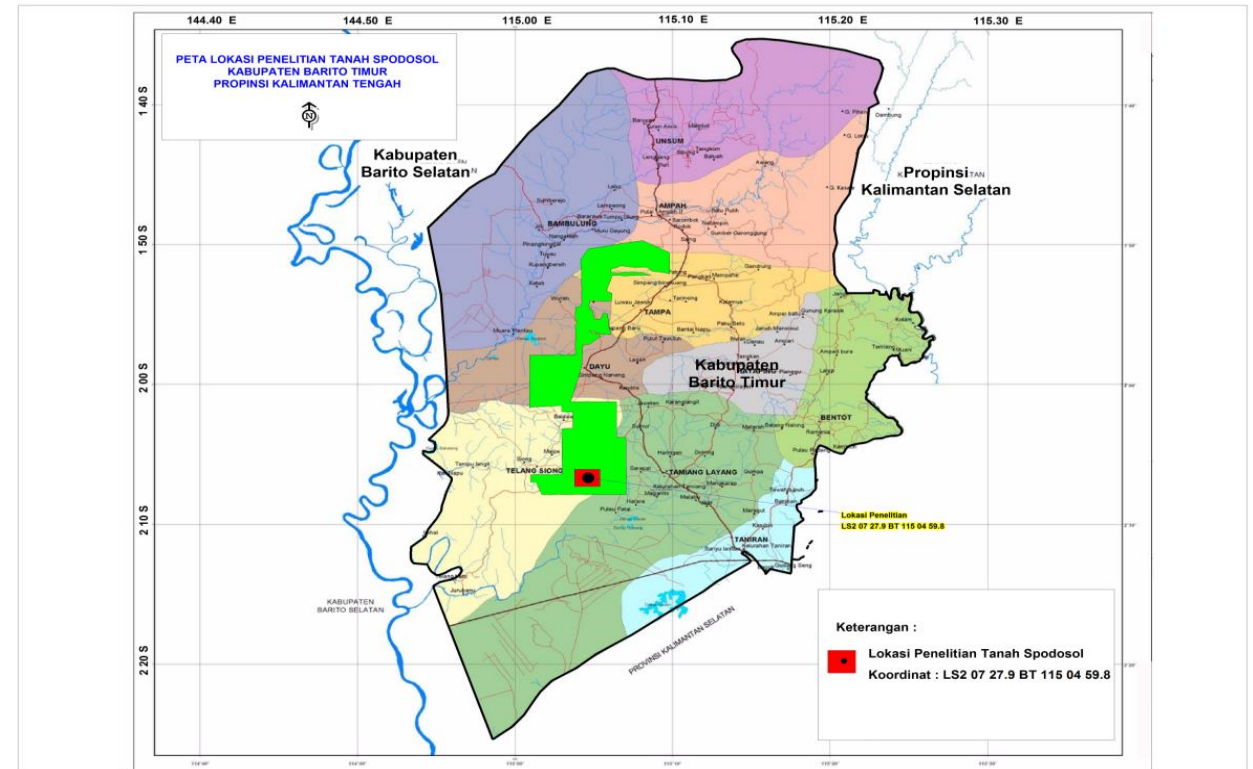


BMPs OF OIL PALM IN SANDY SOIL

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The area observed is located in Kabupaten Barito Timur in the Province of Kalimantan Tengah, Indonesia. It lies between latitudes of $01^{\circ} 50' 3.14''$ S to $02^{\circ} 08' 2.53''$ S and between longitudes of $115^{\circ} 01' 7.42''$ E to $115^{\circ} 10' 3.36''$ E



Soil Type and Characteristic

The sandy soil type of the estate is Spodosol that has **A-horizon, E-albic, B-Spodic and C-horizons** and classified as *Typic Placorthod* sub-group with low physical and chemical soil fertility. The limiting factors of palms growth on Spodosol soil may have been due to low suitability for development

Major soil limitation is presence of hardpan and low moisture and nutrient holding capacity from the sandy soil

To overcome the above soil limitations, land preparation, water management system, soil moisture conservation and methods of fertilizer application must be look into more closely



Land Preparation

Water Management System



The big hole system is a planting hole type which was vertical-sided with 2.00 m x 1.50 m on top and bottom side and 3.00 m depth



Land Preparation

Water Management System



Individual flatbed without big hole system



Ponding



Soil Surface Ponding

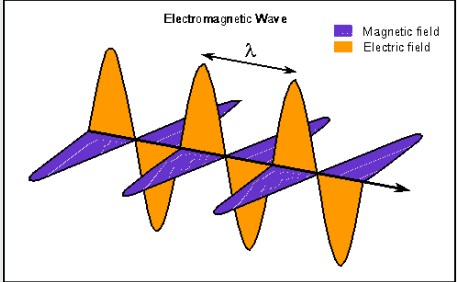
Land Preparation

Water Management System

Big Hole and field drain (1.50 m depth x 1.00 width m x 200 m length) combination

