Vol. 13, No. 1 (2024): 132 - 146 http://dx.doi.org/10.23960/jtep-l.v13i1.132-146

JURNAL TEKNIK PERTANIAN LAMPUNG

ISSN 2302-559X (print) / 2549-0818 (online)
Journal homepage : https://jurnal.fp.unila.ac.id/index.php/JTP

Specifications of Sugar Cane Varieties Based on Land Characteristic and Typology

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Article History:

Received : 26 October 2022
Revised : 15 August 2023
Accepted : 17 September 2023

Keywords:

Soil drainage,
Soil texture,
Soil type,
Soil typology,
Sugarcane varieties.

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ABSTRACT

The productivity of sugarcane is decreasing and there are more and more varieties in circulation. The decrease in productivity is caused by the incompatibility of each variety of land typology. The purpose of this research is to arrange the right varieties in increasing the productivity of sugarcane. The research method is surveying and matching. Parameters used include soil texture, land type conditions, soil drainage conditions, and rainfall. Based on the research results, the total working area of 11,866.81 ha was divided into 4 land typologies, namely BHJ with an area of 2,910.95 hectares (24.53%), BPJ with an area of 2,047.44 hectares (17.25%), RHL an area of 471.12 hectares (3.97%), RPL area of 1,527.01 hectares (12.87%). Based on land typology the suitability of BHJ varieties of sugarcane suitable varieties PSMLG 1 AGRIBUN, VMC76-16, NX03, PS921, PSJT941, PSDK923; BPJ land typology of suitable varieties Cenning, VMC71-238, PA0218, NX01, Kentung, AASAgribun, PSJT 941, PSDK923, PSBK051, NX02; RHL land typology of suitable varieties PSKA 942, PA028, PSBK061, VMC76-16, AMS Agribun, ASA Agribun, PSJT941, NXI4T, MOJO01, Bululawang; RPL land typology of suitable varieties PS881, TLH02, PSKA 942, PSBK061, PS091, PSJK922, VMC86-550, PS862, PS851, PSCO902, Kidang Kencana, PS882, PS092, PS865, PS864, NXI4T, Bululawang.

1. INTRODUCTION

Most of the land on the island of Java is used for agricultural businesses with food crops, horticulture and plantation commodities. In general, there are many companies and business entities operating in the agricultural sector on the island of Java (Basuki *et al*., 2021a). East Java is a province that has good land potential and there are several factories with main commodities processed from agricultural products such as sugar cane (Basuki *et al*., 2022; Basuki & Winarso, 2021). Areas that are central to sugarcane cultivation in East Java include Situbondo Regency which has five sugar factories (PG), of which by 2022 there will only be 3 sugar factories operating, namely PG Asembagoes, PG Panji, and PG Wringinanom (Durroh, 2018). PG Asembagoes operates in the eastern part of Situbondo Regency, PG Panji operates in the central area of Situbondo Regency, and PG Wringinanom operates in the western part of Situbondo Regency. PG Wringinanom is located in Wringinanom Village, Panarukan District, Situbondo Regency.

PG Wringinanom has a milling capacity of 1,200 TCD (ton cane per day). PG Wringinanom in the process of producing sugar depends on sugar cane plants. The sugar cane produced comes from agricultural land in the area of Situbondo Regency. 80% of the sugarcane land planted comes from community sugar cane and the rest belongs to PG.

The sugarcane planting process requires high inputs such as inputs, especially fertilizer and seeds (Apriscia *et al*., 2016; Haqi *et al*., 2016). The land area in the PG Wringinanom work area decreases every year, while the annual target increases. In the last 10 years, the decline in sugarcane plantation area has decreased by 30-40% (Basuki *et al*., 2022). On the other hand, the land of PG Wringinanom experienced degradation, decreasing the suitability of varieties, which caused production not to meet the expected target of 2,000 tons per day (Wibisono, 2021). Sugarcane plant varieties do not match the land typology so production does not meet expectations (Basuki, 2020; Erni *et al*., 2015). Sugarcane varieties planted on land have characteristics of three types of maturity, namely early, middle and late maturity (Erlina *et al*., 2017; Permana *et al*., 2018; Sari *et al*., 2021).

The planting and milling processes are always carried out in the same month, between April and October (Ardiansyah & Purwono, 2015; Jayanti, 2016). The crop varieties planted are mostly late ripening varieties (average yield 7%) so that the resulting yield is not high. In ideal plan, between April-October, it should be divided into 3 types of ripening varieties such as in April-May planting early ripening sugarcane varieties (yield 9-10%), in June-July, plant a mid-ripe sugarcane variety (yield 9%), and in August-October, plant a late-ripe sugarcane variety (yield 9%). Based on these conditions, there are big problems for partners, namely the decreasing of working area, the low suitability status of varieties for land so that production targets are difficult to be achieved. The aim of this research is to revitalize the on-farm part of the Wringinanom sugar factory by organizing the compatibility of varieties with the land and making decisions regarding the suitability of the right variety so that the productivity of the sugar cane plant increases according to the expected target with a yield of 9-10%.

2. MATERIALS AND METHODS

Research activities were carried out in the working area of PG Wringinanom, Situbondo Regency (Figure 1), with coordinates 113.764572 to 114.093045 E, and 7.623746 to 7.69972 S. Soil analysis was conducted at the Laboratory of the Faculty of Agriculture, University of Jember. The research was carried out in July-October 2022. The tools used in the survey activities included a soil drill, dagger, clinometer, compass, GPS, Quantum-GIS software, a set of laboratory analysis tools and mapping analysis. Materials used in research include distilled water, soil samples, topographic maps, climate maps, land use maps, soil maps, rainfall data, raffia rope, and laboratory analysis materials.

