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Land Suitability and Agricultural Technology for Rice Cultivation on Tidal Lowland Reclamation in South Sumatra

Kesesuaian Lahan dan Teknologi Pertanian untuk Budidaya Padi di Lahan Reklamasi Rawa Pasang Surut Sumatera Selatan

Momon Sodik Imanudin[1*)], Probowati Sulistiyani[1], M. Edi. Armanto[1], A. Madjid[1], Anton Saputra[2]

[1]Department of Land, Faculty of Agriculture, Universitas Sriwijaya, 30662, South Sumatra, Indonesia
[2]Center for Data and Information on Swamp and Coastal Areas, South Sumatra, Indonesia
[*)]Corresponding author: momonsodikimanudin@fp.unsri.ac.id

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ABSTRAK

Lahan pasang surut adalah lahan potensial untuk pertanian, dan sangat luas di temukan di kawasan pesisir Sumatera Selatan. Ada lebih kurang 400.000 ha telah dibuka untuk pertanian. Di sisi lain, di beberapa wilayah produksi padi masih rendah (<3 ton/ha), terutama di lahan yang tinggi tipe C (air pasang tidak masuk ke lahan). Penelitian ini bertujuan untuk mengevaluasi tingkat kesesuaian aktual dan potensial pada lahan rawa pasang surut untuk tanaman padi. Penelitian ini telah dilaksanakan di Desa Bandar Jaya Kecamatan Air Sugihan Kabupaten Ogan Komering Ilir. Penelitian ini menggunakan metode survai tingkat sangat detail (intensif) dengan skala 1:6.000 dengan luas areal penelitian 16 ha. Hasil penilaian kesesuaian lahan aktual untuk tanaman padi adalah N-n dengan luas 5 ha dan N-f,n dengan luas 11 ha dengan faktor pembatas pH tanah dan unsur hara P. Kelas kesesuaian lahan potensial untuk tanaman padi di lokasi penelitian yaitu S3-n dengan luas 5 ha dan S3-f,n dengan luas 11 ha. Peningkatan perbaikan kualitas lahan adalah dengan pemberian kapur dan menjaga muka air tanah pada kedalaman minimal 10 cm dari permukaan tanah selama pertumbuhan padi. Air hujan harus di tahan di petakan lahan sebanyak mungkin untuk kebutuhan air tanaman. Pengaturan waktu tanam (November-Januari) dan pemupukan berimbang akan mampu meningkatkan kelas kesesuaian lahan menjadi S1 (sangat sesuai).

Kata kunci: kesesuaian lahan, pasang surut, tanaman padi

ABSTRACT

Tidal lowland is one of the potential lands for agriculture that is found very widely in coastal areas of South Sumatra. There are about 400,000 hectares (ha) was reclaimed for agriculture purpose. However, in many parts, the rice production is still low (<3 tons/ha), mainly in the high part of hydrotopography class (Type C) that the tidewater could not possibly irrigate the land. This study aimed to evaluate the level of actual and potential suitability of tidal swamps for rice plants. This research has been carried out in Bandar Jaya Village, Air Sugihan Subdistrict, Ogan Komering Ilir Regency. This research used a survey level method with very detailed (intensive) with a scale of 1:6,000 covering a research area of 16 ha. The results showed that actual suitability for rice plants in the study site is N-n with an area of 5 ha and N-f, n with an area of 11 ha with limiting factors of soil pH and P nutrient. The potential land suitability class for rice plants in the study location is S3-n with an area of 5 ha and S3-f, n with an area of 11 ha. Land quality improvement was done by using the lime application and control water table at a depth of at least 10 cm from the soil surface during rice growth. Rainwater should be retained in the tertiary block as much as possible to fulfill crop water requirements. Setting the planting time (November-January) and balanced fertilization will be able to increase the land suitability class to S1 (highly suitable).