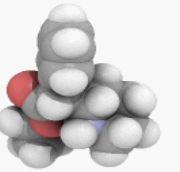


PHYSICAL SOIL PROPERTIES



Horizon	Depth (cm)	Description
Ap	0 – 8	Grayish brown (10YR 5/2) with very dark brown (7.5YR 2.5/2) and light gray (7.5YR 7/1); loamy fine sand; structureless and single grain; loose; few fine roots; abundant coarsepores; abrupt and smooth boundary
E	8 – 12	White (10YR 8/1); coarse sandy loam; structureless to single grain; loose; very few fine roots; many coarse and medium pores; abrupt and wavy boundary
Oa	12 – 14	Dark reddish gray (10R 3/1); organic litter; highly decomposed; abrupt and wavy boundary
Bw	14 – 45	Gray (10YR 5/1); fine sandy loam; structureless to single grain; loose; very few fine roots; many coarse pores; many undecomposed trunk 4 cm x 15 cm x 2 mm; clear smooth boundary
Bhs1	45 – 55	Strong brown (7,5YR 4/6); strongly cemented hardpan; gradual and smooth boundary
Bhs2	55 – 75	Strong brown (7.5YR 4/6); moderately cemented hardpan; clear and smooth boundary
B1	75 – 100	Pale Yellow (2.5Y 8/3); fine sandy loam; weak, medium and fine angular blocky; friable; no roots; no pores

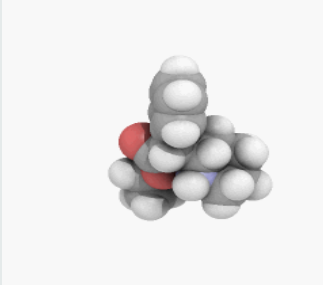
Physical Analysis Result			
Code	Depth (cm)	Bulk Density (g/cm³)	Permeability (cm/hour)
Forest	0-20	1,50	18,96
	20-40	1,57	12,01
Big Hole	0-20	1,32	12,64
	20-40	1,35	21,17



Depth (cm)	Horizon	pH (H2O)	C-org (%)	N-Total	C/N	Bray 1	HCL 25%	NH ₄ OAc (pH 7.0)				CEC	Base	1 N KCL	
						Aval. P	Total P	Ca	Mg	K	Na		Saturation (%)	Al	H
						(ppm)								(me/100g)	
0-8	Ap	3.75 (l)	0.92 (l)	0.07 (vl)	13,14	0.4 (vl)	6.25 (vl)	0,20	0.10 (l)	0.03 (vl)	0,01	5.14 (vl)	6,61	0,59	0,43
8 - 12	E	4.32 (h)	0.19 (vl)	0.06 (vl)	3,17	0.8 (vl)	5.00(vl)	0,10	0.04 (vl)	0.03 (vl)	0,02	2.25 (vl)	8,44	0,11	0,11
12 -45	Bw	3.84 (l)	0.68 (vl)	0.06 (vl)	11,33	2.14 (vl)	4.03 (vl)	0,10	0.03 (vl)	0.03 (vl)	0,01	2.95 (vl)	5,76	0,34	0,35
75-110	B1	4.25 (h)	0.57 (vl)	0.05 (vl)	11,40	3.3 (vl)	14.44 (vl)	0,13	0.03 (vl)	0.02 (vl)	0,01	2.53 (vl)	7,51	0,38	0,08

Depth (cm)	Horizon	0.05 N HCL					Coarse sand	Fine Sand	Silt	Clay	Textural Class
		Fe	Cu	Zn	Mn	B					
		(ppm)									
0-8	Ap	200.96 (I)	0.6 (I)	1 (I)	1.21 (I)	0.53 (I)	18	64	6	12	lfs
8 - 12	E	24.02 (I)	0.8 (I)	1 (I)	0.7 (I)	0.36 (I)	53	22	8	17	co.sl
12 -45	Bw	35.1 (I)	0.4 (I)	0.8 (I)	0.9 (I)	0.41 (I)	35	45	6	14	fsl
75-110	B1	535.49 (I)	1.85 (I)	7.62 (I)	2.06 (I)	0.4 (I)	35	47	2	16	fsl