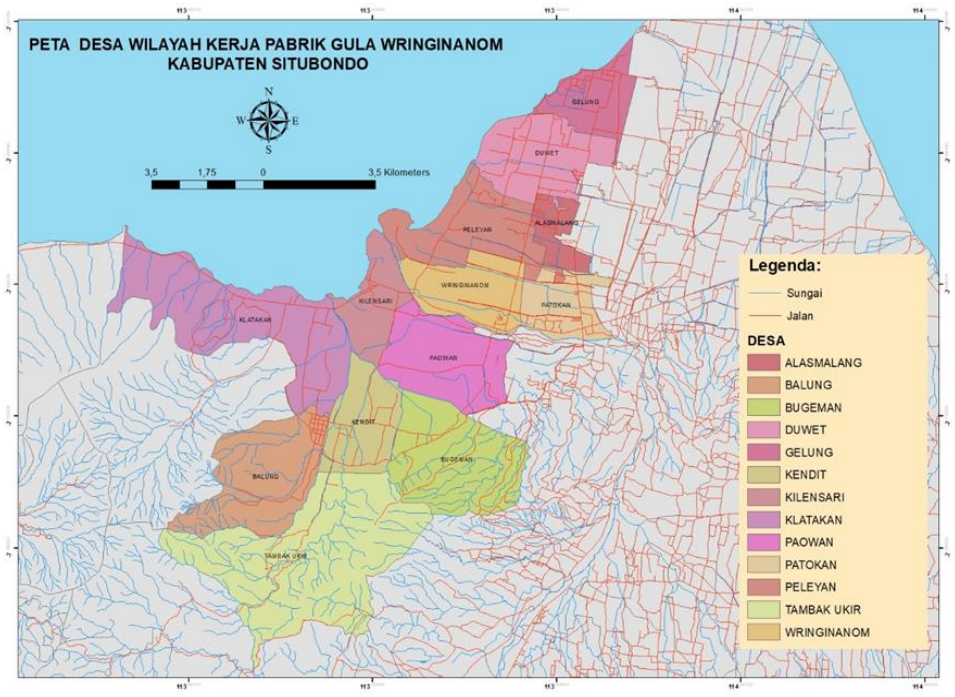


Figure 1. Map of the working area of the PG Wringinanom, Situbondo Regency

The research is classified as exploratory research using a descriptive survey approach method (Basuki *et al*., 2022). Research activities were divided into 3, including pre-survey, field survey, and post-survey. The aim of the pre-survey activity was to find out the distribution of sugarcane varieties planted by PG Wringinanom and farmers. This activity included collecting information regarding the location of variety planting coordinates as well as studying literature related to the distribution of sugarcane varieties in the period 2020-2022. The resulting field survey activities included soil drainage characteristics, climate, topography and landform data, soil types, and soil samples for laboratory analysis. Post-survey activities included laboratory analysis to determine soil characteristics. Soil characteristics included texture using the pipette method (Basuki, 2020; Subardja *et al*., 2014); soil drainage using a color spot approach in the field (Basuki, 2020; Rohmat & Soekarno, 2006). The results of laboratory analysis were combined with the results of field analysis to create a land typology map. Land typology was used as a basis for matching the description of each clonal variety of sugar cane. Description of land suitability for clonal sugarcane varieties was presented in Table 1.

Table 1. Description of sugarcane plant varieties

No.	Sugarcane Variety	Typology	Ripe (mature)
1	PSMLG 1 AGRIBUN	BHJ	Early
2	Cenning	BPJ	Early
3	VMC 71-238	BPJ	Early
4	PA0218	BPJ	Early
5	NX01	BPJ	Early
6	PSKA 942	RHL	Early
7	PA028	RHL	Early
8	PS 862	RPL	Early
9	PS881	RPL	Early
10	TLH 02	RPL	Early
11	PSKA 942	RHL, RPL	Early
12	PSBK061	BPJ , RHL	Early
13	PS091	RPL	Early
14	PSJK 922	RPL	Early
15	VMC 86-550	RPL	Early
16	PS 851	RPL	Early
17	PSCO 902	RPL	Early
18	VMC76-16	BHJ, RHL	Mid
19	NX03	BHJ	Mid
20	PS 921	BHJ	Mid
21	PSJT 941	BHJ, BPJ, RHL	Mid
22	Kentung	BPJ	Mid
23	AAS Agribun	BPJ	Mid
24	AMS Agribun	RHL	Mid
25	ASA Agribun	RHL	Mid
26	Kidang Kencana	RPL	Mid
27	PS882	RPL	Mid
28	PS092	RPL	Mid
29	PS 865	RPL	Mid
30	PSDK923	BHJ, BPJ	Late
31	PSBK051	BPJ	Late
32	NX02	BPJ	Late
33	NXI4T	RHL, RPL	Late
34	MOJO 01	RHL	Late
35	BL	RHL, RPL	Late
36	PS864	RPL	Late

Note: BHJ = land with clay content >30%, rain-fed irrigation system, poor drainage system; BPJ = land with clay content >30%, irrigation/pump water system, poor drainage system; RHL = land with clay content < 30%, rain-fed irrigation system, smooth drainage system; RPL = land with clay content < 30%, irrigation/pump water system, smooth drainage system (Basuki, 2020).

3. RESULTS AND DISCUSSION

The working area of PG Wringinanom in Situbondo Regency covers the villages of Klatakan, Balung, Tambakukir, Bugeman, Kendit, Kilensari, Wringinanom, Patokan, Alasmalang, Peleyan, Duwet and Gelung (Figure 2). The sugar cane land categories used to plant sugar cane which is milled at the PG Wringinanom consist of the own sugar cane (TS) and the smallholder (partnering farmers) sugar cane (TR) category (Andoyo & Wibowo, 2019). The smallholder sugar cane category dominates with a land area percentage of 85%. The own sugar cane is planted by and at the expense of PG Wringinanom either through land rental or through land owned by the sugar factory. The smallholder sugar cane is sugar cane owned and managed by the community or farmers, either at subsidized or non-subsidized costs from PG Wringinanom.

