Manuring *the* Oil Palm

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Agri ▪ Research ▪ Advisory ▪ Biotech Services

new ideas for agriculture

Advert by Fertilizer Manufacturer !!!

Nutrient Removal by Plantation Crops

Crop	Yield Level (per Ha/yr)	Total Fert Requirement (kg/Ha/yr)
Palm spp. (Monocot)		
Oil Palm	25-40 t FFB	655
Coconut	2500 kg copra	434
Tree spp. (Dicot)		
Cocoa	1 t dry cocoa bean	258
Coffee	1 t coffe bean	300
Tea	1500 kg dried leaves	376
Rubber	2000 kg dry rubber	142

Oil Palm's Responsiveness to Fertilizers …

- Results of Oil Palm Fert Trials...

Author	Date	Country	Soil Type	Fert Trtmt	Yield Respons
					tFFB/Ha/yr
Tampubolon *et al.*	*1989*	I'sia (Sumatra)	Volcanic / Sedimentary	Nill: Best:	*12.5* *22.0*
Warrior & Piggot	*1970*	M'sia	Inland Sedimentary	Nil: Best:	*7.0* *25.0*
Corley *et al.*	*1973*	M'sia	Inland Sedimentary	Nil: Best:	*16.3* *25.1*
Foster *et al.*	*1989*	PNG	Volcanic	Nil: Best:	*8 - 23* *34 - 38*

Econ Importance of Manuring Oil Palm

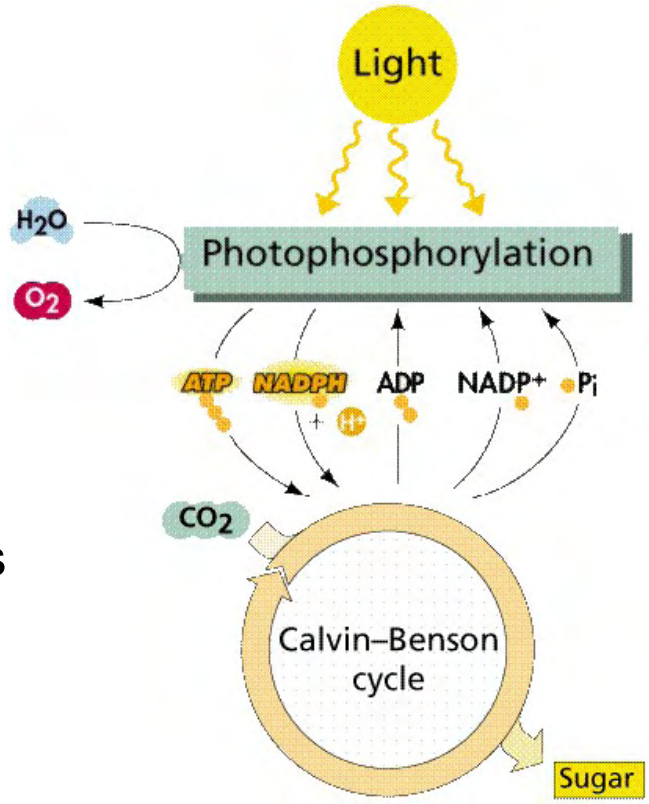
- Importance of OPTIMAL Manuring of Oil Palm:
  - –fertilizers account for 40-50% of field cost of producing FFB's (or 20-25% of CPO production cost) !
  - – at the field level, it is the largest cost of production item together w/ labour costs.
  - –fertilizers impact directly on yields i.e. income (both short and long term)

- Therefore important to optimize **Type**, **Amount** and **Timing** of fert application

  - *for every single Block!*

Photosynthesis - trapping solar energy

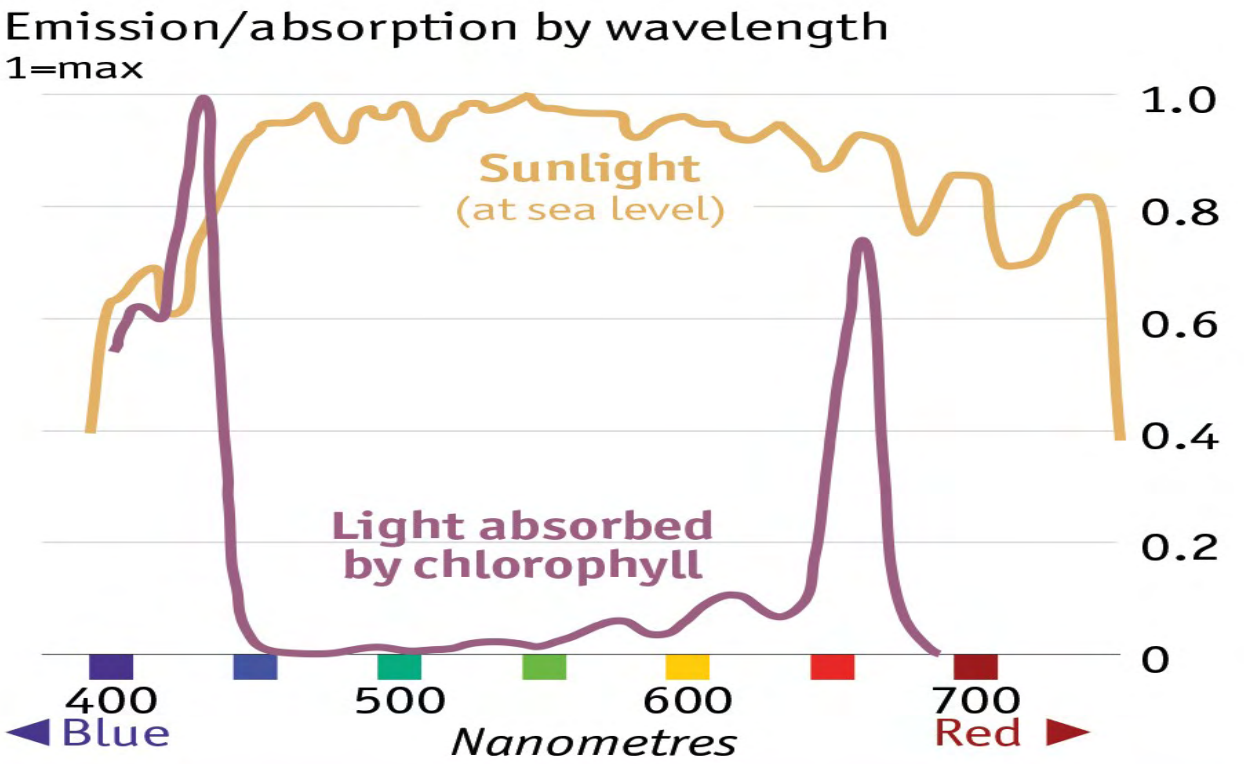
- Bioenergy Generation Factory:
  - –Location: Chloroplast cells in foliar tissues
  - –Machine: Chlorophyll (molecule)
  - –input: CO_2, H_2O & Solar En
    (input cap: root & trunk size - girth & height)
  - –output: Sucrose & O_2
  - –Machine Capacity: LAI
  - –Machine Efficiency: nutrient status of foliar tissues
    (→ speed of biochem rxns)
  - –losses: respiratory losses



- Photosyn (bioenergy generatn machine):

CO_2 + H_2O -- Solar En → Sucrose + O_2

input + LAI-nutrients *output* (bioenergy)



Chlorophyll absorbs blue and red light. Modern LEDs can be tuned to provide only these, so that all of their output is used for photosynthesis.

Respiration - using bioenergy (sucrose)

- Sucrose is burned up in Respiration to release bioenergy for use to generate:
  - Growth of Biomass (Girth, Height, Root & LAI)
  - Yields (Fruiting)
    sucrose is also converted to oil in the bunches

- Respiration (bioenergy usage machine):

$$\text{Sucrose} + O_2 \text{ ---> Biomass (Carb / Oil etc)} + CO_2 + H_2O$$

input (bioenergy) — output

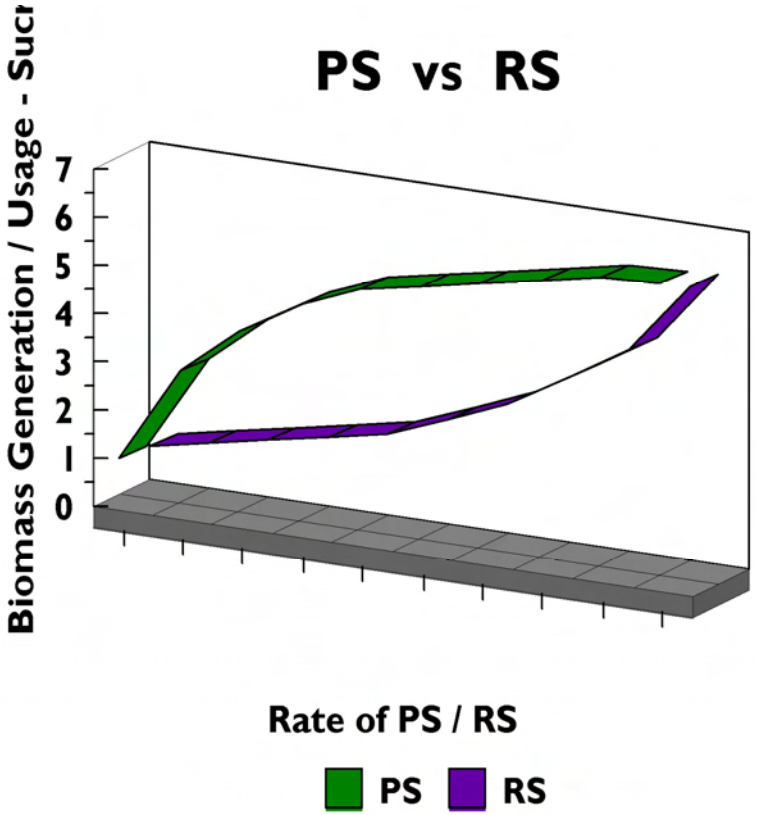
Photosyn vs Respiratn

- PS:

