

Field Clinic and Colloquium

International Society of Oil Palm Agronomists (ISOPA)

28 – 29 September 2016

Marihat, North Sumatra, Indonesia.

How to Optimize Oil Palm Production on Marginal Land in Malaysia

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Presentation outline

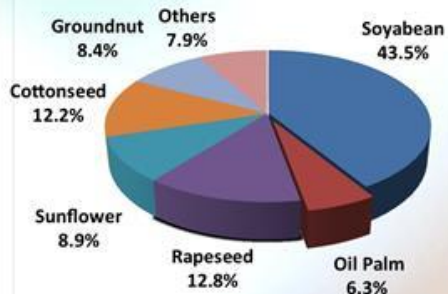
- INTRODUCTION
- Best Management Practices of Oil Palm Planted on **Peat Soil**.
- Managing **Acid Sulfate Soil** for Oil Palm Cultivation.
- Managing **Sandy Soil** for Oil Palm Cultivation.
- CONCLUSION



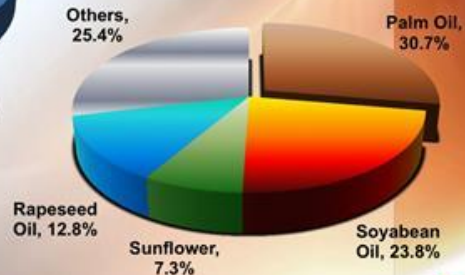
GLOBAL OIL AND FATS (2015)

Global Oils & Fats in 2015

Harvested Area of 10 Major Oilseeds: 275.98mil ha



Production: 204.89mil tonnes

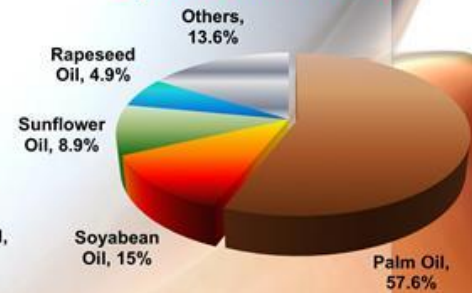


Source : Oilworld Annual (Dec 2015)

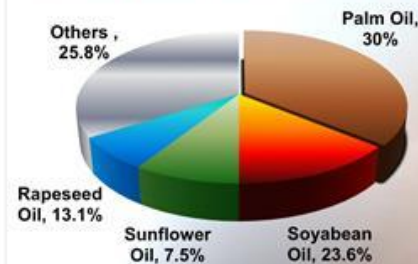


Global Oils & Fats in 2015

Exports: 82.96mil tonnes



Consumption: 203.61mil tonnes



Source : Oilworld Annual (Dec 2015)



MALAYSIAN PALM OIL INDUSTRY (2015)

- Oil palm - backbone of Malaysian economy, and occupy 60% of total agriculture land and become a major economic crop
- 4th largest contributor to national economy
- Produced 22.1 million tonnes palm oil / palm kernel oil
- Exported 25.4 million tonnes palm oil and its products worth RM 60.3 billion of GNI and expected to increase to RM 178 billion by 2020
- Committed to sustainability, Social, environment and economic responsibility
- PROBLEMS:
 - LOW FRUITSET,
 - STAGNATION OF YIELD – related to land suitability and management practice

INTRODUCTION

- ❑ Oil palm grow on a wider range of soil types.
- ❑ The best soil for oil palm should be;
 - ✓ well drained and
 - ✓ well structured with unrestricted rooting medium
 - ✓ good water holding capacity
- ❑ Flat and undulating lands are preferable, terraces and other soil conservation measures must be practiced on steep land below 20°.



INTRODUCTION: Marginal Soils

- ❑ The rapid expansion of the oil palm industry and the depletion of prime land for oil palm cultivation have resulted in oil palm being planting on marginal soils.
- ❑ Marginal soils - “unsuitable soils for cultivation in their natural states but upon proper soil management and amendments, they can be converted for plantation tree crops with yield performances, at times, matching those on suitable soils”.
- ❑ The soils, as listed by Goh (1995), Tayeb (1999) and Chan (2000) include:
 - *deep peat;*
 - *sandy soils with cemented podsols or spodosols;*
 - *high altitude (>300 m above sea level) soil;*
 - *shallow acid sulfate soil;*
 - *Saline soil;*
 - *shallow laterite;*
 - *steep land (>25°).*



PEAT SOIL

- ❑ The poor inherent physical and chemical properties of peat make its development for oil palm cultivation difficult and costly.
- ❑ FFB yield limiting factors:-
 - Extremely high ground water level;
 - Low plant available water;
 - Poor in-field accessibility;
 - Palm leaning and toppling; and
 - Poor soil fertility.



Distribution of Oil Palm Cultivation on Peat in Malaysia

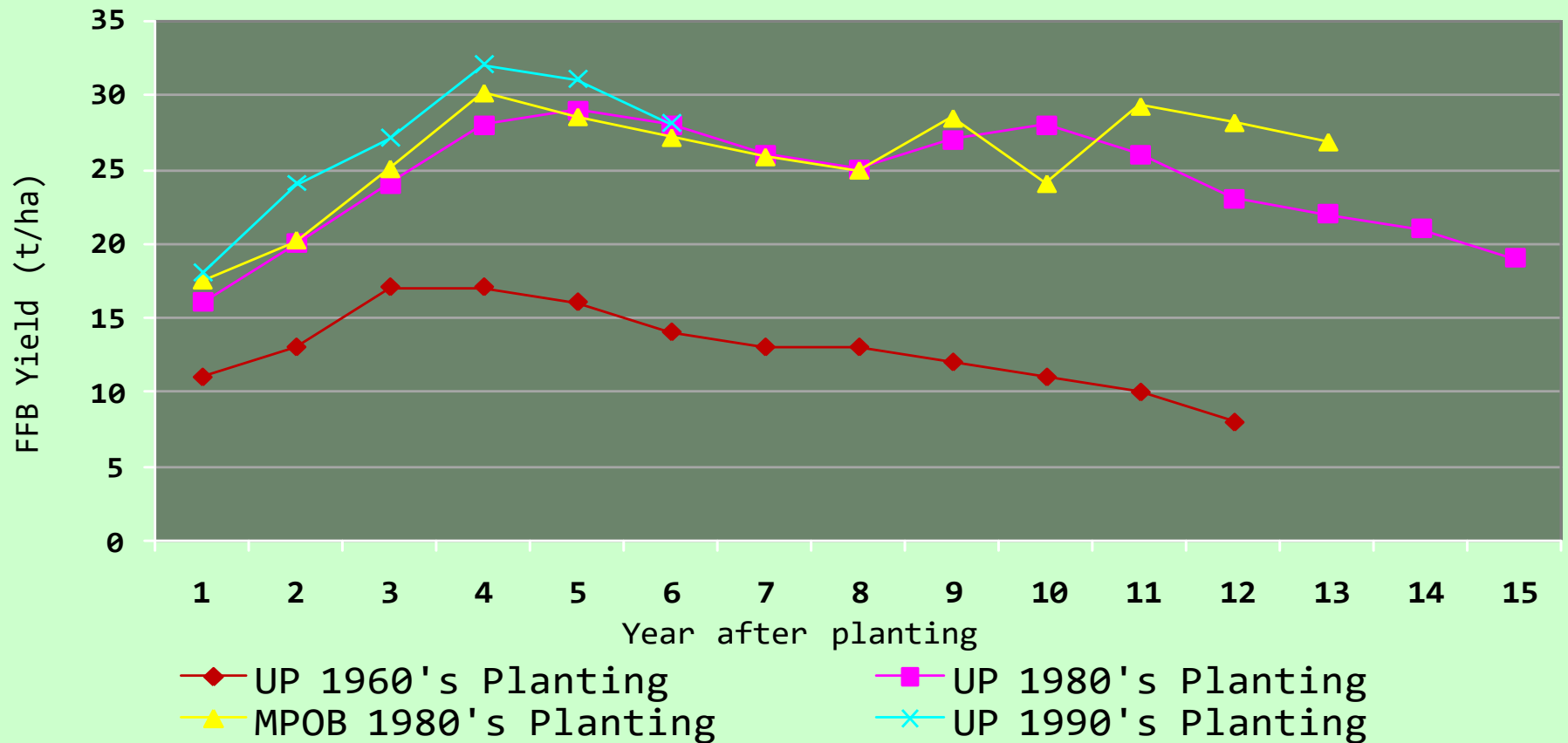
Region	Hectare		
	Peatland	Oil palm	Oil palm on peatland
Peninsular	716,944	2,503,682.02	207,458.01 (8%)
Sabah	121,514	1,340,317.39	21,405.75 (2%)
Sarawak	1,588,142	1,167,172.51	437,174.27 (38%)
Malaysia	2,426,600	5,011,171.92	666,038.03 (13%)



