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Soil Fertility Evaluation for Strategic Direction Jati Plus Perhutani (JPP)

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Abstract. Soil fertility evaluation conducted to assess the characteristics of the soil and determine the significant constraint factor and alternative supervision. This research aims to determine the limiting factors of soil fertility in Jati Plus Perhutani (JPP) clonal forestry and routine plantation at the research sites in a few years of planting and determining the strategic directives of supervision. Total land of 12 soil map units evaluated based on a representative profile in the semi-detail level on the research sites of FMU Ngawi and Pemalang. Data collection of soil fertility was based on Soil Research Institute and the National Soil Survey Center guidelines. Classification of soil fertility shows that the soil was dominated by silty texture and has a flat to a moderately steep slope. Soils at the research sites have low infiltration rates, high ability to restrain water, difficult cultivation, and a high potential for a run-off on sloping land. Assessment of soil fertility status at the research sites shown of CEC and base saturation high to very high. C organic, P_2O_5, and K_2O are rated very low to low, strategic directives for land supervision and cultivation in the research sites are the application of organic substances, intensive soil management and implementation of soil conservation.

1. Introduction

Soil as the growing medium known ever since the human civilization shifted from the nomad food gatherers to the settled civilization, which carries out the transference of both food and non-food crops to the area near their settlement. Furthermore, humans began to understand the function of soil as a provider of nutrients for plants to fulfill their necessity of food, so that productivity is achieved on the ability of soil to supply the nutrients (soil fertility) [1]. Each soil has the quality and characteristics that determine its ability as the land resources. Therefore, the soil needs to be evaluated, so that it can be used optimally for a particular use.

In forestry, State Forestry Enterprise (*Perum Perhutani*) has an essential role in the revenue of the country, providers of raw material in wood industrial and enhancement of community food tenacity, as well as maintaining the forest ecosystem. Until now Perum Perhutani has had teak clones as the result of cultivation and improvement developed within research plots managed by Center for Perhutani Research and Development in collaboration with the University of Gadjah Mada, known as *Jati plus Perhutani* (JPP).

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Soil fertility is the major constraint in JPP productivity and pertinacious challenge for Perum Perhutani. Evaluation of soil fertility through soil surveys was carried out aimed to appraise the characteristics of the land and determine the significant constraint factors in soil fertility as well as alternative supervisions in order to increase the productivity of the land.

The threat of forestry production in many developing countries as the result of soil fertility degradation caused by inadequate inputs of fertility usage, continuous land reduction, and the more intense. The use of land without organic inputs and minerals to improve soil fertility [2]. The classification Assessment to the soil fertility can be appraised by the Soil Fertility Capability Classification (FCC) [3]. This research aims to determine the limiting factors of soil fertility in JPP clonal forestry and routine plantation at the research sites in a few years of planting and determining the strategic directives.

2. Method

2.1. Research Time and Sites

The research was conducted in October 2014 to August 2015. The location of the research was carried out at two Sites, namely in the JPP clonal forest and routine JPP cultivation of Forest Management Unit (FMU) Ngawi within planting years of 2008 and 2011, and in Forest Management Unit (FMU) Pemalang within the planting year of 2009.

2.2. Research Stages

The research was conducted within two stages. The first stage of the research consists of activities series, including 1). Research preparation and fieldwork map-making, 2). Fieldwork, 3). Analyzing and processing data, 4) Actual soil fertility class determination, 5) Limitation factor determination. Actual soil fertility is then used to ascertain the limiting factors as determinants of the strategic directives for Jati plus Perhutani (JPP) / Teak plus Trees cultivation.

The second research stage is making a strategic direction for planning the escalation in soil productivity associated with Jati plus Perhutani (JPP) planting at the research sites. Determination of strategic directives based on the dynamic growth of teak plus trees at each research sites by investigating the potential of each soil maps units (SMU) which are evaluated from the first stage of research by considering the limiting suitability of soil fertility from the lightest and easy handled to the hardest and difficult to overcome.

2.3. Field Data Collection and Soil Analysis

Field observations and soil fertility data collection are done by considering the guide of Soil Research Institute (2004) [4] and the National Soil Survey Center (2002) [5]. Soil analysis in the laboratory is done within the form of soil texture by using the pipette method, soil pH scale, C-organic method of Walkley and Black, N by the Kjeldahl method, P by Olsen method, K Extraction NH4Oac pH 7, Alkali exchange Ca, Mg, Na, K, Alkali Saturation and CEC extracts NH4Oac pH 7, acidity exchange Al-dd and H-dd extracts 1M KCl. Methods of laboratory analysis are based on the Technical Guidelines of soil Chemical Analysis, Plant, Water, and Fertilizer book [6]. The determination of soil sub-orders based on soil taxonomic solution [17].

