April 2006

AAR - NEWS

EDITORIAL

Since the previous issue of AAR Newsletter in October 2005, the following events of significance to the plantation industry in general and to AAR in particular have taken place ;

⇒ Dr Soh Aik Chin, Head of Agricultural Research, AAR, was presented with the Malaysian Science & Technology Toray Award for excellence in scientific contribution to the scientific community

⇒ the successful transfer of tissue culture facilities to the state-of-the-art Tissue Culture Laboratory in Tuan Mee estate

⇒ the recruitment of a Senior Tissue Culturist, a Junior Tissue Culturist, a Biotechnologist and the reemployment of an Agronomist who left AAR three years ago to pursue his Ph.D. Welcome aboard and please put your hand to the plough!

⇒ the increase in price of CPO from RM 1350 to RM 1450 per ton and the continued escalation of rubber price to RM 8 per kg. (SMR CV).

Front view of the new Tissue Culture Laboratory

2006 should be another fruitful year for AAR and the plantation industry.

In line with the renewed interest in rubber due to the high rubber price, the paper presented by CWH at the Rubber Growers Conference in Kuala Lumpur in November 2005 is reproduced for your reading pleasure.

HAPPY 2006!

CWH

Inside this issue:

NEW PERSPECTIVE FOR RUBBER PLANTING IN A LARGE PLANTATION GROUP
(Paper presented at Rubber Planters Conference 2005 in Kuala Lumpur)
CHAN WENG HOONG

Rubber and rubberwood prices have risen sharply in the last three to four years after being in the doldrums for the past several years. The high prices have been driven by the expanding economies in China, India and Eastern Europe and recently by the sharp increase in price of crude oil. Global demand for both the commodities is expected to be long term as demand is expected to outstrip supply for the next ten to fifteen years.

In view of the positive outlook for rubber, a large plantation group is considering replanting back to rubber in areas considered marginal for oil palm. Rubber trees with their deeper root system are able to withstand harsher conditions than oil palm.
Planting rubber in the following designated areas in the Group would likely achieve higher profitability than oil palm;

1) Region 1 comprising the districts of Bahau and Segamat in Peninsular Malaysia, where mean annual rainfall is mainly below 1600mm. Terrain ranges from undulating to steep while soils are mainly lateritic with shallow profiles.

2) Region 2 comprising the state of Kelantan in Peninsular Malaysia, where extremes in weather pattern exist. The latter embodies a dry season with less than 50 mm rain per month which can persist for two to three months in the early part of the year and monsoonal rains exceeding 400 mm per month for one to two months, usually occurring at the end of the year.

Mean yield of oil palm in these marginal regions ranged from 17.1 to 21.0 tons per hectare FFB compared with 25.0 tons per hectare FFB and 27.6 tons per hectare FFB in the more favourable Region 3 (Taiping district) and Region 4 (Tawau district, Sabah) respectively. On the other hand, mean rubber yields ranging from 1769 to 2014 kg per hectare in Region 1 and around 1710 kg per hectare in Region 2 are considered satisfactory to high.

Based on the Group`s statistics on profitability, price and yield obtained for rubber and oil palm in 2004, profitability of rubber at the above yield levels would exceed oil palm in Regions 1 and 2. At current higher price for rubber and lower price of crude palm oil than in 2004, profitability of rubber in Region 1 and 2 would be even higher than oil palm.

The current high rubber price has been predicted to sustain for some time.
Promising high yielding clones like PB 347 and PB350 and some of the new RRIM 2000 series clones, would enhance profitability even further through higher latex and/or rubberwood yield than PB 260. Innovative short cut exploitation systems would also prolong lifespan of trees as well as enable tappers to earn more income from higher yields obtained from increased task sizes.