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FFB Yield Profile of Oil Palm on Deep Peat



Through research and development carried out by various institutions including MPOB, planting of oil palm on drained peat has been successful and oil palm yield on peat is comparable to those from mineral soils.



BMPs for Oil Palm Cultivation on Peat



1. Soil Compaction
2. Ground Cover Management
3. Water Management
4. Fertilizer Management
5. Palm Leaning Management



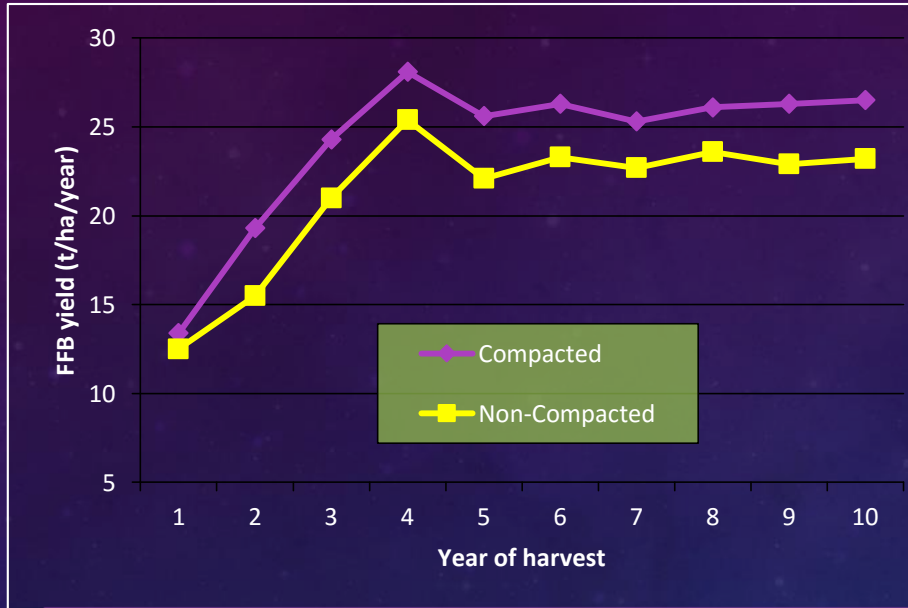
Soil Compaction

- ❑ **Commence:** 3 to 4 weeks after the field drains have been dug.
- ❑ **Water table:** > 70 cm below ground surface.
- ❑ **Method:** mechanical soil compaction using an excavator.
- ❑ **Area compaction:** along planting rows and harvesting paths (minimum width of 9.5 m)
- ❑ **Round of compaction :** two - four runs.
- ❑ **Compaction quality indicator:**
 - ✓ Depth of compact: > 0.40m below the original surface level.
 - ✓ Soil bulk density: > 0.15 gcm⁻³

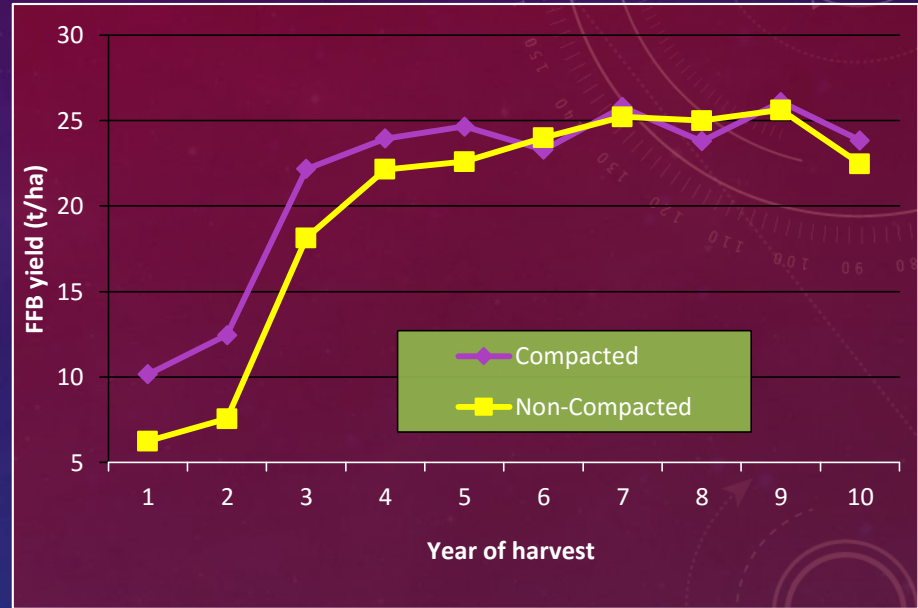


Soil Compaction

- ✓ Improved palms growth and yield.
- ✓ Improved in field accessibility.



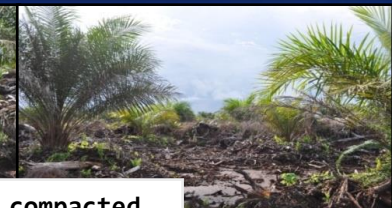
Effect of soil compaction on FFB yield of oil palm planting on deep peat at MPOB Research Station Teluk Intan, Perak



Effect of soil compaction on FFB yield of oil palm planting on deep peat at MPOB Research Station Sessang, Sarawak



Compacted peat



Non compacted peat

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Ground Cover Management



Natural ground covers: *Nephrolepis*



- ☐ For soil moisture conservation.
- ☐ For improve soil fertility.
- ☐ For weed management.
- ☐ To minimize the risk of peat fires.