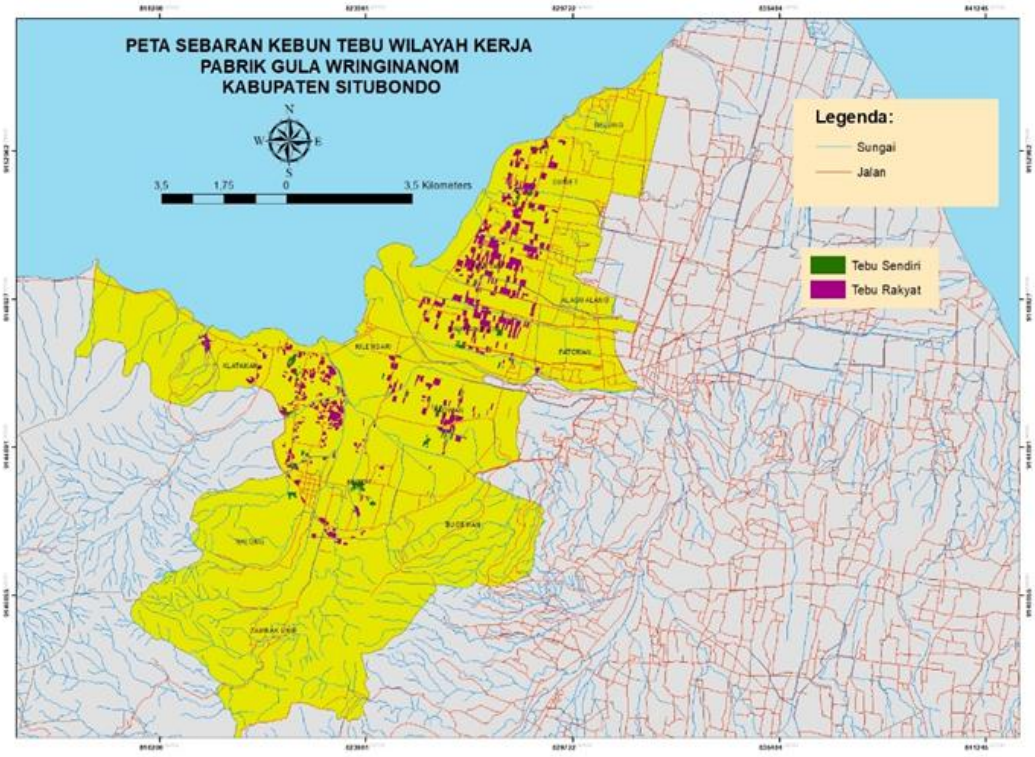


Figure 2. Map of the distribution of sugar cane plantations in the working area of the PG Wringinanom, Situbondo Regency

3.1. Land Characteristics

3.1.1. Rainfall

Sugarcane are planted mostly in rice fields and dryland as well (Putra, 2020). According to Basuki (2020), in order to produce optimally sugarcane cultivation should be supported by sufficient irrigation water and good soil characteristics. Rainfall in Situbondo Regency is in the range of 1,000-1,500 mm/year (Hartatie *et al*., 2021). Rainfall in the PG Wringinanom working area which includes 12 villages, namely Klatakan, Balung, Tambakukir, Bugeman, Kendit, Kilensari, Wringinanom, Patokan, Alasmalang, Peleyan, Duwet and Gelung, has an average of 980 mm/year for 10 years (2007-2022) with an average of 53.3 rainy days. Rainfall <2,000 mm/year is classified as a dry climate according to the exploration scale of rainfall distribution and climate type (Kusumo & Septiadi, 2016; Mulyani *et al*., 2020; Sasminto *et al*., 2014). In the 10 year period of 2007-2022 there was rainfall below 1,000 mm/year or even below 500 mm/year, which indicates years where rainfall was very low (Pramuhadi, 2016). Table 2 shows very low rainfall with amounts of 230 mm/year (2009), 551 mm/year (2010), and 569 mm/year (2015).

Table 2. Rainfall in the PG working area. Wringinanom

Year	Jan	Feb	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Sum
	mm											
2007	19	71	381	8	93	0	4	0	0	32	219	827
2008	326	453	150	11	15	0	0	0	0	19	66	1040
2009	179	34	6	5	0	0	0	0	0	0	6	230
2010	41	43	9	16	37	11	4	18	32	196	144	551
2011	428	268	153	40	30	0	0	0	0	13	205	1137
2012	451	285	419	19	38	0	0	0	0	0	338	1550
2013	0	220	249	156	181	0	0	0	0	215	0	1021
2014	519	505	36	158	0	0	0	0	0	0	24	1242
2015	243	16	150	97	0	0	0	0	0	0	0	506
2016	78	289	170	202	0	76	1	0	309	262	941	2328
2017	204	245	161	59	39	0	0	0	0	0	142	850
2018	197	234	156	60	31	0	0	0	0	0	122	800
2019	190	202	169	140	0	0	0	0	0	0	140	841
2020	250	230	190	120	0	0	0	0	0	0	139	929
2021	220	222	186	122	87	0	0	0	0	0	141	978
2022	211	210	178	130	14	0	0	0	0	0	110	853
Average	222	220	173	84	35	5	1	1	21	46	171	980

The rainy season in the PG Wringinanom working area on average starts from November to April (Table 2). The highest peak rainfall in the PG Wringinanom working area on average occurs in January with a value of 228 mm/month except in 2007, 2010, 2013, 2016. Meanwhile, the dry season in this area peaks in September. Sugarcane is an annual plant with a harvesting period of 9-12 months which is divided into 4 growth phases including the germination phase, tiller multiplication phase, stem elongation phase, and maturity phase (Jayanti, 2016). The process of propagating tillers and the stem elongation phase of sugarcane requires a lot of water, so high water intake is required (Permana *et al*., 2018). Water supply can come from irrigation water or rainwater (Hakim, 2010).

Oldeman divides climate types based on wet months and dry months which are used as a basis for managing annual plants such as sugarcane (Kusumo & Septiadi, 2016; Nasution & Nuh, 2018; Sasminto *et al*., 2014; Wunangkolu *et al*., 2019). Considering that sugar cane is an annual crop, management is based on the Oldeman climate type classification (Basuki & Sari, 2020; Sari *et al*., 2021). Wringinanom has 3 consecutive wet months (rainfall of more than 200 mm/month), which occurs in December-February, and 7 consecutive dry months (rainfall of less than 100 mm/month) occurs in May-November. Based on the Oldeman classification on the number of dry months being 7 months and wet months being 3 months, the PG Wringinanom working area is included in the D4 climate type category (Sasminto *et al*., 2014).