Interest in rubber has resurfaced as price of the commodity (and also rubberwood) has escalated after several years of low prices. The average price per kg of SMR CV has moved up from RM3.50 in 2002 to RM 4.50 in 2003, RM 5.50 in 2004 and has breached the RM 7.00 mark in 2005 (`Star` Newspaper, Business section, 2002 to 2005) due mainly to shortage in supply of the commodity. The latter has been traced to planters pulling out rubber and putting in oil palm in the last three decades (Peyman, 2003) caused by prolonged weak prices which resulted in reduced replanting/new planting of rubber. The expanding economies in China, India and Eastern Europe, resulting in an increased global demand for rubber (Budiman, 2004) has also assisted in pushing up the price of the commodity. In China, 5.2 million vehicles were sold in 2004 and vehicle demand is forecast to grow to 10.1 million units in 2010 (Star newspaper, November 2004).

Owing to the current increase in demand for rubber, rate of replanting of trees has reduced slightly, whilst downstream demand for furniture manufactured from rubberwood continues to grow at a steady pace. As a result of this imbalance in supply and demand for rubberwood, the price of rubber trees at replanting has leaped to above RM20,000 per hectare (Tan Seng Yeang, per. comm., 2005). This exceeds the cost of replanting of rubber up to maturity, implying zero cost of investment at time of opening of trees for rubber to rubber replants. Price of rubberwood however has declined of late due to a ban on export of logs. In the light of the current positive position, it would appear worthwhile to review the long term outlook for rubber with a view to returning to rubber in areas where oil palm has not yielded well. Rubber trees with their deeper root system are able to withstand harsher conditions than oil palms.

Long term prospects for Natural Rubber

Supply and Demand situation

According to the International Rubber Study Group, the current and future growth of both Natural and Synthetic Rubber (NR and SR) appears healthy (Budiman,2004). The future demand for NR appears well secured by the global tyre industry. Consumption of NR is projected to increase to 18.0 million tons by 2035 and based on production status of 8.0 million tons in 2004, appears unlikely to meet the demand for NR.

SHORTAGE OF SUPPLY DUE TO

EXPANDING ECONOMIES IN CHINA, INDIA, EAST EUROPE.

CHINA - 10 million vehicles per year by 2010

Some of the reasons for the likely shortfall in supply are:

1) Lack of new investment in rubber globally

Despite the bright outlook for rubber, the three main producing countries of Malaysia, Thailand and Indonesia continue to switch to oil palm. Oil palm continues to give good returns in most situations in these countries, has a short gestation period and is also easier to manage in terms of labour. Individually, these countries also face problems peculiar to their own situation. In Malaysia, labour availability has always been a problem. In the case of Indonesia, Peyman (2003), mentions the absence of cess levy to fund new planting. Thailand has already exhausted land in the south and hence little to no new land is available for planting. Vietnam, and Kampuchea are probably the new frontiers for rubber expansion. Current rubber hectarage in the latter is however small and therefore will require some time to make a significant contribution.

2) Long gestation period of rubber

Unlike oil palm which can respond rapidly to any supply shortfall, rubber would take at least 5-6 years to reach maturity and a few more years to reach peak yields.

Peyman (2003) suggested that effectively it would take 10 to 15 years of consistent replanting and new planting to enable supply to catch up with demand. With no significant increase in supply in the near term, rubber price is set to remain high for the next ten or more years.

3) Increased market share of total global rubber

The global requirement for rubber is presently fulfilled by 60 percent SR and 40 percent NR (Budiman, 2004). With the price of crude oil crossing US$ 70 per barrel, NR would have a competitive edge over SR. NR would likely eat into the market share of the latter, thereby increasing the demand for NR. As fossil fuel reserves can only deplete with time, SR will get costlier with time thereby enhancing the long term prospects for NR.

4) Investment in rubber has also to include the economic value of rubberwood. Johari and Ramli Othman (2003) estimated a shortfall in supply of rubberwood to meet the burgeoning rubberwood industry (valued at RM 4.9 billion in 2002) which may only be met by annual replanting of around 25,000 ha of rubber forest from 2003 onwards for the next 15 years.

On the basis of the anticipated shortage of both latex and rubberwood, outlook for rubber appears very bright indeed for the next 10-15 years.