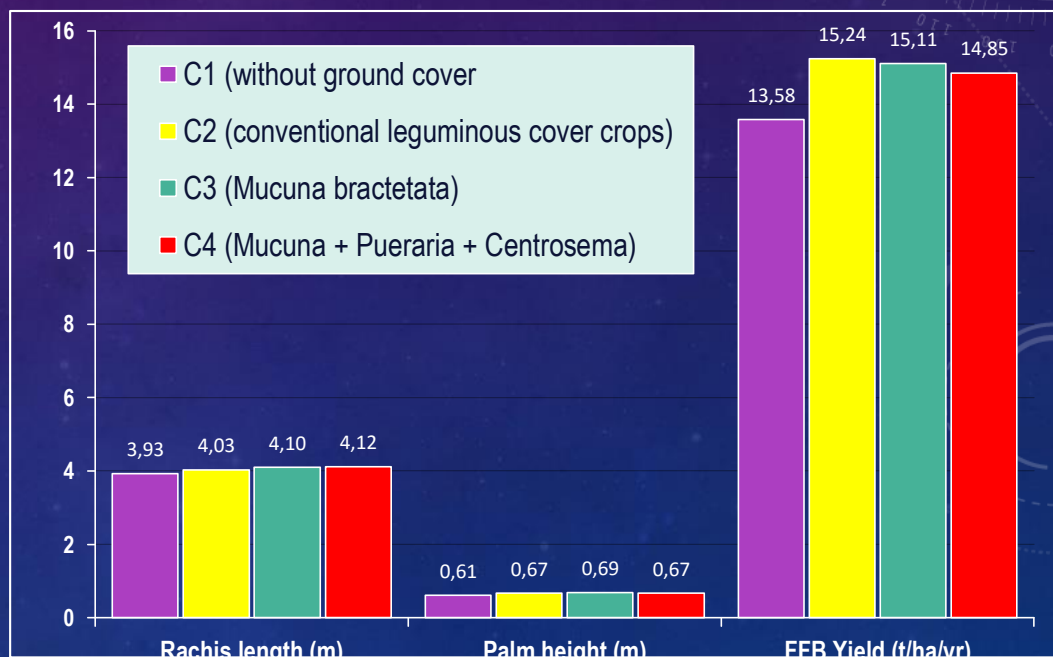
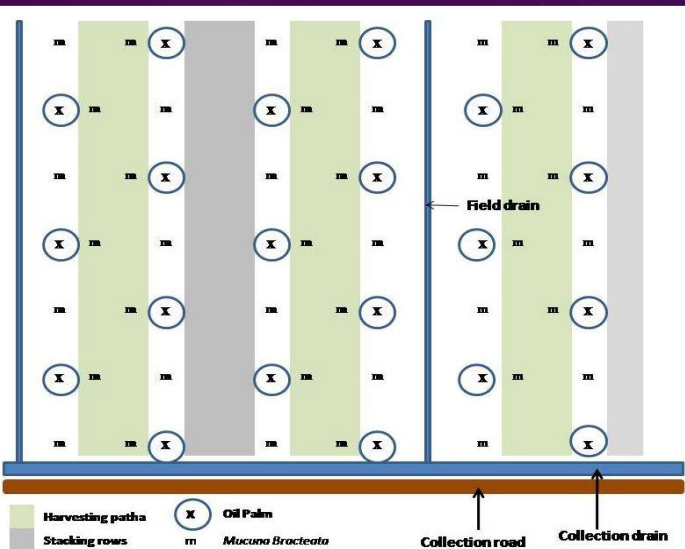


Establishment of *Mucuna bracteata*



Mucuna bracteata seeds

Six months old Seedling



The effect of ground covers management on early oil palm performance

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Water Management



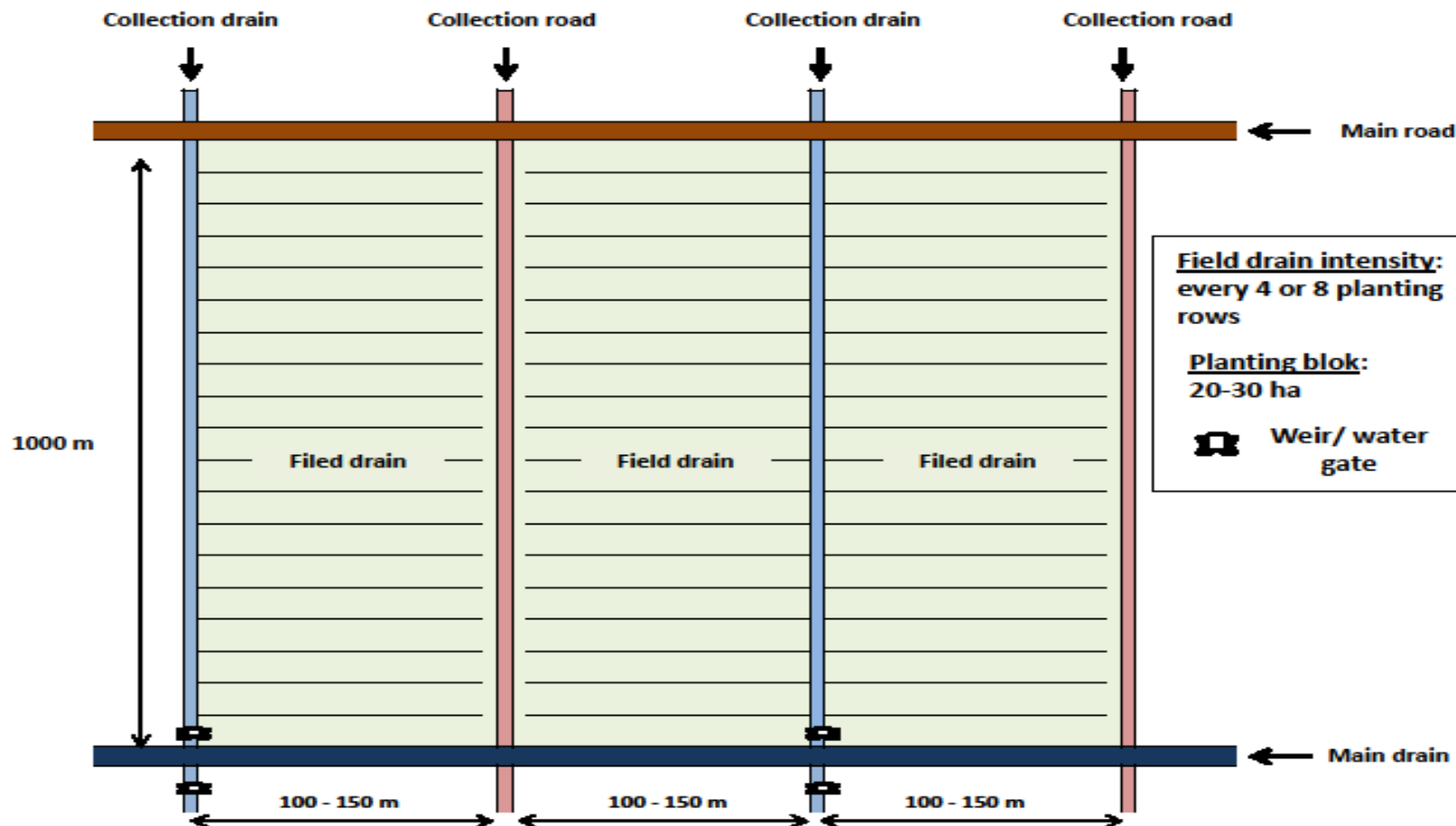
- ❑ To retain an optimum ground water table for superior palm growth and high yield.
- ❑ To drain out excess water and avoid prolonged flooding periods.
- ❑ To minimise excessive peat subsidence, thus, minimising CO₂ emission.
- ❑ To avoid irreversible drying of the peat surface.
- ❑ To minimise the risk of peat fires.