$CO_2 + H_2O + SolarEn = Sucrose + O_2$

- RS:

$Sucrose + O_2 = Biomass + CO_2 + H_2O$



Role of Plant Nutrients

- N
  - –major structural part (w/ Mg) of the green chlorophyll molecular complex
  - –a major component of amino acids / proteins
- P
  - –drives biochem process (molecular energy source - ADP/ATP); structure
- K
  - –enzyme catalyst in photosyn & respiration processes
  - –maintains cellular osmotic press (drought tolerance)
- Ca
  - –an important structural component of cell walls (Ca-pectate) essential for normal plasma membrane functions in cells (movement of nutrients / biochems)
- Mg
  - –chelates w/ many N atoms to form the chlorophyll porphyrin (the green molecule that traps solar energy)
- S
  - –component of amino acids / proteins; important in respiration and other biochem processes

Deficiency Symptoms in Oil Palm

- N - NH_4+ / NO_3^+
  - in young palms: pale colouration of younger fronds (rachis & pinnaes)
  - in older palms: induces contraction of foliar tissues (smaller pinnaes, frond length etc)- although pinnaes may be dark green. Rachis are however pale green / yellowish
- P - $H_2PO_4^-$ / HPO_4^{--}
  - Chlorosis → necrosis burn / drying up of lower frond tips / whole fronds
  - narrowing of trunk and poor root development (soil is "dead" w/ poor micro-org survivability)
  - poor flower development & small bunch weights
  - increase susceptibility to P&D
- K - $K+$
  - younger palms: orange rachis and orange spotting / orange colouration of pinnaes
  - older palms: orange spotting of foliar tissues (rachis & pinnaes)
- Ca - $Ca++$
  - unusually large / papery pinnaes - increase susceptibility to P&D
- Mg - $Mg++$
  - yellowing of lower fronds / foliar tissues
- S - SO_4^{--}
  - pale colouration of fronds of both younger and older fronds

Oil Palm - Deficiency Symptoms

N -def

P -def

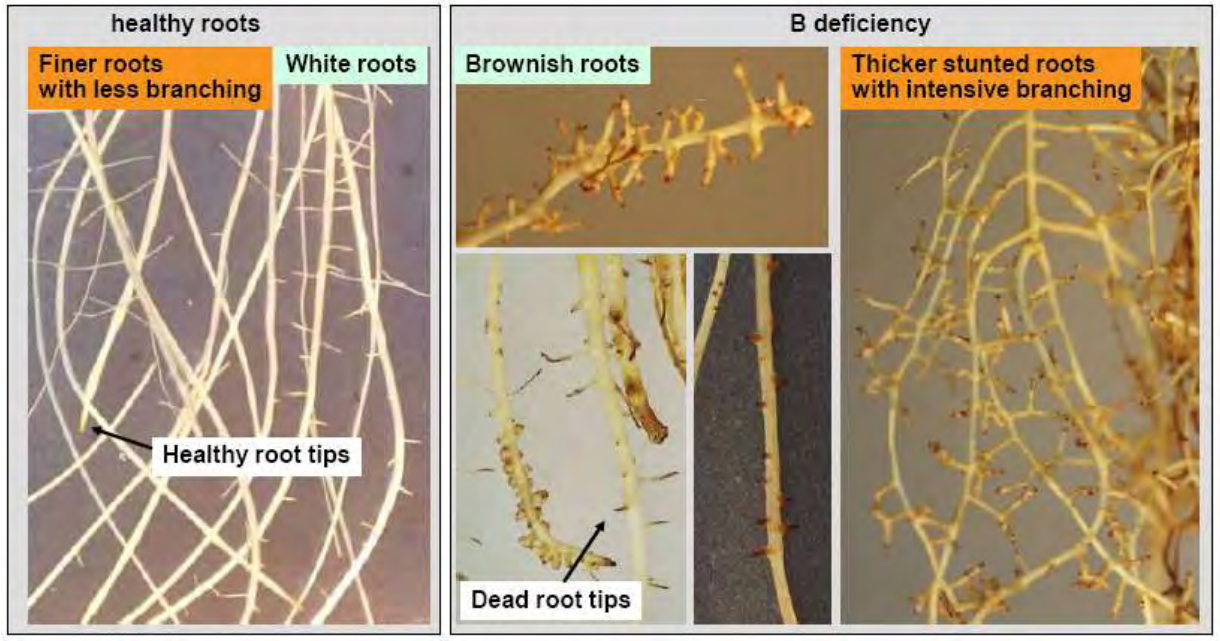
K -def

Mg -def

Boron deficiency

Hook / crinkled (stiff) pinnaes and rachis (→ pinnae/frond snaps)

Shortened frond lengths (stiff)



The Oil Palm ...

- Bunch Set depends on growth and health of palms (LAI and Girthing mainly)

Assessment of Palm Growth

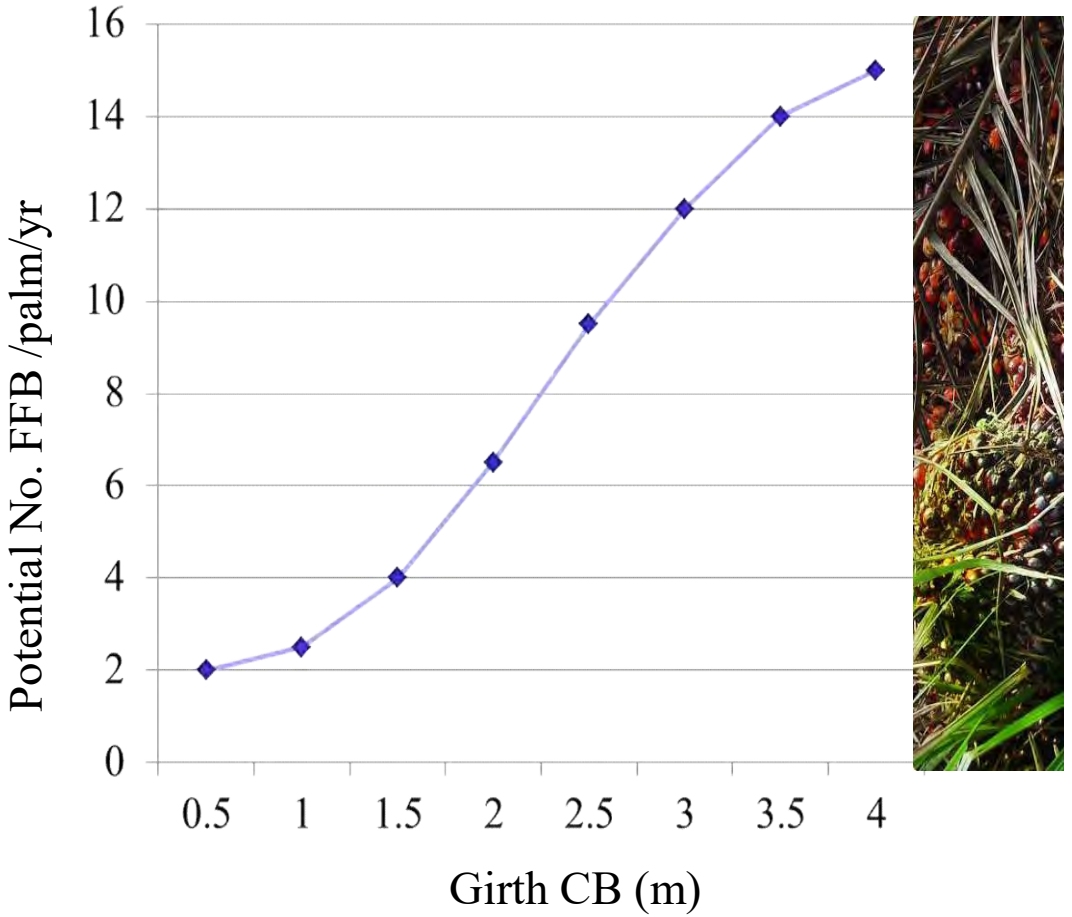
- Girth
  - at Crown Base (CB)
  - at Breast Height (DBH)
- Height
  - upto Crown Base (CB)
- LAI

LAI = [(P.Width x P.Length x FrLength x NoFr) / 10,000]