Keywords: land suitability, rice, tidal lowland

INTRODUCTION

The increase of population numbers should be followed by increase of food supply. Staple food for Indonesian citizens is rice so that yearly rice production shoulde be increased. Added by Rohman and Maharani (2017) rice is the main food comodity in Indonesian society, almost the entire population consume rice. Thus, the rice commodity to have a very strategic value, apart from because control the live of many people, to be used as a parameter of economic and social stability.

On the other hand, rice land area on Java island is steadily decreasing due to conversion into industry and housing areas so that agricultural area should be developed into out of Java island. Area development at South Sumatra is focused on swamp land, especially on tidal lowland area. There are approximately 380,000 ha that have been reclaimed for agriculture purpose (Imanudin et al., 2018)

Tidal lowlad areas is located at area along the coast, river bank flow area or swamp area which get into interior area up to about 100 km or as far as the influence of the tidal movement (Mamat & Noor, 2018). Therefore, the tidal lowland is the one which is affected by seawater tidal movement or river water or river at its surrounding. This land is usually flooded during rainfall season and at dry condition during dry season in which watertable depth is dropped more than 50 cm (Khairullah & Noor, 2018). According to Imanudin et al. (2019) stated that at C-typology land, the depth of water table at dry season can be up to 90-120 cm below soil surface, whereas phyrite layer was found at depth of 60-80 cm so that most of land experience phyrite oxidation. This condition causes the decrease of land quality especially for rice crop cultivation. Reported by Razie (2019) when the phyrite layer is less than 50 cm, the maximum rice production is only 3.9 tons/ha.

Tidal lowland area at South Sumatra, especially at Banyuasin District, usually had high productivity. For instance, Telang I and II areas had already had Planting Index (PI) of 200 and average rice production of 5-6 tons/ha (Bakri et al., 2020). However, for C-typology area especially at Delta Sugihan area, rice production was lower than 4 tons/ha and had Planting Index (PI) of 100 (Imanudin et al., 2016). Therefore, technological improvement efforts are needed related to soil quality and water management (Imanudin et al., 2017). Acid sulphate soil with good management effort can produce rice yield of 7,5 tons/ha in Malaysia. The main key factor is improvement of water manegament system besides addition of ameliorants material (Shamshuddin et al., 2013).

Technological improvement, on soil and water managament in tidal lowland development was the best alternative to overcome problems of rice production increment and agricultural land conversion into non-agricultural land allotment. Tidal lowland has advantage especially in term of water sufficiency aspect. The problem is how to manage water that is available in sufficient amount, proper time and good quality (Imanudin et al., 2019). Moreover, addition of soil conditioners material (organic matter) can increase soil pH and decrease Aluminum concentration that is toxic to crops (Rendana et al., 2018). The water management system in acid sulphate soils must have a proper leaching and plushing capacity to clean the oxidation product (Yusuf & Mukhlis, 2020).

Land evaluation results so far at tidal lowland area of C-typology (acid sulphate) are marginally suitable (S3) which can be maximally improved into somewhat suitable (S2). The main constraint factor is shallow phyrite layer, nutrients retention and low pH, especially at zone of 30-60 cm (Mawardi et al., 2018; Subagio, 2019). Therefore, assessment of land suitability at acid sulphate land is important to be discovered in order to deterimen the main constraint factors that had high influence to rice crop cultivation. On tidal lowland areas, the status of the ground water table has a very significant effect on plant growth. So that the season growing period becomes the main limitiation for crop cultivation (Imanudin et al., 2020). Moreover, Dengiz (2013) showed that analysis of land suitability class had produced significant yield on rice production potential. The very suitable class (S1) will produce higher yield than that of quite suitable (S2), however if the land has many limiting factor especialy water availability, it was better not planted rice (Agbeshie & Adjei, 2019). Therefore, the study of land capability class is important to be conducted for development of an area, especially for tidal lowland area. El Baroudy et al. (2020) in the process of land suitability analysis, the physical and chemical parameters of the soil is play the infortant role. There are permanent parameters that cannot be changed and will become the main limitation.