3. Results and Discussion

3.1. Physical Condition of Land in Research Sites

The topography of the research sites of Forest Management Unit (FMU) Ngawi is considerably flat (<3%) to slightly slope (3-8%), with an altitude range between 50-150 m ASL (Above Sea level). The average

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rainfall measured around 2,072 mm/year, and the average temperature is 27.58 ° C with four months dryness and seven months wetness. Isohyperthermic soil temperature regime that is characterized to have average annual soil temperature ≥ 22 ° C with a temperature difference between the hottest and the coldest of less than 5 ° C. Soil moisture regime on Ustic research sites with sub-orders of Orthent and Ustert soil. While the physical condition of the land at the research site of FMU Pemalang has a flat (<3%) to moderately steep topography (15-30%), with an altitude range between 10-200 m ASL (Above Sea level). It has average rainfall measured in 2,231 mm/ year and an average temperature of 28.04 ° C with three months of dryness and eight months of wetness. Isohyperthermic soil temperature regime with Ustic soil moisture regime. Soil Sub-order on the site are Ustept, Ustalf, and Ustert.

3.2. Soil Map Unit (SMU) of Land Research Sites

Soil map units of the research site consist of 12 SMU. Soil map units of research sites, soil sub-orders, and slope are presented in Table 1.

Table 1. Soil Map Unit, Soil Sub-order, and slope at the research sites

SMU	Soil Order	Slope	SMU	Soil Order	Slope
FMU Ngawi Planting year 2011			FMU Ngawi Planting year 2008		
24b	Orthent	8%	25g	Orthent	3%
67k	Ustert	3%	108d	Ustert	3%
63a	Ustert	3%	65a	Ustert	3%
FMU Pemalang Planting year 2011			FMU Pemalang Planting year 2009		
35d	Ustalf	15%	12c	Ustept	15%
7b	Ustalf	3%	103f	Ustalf	8%
46a	Ustalf	3%	68d	Ustert	3%

3.3. Soil Physical Characteristics

3.3.1. Texture, Soil Structure and Soil Consistency

Soil texture and structure affect the amount of water and air in the soil. Smaller soil particle size has a stronger bond compared to the bigger size ones. Argillaceous textured soil, with the finer and smoother particle size, has a vaster surface, so the ability to restrain water and provide nutrients is hight. Fine-textured soil is more active for chemical reactions than coarse-textured soil [8].

The soil consistency is the ability of the soil to resist the pressure from outside forces, which are indicators of the strength degree manifestation and pattern of physical forces (cohesion and adhesion), which are working on the soil in harmony with the water saturation level [1]. Soil with the right consistency is easy to be processed soil and not attached to the soil processing equipment. The texture, structure, and consistency of the soil in the research sites are presented in Table 2.

Table 2. Soil texture, structure, and consistency in the research sites

SMU	Depth (cm)	Texture	Structure	Consistency
FMU Ngawi				
67k	0-35	Clay sandy loam	Clomp and angled	Solid
25g	0-15	Loam	Clomp and angled	Highly solid
	0-30	Clay	Clomp and angled	Highly solid
108d	30-50	Clay	Clomp and angled	Highly solid
	50-70	Clay	Clomp and angled	Solid
24b	0-15	Loam sandy	Clomp and angled	Highly solid
	0- 30	Clay	Clomp and angled	Highly solid
65a	30-45	Clay	Clomp and angled	Highly solid
	45-65	Clay	Clomp and angled	Highly solid
	0-30	Clay	Clomp and angled	Solid
63a	30-50	Clay	Clomp and angled	Highly solid
	50-72	Clay	Clomp and angled	Highly solid
FMU Pemalang				
	0 – 30	Clay	Clomp and angled	Finely solid
12c	30 – 70	Clay loam sandy	Clomp and angled	Highly solid
	70 – 150	Sandy loam	Clomp and angled	Highly solid
	0 – 20	Loam	Clomp and angled	Highly solid
103f	20 – 60	Clay	Clomp and angled	Highly solid
	60 – 80	Clay loam	Clomp and angled	Highly solid
	0 – 30	Clay	Clomp and angled	Solid
35d	30 – 80	Clay	Clomp and angled	Highly solid
	80 – 120	Clay	Clomp and angled	Highly solid
	0 – 20	Clay loam	Clomp and angled	Solid
7b	20 – 40	Clay	Clomp and angled	Solid
	40 – 60	Clay	Clomp and angled	Highly solid
	60 – 80	Clay	Clomp and angled	Highly solid
	0 – 20	Loam	Clomp and angled	Highly solid
46a	20 – 70	Clay	Clomp and angled	Highly solid
	70 – 110	Clay	Clomp and angled	Highly solid
	0 – 30	Clay loam sandy	Clomp and angled	Highly solid
68d	30 – 70	Clay	Clomp and angled	Highly solid
	70 – 100	Clay	Clomp and angled	Highly solid