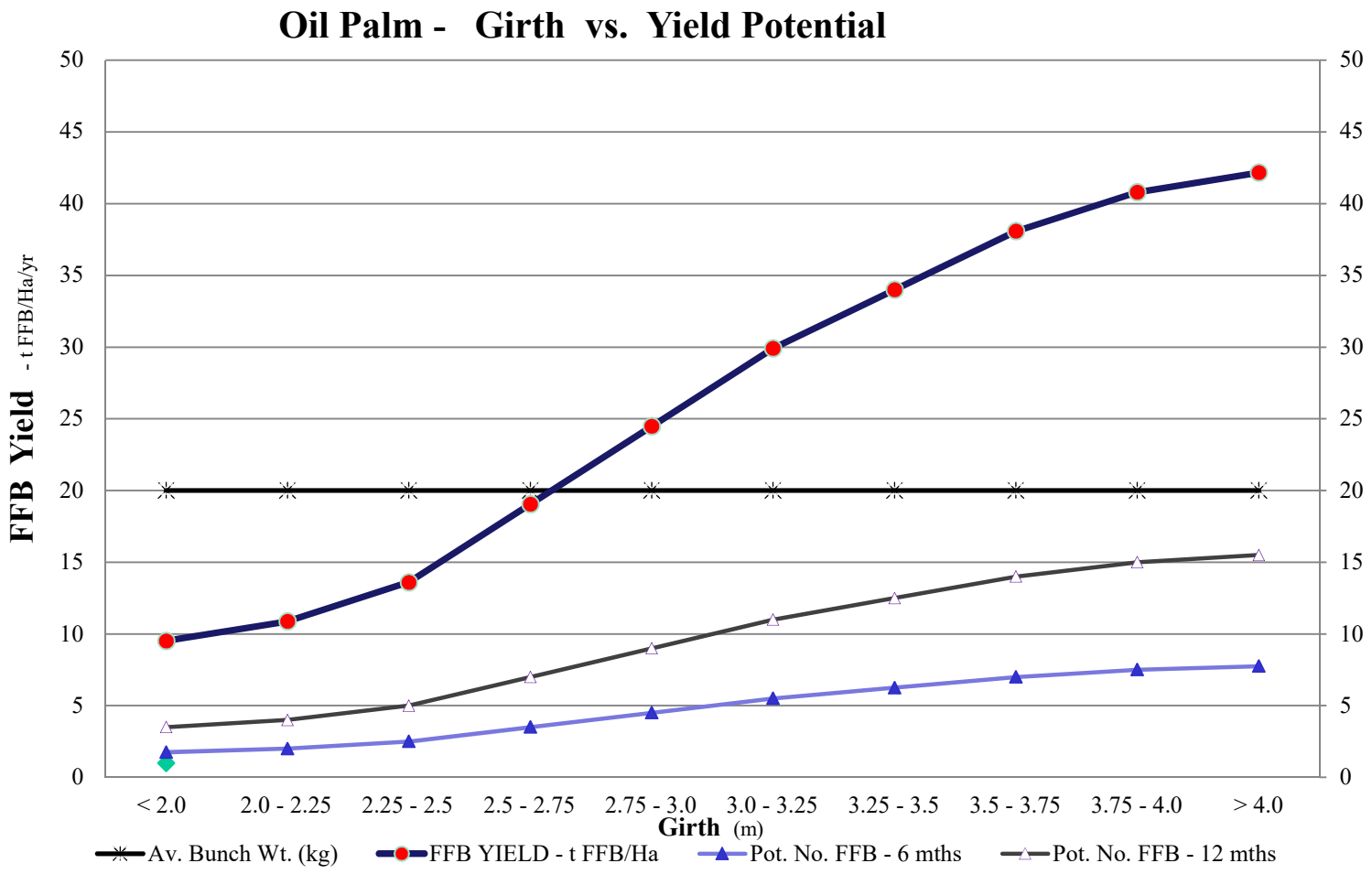
- Note:
  - Girth gives an indication of the potential number of bunches a palm can "carry" at any one time. Together w/ the Height, the Volume of the trunk gives an indication of the input uptake capacity of the palm for water and nutrients.
  - LAI gives an indication of the amount of photosynthetic tissues a palm has i.e. the size / capacity of the photosynthesis factory. (The quality of the photosynthesis factory is given by its nutrient content).

Girth & Pot. No. Bunches

- Girth is *highly correlated* w/ the Pot. Number of Bunches a palm can carry at the crown base.
  - Note that acute P deficiency can lead to narrowing of palm trunks thus lowering the pot. no. of bunches on a palm.
    (Also P def gives rise to smaller bunches - w/ lower bunch wt's).



Palm Girth (m) at crown base	Pot. No. FFB carry cap. (per 6 mths)	Pot. No. FFB carry cap. (per 12 mths)	Av. Bunch Wt. (12+ yr pltngs)	Pot. FFB YIELD t FFB/Ha/yr @ 136 palms/Ha
				136
Palm Girth (m)	**Pot. No. FFB - 6 mths**	**Pot. No. FFB – 12 mths**	**Av. Bunch Wt.** (kg)	**FFB YIELD - t FFB/Ha**
< 2.0	1.75	3.5	20	9.5
2.0 - 2.25	2	4.0	20	10.9
2.25 - 2.5	2.5	5.0	20	13.6
2.5 - 2.75	3.5	7.0	20	19.0
2.75 - 3.0	4.5	9.0	20	24.5
3.0 - 3.25	5.5	11.0	20	29.9
3.25 - 3.5	6.25	12.5	20	34.0
3.5 - 3.75	7	14.0	20	38.1
3.75 - 4.0	7.5	15.0	20	40.8
> 4.0	7.75	15.5	20	42.2


Oil Palm - Girth vs. Yield Potential
FFB Yield - t FFB/Ha/yr
50
45
40
35
30
25
20
15
10
5
0
< 2.0
2.0 - 2.25
2.25 - 2.5
2.5 - 2.75
2.75 - 3.0
3.0 - 3.25
3.25 - 3.5
3.5 - 3.75
3.75 - 4.0
> 4.0
Girth (m)
Av. Bunch Wt. (kg)
FFB YIELD - t FFB/Ha
Pot. No. FFB - 6 mths
Pot. No. FFB - 12 mths

Girthing sets the Bunch Number potential …

Mature Oil Palm with good girth (3.5m) due to good P manuring right from start of immature years – leading to good bunch carry capacity when mature at Age 6. Good frond retention prevents tapering of trunks to maximize and maintain girth and potential bunch carry capacities.

Mature Oil Palm showing severe trunk tapering due to P deficiency and excess frond pruning. Bunch carry potential has been severely reduced for the palms lifetime.

Mature Oil Palm with poor girth (2.5m) but not severely tapering trunk due to adequate frond retention and P heavy manuring after Age 4.

and … LAI and Nutrition determines Girthing !

Adequate P Nutrition helps control Ganoderma

… and also other Pests & Diseases

Old Oil Palm field with low soil available P
→ **high** rate of Ganoderma casualties – 60% of full stand!
No algae seen on ground.

Old Oil Palm field with high soil available P
→ **low** rate of Ganoderma casualties - almost full stand!
Ground covered by algae.

How the Plant prioritizes nutrient uptake ...

- N + Mg --- P → N-Mg porphyrin

(chlorophyll)

- P (for ATP/ADP) is first required (upto a threshold basic level) to combine N & Mg to manufacture chlorophyll in foliar tissues !

- only then can ...
  - other nutrients be taken up (K, Ca, S, micronutrients) and begin to function
  - LAI increase
  - the plants grow w/ good girthing & height measures
  - the Bunch No. potential & Bunch Wt. increase !

No point giving too much of other fert.'s when P is very limiting !

- Nutrition Management of Oil Palms

Nutrient Balance Concept

- Oil Palm

Nutrient Availability		Nutrient Usage/ Wastage	
Natural	**Replenishment**	**Usage**	**Wastage**
Inherent Soil nutrient reserves	Fertilizers	Immobilized in palms	Runoff & Leaching
nutrient recycling		Used for growth & production	Erosion of nutrient rich top soil
BASIS of Estimatn:			
Estmtd by Soil Analysis & Palm Growth	COMPUTED by PAXSYS Fert Rec Sys	Estmtd by Foliar Analysis & Growth / Yield records	Estmtd based on Soil physical & chemical characteristics