Subsequently, actual and potential land suitability class will be evaluated. Potential assessment will be conducted by using different approach because planting pattern and planting time had high effect on water sufficiency of rice crop. Water management is not only for flooding, but also for promoting the land leaching (Olivier et al., 2000). On the other hand, excessive drainage should be avoided to prevent phyrite oxidation (Vo Quang et al., 2020). This study aimed to evaluate the level of actual and potential suitability of tidal swamps for rice plants in Bandar Jaya Village, Air Sugihan District, Ogan Komering Ilir Regency.

MATERIALS AND METHODS

This research has been conducted at Bandar Jaya Village, Air Sugihan Subdistrict, Ogan Komering Ilir District (Figure 1). Soil analysis was conducted at Laboratory of Chemical, Biological and Soil Fertility, Soil Department, Faculty of Agriculture, Universitas Sriwijaya from November 2018 up to January 2019. The research area is categorized as C-type flooding land. This land does not receive high tidal water for irrigation. High tidal water just fill up the tertiary channel. Therefore, rainfall water is the main asset for water supply of crop water requirement.

Equipments used in this study were as follows: 1) Laboratory equipments, 2) Belgian drill, 3) Hoe, 4) GPS (*Geografic Position System*) (*Geografic Position System*), 5) Field knives, 6) Tape. Materials used in this study were as follows: 1) Soil samples, 2) Work location map, 3) Materials for laboratory analysis and 4) Other materials suchas plastic bag and labeling paper.

This study used survey method of very detail (intensive) level with scale of 1: 6,000 and study area of 16 ha. Sampling points were taken by using path system or grid with 1 sample represents area og 1 ha. Distance between sample points is 100 m x 100 m so that 16 sample points were obtained for the whole area of the study.

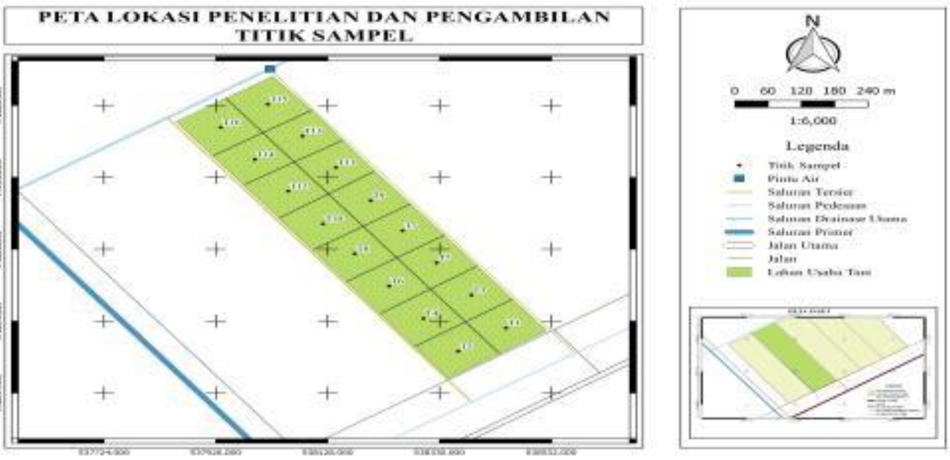

Figure 1. Schematic of soil sampling plots

Soil parameters analyzed in laboratory were consisted of pH, N-total, CEC K_2O, P_2O_5, salinity and texture. Secondary data was climatic data from the study location, The Assessment process for detemine the land capability class for rice crop was conducted by using mathching method between crop requirement and condition of land biophysical characteristics. Standard for land matching is based on land suitability criteria according to CSR/FAO, 1983. The main limiting factors are the depth of the sulpidic layer, low pH, and water table satus in tertiary block. Thus, the planting time is very important in rice cultivation (Panhwar et al., 2016). Analysis of high and low tidal water and ground water table pluctuation was conducted by using secondary data from previous study.