Optimum Groundwater Table

Development stage	Water level from ground surface (cm)	
	Groundwater table (in field)	Water level (at collection drain)
Immature (1-3 years old)	30 to 40	35 to 45
Young mature (4-7 years old)	35 to 45	45 to 55
Fully mature (> 8 years old)	45 to 50	50 to 60

Water Management

An efficient and sufficient drainage systems and water management are the key of the success of a planting oil palm on peat



Fertilizer Management

- ❑ Low soil bulk density – nutrients leaching
- ❑ Very acidic – low availability of micronutrients
- ❑ High C/N ratio - low availability of N
- ❑ Peat decomposition – release high N
- ❑ High organic matter – high availability of P
- ❑ High soil Mg – depress uptake of K
- ❑ Low soil fertility – K, Cu, Zn and B
- ❑ Low water retention – effected nutrients uptake



Fertilizer Management

N Fertilizer Requirement

- ❑ Excessively high N inputs will lead to high nitrous oxide and methane emissions (Melling, *et al*, 2006; Melling, *et al*, 2011).
- ❑ The optimum rate of N fertilizer application is lower than N1 rate (0.5 to 0.6 kg urea palm⁻¹ yr⁻¹).

P Fertilizer Requirement

- ❑ Excessive P fertilizer application should be avoided to ensure lower *Ganoderma* basal stem rot incidence (Mohd Tayeb, 2002).
- ❑ The optimum rate of P fertilizer for oil palm on peat should not exceed 1.0 kg RP palm⁻¹ yr⁻¹.

K Fertilizer Requirement

- ❑ Potassium was leached rapidly from the peat and a contributory factor to rapid K release was the low effective cation exchangeability capacity (CEC) of the peat (Malcolm *et al*, 1997).
- ❑ The optimum rate of K fertilizer for oil palm on peat recommended at 4.0 - 6.0 kg MOP palm⁻¹ yr⁻¹.



Fertilizer Management



Bunch Ash: An efficient and cost effective K fertilizer source for mature oil palm on peat under high rainfall environment.

- ✓ Strongly alkaline (pH=12) that help to improve the soil pH
- ✓ Increased FFB yield from compare with the equivalent quantity of K applied as MOP and SOP
- ✓ The FFB production cost was lower compared with the equivalent quantity of K applied as MOP and SOP



Best Management Practices for Oil Palm Cultivation on Peat: Using Zeolite as Soil Conditioner

The combination application of 3.0 kg palm⁻¹ year⁻¹ zeolite and 3.5 kg palm⁻¹ year⁻¹ MOP is the agronomically and economically optimum input for oil palm on peat.



Fertilizer Management

Mg Fertilizer Requirement

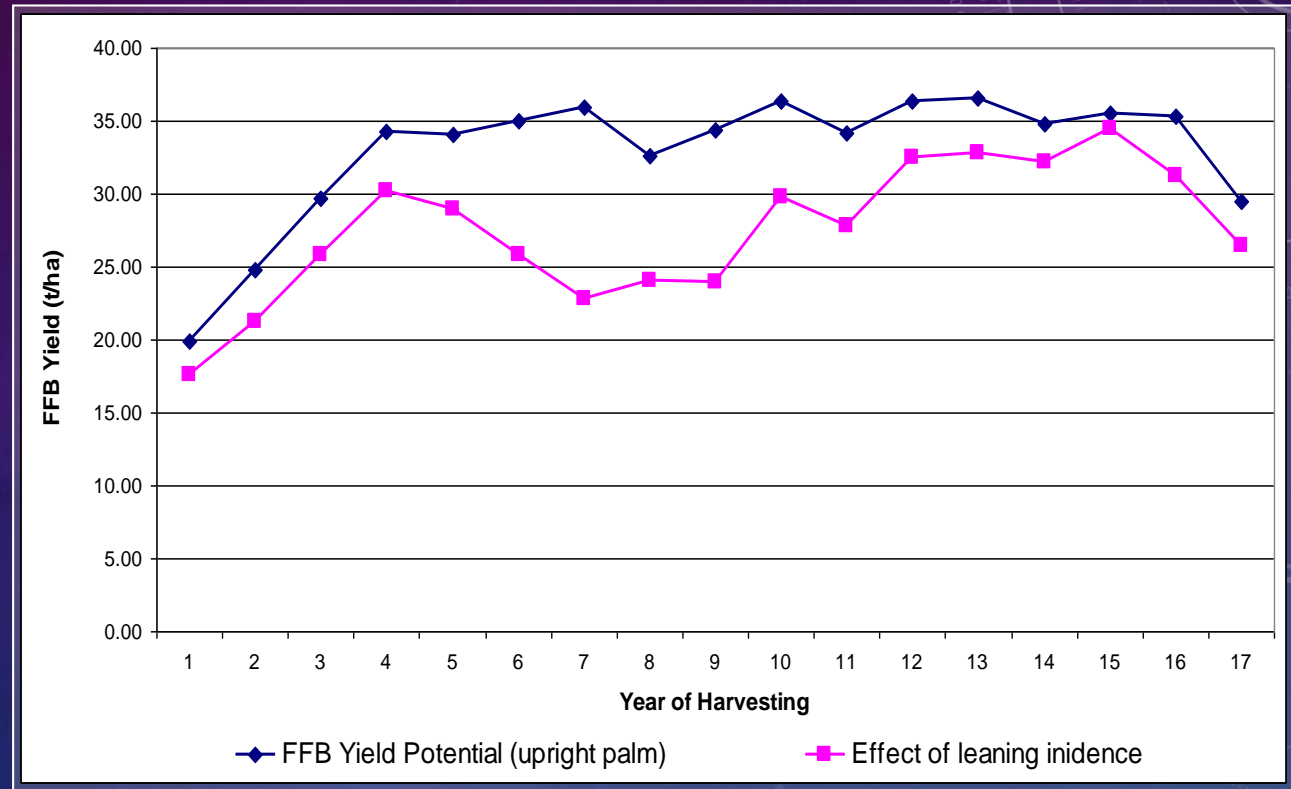
- There was adequate Mg in the peat to meet the palm's requirement (Gurmit *et al*, 1987; Jaman and Kueh, 1996).
- Mg fertilizer requirement should be based on leaf analysis results.

Micro Nutrients Requirement

Nutrient	g/palm			
	Y1	Y2	Y3	Y4 & above
CuSO ₄	200	150 - 200	150 - 200	Based on foliar analysis result
ZnSO ₄	200	150 - 200	150 - 200	Based on foliar analysis result
Borate 48	-	150 - 200	-	150 – 200 (alternate year)
MnSO ₄	Not required			
FeSO ₄	Not required			



Palm Leaning Management



Effect of palm leaning on FFB yield of oil palm on deep peat at
MPOB Research Station Teluk Intan, Perak

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Palm Leaning Management

Technique for Mechanically Forced Unidirectional Leaning of Oil Palm on Peat

Benefits

- ❑ Helping to alleviate haphazard leaning, and subsequently minimized FFB yield losses;
- ❑ Providing good in-field accessibility, thus increase the efficiency of field operations; and
- ❑ Having a more uniform palm height that increase the productivity of harvesting works



The young palms were forcibly pushed using an excavator to lean in one direction, and day after, the mechanically forced palms leaned progressively and unidirectional.