Profitability of rubber and oil palm in the Group

Whilst most large plantation companies have virtually felled all their rubber for oil palm, a public listed plantation based Company has maintained 15 percent of their total hectarage under rubber. This Company appears to have been rewarded for their patience as depicted by the increasing profit from rubber in the last 2 years and probably in the next few years as compared with oil palm as shown in Table 1 (Annual Report 2004, Kuala Lumpur Kepong Bhd, 2004).

TABLE 1: COMPARISON OF PROFITABILITY BETWEEN OIL PALM AND RUBBER

Oil palm	*Year*		
	2003	*2004*	*2005*
Yield tons per ha FFB	22.15	21.57	22.89
Price RM per ton CPO	1476	1636	1391
Profit per ha (RM)	4160	4448	3744
Rubber			
Yield Kg per ha rubber	1507	1611	1563
Price Sen per kg rubber	386	519	539
Profit per ha (RM)	1606	3975	3961

Profit per hectare of rubber at a price of 519 sen per kg rubber and yield level of 1611 kg per hectare was RM 3975 compared with RM 4448 per hectare for oil palm at a price of RM1636 per ton of CPO (crude palm oil) and yield level of 21.57 tons per hectare FFB. Actual profit from rubber would of course be higher if revenue from sale of rubberwood is taken into account. The Company has obtained prices ranging from RM15,000 – 23,000 per ha for their rubberwood in the last 1-2 years. Price of rubberwood however has declined of late. Price of rubber has crossed RM 7.00 per kilogram (SMR CV) while price of CPO has dropped to between RM1350-1400 per ton in 2005.

Based on the likelihood of rubber price sustaining at current levels and satisfactory price for rubberwood, the Company has planned for more replanting of rubber, especially where oil palm has not performed well.

Prospective areas for replanting/new planting to rubber in the Group

Four regions in the Group with diverse site characteristics were selected to identify areas where rubber would likely achieve higher revenue than oil palm. These regions with their site characteristics are presented in Table 2.

TABLE 2: SITE CHARACTERISTICS OF SELECTED REGIONS IN THE GROUP

Region	Characteristics			
	Climate		Soil	
	Mean Rainfall (mm) (10 years)	Rainfall pattern	Terrain	Depth
1 Bahau and Segamat districts	1444-1573	2-3 months with rainfall below 100 mm	Undulating to steep	Shallow and mostly lateritic (<50 cm)
2 Kelantan state	2500-3000	2-3 months continuous dry season < 50 mm rainfall per month.1-2 months monsoonal rainfall>400 mm	Undulating to steep	Moderately deep to deep (50cm-100cm or >)
3 Taiping district	3057	Mostly 150-250 mm rainfall per month	Mainly undulating to rolling	Deep (100 cm or >)
4 Tawau district	2062	Fairly even rainfall of 120-210 mm per month	Undulating	Deep (100 cm or >)

Region 1

e.g. Districts of Bahau and Segamat, Peninsular Malaysia

Terrain in these areas is mainly hilly to steep. Soils are mainly lateritic with shallow profiles. Mean annual rainfall at below 1600 mm is considered low. Rainfall distribution is poor with at least 2-3 months receiving less than 100mm precipitation.

Region 2

e.g. State of Kelantan, Peninsular Malaysia

Whilst annual rainfall is adequate, rainfall distribution is considered unfavourable. This region experiences monsoonal climate where peak rains can exceed 400mm per month for 1-2 months while drought conditions with less than 50 mm per month commonly occur continuously for 2-3 months. Flooding of lowlying areas occurs frequently during the monsoonal months.

Region 3

e.g. District of Taiping, Peninsular Malaysia

This region has little to no limitations to crop growth. Annual rainfall is high and also well distributed. Soils have deep profiles and the undulating terrain is favourable to crop growth.

Region 4

e.g. District of Tawau, Sabah

Apart from moderate annual rainfall, environmental conditions are considered favourable to crop growth. The moderate precipitation is however ameliorated by the even rainfall distribution pattern and the deep soil profile in the region.