3.1.2. Topography and Landform

The landform of the PG Wringinanom working area is in the alluvial plains, old volcanic plains, flow streams, old volcanic hills, tidal swamps, old volcanic mountains, and peneplains (Apriyanto *et al*., 2020). Alluvial plains in this area are plains with a material composition constituted of sand, gravel, clay and silt sedimentation originating from the Ijen volcano, and originating from the north coast of Java with most of the composition being clay (Dengiz *et al*., 2012). The alluvial plain in the PG Wringinanom working area occupies an area of 2188.05 ha or 18.44% (Table 3). Most of the alluvial plains are in Pauwon and Kendit Villages. The second landform that makes up this area is the old volcanic mountain with an area percentage of 38.91% or 4,617.19 ha. Because this landform originates from the mountains, the parent material that makes up this landform is igneous rock without any sedimentary influence from the sea (Brahmantyo & Salim, 2006). The parent material forming this landform is basalt andesite rock. Basalt andesite is an external igneous rock composed of fine minerals and is usually white, gray to dark in color (Andreas & Putra, 2018; Kristanto & Sugarbo, 2020). Andesite is formed from the rapid cooling process of lava so that the texture formed is smoother (Andreas & Putra, 2018; Derebi *et al*., 2019). The chemical composition of andesite rocks consists of SiO_2 around 55-63%, Al_2O_3 15-17%, Fe_2O_3 1-3%, FeO 3-5%, CaO 3-6%, MgO 2-3%, Na_2O 3-4%, K_2O 0.5-1%, TiO_2 0.5-1%, MnO 0.1-0.5%, and P_2O_5 0-0.25% (Lolong & Wibowo, 2016).

Table 3. Landform of the PG Wringinanom working area

No	Landform	Luas (ha)	Presentase (%)
1	Aluvial plain	2188.05	18,44
2	Old volcanic plain	28.36	0,24
3	Flow stream	386.61	3,26
4	Old volcanic mountain	4617.19	38,91
5	Peneplain	3006.90	25,34
6	Old volcanic hill	1004.68	8,47
7	Tidal swamp	635.03	5,35
	Jumlah	11,866,81	100.00

The third dominant landform that makes up this area is the peneplain (Figure 3). Peneplain is a sloping plain area that is becoming flatter as it develops due to continuous erosion. The final result of the process is fluvial land which is influenced by exogenous forces (Prasetyo & Setyorini, 2008). The area with peneplain landforms in this region is 3,006.90 ha or 25.34%. The peneplain area is in the villages of Wringinanom, Duwet, Alasmalang, Patokan, and Peleyan. The parent material for peneplain is sandstone and claystone.

The sugarcane cultivation system requires a flat to rather flat area to facilitate the irrigation water management as part of the management of sugarcane cultivation in general (Basuki, 2020). The topography of the land in Situbondo Regency which is the sugarcane planting area for the PG Wringinanom is divided into five topographic types including flat, slightly flat, undulating, hilly, and mountainous (Figure 4). Based on the distribution of plantation land, 80% of sugar cane plantations are in flat and slightly flat topography. Flat topography (0-1%) is spread over the study area with an area of 2,823.08 ha or 23.79%, while slightly flat topography (>1-3%) is spread over an area of 3,414.81 ha or 28.78%.

3.1.3. Land Type

The land types in the PG Wringinanom working area consist of 14 land types. The dominant land types in the research area include rainfed rice fields, shrubs, irrigated rice fields, settlements, grasslands, moorlands/dryland, and ponds. Table 4 and Figure 5 show that the types of irrigated rice fields are distributed in the PG Wringinanom working area with a total area of 1,443.20 ha 12.16% of the total area. Paddy fields are land that has been treated with continuous

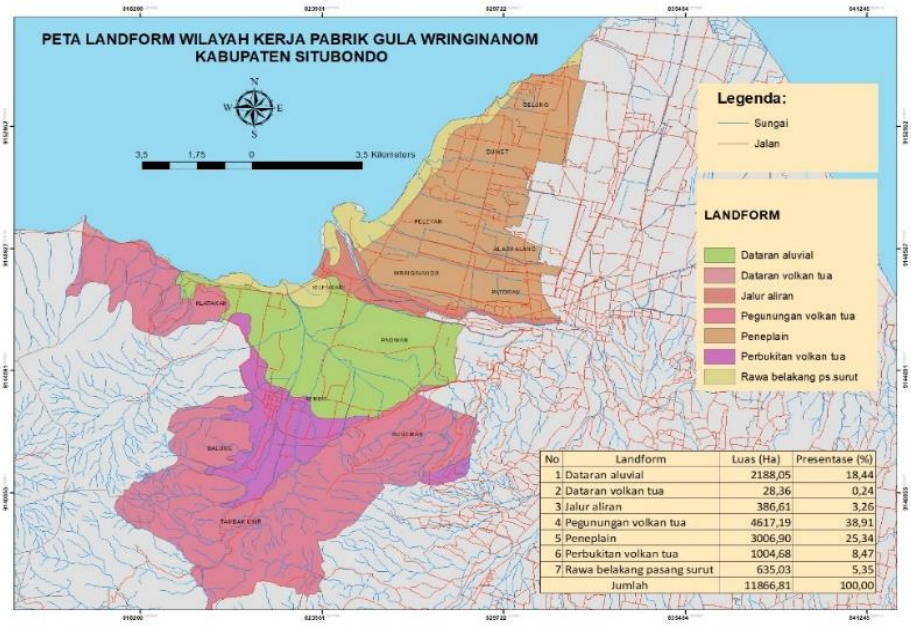
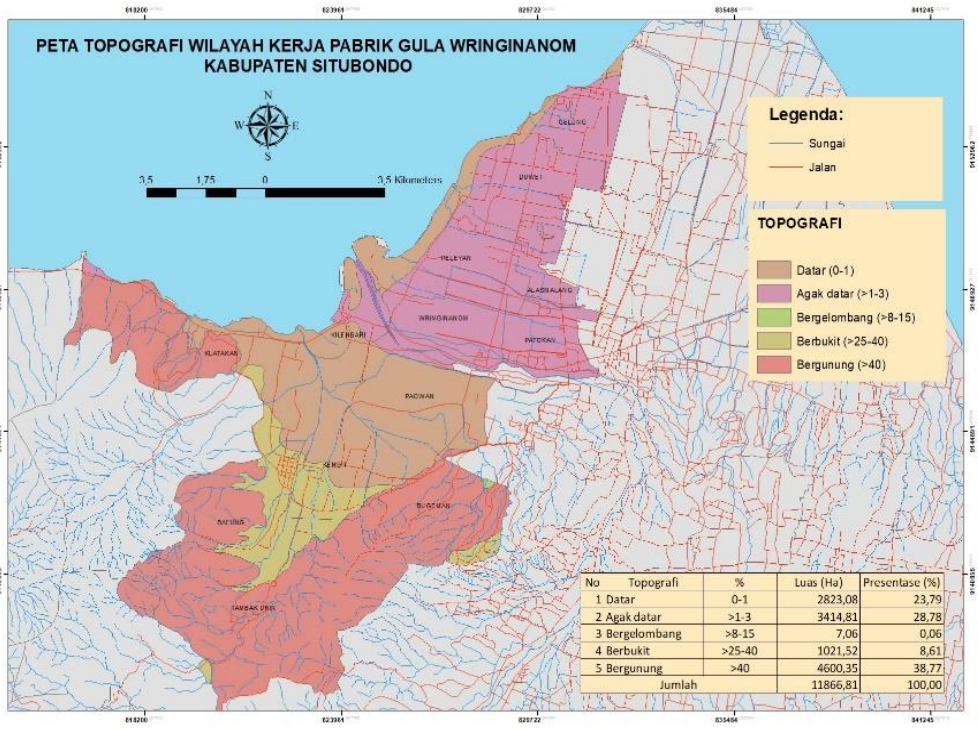