Building up
Soil Nutrient Reserve Levels

Soil Nutrient Reserve - Natural

Native Soil Fertility

Soil Nutrient Reserve Increases

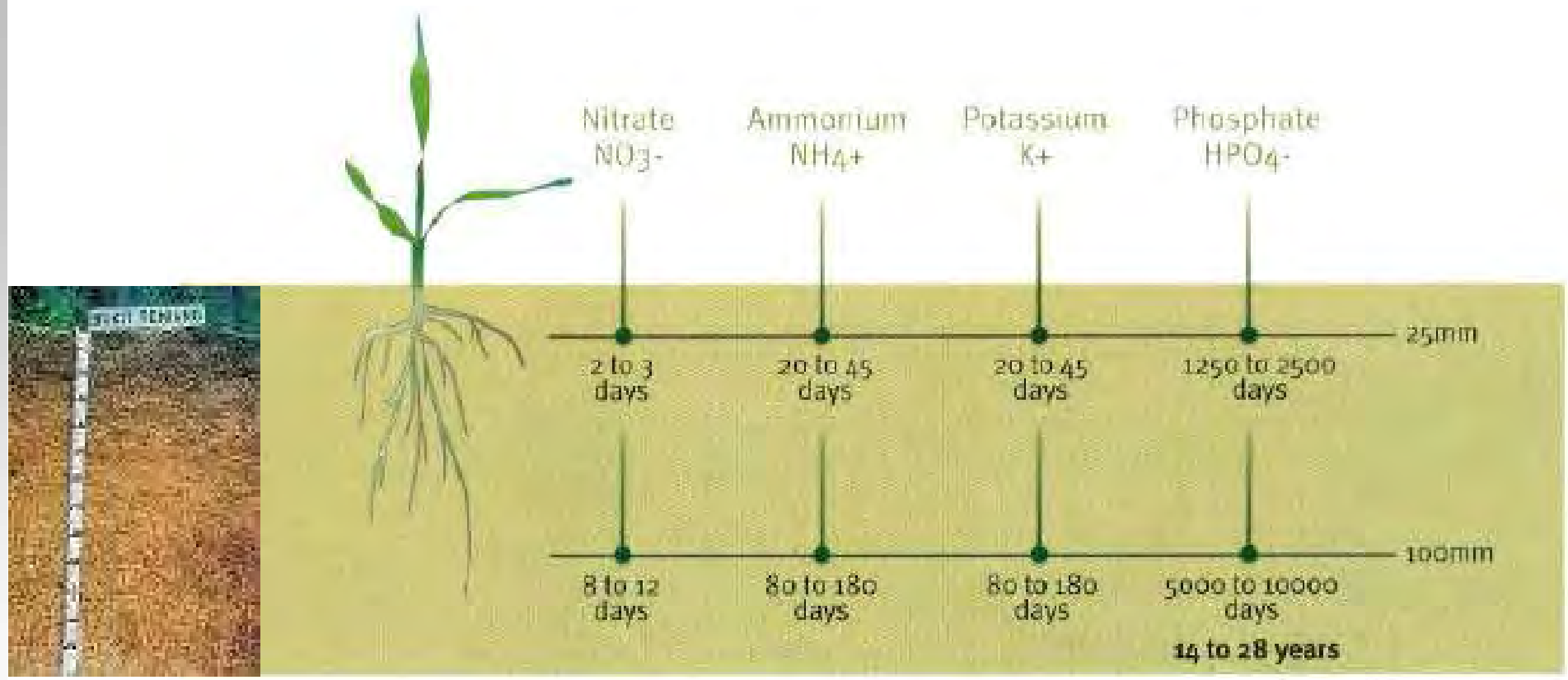
Soil Fertility build up w/ fertilizers

Soil Nutrient Reserve Decreases

Mining of Residual Soil Fertility

Time change in soil fertility status

Nutrient Movement in Soil

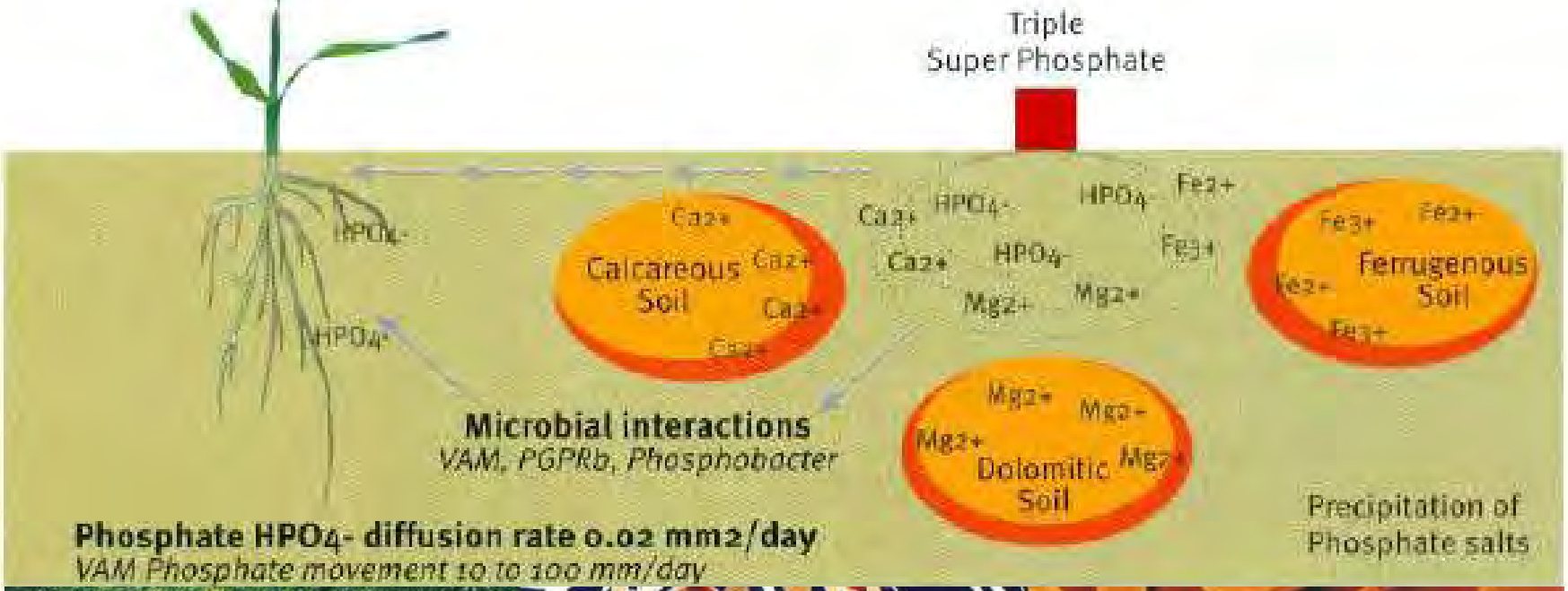


Microbes in Phosphate Uptake

Direct Phosphate uptake by roots is slower in more alkaline soils – needs the assistance of microbes in this.

Microbes themselves need Phosphorus (and Nitrogen) to multiply in the soil.

Note: Soil Phosphate amount and placement determines rooting pattern / spread.



Fert Reqd to compensate for Nutrient Removal / Immobilization

- in Oil Palm (mature)

Crop	Yield Level		S/A	TSP	MOP	LIME	KIES	TOTAL Kg/palm/yr
Oil Palm	25 t FFB/Ha	Removal	2.4	0.42	1.19		0.88	4.66
		Immobilized	0.95	0.07	0.89		0.42	2.29
		Total >	**3.35**	**0.49**	**2.08**		**1.30**	**6.95**
		Recycled in fronds	3.29	0.42	1.32		1.20	6.32

N - dynamics in Oil Palm

- N usage

S/A = 21% N

	N kg/palm/yr	N kg/Ha/yr	S/A kg/palm/yr
Recycled in Fronds	0.67	100	3.29
Immobilized in Trunk	0.20	29	0.95
Exported via FFB @ 25 t FFB/Ha	0.49	73	2.40
TOTAL ->	**1.36**	**202**	**6.64**

Need to replace…

P - dynamics in Oil Palm

- P usage

TSP = 20% P (46% P2O5)
RP = 15% P (34.5% P2O5)

	P kg/palm/yr	P kg/Ha/yr	TSP kg/palm/yr
Recycled in Fronds		12	0.42
Immobilized in Trunk		2	0.07
Exported via FFB @ 25 t FFB/Ha		12	0.42
TOTAL ->		**26**	**0.90**

Need to replace…

K - dynamics in Oil Palm

- K usage

MOP = 50% K (60% K2O)

	K kg/palm/yr	K kg/Ha/yr	MOP kg/palm/yr
Recycled in Fronds		102	1.32
Immobilized in Trunk		69	0.89
Exported via FFB @ 25 t FFB/Ha		93	1.19
TOTAL ->		**264**	**3.40**

Need to replace…

Mg - dynamics in Oil Palm

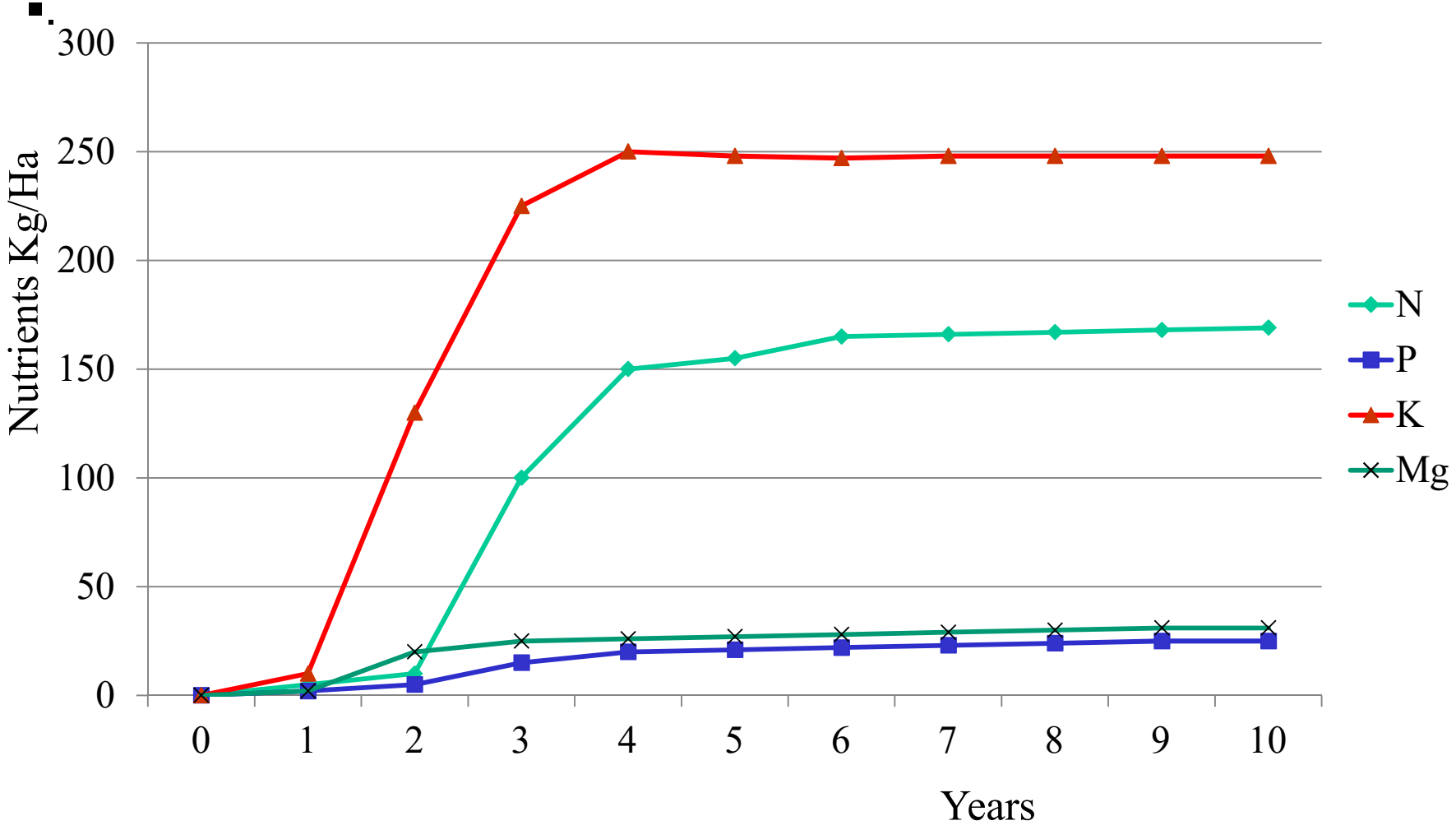
- Mg usage

Kies = 20% Mg (27% MgO)