3.4. Soil Chemical Characteristics

3.4.1. Soil Reaction

Soil reaction (pH) is a valuable chemical property of the soil as a device for plant growth that will affect whether it is easy or not for nutrients to be absorbed by plants, the possibility of the toxic element, and surmise the blooming of soil organisms. In the natural acidity activity (pH) of the soil can be affected by several factors, those are the prime soil material, precipitation, natural vegetation, plant growth, soil depth, and Nitrogen fertilizer (N) [18]. The soil reaction at the topsoil depth and the substratum layer at the research sites are presented in Table 3. The overall pH of the soil at the research sites is alkalis, approximately pH 7.6 to 8.5 [6].

Table 3. Soil Reaction at Topsoil layer depth and substratum layer on research sites

pH H_2O					
SMU	0-20 cm	20-50 cm	SMU	0-20 cm	20-50 cm
FMU Ngawi			FMU Pemalang		
67k	8,49	7,73	12c	8,19	7,61
25g	8,22	-	103f	7,41	8,51
108d	7,5	8,87	35d	8,63	8,14
24b	7,93	-	7b	8,15	7,61
65a	8,09	7,66	46a	8,11	8,18
63a	8,42	7,89	68d	8,26	8,21

3.4.2. *Organic Substances*

Soil organic substance is material portion that has been modified and run on new synthesis results derived from plants and animals which has classified by Winarso [15] as follows: <0.5% (very low), 0.51 to 1% (low),> 1-2% (moderate),> 2-4% (fairly high),> 4-8% (high), > 8 -15% (very high), and> 15% (peat). The organic substance influences soil characters such as its effects on soil structure, as a source of plant nutrients, increases soil ability to retain water and nutrients, and energy source for soil microorganisms [9]. The contents of organic substances, N, P, and K at a depth of topsoil and substratum layer at the research sites are presented in Table 4.

3.4.3. *Soil Nutrients*

Nutrients are one of the limiting growth. The availability of nutrients in the soil is determined by temperature, humidity, an air of soil, soil cultivation, soil reaction, and organic substance. The soil at the high temperatures and humidity, as well as good air condition, will speed the process of decomposition of organic substance up, and the decomposition process will be inhibited if the soil becomes acidic [9].

Table 4. Organic substances, N, P, and K in Depth of topsoil and substratum layers in research sites

SMU	N (%)		P (ppm)		K (ppm)		Organic Substances (%)	
	0-20	20-50	0-20	20 -50	0-20	20 -50	0-20	20 -50
	....cm..							
FMU Ngawi								
67k	0,20	0,09	1,69	2,33	9,0	5,1	2,12	1,83
25g	0,13	-	4,69		3,70	-	2,69	-
108d	0,14	0,08	2,69	2,08	15,9	2,7	2,45	1,03
24b	0,13	-	1,42	-	12,9	-	2,29	-
65a	0,12	0,06	7,40	0,90	0,70	2,8	2,28	0,86
63a	0,11	0,10	0,70	3,24	3,90	2,5	1,57	1,19
FMU Pemalang								
12c	0,06	0,05	1,05	2,55	12,8	5,8	1,03	0,67
103f	0,23	0,12	6,82	3,87	7,50	4,9	3,33	2,22
35d	0,1	0,05	0,93	1,37	10,9	7,7	1,86	1,88
7b	0,13	0,08	6,40	1,64	2,90	5,7	2,17	1,07
46a	0,19	0,08	1,34	2,86	15,8	7,3	3,76	2,31
68d	0,13	0,09	3,50	2,67	2,50	3,8	2,22	1,50

Total nitrogen soil nutrients according to BPT (2009) [6] is stated in very low rate (<0.1%), low (0.1-0.2%), moderate (> 0.2-0.5%), high (> 0, from 5 to 0.75%), and very high (> 0.75%). The total nitrogen content of the research sites is shallow (<0.1) to a low percentage (0.1-0.2%). The low level of total nitrogen content caused due to poor soil moisture and water, drainage, and non-optimal aeration, thus hindering the process of organic substance mineralization as a source of nitrogen in the soil, and inadequate vegetation that is capable of binding nitrogen.