RESULTS AND DISCUSSION

General Condition of The Study Location

Bandar Jaya Village, Jalur 25 Blok B, Air Sugihan Subdistrict, Ogan Komering Ilir District is included in area of Delta Air Sugihan Kanan. Bandar Jaya Village is bordering Marga Tani Village on the North, Tirta Mulya Village on the east, Mukti Jaya Village on the south, Nusantara Village and PT. SAML on the west. This village is developed in 1981 as transmigration village.

Based on flooding types, Bandar Jaya Village is categorized as tidal lowland area of C/B zone which receive tidal seawater and it has water with freshwater characteristics, but this area is affected by salt water during excessive dryness (dry season). Most part of this village has C-typology. High tidal water can not overflow land, but it enters into channel. The function of high tidal water inflow to channel is to maintain water table depth not to drop quickly at dry season.

Farmers had yard land and arable land. Most of yard land is planted with perennial crops such as rubber and oil palm. Some farmers had planted oil palm at arable land. However, most of arable land I and II are planted with rice crop and secondary crops. Planting pattern that will be developed nowadays is rice-corn. However, agricultural productivity is still low. The impact of long dry season in 2015 had effect on agricultural production in 2016. Planting season on period of November-Februari 2016 showed the lowest yield in which rice production was only 2-3 tons/ha. This is due to pests and low soil quality.

In addition, high tidal water supply can not flow into channel because it is frequently contains pollutants which are toxic for crops. Therefore, farmers at initial phase should retain rainfall water as much as possible within tertiary channels.

Climate and Hydrology

Climatic data obtained from Station of Meteorology, Climatology and Geophysics (BMKG) Kelas I Kenten Palembang is rainfall data and monthly air temperature for the last ten years (2010-2019).

Yearly average rainfall can be determined from monthly average rainfall. Yearly average air temperature and yearly average rainfall as well as number of dry months are the required data in assessment activity for a crop based on reference framework of CSR/FAO (1983).

Based on the collected 10 years data (2010-2019), the study location had yearly average air temperature of 27.27 ^{o}C with the highest temperature of 27.77^{o}C in 2015 and the lowest temperature of 25.71 ^{o}C in 2014. Based on the collected 10 years data (2010-2019), the study location had yearly average rainfall of 2,468.6 mm with the highest rainfall of 3,409 mm in 2014 and the lowest rainfall of 1,642 mm in 2015. Based on the collected 10 years data and adjusted to land suitability which refers to CSR/FAO Staff (1983), the study area is classified into Highly Suitable seen from rainfall data.

Dry month is determined from monthly rainfall with magnitude of less than 75 mm which refers to CSR/FAO Staff (1983) and the study location has no dry month based on this criteria. However, most of rainfall water during rainfall season is lost into primary channel and subsequently flow into river due to poorly water management system. Water table in soil will drop if water is not available in channel. It is noted that water table at dry season can drp 90 cm below soil surface. This condition is certainly unsuitable for crop cultivation, especially for rice crop. Therefore, rice cultivation is highly depended on season. The ideal planting season is in November-February period known as Planting Season I (MT1).

The study area can not receive high tidal water so that gravitational irrigation can not be implemented. Therefore, crop water requirement is mostly from rainfall water supply and capillary movement within soil. Water management system resembles rainfed rice. Criteria for actual land suitability are not suitable for rice crop, but it can be changed by changing of planting season and management. Suitability class could be only S1 (Highly Suitable) if rice is planted in November and harvested in February. This condition should be accompanied by water retention effort in tertiary channel by closing tertiary channel gate so that rainfall water can be stored, i.e. long storage concept. Full water condition in this channel will decrease percolation rate and even zero percolation so that rainfall water can be stored in land for 3 months planting season period and land was flooded (Figure 2). Good rice growth can be achieved at this condition.