	Mg kg/palm/yr	**Mg** kg/Ha/yr	**KIES** kg/palm/yr
Recycled in Fronds		31	1.29
Immobilized in Trunk		10	0.42
Exported via FFB @ 25 t FFB/Ha		21	0.88
TOTAL ->		**62**	**2.59**

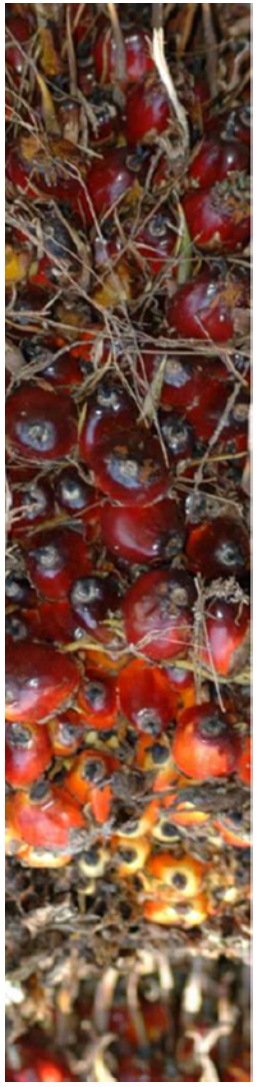
Need to replace…

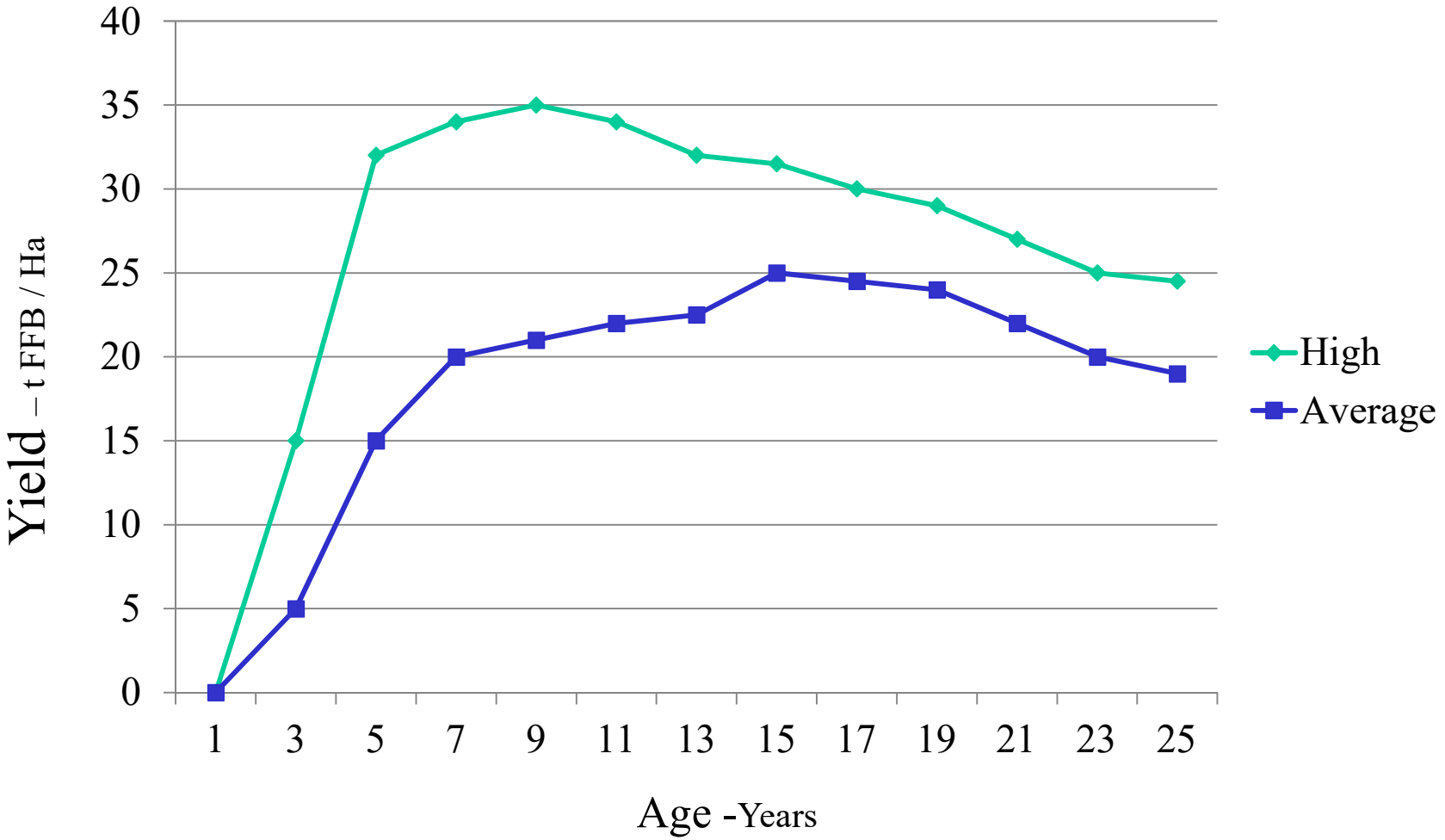
Annual Nutrient Uptake by Oil Palm



Source: Ng. S.K.

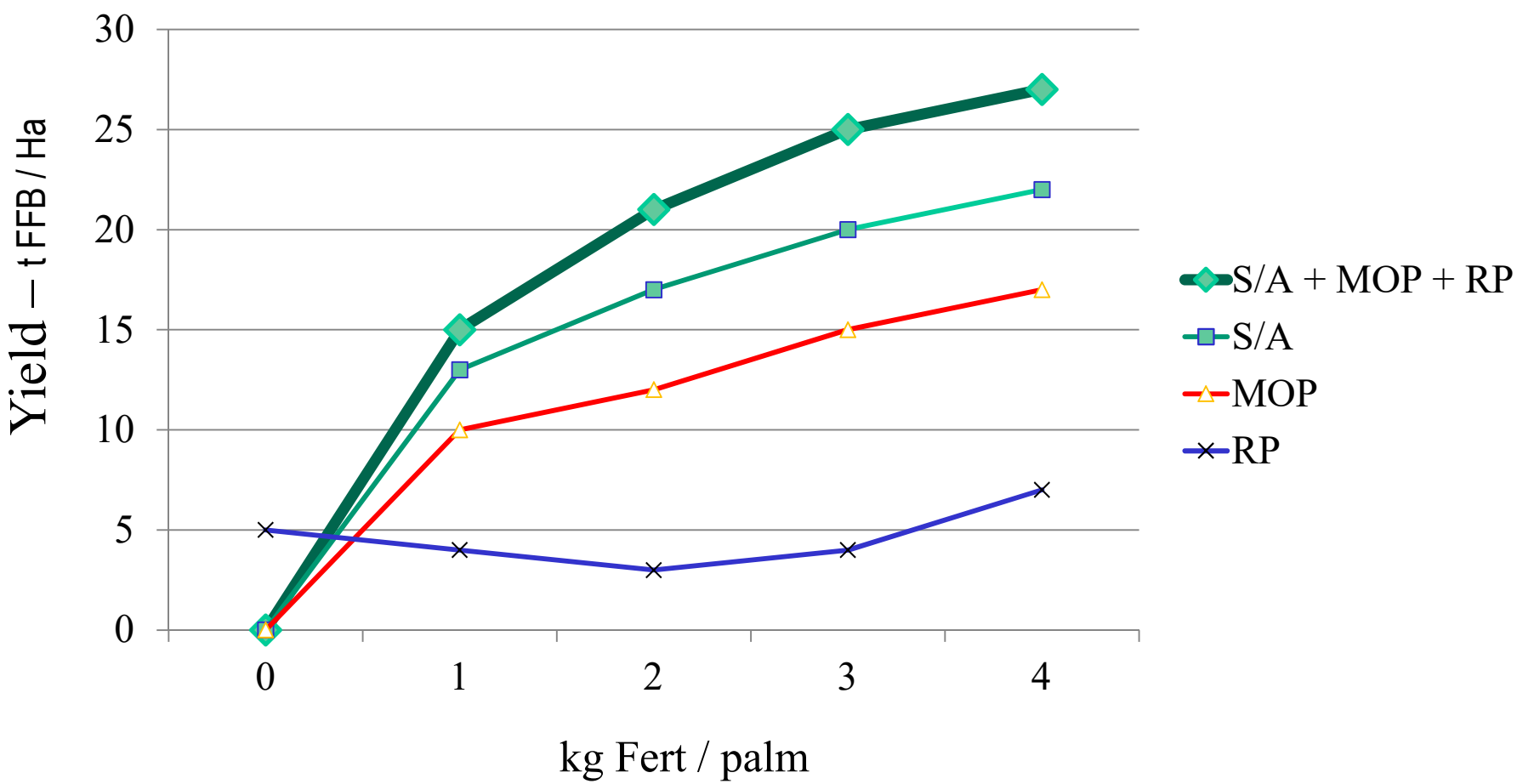
Oil Palm Yield Profile





Oil Palm Yield Response to Fertilizers

- expt. on sandy soils (minimal nutrient content) under irrigation to eliminate effects of water stress