Figure 3. Landform of PG Wringinanom working area



No	Topografi	%	Luas (Ha)	Presentase (%)
1	Datar	0-1	2823,08	23,79
2	Agak datar	>1-3	3414,81	28,78
3	Bergelombang	>8-15	7,06	0,06
4	Berbukit	>25-40	1021,52	8,61
5	Bergunung	>40	4600,35	38,77
	Jumlah		11866,81	100,00

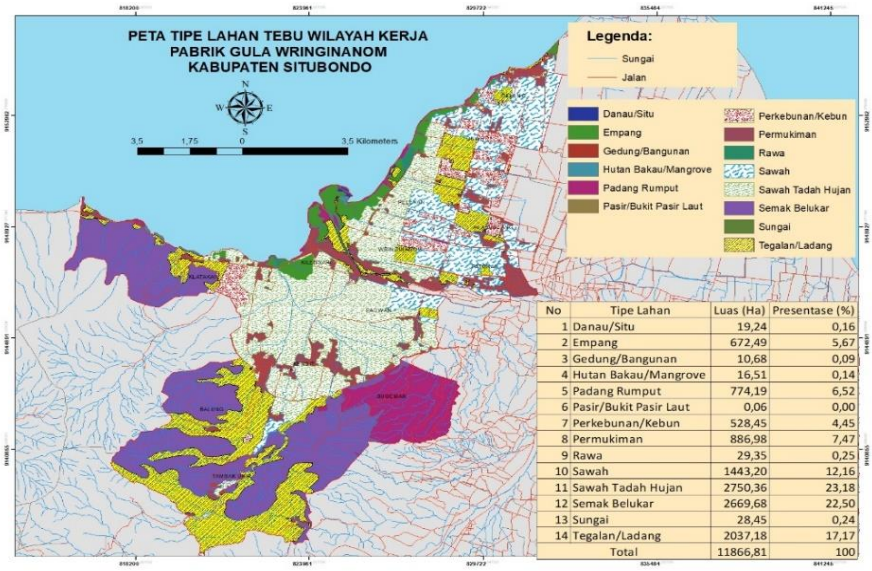
Figure 4. Topography of PG Wringinanom working area

Table 4. Land types in the PG Wringinanom working area

No	Land Type	Area (ha)	(%)
1	Lake or Situ	19.24	0,16
2	Pond	672.49	5,67
3	Building/Construction	10.68	0,09
4	Mangrove	16.51	0,14
5	Meadows	774.19	6,52
6	Marine Sand or Dunes	0.06	0,00
7	Plantation or Garden	528.45	4,45
8	Settlement	886.98	7,47
9	Swamp	29.35	0,25
10	Lowland ricefield	1443.20	12,16
11	Upland or rain-fed rice	2750.36	23,18
12	Shrubs	2669.68	22,50
13	River	28.45	0,24
14	Moorland or upland	2037.18	17,17
	Total	11,866,81	100

flooding and has soil morphological characteristics that have changed from the original soil (Ahmad et al., 2019; Azuka *et al*., 2015; Sukarman *et al*., 2020). The characteristics of irrigated rice fields are that they have a watertight layer or plow sole layer (Bdg horizon), and the condition of the soil is glaciated. Rice fields are spread across the villages of Gelung, Duwet, Alasmalang, Patokan, Wringinanom, and Peleyan.

The type of rice fields in the PG Wringinanom working area is planted with sugarcane using a semi-mechanical system considering that big tractors and heavy equipment cannot enter the rice fields because the soil is wet. The second type of land used for sugarcane cultivation in the PG Wringinanom working area is moorlands or drylands. Moorland is dryland that is cultivated by farmers or communities for cultivating plants without using continuous water



No	Tipe Lahan	Luas (Ha)	Presentase (%)
1	Danau/Situ	19,24	0,16
2	Empang	672,49	5,67
3	Gedung/Bangunan	10,68	0,09
4	Hutan Bakau/Mangrove	16,51	0,14
5	Padang Rumput	774,19	6,52
6	Pasir/Bukit Pasir Laut	0,06	0,00
7	Perkebunan/Kebun	528,45	4,45
8	Permukiman	886,98	7,47
9	Rawa	29,35	0,25
10	Sawah	1443,20	12,16
11	Sawah Tadah Hujan	2750,36	23,18
12	Semak Belukar	2669,68	22,50
13	Sungai	28,45	0,24
14	Tegalan/Ladang	2037,18	17,17
	Total	11866,81	100

Figure 5. Land type of PG Wringinanom working area

applications so that gleization does not occur and morphologically the soil does not have a plow sole layer (Bdg horizon) (Mulyani *et al*., 2020). Moorlands are spread across almost all of the PG Wringinanom working area with locations spread across several spots with a total area of 2,037.18 ha or 17.17%. Areas of distribution of moorland types include the villages of Gelung, Duwet, Peleyan, Alas Malang, Wringinanom, Patokan Paowan, Klatakan, Kendit, Balung, and Tambakukir.