Figure 2. Water condition at tertiary channel as results of rain water detention

Land Characteristics

Based on CSR/FAO (1983), factors which influence rooting condition are soil drainage class, soil texture and soil effective depth that will be explained as follows:

1. Land drainage class

Drainage is water curvature or water channel in soil surface or below soil surface either naturally developed or man-made. Drainage shows water seeping from soil or soil condition which shows period and frequency of water saturated condition. Drainage condition can determine crop types that capable to grow. Land drainage system in the study area is very good because land had high porosity at upper part. However, clay was found at depth of more than 40 cm which make drainage begins to become obstructed. Reported by Triadi (2018) the water movement in the soil is highly efected by porosity. Development on peatlands for plantations to be managed with controlled drainage pattern. Controlled drainage can slow down soil subsidence and reduce fire risk and minimize bad impact by water level fluctuations in land. Drainage controlled obtained by designing the system so that the water level can be maintained the water level is at the effective depth which is more or less constant throughout the year.

Based on field observation, soil drainage class at the study location in general is poorly drained. Drainage class which is classified as *poorly drained* is characterized by soil having gley color (reduction) and spooting or rusty iron and/or little part of mangan at layer up to soil surface (Djaenuddin et al., 2011). Drainage condition is not the main constraint for paddy field rice cultivation. During the rainy season when the tertiary gates are closed, the ground water level can be inundated to a depth of 10-20 cm. It was good potential for rice cultivation. Maintenad water level in tertiary canal at 100 cm was good effect to have water storage during dry season. Thus, the canal able to full of water in rainy season and may have flod water in tertiary block during the rice growing period (Imanudin et al., 2018).

2. Soil Texture

Soil texture is relative comparison amongst sand, loam and clay fractions. Soil texture is one of soil properties that highly determine soil capability to support crop growth. Soil texture will affect soil capability to store and to deliver water as well as to provide nutrients for crops. Laboratory analysis results showed that soil in this study area are sandy clay loam and sandy loam.

Results from laboratory analysis showed that soil in this study area had two textural classes which are dominated by sandy clay loam covering area of 13 ha and sandy loam covering area of 3 ha.

3. Effective Depth

Effective soil depth is soil depth that can be penetrated by roots of crop. Number of roots, either fine roots or coarse roots as well as the depth in which roots can penetrate soil and in if roots of crop are unavailable, then effective depth is determined based on soil solum depth. Results of field observation showed that effective depth at the studylocation was in the range of 60-75cm covering area of 16 ha. The value of effective depth was suitable for agricultural crop.

4. Nutrients Retention

Nutrients retention is ability to hold and to release nutrients in soil. Nutrients retention or capability to hold nutrients which is observed and processed in laboratory for this study area is cation exchange capacity (CEC) and soil pH. Analysis results in laboratory showed that CEC concentration of soil at the study area is classified as low with magnitude of 7.5 - 15 (Cmol/kg).

Cation Exchange Capacity (CEC) is soil chemical property which is closely related to soil fertility. Soil having high CEC has better capability to absorb and provide nutrients than that of low CEC. Because nutrients are available within colloid sorption complex, then these nutrients are not easily leached by water. Soils with high organic matter content or high clay content have higher CEC than soil with low organic content or sandy soils (Soewandita, 2008).

5. Soil Reaction (pH H_2O)

Based on analysis results of soil fertility obtained from laboratory, the study area had soil pH of 3.31 (Sm) – 4.60 (M) which is classified as very acid. Based on term of reference of CSR/FAO (1983), the study area had very acid pH. This low soil pH can be caused by rainfall and insufficient land cultivation. Low pH of soil can also affect nutrients availability at the study area. Therefore, inputs in form of fertilizers and lime should be added in order to increase soil pH. Reported by Santri et al. (2019) The dose of lime for rehabilitating acid sulfate soils ranges from 12-20 tons/ha. The application of lime will be effective when accompanied by the addition of organic matter.