Agronomic & Fertilizer Recommendations

by **ARABIS**

Fert Recommendations by ARABIS

- using PAXSYS Fert Rec Sys

Sampling Intensity:	Every Block of 25 - 50 Ha (or less)
Field Observations:	
Soil Texture, Slope etc	Compensate for leaching / runoff losses of fert
Crop Variety, PltYr, Growth, Yield	
Rainfall	
Nutrient Export:	replacing exported nutrients
Soil Analysis:	adjusting for soil reserve levels of the various nutrients
Foliar Analysis:	determining nutrient status of palms and identifying yield limiting nutrients
Fert Recommendation:	computer based analysis and generation of block specific fert recommendations

ARABIS's Approach to Fert Rec

Agro Info - Field Obs

Soil Analysis

Foliar Analysis

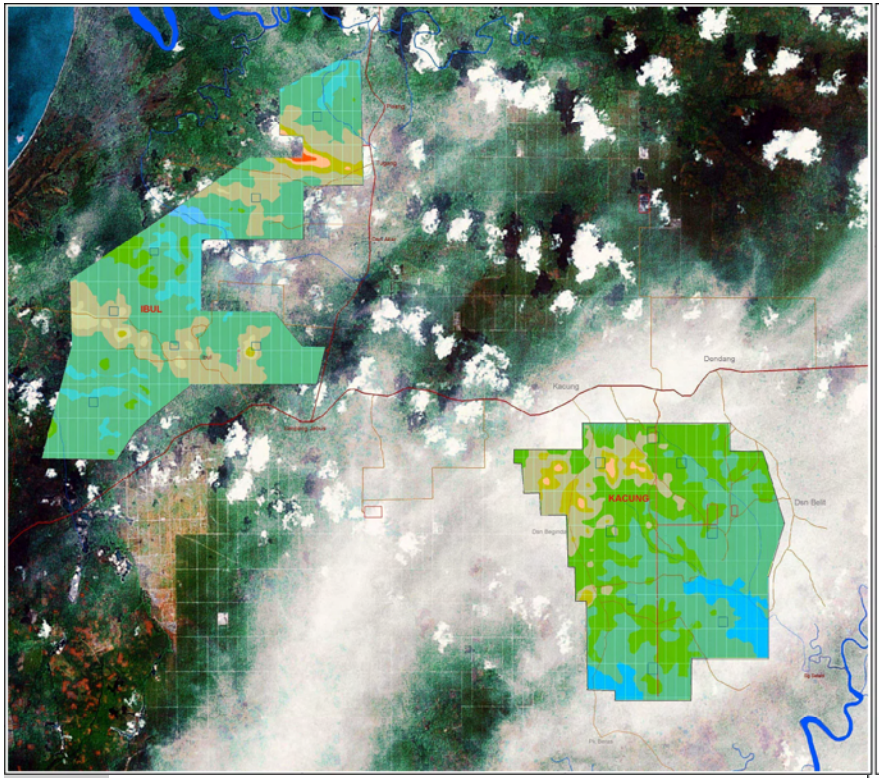
Past Fert &
Nutrient History

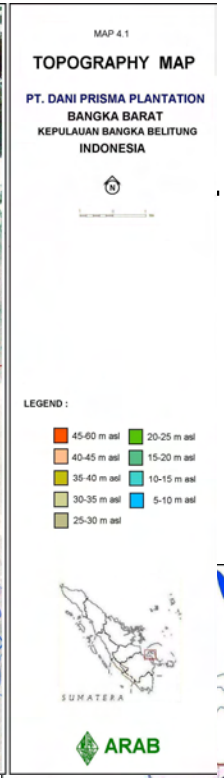
PAXSYS
Fert Rec Sys

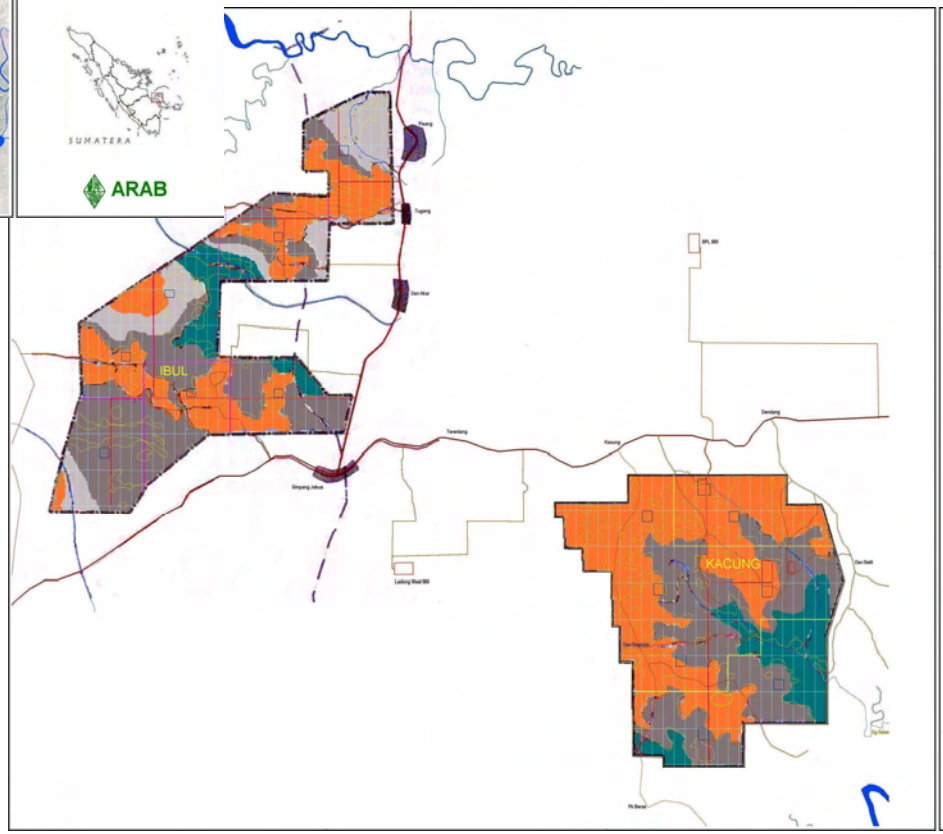
Interpretatn &
Fert Rec
- by Agronomist

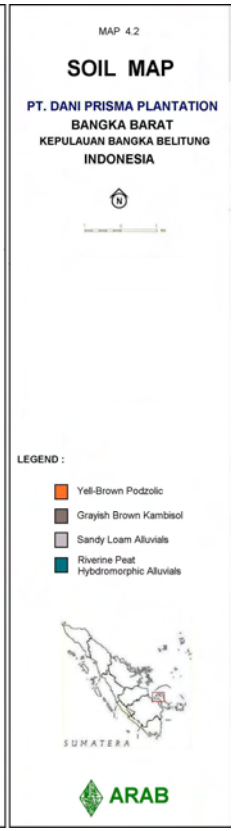
MAPS - Topo, Soil & Planting Block

Info extracted and input into PAXSYS database









Generating Fert Rec's w/ PAX*FertRec

- Factors considered by FRS:
  - –Age / Plant Yr
  - –Climate (Rainfall)
  - –Soil Physical characteristics (texture, slope etc).
  - –Soil Analytical Data (pH, OM, C, N, C/N, Av P, Ex K, Ca, Mg, CEC)
  - –Foliar Analytical Data - Fr 9/17 (N, P, K, Ca, Mg, S, + MicroNut)
  - –Yield Level / Profile
  - –Growth Parameters (Girth, Height, LAI etc)
  - –Vegetative Appearance
  - –Results of Fert Trials (if avail)
  - –Past Manuring History
  - –Fert application type (sol vs rel. insol)

Computation Procedure by FRS...

- Procedurally, the FRS does the foll. for each plant macro nutrient...
  - –examines the planting's phy environ - soil text, slope, colour, infil cap etc.
  - –examines soil reserves of the nutrient (soil analytical results)
  - –calc the age of planting (based on Plant Year)
  - –examines the crops Growth Measures (Girth, Height, LAI) and Yields to estimate nutrient immobilization and export levels
  - –computes a BaseDose rate (based on above)
  - –examines palm nutritional status (foliar analytical results)
  - –computes PrelimRec by adjusting BaseDose rate to account for good/poor palm nutritional status.

Computation Procedure cont'd ...

- After above procedure has been repeated for all individual macro nutrients, FRS ...

  - computes **nutrient balance ratios** to identify the primary / secondary limiting nutrient factors

  – examines **econ parameters** -Prices of FFB and Fertilizers

  – notes the **types and quantum of fert's** to be applied (nutrient sources) - to estimate runoff / leaching losses

  – decides on the various fertilizer types to be applied and the **combination and timing / sequence** of application

  – **computes** a FinalRec by adjusting the PrelimRec accd to above

Note: the properties of the individual fert types (ie soluble vs partially soluble) allows runoff and leaching losses of the various fert types to be estimated when applied to blocks whose soil texture and slope properties are known.

Growth Standards for Oil Palm

Age of Planting	Girth m DBH	Girth m CB	Height m	LAI
3			2	12
4			4	15
5	2.75-3.00	> 2.50	5	17
7			8	20
10			10	25
15			17	25-30
20			20+	25-30

Desirable & Critical Nutrient Levels
in Oil Palm Foliar Tissue

- by palm age (Frond 9 / 17)

Age of Palm	% N	% P	% K	% Ca	% Mg	% S
1 - 3	2.9	0.18	1.1		0.26	
4 - 10	2.70 - 2.90	0.17 - 0.18	0.90 - 1.00	0.35 - 0.55	0.20 - 0.26	0.20 - 0.35
10 - 15	2.60 - 2.80	0.16 - 0.18	0.80 - 0.90	0.35 - 0.55	0.18 - 0.24	0.20 - 0.35
> 15						
Critical > mature palms	2.5	0.15	1	0.3	0.17	0.15

Note: Assessment of a plants nutrient status has also to take into account the total amt of photosyn tissue together w/ the nutrient conc. of foliar tissues.

