using the NH_4OAc 1 N pH 7 extraction method ranged from 0.26 $cmol\,kg^{-1}$ to $cmol\,kg^{-1}$. Based on the classification of soil chemical properties according to LPT (1983), the K-dd in paddy soil at Ulak Bedil Village is included in the low to very high category. The results of the soil K-dd distribution map can be seen in Figure 4.

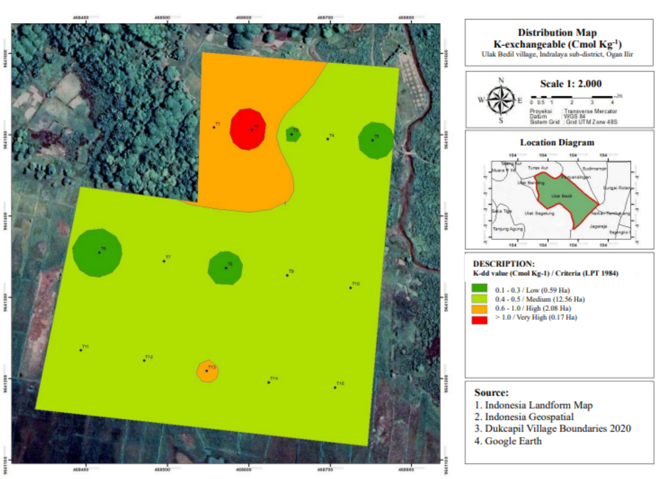

Figure 4. Soil K-exchangeable Distribution Map

Potassium is available to plants in the form of exchangeable potassium (Kdd) and soluble potassium (K^+). Factors such as pH and cation exchange capacity (CEC) affect the availability of potassium in the soil. The low content of exchangeable potassium (K-dd) in the soil is due to the effect of soil pH on the amount of available potassium. Potassium availability is further reduced if the aluminum (Al) content in the soil is high, which in turn can reduce reducing sugars in the roots and crowns of plants. In soils with low pH, potassium is more susceptible to being carried away by water flow, so it is more easily lost (Oklima et al., 2024). In flooded paddy fields, this trait contributes to an increase in potassium nutrient content (Fadilla et al., 2024).

3.3 Recommendations for Location Specific Doses of N, P, and K Fertilization for Paddy Rice

Based on Agriculture and P. (2020), the calculation of nitrogen (N) fertilizer dosage is adjusted to the productivity level of paddy rice plants. At low productivity levels (less than 5 $tons\,ha^{-1}$), about 200 kg of urea per hectare is required. For medium productivity (5-6 $tons\,ha^{-1}$), the recommended dose of urea ranges from 250 to 300 $kg\,ha^{-1}$. While at high productivity levels (more than 6 $tons\,ha^{-1}$), the required urea dosage can reach 300-400 $kg\,ha^{-1}$. One way to improve soil conditions and increase rice productivity is to provide inputs that are appropriate to the needs of the plant. Fertilization recommendations are obtained based on the analysis of N-total, P-available, and K-dd contents in the soil, which are then converted using the formula for calculating the doses of urea, SP-36, and KCl fertilizers. The results of the urea, SP-36 and KCl fertilizer recommendations are presented in Table 3.

Based on the comparison of recommendation doses in Ulak Bedil village with the recommended doses for Indralaya sub-district (Urea 200 $kg\,ha^{-1}$, SP-36 100 $kg\,ha^{-1}$, and KCl 100 $kg\,ha^{-1}$), some differences were observed. Urea recommendations in Ulak Bedil Village ranged from 26.09-126.09 $kg\,ha^{-1}$ with an average of 91.30 $kg\,ha^{-1}$, which is lower than the recommendation of 200$kg\,ha^{-1}$. Also for SP-36, recommendations ranged from 5.73-92.50 $kg\,ha^{-1}$ with an average of 31.03 $kg\,ha^{-1}$, which was also less than the recommended 100-(kg ha-1). However, for KCl, the recommended dose in Ulak Bedil Village ranged from 29.98-139.93 $kg\,ha^{-1}$ with an average of 109.65 $kg\,ha^{-1}$, slightly higher than the recommendation of 100 $kg\,ha^{-1}$. This difference reflects the specific soil conditions at the research site, where the status of available phosphorus (P) nutrients in the soil is sufficient, so SP-36 fertilization is not required. Meanwhile, nitrogen (N) and potassium (K) requirements still require fertilization, with higher KCl doses than recommended.