6. Nutrients Availability

Nutrients that accessed are nitrogen nutrient in form of N-total soil (%), phosphorous nutrient in form of available P_2O_5 (ppm) and potassium nutrient in form of available K_2O (Cmol/kg). Based on analysis results in Laboratory of Chemical, Biological and Soil Fertility, Soil Department, Faculty of Agriculture, Sriwijaya University showed that N-total value at the study location was 0.01-0.14 %. N-total values at the study location on sample points of T1, T2, T3, T4, T5, T11, T13, T15 and T16 are less than 0.10 with very low criteria according to CSR/FAO 1983, whereas N-total values on sample points of T6, T7, T8, T9, T10 and T14 are higher than 0.10 with medium criteria according to CSR/FAO 1983.

N nutrient is essential macro nutrient that can be substituted by other nutrients and crop will have poor growth if this nutrient is unavailable (Hanafiah, 2005).

Laboratory analysis results showed that available P at the study location is very low in the range of 0.65 to 7.45 ppm. Based on reference framework of CSR/FAO (1983) for rice crop, the study location which represented by sample points T1 – T16 had very low available. Phosphorus (P) is one of essential nutrients for crops. Crops desperately need phosphorus for their growth. However, available phosphorus that can be absorbed by crops within soil is very low. This is due to the fact that phosphorus within soil is available in form of absorption (Hardie et al., 2014). Reported by Fahmi et al., 2012) optimum water management and the provision of organic matter can improve the leaching process to reduce iron levels in the soil and increase the availability of phosphorus nutrients in the soil

Laboratory analysis results showed that K_2O content was medium with values in the range of 0.32-0.64 me/100 g. Based on reference framework of CSR/FAO (1983), the study location represented by sample points T2 – T16 had K_2O content with medium criteria, whereas sample points T1 had K_2O content with high criteria.

7. Phyrite Layer Depth

Phyrite layer was found at depth of 60-70 cm. This condition is hazardous because watertable level condition in dry season can drop below 90 cm. Phyrite layer oxidation in a long time cause the land become very acid and land suitability level become unsuitable. Therefore, intensive leaching should be done during rainy season. Low rice production at this time is also due to acid pH and high aluminum concentration as a result of phyrite oxidation.

8. Salinity

Salinity is natural process which related to landscape and soil formation process.. Salts within soil can originate from parent material weathering which contains salts deposit. In the dry season, high tide or irrigation water often contains salt, this condition can increase soil salinity levels in the soil. The use of water by plants and evaporation from the soil surface can cause salt deposit in the root zone. Therefore, the salinity parameter is the main indicator for agricultural pruposes in tidal lowland areas (Suvra Das et al., 2020). Laboratory analysis results showed that the highest salinity value was found on sample point T7 with magnitude of 3.25 dS/m and the lowest salinity value was found on sample point T2 with magnitude of 0.58 dS/m, respectively. Salinity content at each sample points had similar category for sample points T1-T16 having the salt category with the highest salt content found on sample point T7 and the lowest salt content found on sample point T2.

Land Suitability Assessment

Land suitability is the matching level of land for specific usage. Based on several physical and chemical properties of soil as well as field observation on the study location, there are some results that can be matched with growing requirement of rice crop according to criteria of CSR/FAO Staff (1983).

1. Actual Land Suitability

Based on land suitability criteria for rice crop, temperature of 27.19°C is classified as land suitability class S1 (very suitable) and rainfall data for the last ten years (2010-2019) showed that average rainfall at the study location with magnitude of 2,4865 mm is classified as land suitability class S1 (very suitable). Dry month is determined from monthly rainfall with magnitude less than 75 mm so that is classified as land suitability class S1 (very suitable). Based on field observation, soil drainage class at the study location is classified as obstructed (*poorly drained*) so that classified as land suitability class S2 (quite suitable). Laboratory analysis results showed that soil texture at the study location had two textural classes which are dominated by sandy clay loam and sandy loam so that its land suitability class is S1 (very suitable). Results of field observation showed that effective depth at the study location was in the range of 60-75 cm covering area of 16 ha so that its land suitability class is S1 (very suitable). Laboratory analysis results showed that criteria of soil CEC content at the study location is low with magnitude of 7.5-15 (me/100g) so that its land suitability class is S2 (quite suitable). Laboratory analysis results of soil fertility sjowed that the study location had soil pH of 3.31 which classified as very acid so that its land suitability class is N (unsuitable). Laboratory analysis results showed that N-total value at the study location is in the range of 0.01-0.14 % so that its land suitability class is S3 (marginally suitable). Laboratory analysis results showed that available P content of soil is vey low in the range of 0.65-7.45 ppm so that its land suitability class is N (unsuitable). Laboratory analysis results showed that available K content of soil is classified as medium in the range of 0.32-0.64 me/100g so that its land suitability class is S1 (very suitable). Laboratory analysis results showed that salinity value at the study location is in the range of 0.58-3.25 dS/m with the lowest value found at T2 sample point of 0.58 dS/m so that its land suitability class is S1 (very suitable).