Palm Leaning Management

Technique for Mechanically Forced Unidirectional Leaning of Oil Palm on Peat



Step 1

30 months old palms were forcibly pushed using an excavator to lean at 45° in one direction.

Step 2

Soil mounding of palms was conducted.

Step 3

The soil was compacted or leveled and cleared of any stumps along the harvesting paths.

Step 4

Pruning of damaged fronds was carried out.

Palm Leaning Management

Technique for Mechanically Forced Unidirectional Leaning of Oil Palm on Peat

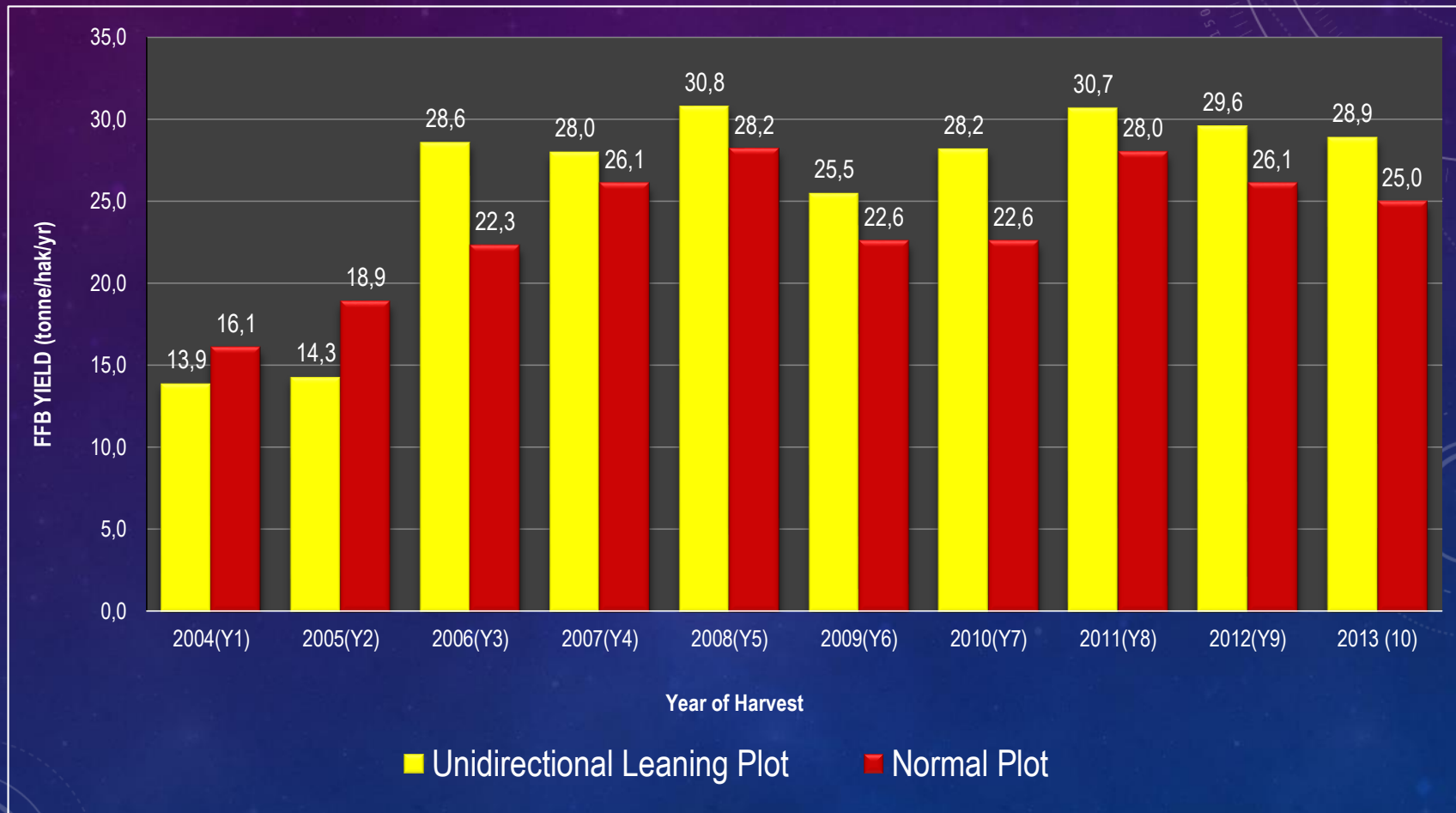


- Palms leaned progressively and unidirectional.
- Up to 14th year of planting, there was no occurrence of palms toppling or uprooting.
- The treatment helped to alleviate haphazard leaning, subsequently minimized FFB yield losses.
- This technique also provided good in-field accessibility, thus helping to increase the productivity of field operations especially harvesting and crop evacuation.

Palm Leaning Management

Technique for Mechanically Forced Unidirectional Leaning of Oil Palm on Peat

Effect of unidirectional leaning of young palms by mechanical force on FFB yield



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Palm Leaning Management

Technique for Mechanically Forced Unidirectional Leaning of Oil Palm on Peat

Increase the Productivity of Harvesting Works



Palm heights in (5a) treatment plot were more uniform compared to (5b) control plot that needed sickle (in foreground) and chisel (in background) for harvesting



Palm Leaning Management

Technique for Mechanically Forced Unidirectional Leaning of Oil Palm on Peat



Providing good in-filed accessibility, thus increase the efficiency of field operations

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Technologies are readily available and with the right techniques used, commercial planting of oil palm on the peat can result in profits comparable to those on mineral soils.

Acid Sulfate Soils

- Acid sulfate soils are estimated to cover an area of about 0.5 million ha in Malaysia (Rosilawati *et al.*, 2012)
- These soils are characterised by very low pH values (< 3.5) and the presence of yellowish jarosite ($\text{KFe}_3 (\text{SO}_4)_2 (\text{OH})_6$) mottles (Shamshuddin and Auxtero, 1991).
- Al toxicity and excess sulfates are the major constraints to FFB production



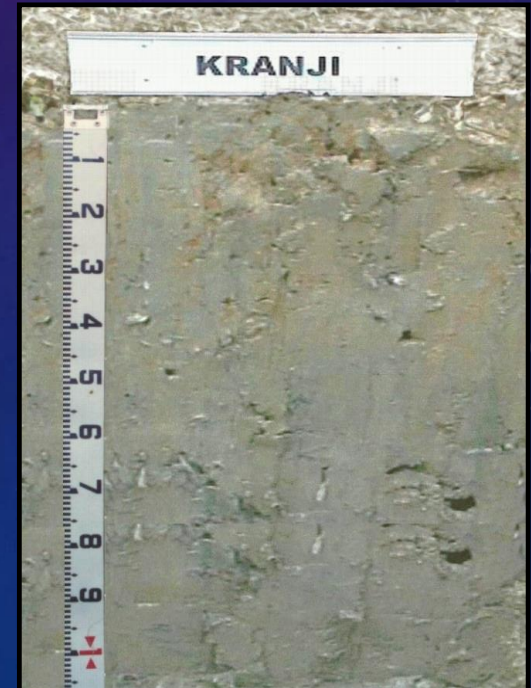
Acid Sulfate Soils

- ❑ In Malaysia a soil is considered to be an acid sulfate soil if the soil has a sulfuric horizon within **one metre** of the soil surface.
- ❑ The horizon considered to be a sulfuric horizon must have pH (1:1 soil: water) of less than 3.5 and has jarosite mottles.
- ❑ Acid sulfate soils can be divided into two groups:
 1. Potential acid sulfate soils and
 2. True acid sulfate soils



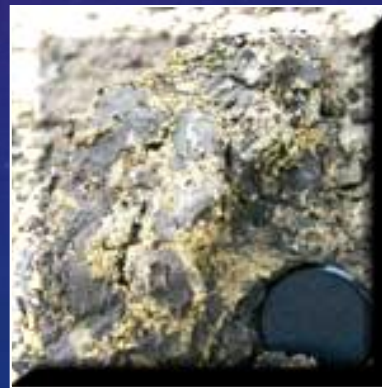
Potential Acid Sulfate Soils

- ❑ Common along the coastal areas and are inundated by sea water.
- ❑ Water logged soils.
- ❑ High sulfide content (>100cm from surface).
- ❑ Smell of hydrogen sulfide (rotten eggs) - >60cm.
- ❑ Organic rich / organic poor
- ❑ Mangrove swamps.