Phosphorus contents in the soil using the Oslen method, according to BPT [6] is deficient (<5 ppm), low (5-10 ppm), moderate (> 10-15 ppm), high (> 15-20 ppm) and very high (> 20 ppm). Phosphorus nutrient availability within the soil at the research sites is relatively meager (<5 ppm) to a low level (5-10 ppm). The lowness of P nutrient content in the soil at the research site is happened due to soil reaction that slightly alkalic (pH 7.6 to 8.5) at the sites. Elfiati [7], stated that the availability of P nutrient in the soil is generally deficient due the bound to the Ca+2 ion to be Ca3 (PO4)2 in alkaline soils. Besides, P availability in the soil is determined by the rate of organic substance decomposition, as well as microorganisms activity such as fungus [11].

The total amount of potassium according to BPT [6], very low (<10 mg.gram-1), low (10-20 mg.gram-1), moderate (> 20-40 mg.gram-1), high (> 40 -60 mg.gram-1), and very high (> 60 mg.gram-1). Total potassium contents in the research sites are relatively in the rate of very low (<10 mg.gram-1) to low (10-20 mg.gram-1). The low content of potassium in the research sites is caused due to fixation of potassium in smectite clay minerals within the crystal lattice [12]. That clay minerals are some of 2:1 types, such as illites, vermiculite, and montmorillonite, which widely exist in the Vertisol soil [13].

3.4.4. Cation Exchanges Capacity (CEC) and Alkaline Saturation

Table 5. Cation exchange capacity and alkaline saturation in the topsoil and substratum layer on the Research site of FMU Ngawi.

SMU	Cation-dd (acetate 1N pH7) Ca	Mg	K	Na	CEC	Alkaline Saturation (%)
	cmol (+) kg-1				cmol (+) kg-1	
FMU Ngawi layer 0-20 cm						
67k	33.12	2.34	0.37	0.4	36.44	99.42
25g	10.37	5.30	0.05	0.50	16.26	99.75
108d	32.13	5.63	0.60	0.41	38.98	99.46
24b	38.37	1.29	0.47	0.03	40.21	99.88
65a	20.10	4.65	0.05	0.27	25.27	99.21
63a	39.23	7.33	0.26	0.47	47.56	99.43
FMU Ngawi layer 20-50 cm						
67k	35.30	1.96	0.15	0.51	38.25	99.14
25g	-	-	-	-	-	-
108d	38.77	5.61	0.16	0.59	45.51	99.17
24b	-	-	-	-	-	-
65a	29.67	5.83	0.06	0.60	36.44	99.23
63a	26.10	6.50	0.07	0.64	33.33	99.94

Table 6. Cation exchange capacity and alkaline saturation in the topsoil and substratum layer on Research site of FMU Pemalang

SMU	Cation-dd (acetate 1N pH7) Ca	Mg	K	Na	CEC cmol (+) kg-1	Alkaline Saturation (%)
	cmol (+) kg-1					
FMU Ngawi layer 0-20 cm						
12c	20.51	11.78	0.52	0.29	33.52	98.75
103f	13.60	10.99	0.37	0.28	36.06	66.14
35d	13.09	6.31	0.14	0.46	20.15	99.26
7b	15.28	9.58	0.08	0.48	25.94	98.00
46a	9.84	7.13	0.51	0.38	18.04	99.00
68d	14.85	7.14	0.11	0.48	23.15	97.54
FMU Pemalang layer 20-50 cm						
12c	23.14	7.46	0.18	0.52	31.34	99.87
103f	16.36	9.33	0.07	0.08	39.20	65.92
35d	14.37	7.11	0.10	0.54	22.21	99.59
7b	35.6	16.7	0.09	0.96	53.40	99.91
46a	8.58	9.15	0.17	0.59	19.00	97.32
68d	15.40	6.48	0.08	0.53	25.35	88.79