Performance of oil palm in the four regions (Table 3)

Highest mean yield of 27.6 tons /ha FFB was obtained for Estate I in Region 4.

Estate H in Region 3 yielded 25.0 tons /ha FFB which may also be considered satisfactory to high.
In Regions 1 and 2, mean yields were lower, ranging from 17.1 tons /ha to 21.0 tons /ha FFB. In addition, yields were only obtained from the fourth year of growth onwards for some estates compared with third year for estates in Regions 3 and 4, implying slower growth of palms in Regions 1 and 2.

TABLE 3: PERFORMANCE OF PB 260 IN THE 4 REGIONS (KG/HA)		
Region	Year	
	6	Mean of 7-18
1 Bahau and Segamat	-	1769 -2014
2 Kelantan	-	1707 - 1709
3 Taiping	1287	1838

Whilst yields surpassed 20 tons per hectare FFB very early in the fourth and fifth year for estates in Regions 3 and 4, estates in Regions 1 and 2 showed low initial yields which only breached the 20 tons per hectare FFB mark in the eighth to tenth year.

Performance of rubber in the four regions (Table 4)

Mean yield of PB 260, the standard rubber clone (Chan,1997) over the first 18 years of planting, ranged from 1769- 2014 kg/ha in estates in Region 1 and was around 1710 kg/ha for estates in Region 2. For estates A and B in Region 1, mean yield was around 1930 kg/ha over the first 11-13 years of planting. In estate H in Region 3 (with favourable conditions for oil palms), mean yield was 1838 kg/ha over the first 12 years of planting. Overall, yield of PB 260 was fairly consistent except in Region 2 where yield was noticeable lower than in the other two Regions due probably to the monsoonal effects which reduce tapping out-turn. It is interesting to note the small difference in yield of rubber planted in Regions 1 and 3 considered marginal and suitable respectively for oil palms, indicating the versatility of rubber over a wide range of growing conditions as compared with oil palms.

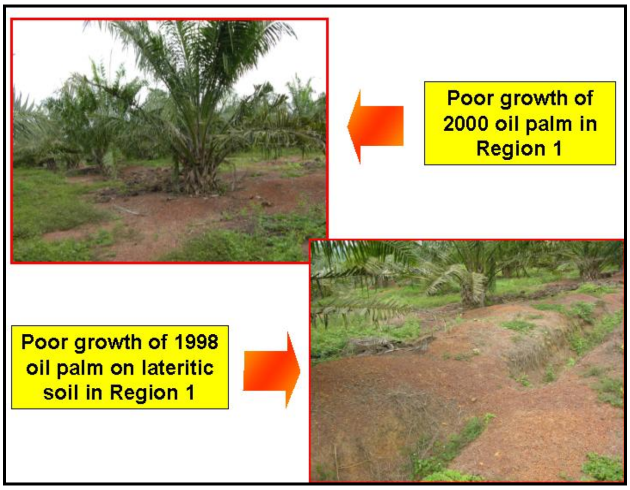
TABLE 4: PERFORMANCE OF OIL PALM IN THE 4 REGIONS (KG/HA)		
Region	Year	
	3	Mean of 4-18
1 Bahau and Segamat	-	17.9 -21.0
2 Kelantan	-	17.1 - 18.5
3 Taiping	15.6	25.0
4 Tawau	14 - 9	27.6

Although yield levels were similar in Regions 1 and 3, the higher rainfall and better growing conditions in Region 3 enabled trees to attain maturity one year earlier than in Region 1.

Simple comparison of profitability between oil palm and rubber in the four regions

Based on price and yield statistics for 2004 given in Table 1, profitability of rubber would likely exceed oil palm for estates A to G as yield of rubber in these estates exceeded the group average of 1611 kg per ha and yield of oil palm in these estates was lower than the 21.57 tons per ha FFB obtained for the Group. Profitability of oil palm would be higher than rubber in Regions 3 and 4 where yield of oil palm exceeded 25 tons per ha FFB.