The third type of land for planting sugar cane is rain-fed or upland rice fields. Upland rice fields in the PG Wringinanom have an area of 2,750.36 ha and are a large land type compared to other land types in the PG Wringinanom working area, which is used for cultivating sugar cane plants up to 23.18% (Figure 5). Rain-fed rice fields are a type of land whose irrigation system depends on rainwater (Ardiansyah & Purwono, 2015; Jayanti, 2016; Mulyani *et al*., 2020; Sinaga *et al*., 2014). The type of rain-fed land in terms of soil morphology will also change from the original land because during the rainy season this type of land is conditioned to be flooded (Sukarman *et al*., 2020). Flooding will cause the formation of redox conditions and a layer of plow tread soil even though it is thin (Darmanto & Setiawan, 2021; Wibisono *et al*., 2020). The Bd horizon in rain-fed rice fields is <1 cm thick and cannot be higher because it is always broken after the dry season.

3.2. Soil Characteristics

The classification of fine textured soils in the USDA classification system is divided into several soil textures which are based on the percentage of particle size fractions. The fine textured soil in the USDA soil classification system includes sandy clay texture, silty clay texture, and clay texture (Ferdeanty *et al*., 2020). The sandy clay texture has a compositional percentage of sand, silt, clay with the following ratios of 45-62.5%, <20%, and 37.5-57.5%, respectively. The silty clay texture has a soil fraction ratio of <20% sand, 40-60% dust, and 40-60% clay, while the clay soil texture has a ratio of sand, dust and clay fractions respectively as follows <45%, <40% , and >40%. Soil texture is part of the physical characteristics of soil which describes the ratio of 3 fractions including clay, silt, and sand (Ahmad *et al*., 2019; Sugandi *et al*., 2017). The results of the analysis of the distribution of soil texture in the PG Wringinanom working area are divided into two classifications of soil texture including fine soil texture and slightly fine soil texture (Table 5).

The soil texture in the second PG Wringinanom working area is quite fine, which in the USDA classification includes the texture of sandy clay loam and silty clay loam. The texture of sandy clay loam has a composition ratio of sand, silt and clay fractions respectively 45-80%, <30%, and 20-37.5%, while the texture of silty clay loam has a soil fraction

Table 5. Soil texture in the working area of the PG Wringinanom

No	Soil Texture	Area (ha)	Percentage (%)
1	Fine	6216.59	52.39
2	Slightly fine	5650.23	47.61
	Total	11,866.81	100.00

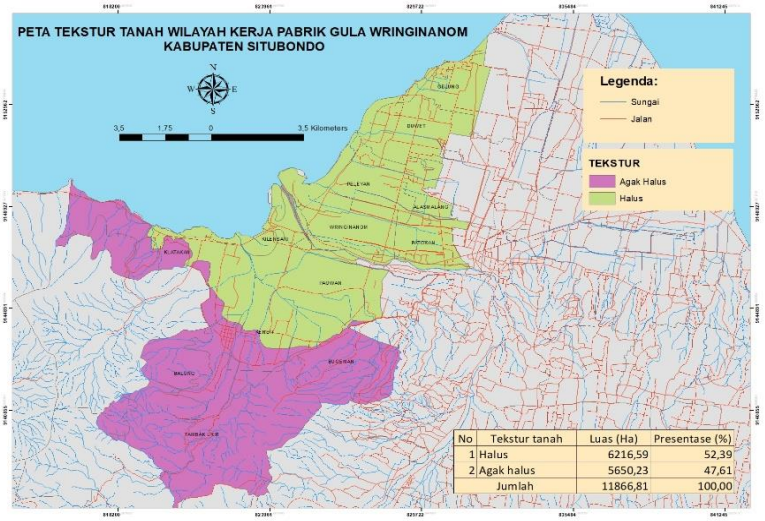


Figure 6. Soil texture in the PG Wringinanom working area

ratio of <20% sand, 40-70% dust, 27.5-40% clay (Suryani, 2013). The distribution of soil texture in the PG Wringinanom working area is shown in Figure 6. The figure shows that the soil texture in the fine category has a distribution of 6,216.59 ha (52.39%), spread across the villages of Gelung, Duwet, Peleyan, Alasmalang, Patokan, Wringinanom, Kilensari, Paowan, and Kendit. The slightly fine textured soil is spread across the PG Wringinanom working area with an area of 5,650.23 ha or 47.61% spread across the villages of Kendit, Klatakan, Balung, Tambakukir, and Bugeman (Figure 6).

Soil texture is closely correlated with soil drainage conditions with a correlation level of P = 0.865. Fine textured soils are dominated by high clay fractions compared to slightly fine and medium textured soils (Ferdeanty *et al*., 2020). The clay fraction in the soil aggregate system has an influence on several other soil characteristics such as infiltration, nutrient holding capacity, water holding capacity, ability to exchange cations, soil color, and binding media (Basuki *et al*., 2021b). The clay fraction functions as a water storage medium because the clay fraction has higher hydroscopic pores and micro pores than macro pores. The results of the analysis of soil drainage parameters show that soil with a fine texture has poor to very poor drainage, and areas with a slightly fine textured soil have good soil drainage levels.

Soil drainage conditions in the PG Wringinanom working area are divided into three categories, namely good, poor and very poor (Figure 7). Soil drainage in good condition is spread over an area of 5,650.23 ha (47.61%). Areas with good drainage are in the villages of Klatakan, Bugeman, Balung, and Tambakukir. Areas with good drainage are in areas with mountainous and undulating topography so that more water is released into lowland areas than is infiltrated into the ground (Rohmat & Soekarno, 2006). The area with soil condition of poor drainage is in the lowlands and has an area of 5,581.55 ha or 47.04%. The distribution of poor drainage soils is in the villages of Kendit, Paowan, Patokan, Wringinanom, Alasmalang, Peleyan, Duwet, and Gelung. Areas with poor drainage soils are used for rice fields, both irrigated and rain-fed. The type of soil drainage is very important in sugarcane cultivation because it will affect root development and stem elongation (Suryani, 2013). There are sugarcane varieties that are tolerant with poor drainage soils, but most are intolerant, so variety selection is very imperative. The third category related to soil drainage in this area occupies an area of 635.03 ha (5.35%), which are classified as very poor drainage category.