Cation Exchange Capacity (CEC) is a soil chemical characteristic that is related very closely to soil fertility. Soil with high CEC can ensnare and provide better nutrients than soil with low CEC. Soil with a high CEC dominated by a positive load of alkaline cations, such as Ca++, Mg+, K+, Na+, NH4+, H+, Al3+, ETC. Those cations dissolved in the soil water or sequestered by the soil colloids.
Alkaline saturation reflects the comparison among alkaline cations, hydrogen cations, and aluminum. The smaller soil alkaline saturation, the sourer it will be. 100% of alkaline saturation reflects a neutral pH of the soil, while the lack of it will lead to acid pH soil, whereas more than it will lead to alkaline [14] — cation exchange capacity and alkaline saturation in the research sites presented in Table 5. and 6.

Results of laboratory analysis show that the soil at the research sites has CEC in moderate (> 24-40 cmol (+) kg-1) to a very high level (> 40 cmol (+) kg-1). The stature value of CEC in the research sites is caused due to its soil that has a high clay content and mostly types 2:1 clay featured with expanding and contract character as in the smectite. Soil with higher clay content or high organic substances has a higher CEC than the soil, which has a low clay content and low organic substances [18].

Alkaline saturation in nearly all research sites is measured in high (> 60-80) to a very high rate (> 80). The high alkaline saturation in the research sites is caused by the high content of Ca cations in the soil due to the prime material that putrefies much Ca and the alkali cations, which cause high soil reaction and P fixation.

3.5. Soil Fertility Evaluation

Soil fertility evaluation is intended to assess the characteristics of the land and determine the significant constraints in soil fertility and figure alternative solutions put in order to increase soil productivity. This system classifies soil fertility into three categories. Those are the type, sub-type, and modifier. Types and subtypes category are determined on the basis soil texture class of topsoil (0-20 cm) and the substratum (20-50 cm). while some kinds of constraints determine the modifier category in its soil fertility. The recapitulation assessment of soil fertility capability in the research sites presented in Table 7.

Table 7. Recapitulation of Soil Fertility Capability Assessment in Research Sites

SMU	Type		Sub-type			Modifier						FCC
	L	C	L	C	R	D	b	k	i	v	(%)	
FMU Ngawi												
67k	L		L			D	b	k	i	v	3	LLdbkiv
25g	L				R	D	b	k	i		3	LRdbki
108d		C		C		D	b	k	i	v	3	CCdbkiv
24b	L				R	D	b	k	i		8	LRdbki
65a		C		C		D	b	k	i	v	3	CCdbkiv
63a		C		C		D	b	k	i	v	3	CCdbkiv
FMU Pemalang												
12c		C	L			D	b	k	i		15	CLdbki
103f	L			C		D	b	k	i		8	LCdbki
35d		C		C		D	b	k	i		15	CCdbki
7b	L			C		D	b	k	i	v	3	LCdbkiv
46a	L			C		D	b	k	i		3	LCdbki
68d		C		C		d	b	k	i		3	CCdbki

L (Loam Texture); C (Clay Texture); d (dry soil); b (Alkali react); k (K Deficiency); i (High P Fixation); v (vertic soil character); (%) Slope; FCC (fertility capability classification)

Soil fertility capabilities classification in the FMU Ngawi research site included in the soil fertility classification unit of LLdbkiv, LRdbki, and CCdbkiv. Whereas in the FMU Pemalang research site included in the soil fertility classification unit of CLdbki, LCdbki, CCdbki, LCdbkiv, and LCdbk. The capability of soil fertility in both sites are not generally different; they both consist of L and C types. L. C and R sub-type with d, b, k, i, and v modifier.

Soil fertility limiting factors contained in the research site of SMU 67k, 108d, 65a, 63a, and 7b. It is Includes several aspects, such as soil and moisture — slight alkalis soil reaction (pH 7.6-8.5). The low availability of K and P and the high soil expand and contracts potential while soil fertility limiting factors were contained in SMU 25g, 24b, 12c, 103f, 35d, 46a, and 68d. It includes several aspects. Such as soil moisture, slight alkalis soil reaction (pH 7.6-8.5). The low availability of K and P. and for SMU 24b, 12a, 103f, and 35d in addition to the mentioned limiting factor. There is also a slope factor.