In summary, this study revealed that swampland in Ulak Bedil Village has highly acidic soil conditions with low to moderate nitrogen availability, very low to moderate phosphorus levels, and variable potassium content. These

Table 3. Calculation Results of Location Specific Fertilizer Dosage and Fertilization Recommendations for Lowland Swamp Rice Paddy

Sample	Calculation Result*			Recommendation**		
	Urea	SP-36	KCl	Urea	SP-36	KCl
	(kg ha^{-1})					
T1	95,65	44,53	29,98			
T2	43,48	-	-			
T3	104,35	-	139,93			
T4	26,09	50,13	121,08			
T5	113,04	40,84	139,93			
T6	82,61	-	139,93			
T7	73,91	-	130,51			
T8	126,09	-	139,93	200	100	100
T9	121,74	20,61	121,08			
T10	73,91	70,36	110,09			
T11	91,30	53,82	121,08			
T12	126,09	87,03	130,51			
T13	121,74	92,50	100,66			
T14	60,87	5,73	110,09			
T15	100,00	-	110,09			
Average	90,72	31,03	109,65	250	100	100

Description: *) The fertilizer requirements were determined based on the results of the soil chemical analysis.
**) Fertilization recommendations from the Ministry of Agriculture (2022)
- No need to add fertilizer

findings highlight the need for site-specific fertilization to optimize rice growth. The recommended application rates of 91.30 kg/ha Urea, 31.03 kg/ha SP-36, and 109.65 kg/ha KCl are expected to improve nutrient balance and increase rice productivity while minimizing environmental impacts. Future research should focus on long-term soil fertility monitoring to further refine fertilization strategies.

Application of fertilizers in accordance with nutrient needs will optimize production from cultivated land. Fertilization recommendations are useful in determining the right dose, time, and type of fertilizer, so that fertilization becomes more efficient, and increases farmers' production and income. In addition, fertilizer recommendations aim to prevent environmental pollution, maintain soil fertility, support sustainable rice production, and reduce fertilizer purchase costs. The benefits and impacts of applying the right location-specific fertilizers in terms of the required rate, timing and type of fertilizer will make fertilization more efficient, result in high production and increase farmers' income. In this way, environmental pollution is avoided, soil fertility is maintained, and rice production is sustainable.

4. CONCLUSIONS

This study revealed that swamp rice fields in Ulak Bedil Village exhibit highly acidic soil conditions (pH 3.80-4.47), with varying levels of organic carbon, nitrogen, phosphorus, and potassium. These findings confirm the necessity of site-specific fertilization to enhance nutrient efficiency and rice yield. The recommended fertilizer application rates 91.30 kg ha^{-1} Urea, 31.03 kg ha^{-1} SP-36, and 109.65 kg ha^{-1} KCl are expected to optimize nutrient availability while minimizing environmental impact. Implementing these location-specific fertilization recommendations can increase rice yields, reduce production costs and minimize nutrient runoff, thereby contributing to sustainable swamp rice farming. Future research should explore long-term soil fertility monitoring and the economic impact of proper fertilization for smallholder farmers.

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REFERENCES

Agoesdy, R., H. Hanum, A. Rauf, and F. S. Harahap (2019). Phosphorus and Potassium Nutrient Status in Rice Fields in Tanjung Morawa District, Deli Serdang Regency. *Journal of Soil and Land Resources*, **6**(2); 1387–1390. https://doi.org/10.21776/ub.jtsl.2019.006.2

Agriculture, B. P. and P. (2020). Location-Specific N, P, and K Fertilizer Recommendations for Rice, Maize, and Soybean Crops in Rice Fields (Per Subdistrict)

Agustina, C., M. Lutfi Rayes, and M. Kuntari (2020). Mapping the Distribution of N, P and K Nutrient Status in Rice Fields in Turen District, Malang Regency. *Journal of Soil and Land Resources*, **7**(2); 273–282. https://doi.org/10.21776/ub.jtsl.2020.007.2

Akbar, R. and R. Zainuddin (2023). Mapping of Soil Chemical Properties in Several Land Uses in Boyantongo Village, South Parigi Subdistrict, Parigi Moutong Regency. *Journal of Agricultural Sciences*, **11**(5); 1104–1110. https://doi.org/10.22487/agrotekbis.v11i5

Ariawan, I. M. R., A. R. Thaha, and S. W. Prahastuti (2016). Mapping of Potassium Nutrient Status in Rice Field Soils in Balinggi District, Parigi Moutong Regency, Central Sulawesi Province. *E-J. Agrotekbis*, **4**(1); 43–49

Donggulo, C. V., I. M. Lapanjang, and U. Made (2017). Growth and Yield of Rice (Oryza sativa L) Plants in Various Patterns of Jajar Legowo and Planting Distance. *Journal of Agroland*, **24**(1); 27–35

Fadilla, U., R. W. Nusantara, and R. Manurung (2024). Analysis of Some Soil Chemical Properties in Two Types of Kubu Raya, West Kalimantan. *Journal of Soil and Land Resources*, **11**(1); 247–252. https://doi.org/10.21776/ub.jtsl.2024.011.1.26

Jawang, U. P. (2021). Assessment of Fertility Status and Management of Rainfed Rice Field Soil in Umbu Pabal Selatan Village, Umbu Ratu Nggay Barat District. *Indonesian Journal of Agricultural Sciences*, **26**(3); 421–427. https://doi.org/10.18343/jipi.26.3