True Acid Sulfate Soils

- Very low pH < 3.5
- Yellow jarosite mottles (FeS_2 ; Iron Sulfide/Pyrite)
- Moisture stress due to poor rooting
- Organic rich / organic poor
 - Organic rich (brown, well structured and friable)
 - Organic poor (light gray, poor structured, sticky)
- Low K
- Affects uptake of other nutrients due to low pH



Yellow jarosite mottles



Management Strategies

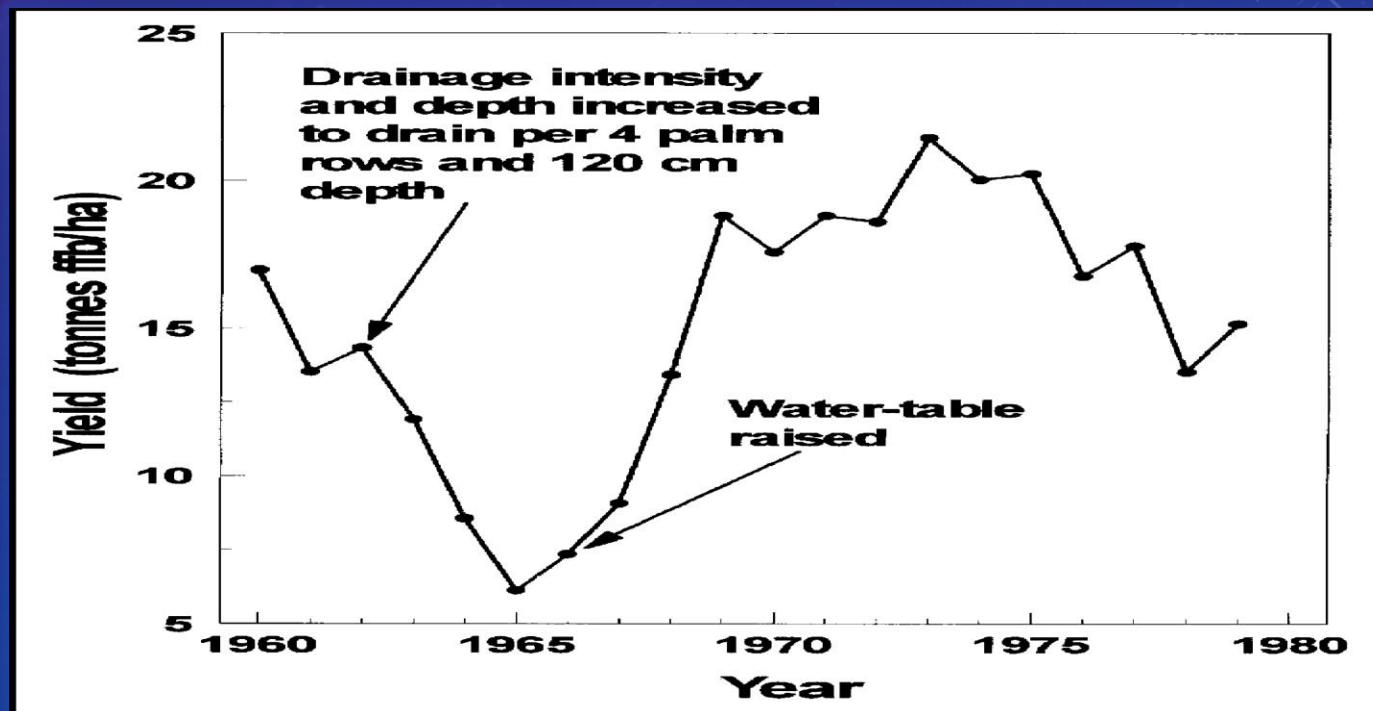
- In the early part of the century, little was known about the management of acid sulfate soils, and consequently deep drainage to remove excess water was practised, resulted in the soils being more acid.
- **The key to the management of these soils is the control of the water table**, by the use of a series of drains and simple structures to control and trap the water in the drains during periods of low rainfalls, so that oxidation is minimised.
- During the rainy season, the control gates are opened and the drains are flushed.
- Water management is critical, keep water table around 45-60 cm with controls, flush acidity in rainy season & retain water at end of rainy season

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Management Strategies

- Use bunch ash (if available), to improve the soil pH and also a source of potassium.
- the application of empty fruit bunches (EFB)



Effect of increased drainage and subsequent raising of water table on yield of oil palms on severe acid sulphate soils