Normal Levels of Trace Elements

in Oil Palm Foliar Tissue

- by palm age (Frond 9 / 17)

Age of Palm	B ppm	Mn ppm	Fe ppm	Zn ppm	Cu ppm	Mo ppm
All ages	12 - 15	200	40 - 50	11 - 20	5 - 6	2 - 5

Desirable Nutrient & Nutrient Balance Ratio's in Oil Palm

- - Optimum (Target) Foliar levels "at balance" (Fr 17):
  - N 2.70 - 2.90 %
  - P 0.16 - 0.18 %
  - K 0.90 - 1.00 %
  - Ca 0.35 - 0.55 %
  - Mg 0.17 - 0.20 %
  - S 0.20 - 0.35 %

–Optimum Nutrient Balance Ratio's:

- N/K 2.5 - 3.0
- N/Mg 14 - 18
- N/P 11 - 17
- N/Ca 4 - 9
- K/Mg 4 - 10
- K/Ca 2 - 5
- Mg/Ca 0.25 - 0.55

Soil Fertility Evaluation

for Oil Palm

Property		v.low	low	mod.	high	v.high
pH		< 3.5	4	4.2	5.5	> 5.5
Org C	%	< 0.8	1.2	1.5	2.5	> 2.5
Tot N	%	< 0.08	0.12	0.15	0.25	> 0.25
Tot P	ppm	< 120	200	250	400	> 400
Av P	ppm	< 5	10	15	20	> 30
Ex K & Mg	% meq	< 0.10	0.2	0.25	0.3	> 0.5
Ex Ca	% meq	< 0.30	0.5	0.75	1	> 1.5

- Note:
  - 1 ppm P (mg/kg) = 2 kg P / Ha (or 0.1 kg RP/palm)
  - 0.1% m.eq. K (cmol/kg) = 80 kg K / Ha (or 1 kg MOP/palm)
  - 0.1% m.eq. Ca (cmol/kg) = 40 kg Ca / Ha
  - 0.1% m.eq. Mg (cmol/kg) = 24 kg Mg / Ha (or 0.9 kg Kies/palm)

The "Soil" is a plantings Nutrient Bank ...

–The **nutrient bank balance** is *assessed* as follows:

- 1 ppm P (mg/kg) = 2 kg P / Ha (or 0.1 kg RP/palm)
  i.e. 30 ppm P = 3 kg RP/palm
- 0.1% m.eq. K (cmol/kg) = 80 kg K / Ha (or 1 kg MOP/palm)
  i.e. 0.3 % m.eq. K = 3 kg MOP/palm
- 0.1% m.eq. Mg (cmol/kg) = 24 kg Mg / Ha (or 0.9 kg Kies/palm)
  i.e. 0.3 % m.eq. Mg = 2.7 kg Kies/palm

→ thus,

if there is "excess" nutrient reserves in the soil bank - we can temporarily drawdown on it (on an unsustainable basis) when commodity prices are very low and when costs have to be tightly controlled.

Note:

–Before recommending a fertilizer input programme, we need to assess which nutrients the plants are taking up and which they are not at the relevant time period.

–Example:

A plant suffering from acute P def will not be taking up too much K from the soils - but they will be taking up N and some Mg as P is made available to the palm !

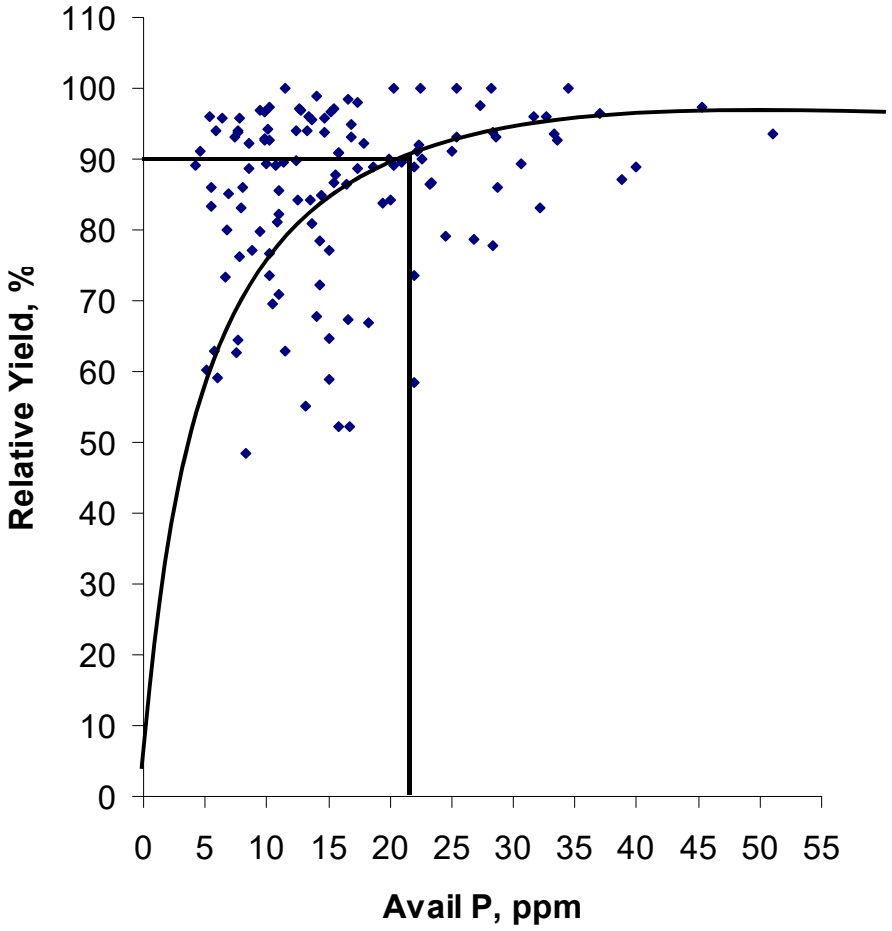
- thus applying K fertilizers (highly soluble) at this time for direct plant uptake is just a waste of money ! (In such cases, K should only be applied to compensate for soil reserve depletion - if this is of concern).

Plant Tissue Analysis allows us to judge the nutrient composition / status of the plant in the current time frame only - but it is Soil Analysis that will provide us information of what the future nutritional status of the palm is going to be with / without any fert inputs. Thus soil analysis allows us to anticipate future nutritional problems and overcome them proactively - i.e. before growth and yields are impacted !

Critical Soil Test P Level

- Oil Palm Yield calibration data show a critical level of 20 to 25 ppm Avail P (40 to 50 kg P/ha)

- This is the level of soil test Avail. P above which only maintenance (starter/removal) application would be required



a. Gen of Fert Rec (Sol Fert)

- S/A, Urea, TSP, MOP, Kieserite

  - Age, SoilNut Status, Growth & Yield combination --> BaseDose

  - PrelimRec = BaseDose +/- $\frac{[(\text{Nut\% +/- TargetNut\%}) (a/b)]}{}$

  - FinalRec (sol fert) = PrelimRec × SoilText factor × SoilSlope factor

b. Gen of Fert Rec (Insol Fert)

- RP, Lime/Dolomite

  – Age, SoilNutSatus, Growth & Yield combination --> BaseDose

  – PrelimRec = BaseDose +/- [(Nut% +/- TargetNut%) (a/b)]

  – FinalRec = PrelimRec
  (insol fert)

Methods & Freq of Fert Application

- Method:
  1. Placement around palms - in weeded palm circle
  2. Broadcast in the interrows
  3. On Frond Heap / Stacks
  4. Pocketing into soil (sub soiling)

  ... or any combination of above

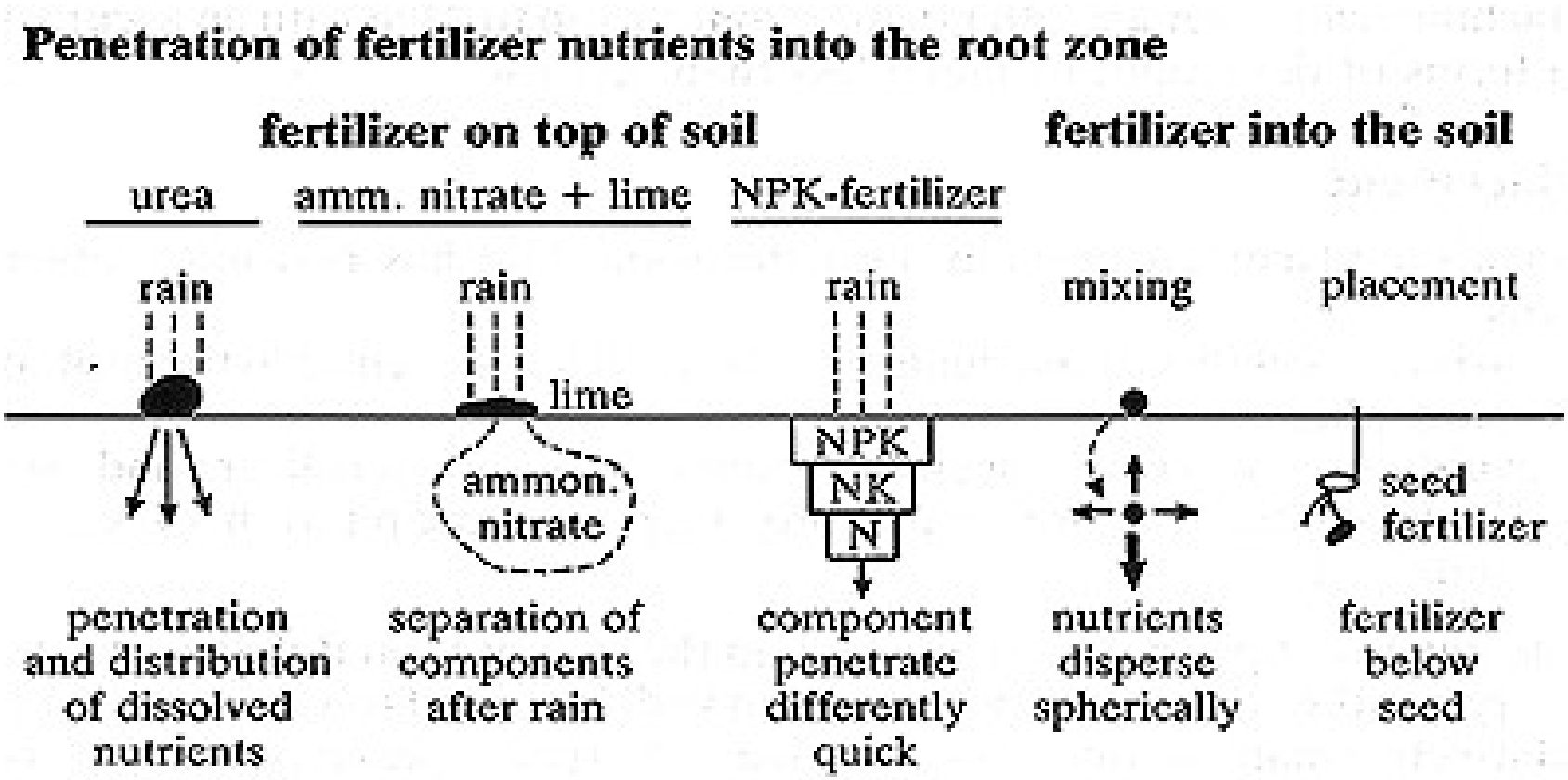
- Frequency:

  Immature palms: 4 - 6 appl / year

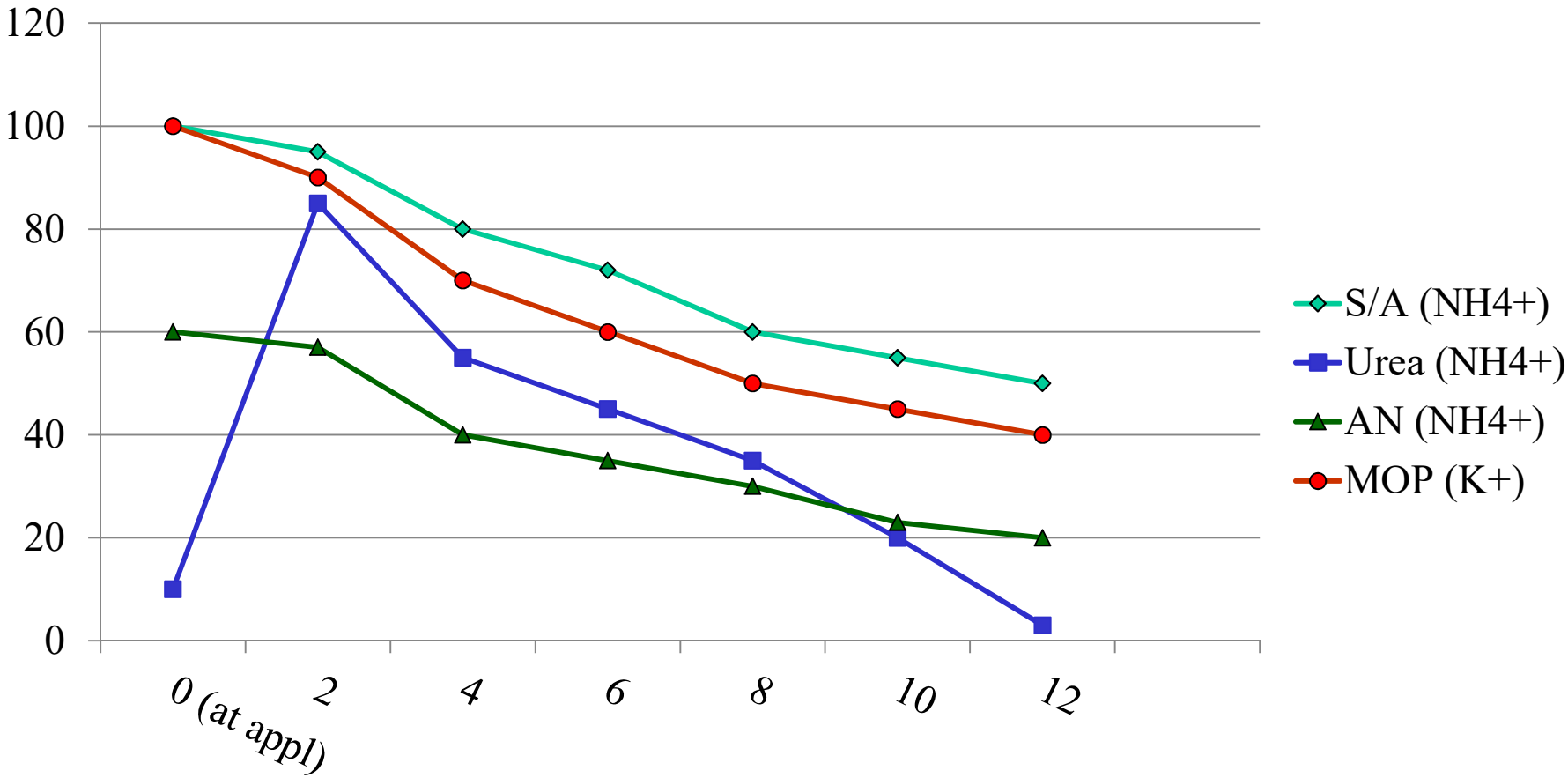
  Mature palms: 3 - 4 appl / year

Dispersion of Applied Fert's ...

- .



Nutrient Retention by Soils



- Note:
  - NH_4^+ levels fall as it converts to NO_3^-(nitrification) and is leached out of the root zone

EFB Application around palm trunks

Adds K to soil and improves soil OM (+ microbial populations) and soil structure (assuming sufficient P is present in the soil)

… imperative for sandy soils!

Effect of Surface vs Sub-soiling Application of Ferts ...

- Estate: KWS 12 yr old Planting

		Mineral *Sub-Soil appl*	Volcanic *Surface appl*	Peat *Sub-Soil appl*
Av. Yield Level	tFFB/Ha/yr	**28 to 30**	**25 to 29**	**24 to 28**
		(2500+Ha)	(7000+Ha)	(1200+Ha)
S/A	21% N sol	*2.75*	3.00	-
Urea	45% N sol/vol	-	-	*2.50*
MOP	50% K sol	*2.50*	2.25	*2.50*
TSP	20% P sol	-	0.50	-
RP	15% P p/sol	*2.50*	3.00	*0.75*
Dol	10% Mg p/sol	*1.00*	-	-
Kies	20% Mg sol	*0.50*	-	-
TOTAL →		***9.25***	**8.75**	***5.75***

Example Fert Rec for Oil Palm on different soil types and yield levels

- in kg/palm/yr (from 3 estates in N. Sumatra under ARABIS's care for 22 years)

		Volcanic	**Red-Yell Podzolic**
		rich in K, Ca & Mg	poor in all nutrients
Av. Yield Level	t FFB/Ha/yr	**28 to 30**	**25 to 29**
		(2500+ Ha)	(7000+ Ha)
S/A	21% N sol	3.5	3
Urea	45% N sol/vol	for peat mainly	-
MOP	50% K sol	2.5	2.5
TSP	20% P sol	0.5	-
RP	15% P p/sol	3.5	2.5
Dol	10% Mg p/sol		1
Kies	20% Mg sol	0.5	0.75
TOTAL →		**10.5**	**9.75**

Summary...

- Fertilizer Rec's from PAX*FertRec are:
  - **Economical**

    - i.e. for every dollar spent on fert, the system expects to get more than a dollars worth in increased FFB yields
    - justifies technically the use of every 0.25 kg of fertilizer (of various types)
    - in coarse textured soils... upto 50% of soluble fert's applied are lost thru leaching / runoff --> smaller dose per appl
    - insoluble ferts remain on the ground longer --> fert appl's are reduced after initial buildup
    - Once a good girth has been achieved and maintained via optimal P nutrition and frond retention, N & K nutrition in palms are the primary yield limiting factors (after water avail) - and is exported in significant amts - FRS gives priority to correcting the P and then the N & K status of the palms before optimizing (balancing) Mg levels

ARABIS's Agro-Tech Mgmt Services

- Agro Tech Services

  –- incl of fertilizer use recommendations

  –<u>PAXSYS based:</u>

  - incl of gen data collection & PAXSYS analysis
    - growth measures, yield analysis, foliar & soil analysis
  - Pro/Cons: more accurate - objective fert use optimization
  - RM 30 / Ha / yr

  –<u>non-PAXSYS based:</u>

  - incl of gen data collection and foliar analysis only
  - Pro/Cons: somewhat accurate - some guestimating in fert use optimization
  - RM 15 / Ha / yr

Summary cont'd ...

- Fertilizer Rec's from PAX*FertRec are:

  - **Intelligent**

    - the system has been "tuned" to optimize the palms nutritional status so as not to limit production (both in short and long run) - and to do this at minimal cost

    - the system has been "taught" to identify soils w/ specific identifiable characteristics - such as volcanic, peat, ultrabasic (ex: serpentine) derived soils. Thus nutrient interaction effects can be mitigated against - ex: wasteful appl of Mg to peat soils can be avoided!

Conclusion ...

- ARABIS's PAX*FertRec provides ...
  - –a Detailed Analysis of EVERY FIELD & generation of *block specific* fert recommendations!
  - –FAST generation of fert recommendations!

Thank you !

- For more info ...

  visit ARABIS's web site ... ***www.arabis.org***

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Q&A *Session …*