CHEMICAL SOIL PROPERTIES



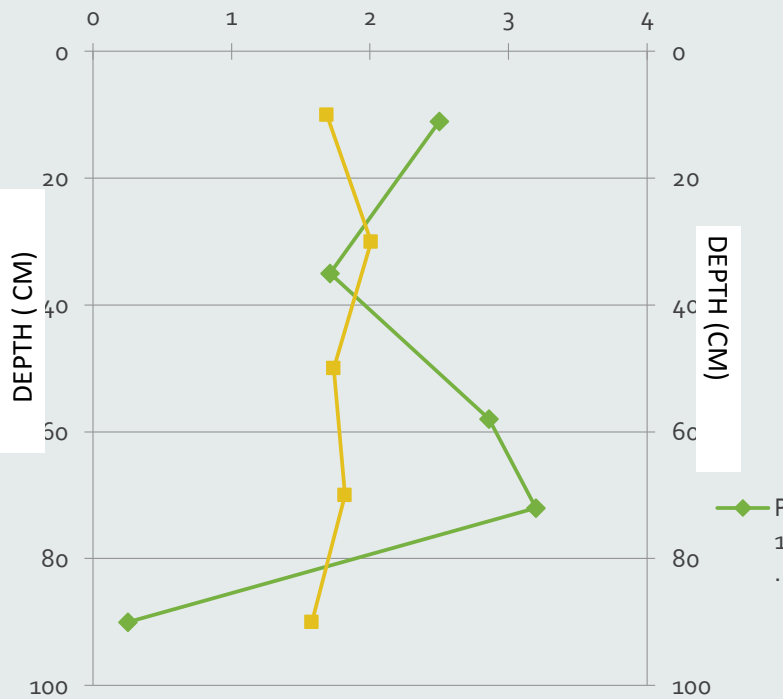
BIG HOLE SYSTEM



NON BIG HOLE



C - ORGANIC DISTRIBUTION IN BETWEEN BIGHOLE AND NON BIGHOLE METHOD
% C - Organic





SOIL MOISTURE CONSERVATION

Appropriate soil moisture conservation methods especially in sandy soil such as growing cover crops (*Mucuna bracteata* and *Nephrolepis* sp) enhance the efficiency of fertilizers by preventing losses through run off

The establishment of LCC is common practice to increase soil fertility in sandy soil, and it was showed that rubber rootstock polybag can be used to successfully establish legumes on sandy soils (Spodosol). In a stand of 150 palms per hectare, only 425 *Mucuna bracteata* seedlings (bags) were required per hectare

Nephrolepis sp can be used as the cover crop that can be manually spread



SOIL MOISTURE CONSERVATION



EFB application – 35 and 40 ton/ ha



FERTILIZER RECOMMENDATION AND APPLICATION



The fertilizer rates in observed areas were determined based on leaf and soil analysis, ffb yield realization and estimation, fertilizer application record, rainfall and palm age

OIL PALM – LEAF ANALYSIS

LEAF NUTRIENT STATUS 2013 - 2016

6-7 years - plantings

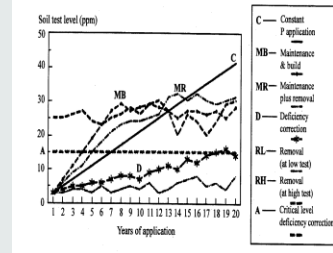
Element	2013	2014	2015	2016
N - Opt N - Diff.	2,39 - 2,77 (-14%)	2,70 - 2,79 (-3%)	2,90 - 2,80 (4%)	2,75 - 2,74 (1%)
P - Opt P - Diff.	0,150 - 0,159 (-5%)	0,170 - 0,169 (1%)	0,169 - 0,175 (-3%)	0,159 - 0,170 (-7%)
K - as % TLC	0,95 - 28	0,95 - 27	0,99 - 27	1,00 - 30
Mg - as % TLC	0,44 - 41	0,41 - 38	0,41 - 36	0,35 - 34
Ca	0,54	0,64	0,67	0,61
B (ppm on DM)	14	18	23	25
Cu (ppm on DM)	5	6	5	4
TLC	87	90	93	85

4-5 years - plantings

Elemen	2013	2014	2015	2016
N - Opt N - Diff.	-	2,52 - 2,78 (-9%)	2,72 - 2,80 (-3%)	2,72 - 2,75 (-1%)
P - Opt P - Diff.	-	0,163 - 0,163 (0%)	0,160 - 0,170 (-6%)	0,157 - 0,170 (-7%)
K - as % TLC	-	0,97 - 28	0,96 - 27	0,95 - 28
Mg - as % TLC	-	0,39 - 36	0,42 - 38	0,35 - 33
Ca	-	0,63	0,63	0,66
B (ppm on DM)	-	15	21	25
Cu (ppm on DM)	-	5	5	4
TLC	-	88	91	86



FERTILIZER RECOMMENDATION AND APPLICATION



A (6-7 years old)