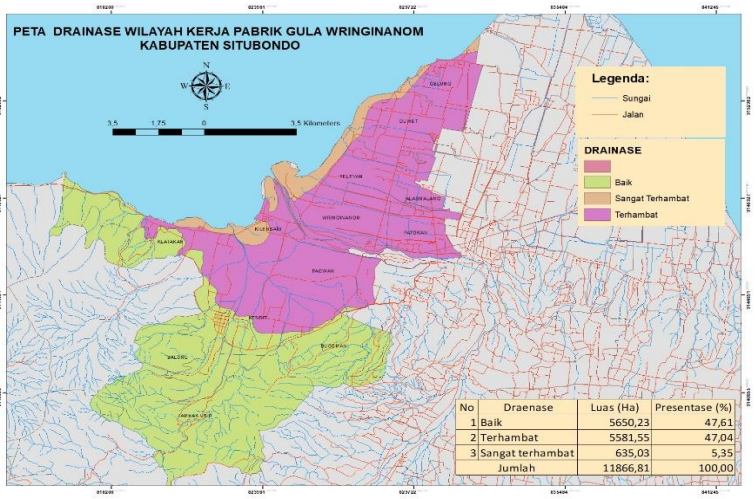


Figure 7. Soil drainage in the PG Wringinanom working area

Table 6. Soil type in the working area of the PG Wringinanom

No	Subgroup	Soil Type	Area (ha)	Percentage (%)
1	Typic Dystrudepts	Kambisol	4697.99	39.59
2	Typic Paleudults	Podsolic	952.23	8.02
3	Typic Epiaquepts	Gleisol	5581.55	47.04
4	Typic Sulfaquents	Alluvial	635.03	5.35
	Total		11,866.81	100.00

Soil types based on the USDA soil classification at the research location are divided into 3 soil orders, namely inceptisol, ultisol, and entisol (Table 6). Entisol is new, undeveloped soil composed of material with a higher sand fraction and composed of alluvial or sedimentary material such as gravel, sand, silt with a low clay content and based on the national soil classification this soil is called alluvial soil (Jimoh *et al*., 2020). The subgroup level of this soil type is in the Typic Sulfaquents subgroup category because it is supported by a fact that the soil condition is flooded for a long time and the gleization process occurs. The distribution of the Typic Sulfaquents subgroup in the study area is 635.03 ha or 5.35% spread across the coastal plain.

The Inceptisol order is divided into 2 subgroups, namely Typic Dystrudepts and Typic Epiaquepts. Typic Dystrudepts is a type of inceptisol soil that is formed with a base saturation of less than 50%. The distribution of Typic Dystrudepts is 39.59% of the research area with an area of 4,697.99 ha spread across Bugeman, Tambak carving, Balung, and Klatakan. Typic Dystrudepts soil types in the national soil classification are included in the Kabisol soil within the district Kambisol soil type (Subardja *et al*., 2014). The second type of Inceptisol soil in the Typic Epaquepts subgroup is a type of soil that is formed in flooded conditions by experiencing episaturation (saturation of the epipedon part) with water resulting in a gleization process (Staff, 2015). In the national soil classification system Typic Epiaquepts is included in the Gleisol soil with the type of eutric Gleisol soil.

The third type of soil formed at the research location, namely Ultisol, is an advanced soil composed of kaolinite clay mineralogy (Ahmad *et al*., 2019). In the UDSA soil classification system, the subgroup level of this soil type is included in Typic Paleodults (Dengiz *et al*., 2012; Staff, 2015). Typic Paleodults are spread over an area of 952.23 ha or 8.02% of the research area (Figure 8).

3.3. Suitability of Sugarcane Varieties

The suitability of sugarcane varieties is based on land typology (Ardiansyah & Purwono, 2015; Basuki, 2020). Land typology is based on three main parameters including soil texture type, irrigation conditions, and soil drainage condition (Basuki, 2020). Soil texture is divided into 2 categories, namely heavy and light. Heavy texture if it has a

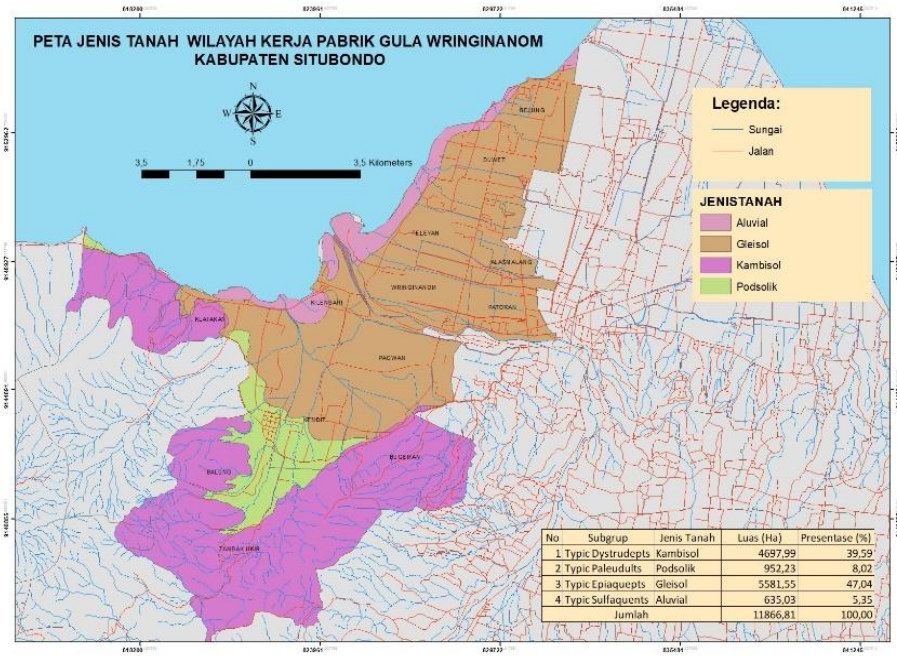


Figure 8. Distribution of soil types in the PG Wringinanom working area

clay fraction > 30% (B) and light texture if the land has a clay fraction < 30% (R). Irrigation conditions are conditions where sugar cane plants can easily obtain irrigation water for the cultivation process. The classification of irrigation systems in land typology is divided into 2 categories, namely technical irrigation and rain-fed irrigation systems. Technical irrigation water systems in the types of land including irrigated rice fields (P), while for non-technical irrigation systems include rain-fed rice fields, dryland (upland), and lands whose irrigation systems rely on rain or rainy season (H). The third parameter of land typology is soil drainage that is divided into poor soil drainage (J), and good soil drainage (B). Soil drainage conditions indicate the ability of the soil to drain water. The results of laboratory analysis show that the research area is divided into 4 land typologies for sugarcane crops, and one land typology for non-cane crops. There are four land typologies for sugar cane plantations, namely BHJ, BPJ, RHJ, RPL (Table 7). BHJ is land that has a heavy soil texture with a clay fraction of >30%, an irrigation system that relies on rainwater, and poor drainage conditions where water does not disappear from the land for more than 10 consecutive days.