Analysis results of several physical and chemical properties of soil and field observation at the study location can be matched wuth growth requirement of rice crop according to criteria of CSR/FAO Staff (1983) and it is shown in Table 1. Actual suitability for rice crop in Table 1 at sample points of T1, T2, T5, T14 and T16 showed actual suitability class of N-n (unsuitable) with the limiting factor of P nutrient covering land area of 5 ha, whereas at sample points of T3, T4, T6, T7, T8, T9, T10, T11, T12, T13 and T15 showed actual suitability class of N-f,n (unsuitable) with limiting factors of soil pH and P nutrient covering land area of 11 ha. This condition showed that total land rehabilitation is needed to make acid sulphate land to become productive. Moreover, the study area is actual acid sulphate land in which phyrite layer is frequently oxidized at dry season.

2. Potential Land Suitability

Actual suitability at the study location can be improved to potential suitability with addition of specific inputs and improvement efforts in order to fix and to improve land suitability at the study location in accordance with growth requirement of rice crop. Assessment results of land suitability for rice crop are unsuitable (S3). This is in line with research conducted by Armanto et al. (2013) at Delta Saleh which classified the land as unsuitable for rice crop (S3). However, over the course of 5 years of water management improvement and lime addition, average rice production nowadays at Delta Saleh achieve 5 tons/ha (Imanudin et al., 2012).

Effort needed to improve the limiting factors that exist on actual land suitability is through inputs addition so that it becomes potential land suitability class. Table 1 showed that observation points of T1, T2, T5, T14 and T16 having actual suitability N-n with limiting factor of P nutrient can be improved by P fertilizer addition so that it can be improved into S3-n, whereas at observation points of T3, T4, T6, T7, T8, T9, T10, T11, T12, T13 and T15 having actual suitability N-f,n with limiting factors of soil pH and P nutrient can be improved into S3-f,n by addition of lime and P nutrient. Potential land suitability for rice crop at the study location and the recommendation for improvement is given in Table 2.

Strategy for Increasing Rice Production

On tidal lowland areas farticulary in acid sulphate soil the lad suitabilty analysis in the actual condition was showed unsuitable for rice. Land capability class being limited by nutrient retention, phyrite depth, high acidity level and the existence of toxic elements such as aluminum and iron. On the other hand, quality of network system should be improved to facilitate land leaching and to control water table height.

This requires hard effort in rehabilitating the land and requires long time to achieve suitable condition (S1) for rice growth. Ar-Riza et al. (2015) had reported that treatments of water control and balance fertilizing capable to achieve rice production of 3.42 tons/ha. Meanwhile, research in Kalimantan showed that rice crop of Impara variety response to N and P fertilizers at acid sulphate land was quadratic and liming at dose of 3 tons/ha was significantly increase rice production.