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Management Strategies

Management of the Water Table

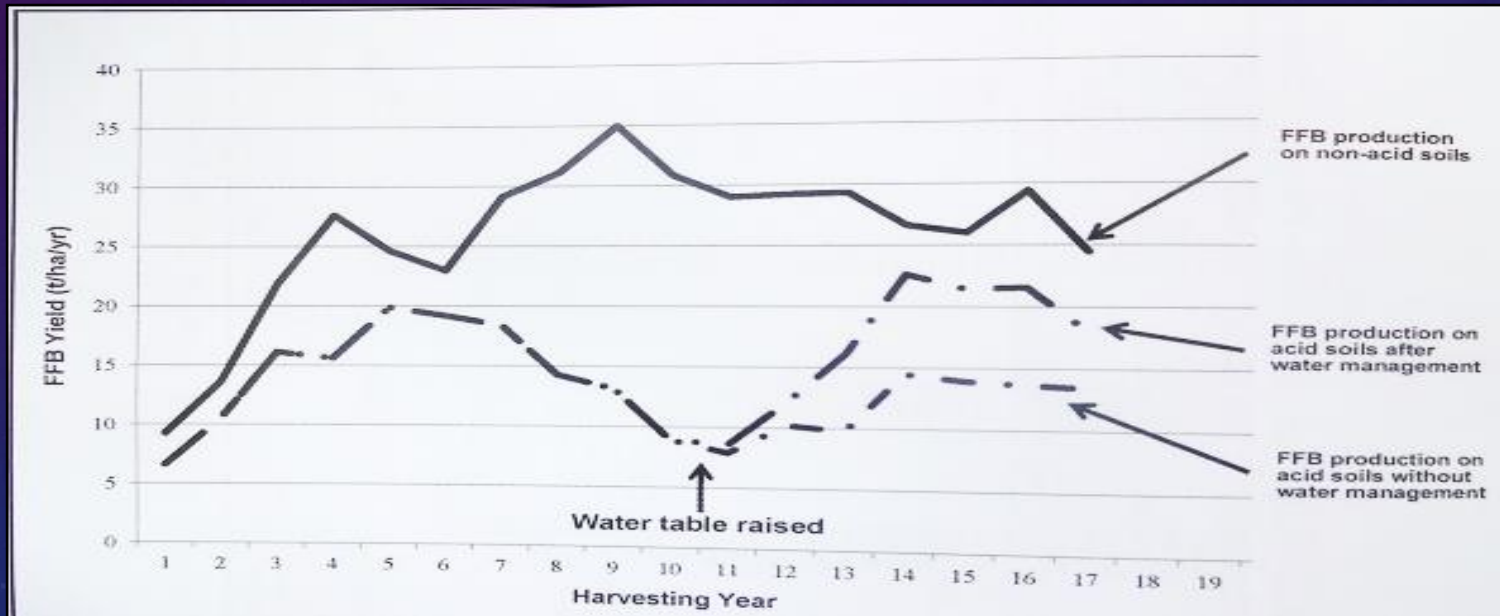


Keep water table around 45-60 cm

Management Strategies

FFB Yield Potential

- Implementation of water management - *increase FFB production 25 to 30 t/ha/yr* (Toh and Poon, 1982)
- Yield increase after seven years of planting – *influenced by saline and acidic water* (Abd Razak et al., 1995)

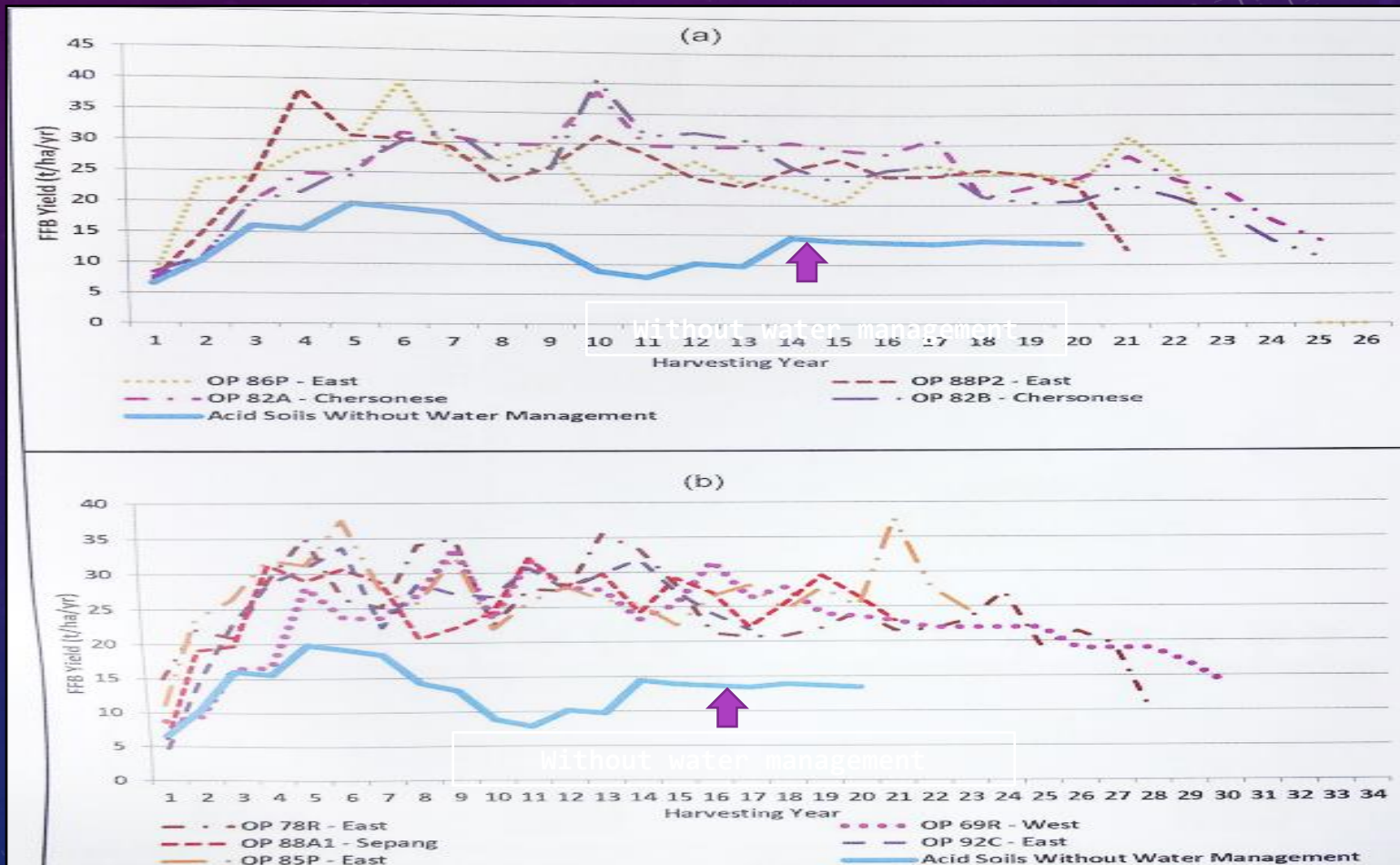


Effect of management the water table on yield of oil palms on severe acid sulphate soils ³⁶



Management Strategies

Effect of Water Table Management on Yield of Oil Palms on Acid Sulphate Soils



Sandy Soils

Two groups of sandy soils;

- i. Deep sandy soils (>100cm)
 - less than 15% clay within 100cm of the soil surface
 - excessively drained
 - Very low nutrient and moisture holding capacity
- ii. Sandy soils with a cemented pan within 100cm of the soil surface
 - strongly cemented spodic (often humus rich) at <50cm or 50 – 100cm from the surface
 - The spodic horizon can be thin (2-5cm) or thick (30-60cm)
 - cemented pan within 50cm can be flooded after rain and very dry in the dry season
 - which usually occur immediately above the groundwater water-table.



Sandy Soils

Physico-Chemical Characteristics of Sandy Soils

- ❖ clay content of less than 15%
- ❖ low nutrient content
- ❖ Spodic horizon - increase in organic carbon at depth
- ❖ Strong cemented – an impediment layer to water and root penetration
- ❖ Low in N and exchangeable cations
- ❖ Poor rooting – wind damage if the area is prone to strong winds
- ❖ Poor vegetative cover – high surface temperature

*BRIS (Beach Ridges Interspersed with Swales), 154,000 Ha in Malaysia,

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Sandy Soils

Sandy soils with a cemented pan within 100cm of the soil surface



RHU TAPAI
(cemented spodic at <50cm)



RUDUA
(spodic at 50cm – 100cm)

Spodic horizon is a subsurface horizon formed by the accumulation of humus, iron or both through a process of leaching (Humus-rich horizons are most common).