Table 7 shows the distribution of BHJ land typology in the research location, 24.53% or 2,910.95 ha. The BPJ land typology in the research area is spread over 17.25% or 2,047.44 ha. The distribution of BPJ land typology is in some irrigated rice fields such as in the villages of Gelung, Duwet, Peleyan, Alasmalang, Patokan, Wringinanom, Paowan (Figure 9). Land typology with a combination of RHL, which is soil with a light texture with a clay content of <30%, rain-fed irrigation conditions, and good drainage conditions is spread across the research area with an area of 471.12 ha or 3.97%. Villages included in the RHL land typology are Kendit Village, Balung, Tambak Ukir, and Klatakan. Land typology with a combination of RPL in the research area is spread over 12.87% or 1,527.01 ha. The distribution of villages with the RPL land typology is in the villages of Balung, Klatakan, and Tambak Ukir (Figure 9).

Table 7. Land typology of the PG Wringinanom working area

No	Land Typology	Area (ha)	Percentage (%)
1	BHJ	2910.95	24.53
2	BPJ	2047.44	17.25
3	RHL	471.12	3.97
4	RPL	1527.01	12.87
5	NON Tebu	4910.30	41.38
	Total	11,866.81	100.00

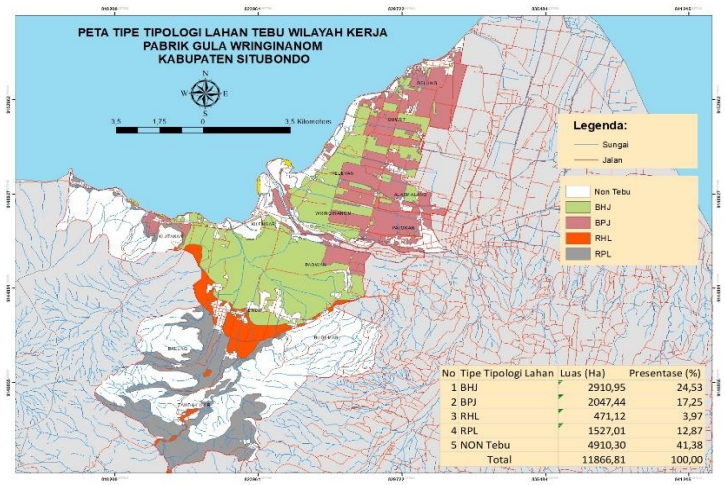


Figure 9. Land typology of PG Wringinanom working area

The results of the suitability analysis between typology and sugarcane plant varieties are shown in Table 8, which shows that the BPJ typology with an area of 2,910.95 ha for early mature sugarcane is suitable for developing the PSMLG 1 Agribun sugarcane variety; for the mid mature type, sugarcane varieties of VMC76-16, NX03, PS 921, PSJT 941 are suitable; and for late mature sugar cane is suitable for developing the PSDK923 variety. BPJ land typology type at the research location with early maturity sugarcane to produce optimal yield using appropriate varieties including Cenning, VMC 71-238, PA0218, NX01; for mid ripe variety Kentung, AAS Agribun, PSJT 941; and late mature varieties PSDK923, PSBK051, NX02. In the RHL land typology for varieties suitable for early maturity PSKA 942, PA028, PSBK061; mid ripe VMC76-16, AMS Agribun, ASA Agribun, PSJT 941; and late maturity NXI4T, MOJO 01, Bululawang. Under RPL land typology for early maturity varieties involves PS881, TLH 02, PSKA 942, PSBK061, PS091, PSJK 922, VMC 86-550, PS 862, PS 851, PSCO 902; suitable mid ripe varieties are Kidang Kencana, PS882, PS092, PS 865; and suitable late ripe varieties are PS864, NXI4T, Bululawang.

Table 8. Suitability of sugarcane varieties and maturity based on land typology

Land Typology	Varieties based on clone maturity			Area (ha)
	Early	Mid	Late	
BHJ	PSMLG 1 Agribun	VMC76-16, NX03, PS 921, PSJT 941	PSDK923	2910.95
BPJ	Cenning, VMC 71-238, PA0218, NX01.	Kentung, AAS Agribun, PSJT 941	PSDK923, PSBK051, NX02	2047.44
RHL	PSKA 942, PA028, PSBK061	VMC76-16, AMS Agribun, ASA Agribun, PSJT 941	NXI4T, MOJO 01, BL	471.12
RPL	PS881, TLH 02, PSKA 942, PSBK061, PS091, PSJK 922, VMC 86-550, PS 862, PS 851, PSCO 902	Kidang Kencana, PS882, PS092, PS 865	PS864, NXI4T, BL	1527.01
Non SC				4910.30
Total				11,866.81

4. CONCLUSIONS

Based on the results of the research related to mapping the suitability of sugarcane varieties in the PG Wringinanom working area, it can be concluded that the working area is divided into 4 land typologies, namely BHJ with an area of 2,910.95 ha (24.53%), BPJ with an area of 2,047.44 ha (17.25 %), RHL area 471.12 ha (3.97%), RPL area 1,527.01 ha (12.87%). Suitability of sugarcane varieties based on land typology are: the varieties of BHJ land typology that are suitable including PSMLG 1 AGRIBUN, VMC76-16, NX03, PS 921, PSJT 941, PSDK923; the varieties of BPJ land typology including Cenning, VMC 71-238, PA0218, NX01, Kentung, AAS Agribun, PSJT 941, PSDK923, PSBK051, NX02; the varieties of RHL land typology including PSKA 942, PA028, PSBK061, VMC76-16, AMS Agribun, ASA Agribun, PSJT 941, NXI4T, MOJO 01, Bululawang; and the varieties of RPL land typology including PS881, TLH 02, PSKA 942, PSBK061, PS091, PSJK 922, VMC 86-550, PS 862, PS 851, PSCO 902, Kidang Kencana, PS882, PS092, PS 865, PS864, NXI4T, Bululawang.

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