Years		N	P ₂ O ₅	K ₂ O	MgO
2014	Kg/palm	0,79	0,56	1,73	0,26
	Kg/ha	113,82	80,64	250,58	37,85
2015	Kg/palm	0,75	0,58	1,77	0,23
	Kg/ha	109,19	83,71	255,92	33,60
2016	Kg/palm	0,77	0,58	1,74	0,42
	Kg/ha	114,87	86,53	260,76	63,04

Fertilizers Type :

1. Slow Release Fertilizer – Immature
2. Compound Fertilizer – Immature + Mature
3. Single Fertilizers – Mature

Method of Application :

B (4-5 years old)

Years		N	P ₂ O ₅	K ₂ O	MgO
2014	Kg/palm	0,72	0,54	1,59	0,24
	Kg/ha	101,35	76,20	222,65	33,77
2015	Kg/palm	0,65	0,53	1,54	0,20
	Kg/ha	89,65	73,33	214,15	27,59
2016	Kg/palm	0,70	0,55	1,60	0,40
	Kg/ha	105,16	82,04	240,59	60,05

1. Slow Release Fertilizer (Planting Hole)
2. Compound Fertilizer (Pocket + Broadcast)
3. Single Fertilizers (Broadcast)

FFB PRODUCTION



FFB YIELD - YEAR 2013 - 2016

Year of Planting	2013	2014	2015	2016 (Ant)	2017 (Bdgt)	2016 - Ant vs 2015
	MT/HA					%
2009	10,38	18,24	20,74	14,59	18,00	-30
2010	5,08	11,98	16,31	12,90	16,00	-21
2011	1,93	6,36	11,29	10,05	14,00	-11
2012	0	2,05	4,57	6,11	10,00	34

RAINFALL 2009-2015



Months	2009		2010		2011		2012		2013		2014		2015	
	mm	days	mm	days	mm	days	mm	days	mm	days	mm	days	mm	days
January	420	20	361	12	513	12	260	14	237	13	185	15	389	25
February	298	16	192	10	270	9	502	14	313	15	216	14	419	15
March	279	13	538	20	411	16	213	13	317	14	384	15	237	18
April	551	12	299	12	189	10	323	11	417	12	379	14	479	17
May	235	9	206	9	156	9	240	7	340	15	421	17	236	11
June	91	5	240	16	130	6	83	6	53	5	197	13	166	10
July	65	5	145	11	181	3	169	6	253	12	105	8	35	4
August	40	5	190	9	101	4	59	5	152	6	82	11	30	3
September	0	0	365	15	62	6	14	3	88	8	29	3	2	1
October	93	8	519	16	233	8	122	11	64	7	84	6	47	6
November	343	18	420	12	381	10	347	16	290	14	322	18	372	16
December	276	14	304	16	465	19	419	15	571	20	391	15	198	19
<i>Total</i>	<i>2691</i>	<i>125</i>	<i>3779</i>	<i>158</i>	<i>3092</i>	<i>112</i>	<i>2751</i>	<i>121</i>	<i>3095</i>	<i>141</i>	<i>2795</i>	<i>149</i>	<i>2610</i>	<i>145</i>
<i>Mean</i>	<i>335</i>	<i>15</i>	<i>179</i>	<i>13</i>	<i>211</i>	<i>16</i>	<i>212</i>	<i>13</i>	<i>226</i>	<i>16</i>	<i>261</i>	<i>20</i>	<i>245</i>	<i>9</i>
<i>Ratio</i>		2,9		2,3		3,3		3,0		2,6		2,4		2,5



Rainfall data is represented by the rainfall records taken from
year 2013 to 2016 (todate July)

	RF	RDs	RO	WD	Notes
2013	3095	141	1990	95	Dry Months and Water Deficit June, September and October
2014	2795	149	1700	105	Dry Moths / Water Deficit August, September and October
2015	2610	145	1696	286	Dry Months / Water Deficit July, August, September and October
2016	1879	95	1219	40	Dry Months and Water Deficit June and July

Note : RF – Rainfall (mm) /RDs – Rainy Days (days) /RO – Run-off (mm) /WD – Water Deficit (mm)

EL NINO IMPACTS



MALE FLOWER ♀



BAGWORM - OUTBREAK

EL NINO IMPACTS



LOW FRUIT SET – FAILED OR ROTTEN BUNCHES – PARTHENOCLARPY FRUITS

CONCLUSION

The sandy soil limitations can be overcome through appropriate soil and water management practices

Adaptation strategy should be applied to reduce impact of dry season on oil palm such as applying appropriate agronomic practices to reduce water and oil palm losses

With appropriate agro-management and proper supervision, a satisfactory FFB yield can be achieved

Thank you