Sandy Soils

Deep sandy soils (>100cm)



**JAMBU
Series**



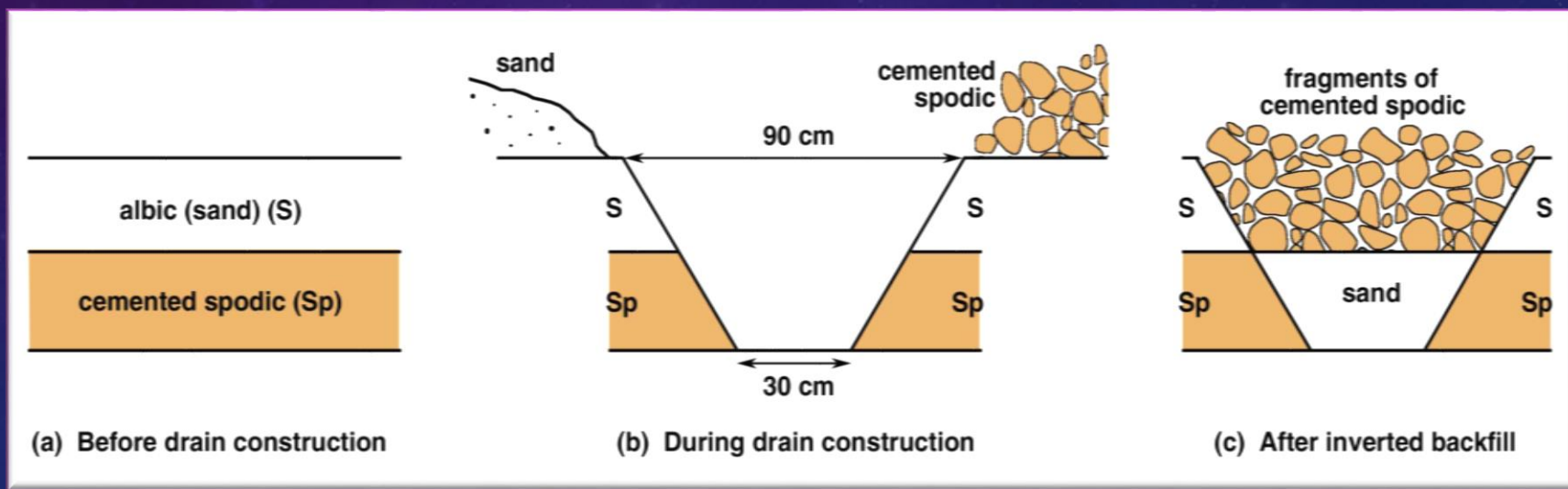
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Sandy Soils: Management Strategies

Land Preparation

- broken the cemented spodic horizons at planting points/rows
- Large planting hole
- Field drains 90cm (top) x 30cm (bottom) and backfilled using inverted back-filled technique



Source : Paramanathan, S. 2007. *Managing sandy soils of the tropics for oil palm cultivation*. ICOPE 2007. Bali, Indonesia.



Sandy Soils: Management Strategies

Fertility Application

- High rates of fertilizers – apply low rates more frequently (7-9 rounds).
- Use Compound / Mixture supplemented by straights
- High rates of RP– encourage rooting.
- GML to built up the soil Mg status.
- The organic matter for improved structure and soil aggregation.



Sandy Soils: Management Strategies

Cover Crop and EFB Mulching

- Establish good ground cover / maintain natural grasses during early growth stage
- EFB mulching; 35 – 60 mt/ha/yr for 5 years
- Spread pruned fronds
- Decanter cake



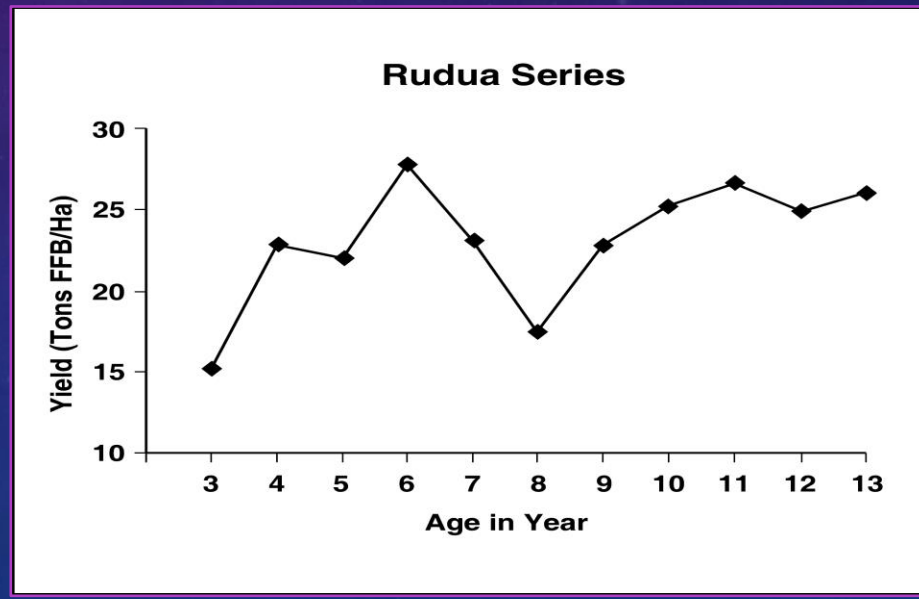
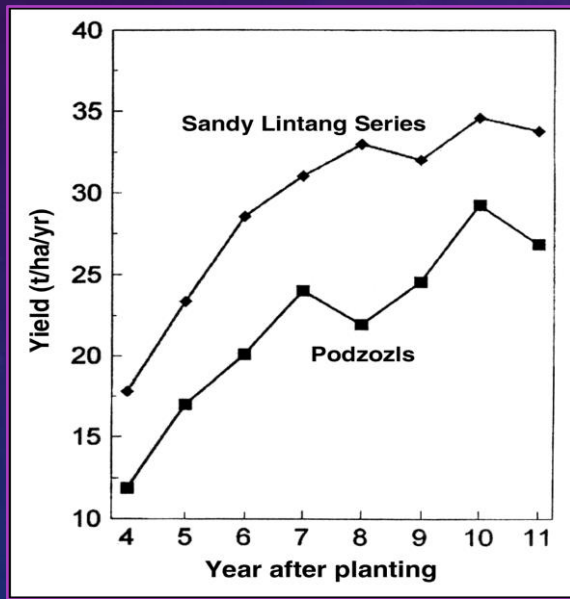
Sandy Soils: Yield Potential

Difficult to determine,

- Rainfall distribution pattern will determine the yield
- Management practice

The initial yield will be low, pick up around 5-6 years after field planting.

FFB yields on sandy soils in Peninsular Malaysia



Source : Paramanathan, S. 2007. Managing sandy soils of the tropics for oil palm cultivation. ICOPE 2007. Bali, Indonesia.



Sandy Soils: Yield Potential

FFB Yields on Sandy Soils in Sarawak, Sabah and Kalimantan Tengah

Region	Climate (Rainfall)	Parent Material	Dominant Slope	Yield (mt/ha/yr)
SARAWAK (Miri)	Miri Airport Total annual rainfall 2,677 mm No dry month	Sedimentary rocks (Sandstones)	Hilly to steep 12-30° slopes	18-24
SABAH	Estate near Telupid Total annual rainfall 3,682 mm No dry month	Sandy Terraces	Level to undulating 0-6° slopes	22-28
KALIMANTAN TENGAH (Sampit)	Estate near Sampit Total annual rainfall 2,625 mm 1-2 months dry	Sandy Terraces	Level to undulating 0-6° slopes	18-22



Conclusion

- ❑ The planting of oil palm on a sustainable basis on marginal soils demands significantly more intense efforts in terms of higher costs, various management practices and increased management inputs.
- ❑ Effective water management is the key to high oil palm productivity on peat and acid sulphate soils.
- ❑ The key to the management of sandy soils is to reduce surface temperature and to increase moisture in these soils – by maintaining good ground cover and mulching.





Thank you very much