The Interpretation of types and subtypes in the research sites are interpreted as follows. At SMU 67k. Types and sub-types; L showed argillaceous topsoil with clay fraction level <35% but did not include sand or argillaceous sand. It causes the soil has moderate infiltration and water restrain ability rate. The type category shown in SMU 25g and 24b; L shows argillaceous topsoil with clay fraction <35%, which led to moderate soil infiltration and ability to restrain water rate and R sub-type shows rocky lower soil layers or soil layer which cannot be penetrated by the roots. LR combined land has a higher possibility of soil degradation due to erosion, especially when the slope of the land is increasingly skewed. SMU 108d. 65a. 63a. 35d. Also, 68d shows the classification of fertility on the C type and sub-type, which shows argillaceous topsoil and lower layers with clay grading fraction > 35%. This soil has a low rate of infiltration — the high ability to restrain water.

The sloping land has a high potential for the run-off. Moreover, it is difficult to cultivate. SMU 12c has the C type shows argillaceous topsoil with clay fraction >35%. It is causing the ground to have a low rate of infiltration — a high ability to restrain water. On sloping land has a high potential in the run-off. Moreover, the land is difficult to cultivate in the sub-type with L; shows moderate infiltration and ability to restrain water rate. SMU 103F. 7b. and 46a. Shows L type classification; where they have argillaceous topsoil with clay fraction <35%. This soil has moderate infiltration and the ability to restrain the water rate.

Moreover, the sub-type, which has C classification, shows the argillaceous subsoil with clay fraction > 35%. This soil has low infiltration and a high ability to restrain water rate (if the slopes are potential, then the runoff surface is high). LC combined land has quite high soil degradation possibility due to erosion, especially when the land slope is increasingly steep.

Modifier Interpretation in SMU at the research sites has several modifiers. Those are barriers d. barrier b. barrier k. barrier i. and the barrier v. Modifier Interpretation for barrier d; soil moisture is the barrier in the dry season unless if it is irrigated; rain in early season often erratic that it interferes with germination; so deciding the right timing for planting and giving N fertilizer is necessary. Modifier Interpretation for border b; alkali react soil; the usage of natural phosphate fertilizers and another phosphate which are not soluble in water should be avoided; the high possibility of microelements substances scarcity to occur, mainly Fe and Zn. Modifier Interpretation for barrier k; the soil has the low rate ability to provide K nutrient; K nutrient availability should be frequently monitored, and K fertilization may be needed; the possibility of K-Ca-Mg nutrient availability is an imbalance. Modifier Interpretation for barrier i; the soil has the high ability to bind P, a large portion of P fertilizer or P fertilizer individual supervision by providing the right extending usage of P fertilizer sources might be needed [16]. Modifier Interpretation for barrier v; argillaceous soil texture topsoil and cracks emerging when it is dry; the soil will be difficult to be cultivated when it is too dry or too wet. The soil productivity potential is high but generally deficient in P nutrient.

Overall classification of soil fertility in the research sites has soil fraction in size that is almost identical among the layers, which leads to a more excellent texture as a result of the genesis process through putrefying and intensive leaching. The similarity in texture between topsoil and lower layers in some SMU causes some soil at the research sites to have the same type and sub-type. It affects the low infiltration rate and high ability to restrain water and on sloping lands to have the high runoff potential and to challenge to cultivate. Inhibiting factors that become the constraints are; soil moisture with ustic damp so that the soil tends to dry. Water availability at existing plants in the ground must be considered; most lands in research sites have high $CaCO_3$ (> 10-20 cmol (+) kg-1) to a very high rate (> 20 cmol (+) kg-1). It led to high soil pH and the P fixation tied by Ca; soil that has vertic feature have solid character and difficult to be cultivated.

3.6. Strategic Directives

The soil suitability and fertility evaluation in the research sites show some constraint factors that can be fixed with the medium supervision level, such as soil consistency. Nutrient retention P_2O_5 and the slope. While as for the soil fertility evaluation. Constraint factors are mostly found in silty textured soil. Soil moisture with ustic humidity. K, and P deficiency. The vertic soil character (expand and contract) and slope. So directive strategies for JPP soil cultivation at both sites are the application of organic substances. Intensive soil supervision and implementation of soil conservation.

4. Conclusion

Constraint factors of soil fertility, silty texture, soil moisture with ustic humidity, K and P deficiency, vertic soil characteristic (expand and contract), and the slightly sloping slope (3-8%) to moderately steep (15-30%). Strategic Directives for the JPP soil cultivation and supervision at both sites are the application of organic substances, soil supervision, and implementation of intensive soil conservation.

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