Langai, B. F., I. Dewi, and G. Riyyani (2024). Effect of urea fertilizer application on the growth and yield of sorghum plants in lebak swamp land. *Ziraa'Ah Agricultural Scientific Magazine*, **49**(1); 120. https://doi.org/10.31602/zmip.v49i1.13717

Lantoi, R. R., S. Darman, and Y. S. Patadungan (2016). Identification of Rice Field Soil Quality in Several Locations in Palu Valley by Lowery Scoring Method. *Journal of Agroland*, **23**(3); 243–250

Latifa, N., D. Budianta, and I. W. Ayu (2023). Determination of Site-Specific Single N P K Fertilizer Dose Recommendations for Rainfed Rice Crops. *Journal of Agri Peat*, **24**(1); 58–66

Mahbub, I. A., G. Tampubolon, M. Mukhsin, and Y. Farni (2023). Improving soil fertility and yield of paddy rice through the application of organic fertilizers. *Journal of Soil and Land Resources*, **10**(2); 335–340. https://doi.org/10.21776/ub.jtsl.2023.010.2.17

Manurung, R., J. Gunawan, R. Hazriani, and J. Suharmoko (2017). Mapping the Status of Soil Nutrients N, P, and K in Oil Palm Plantations on Peatlands. *Journal of Pedon Tropika*, **3**(1); 89–96

Mulyawan, R., R. R. Apriani, Nurlaila, N. N. Sari, and H. Ellya (2023). Soil Chemical Status in the Alabio Sweet Potato (Dioscorea alata) Cultivation System in Shallow and Middle Lebak Swamplands. *Journal of Ecosolum*, **11**(2); 157–167

Nospagiarti, T., D. Okalia, and G. Marlina (2020). Analysis of C-Organic, Nitrogen and Soil C/N in Beken Jaya Agrotourism Land. *Journal of Agroscience and Technology*, **5**(1); 11–18

Nurrohman, E., A. Rahardjanto, and S. Wahyuni (2018). Study of Soil Macrofauna Diversity Relationship with Soil C-Organic and Organophosphate Content in Chocolate Plantation (Theobroma cacao L.) Kalibaru Banyuwangi. *Journal of Bioexperiment*, **4**(1); 1–10. https://doi.org/10.23917/bioeksperimen.v4i1.5923

Oklima, A. M., S. Mastar, I. Suhada, and Y. R. Pradini (2024). Determination of Phosphorus (P) and Potassium (K) Nutrient Status of Rice Field Soil in Kaswangi Embung Irrigation Area. *Journal of Agrotechnology Samawa University*, **4**(2); 1–14

Puja, I. N. and I. W. D. Atmaja (2018). Assessment of Soil Fertility Status to Determine Site Specific Fertilization of Rice Plants. *Journal of Agrotop*, **8**(1); 1–10

Simatupang, D., D. Astiani, and T. Widiastuti (2018). Effect of Groundwater Level on Some Physical and Chemical Properties of Peat Soil in Kuala Dua Village, Kubu Raya Regency. *Journal of Lestari Forest*, **6**(4); 998–1008

Suarjana, I. W., N. A. A. Supadma, and M. D. I. Arthagama (2015). Assessment of Soil Fertility Status of Rice Fields to Determine Anjurn Balanced Fertilization Site Specific Rice Crops in Manggis District. *E-Journal of Tropical Agroecotechnology*, **4**(4); 314–323. http://ojs.unud.ac.id/index.php/JAT

Supriatin, S., S. Sarno, D. Dermiyati, and A. K. Salam (2023). Determination of Fertilization Recommendations for Rice Paddy Crops through Soil Tests in North Wonodadi Village, Pringsewu District, Lampung. *Journal of Service of the Faculty of Agriculture, University of Lampung*, **2**(1); 123–134

Syachroni, S. H. (2019). Assessment of Some Soil Chemical Properties in Rice Field Soils in Various Locations in Palembang City. *Journal of Sylva*, **8**(2); 60–65

Syahri, S. and R. U. Somantri (2013). Response of rice plant growth to PUTS and KATAM fertilization recommendations from the R & D in South Sumatra. *Journal of Suboptimal Land*, **2**(2); 170–180

Virgawati, S., O. Padmini, and M. E. Poerwanto (2014). Soil NPK Mapping for Precision Fertilization Recommendation Prediction in Rice Crops. *National Seminar of Indonesian Agricultural Engineering Association*; 161–164

Wijaya, R. and D. Budianta (2023). In situ determination of NPK fertilization for rice growth in intensive farming systems. *Journal of Agricultural Technology and Smart Environment*, **1**(1); 1–6

Yuliani, S., Daniel, and M. Achmad (2017). Analysis of Nitrogen Content of Rice Field Soil Using Spectrometer. *Journal of Agri Techno*, **10**(2); 188–202

Zainuddin, Zuraida, and Y. Jufri (2019). Evaluation of Phosphorus (P) Availability in Intensive Rice Fields of Sukamakmur District, Aceh Besar Regency. *Journal of Agricultural Student Science*, **4**(4); 603–609