Table 1. Actual land suitability for rice crop

Sample Code	Area (ha)	Actual Suitability	Limiting Factors
T1,T2,T5,T14,T16	5	N-n	P nutrient and high concentration of Al and Fe
T3,T4,T6,T7,T8,T9,T10,T11,T12,T13,15	11	N-f,n	Soil pH and P nutrient, shallow phyrite layer

Remarks: n = available nutrient (P); f = nutrient retention

Table 2. Potential land suitability

Sample Code	SPT	Potential Suitability	Limiting Factors	Input
T1,T2,T5,T14,T16	15	S3-n	P nutrient	P fertilizer addition, land leaching at initial rainfall period
T3,T4,T6,T7,T8,T9,T10,T11,T 12,13,T15	21	S3-f,n	Soil pH and P nutrient	Lime addition, land leaching at initial rainfall period

Notes: n = available nutrient (P); f = nutrient retention

Treatment on Impara rice variety at demo area scale gave rice production in the range of 5-6 tons/ha (Khairullah and Noor, 2018). Moreover, Shamshuddin et al. (2013) using plot-scale field experiment gave rice production in the range of 4-7 tons/ha. This field experiment used application of standard NPK fertilizer and compost addition at dose of 0.25 t/ha. This condition provides a new hope to maximize acid sulphate land as rice production center in South Sumatra.

Thus, improvement strategy can be formulated in managing acid sulphate land in Air Sugihan as follows: First, water management improvement: the objective is to facilitate land leaching at initial priod of rainfall season. It requires small channel every 6 m with depth of 20 cm. The first rainfall in October-November is left to leach the land and quarterly channel gate should be opened so that water flows into tertiary channel. Tertiary channel is cleaned and normalized so that rainfall water storage is increasing in channel. Channels equipped with gate that has function to retain rainfall water with a target that for 1 month the tertiary channel is full of rainwater. Second, rainfall harvesting effort by closing water gates in tertiary and quarterly channels strating from middle of November (rice had already grown) up to harvesting period in the end of February. This condition provides roots area with sufficient water and land can be flooded by rainfall water.

Third, lime is still requred at initial phase. Dolomit application at dose ranging 15 tons/ha to 30 tons/ha was the best treatment to remidiate the acid sulphate soil and capable to create soil pH condition with magnitude of 4.5 to 5.5 (Lestari et al., 2016; Ramadhan et al., 2018). In addition, fertilizing at the correct dose and time using NPK macro nutrients should be conducted. Urea at dose of 100kg/ha and Ponska-type NPK at dose of 150 kg/ha and 2:1 intermittent row planting can produce maximum production of 4.1 tons/ha (Subagio, 2019). Forth, the new breakthrough is needed in addition to water management improvement, fertilizers and lime in forms of soil conditioners application such as biochar from rice husk as well as rock phosphate addition. To improve soil quality, farmer should applied the phospat fertilizer. The optimum doses of Phospat was 60 kg P_2O_5/ha during the dry season and 80 kg P_2O_5/ha in the rainy season. (Nguyen et al., 2017). Biochar utilization as soil conditoners substance had been known since 1870. Biochar has alkaline property and capable to increase soil pH as well to improve soil physical properties (Juhrian et al., 2020). In addition, biochar application on acis sulphate soil will capable to decrease aluminum solubility and iron as well as to increase P nutrient availability. Głąb et al. (2016) also stated that biochar application can increase soil porosity which in turn increases soil ability to absorb water.

CONCLUSION

Actual land suitability for rice crop at the study location showed that land had N suitability (unsuitable) with soil pH and P nutrient as the limiting factors. Potential land suitability class for rice crop at the study location was S3-n with limiting factor of P nutrient as well as S3-f,n with limiting factors of soil pH, phyrite depth and P nutrient. It is recommended to increase P nutrient through P fertilizer addition and to increase soil pH through additionof lime in order to increase land suitability value for rice crop at the study location. Improvement of water management system is needed to facilitate land leaching during soil tillage and rainfall water retention during rice growth period. By closing the tertiary gate during rice cultivitation period (November up to February), the rainfall was maximaize to retain in the canal and the water table could flod in the rice field. Farmer setting the planting time (November-January) and balanced fertilization will be able to increase the land suitability class to S1 (highly suitable).

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