Based on price and yield statistics for 2005, it would be even more profitable to plant rubber than oil palm in Regions 1 and 2.



Recent R and D developments in rubber in relation to clonal performance and exploitation systems

a. Promising Prang Besar clones

Two promising new clones showing higher initial yields than PB 260 (Table 5) have been picked out from commercial fields. These have been multiplied in budwood nursery for future replanting.

TABLE 5: COMMERCIAL YIELDS (KG/HA) OF CLONES ON SHORT CUTS ON PANEL BO1					
Clones	*Year*				
	1	*2*	*3*	*4*	*Mean*
1. PB347	1901	2266	2123	-	2096
2. PB350	1903	2022	-	-	1962
3. PB260	1613	1798	2163	1881	1858

Task size = 730 trees
Stand/ha = 435 trees
Tapping system = 1/3Sd4 + stimulation
Tappings per year = 80

TABLE 6 MEAN GIRTH (CM) OF PROMISING RRIM 2000 SERIES CLONES - 5 YEARS (AFTER CHAN,2004)	
Clone	*Mean girth*
RRIM 2014	51.3 (108)
RRIM 2025	50.9 (107)
RRIM 2023	49.3 (104)
RRIM 2002	48.8 (103)
RRIM 2024	48.4 (102)
PB 260	47.3 (100)

( ) - %

b. RRIM 2000 series clones

The RRIM 2000 series clones were first introduced in 1995 by the Lembaga Getah Malaysia (LGM) in 1995 (Ong et.al.,1995). Table 7 shows that the five most vigorous RRIM 2000 series clones outgrew PB 260 by 2 to 8 percent (Chan,2004). Initial yields of some of these clones are however below PB 260 (Table 8).

TABLE 7: EARLY YIELDS OF RRIM2000 SERIES AND RELATED CLONES. 1998 PLANTING (SEPTEMBER'04-AUGUST'05)

No.	Clone	g/t/t	kg per ha	%
1	RRIM 2001	29.3	996	85
2	RRIM 2002	28.7	975	84
3	RRIM 2008	32.4	1101	94
4	RRIM 2009	28.6	972	83
5	RRIM 2014	19.9	676	58
6	RRIM 2015	32.4	1101	94
7	RRIM 2020	31.8	1081	93
8	PB 366	40.7	1383	119
9	PB 260	34.3	1166	100

Note: Assumed task size = 650 trees
Assumed std/ha = 425 trees
No. of tapping/yr = 80
Tapping system = 1/3Sd4 + 4 x 0.7%E

TABLE 8: YIELD 1/3Sd4 + STIMULATION ON PANEL BO1 OF 1990 PB 260 - 6 YEARS

Treatment	*kg per tapper*	*kg per ha*
1/2Sd4	32.7 (100)	1802 (100)
1/3Sd4 + 1.5%E x 6	38.1 (117)	1682 (93)

Task size	1/2Sd4	:	585
	1/4Sd4 + stimulation	:	730
Stand per ha		:	403
Number of tappings		:	80
( )		:	%

c. Exploitation system

Short cuts provide additional panels for exploitation, thereby extending the lifespan of trees. In theory, the 1/3Sd4 system could provide an additional panel on basal virgin bark and therefore extend lifespan of trees by six years and the 1/4Sd4 system by twelve years from the two additional panels available for tapping compared with the standard 1/2Sd4 system. Another advantage of short cuts is the extension in task size which would raise the yield per tapper, thereby improving earnings of tappers.

TABLE 9: YIELD OF 1/4SD4 + STIMULATION ON PANEL BO2 OF 1988 PB 260 - 4 YEARS

Treatment	*Estate A*		*Estate B*	
	kg per tapper	*kg per ha*	*kg per tapper*	*kg per ha*
1/2Sd4 control	31.2(100)	1909(100)	36.3(100)	2081(100)
1/4Sd4+1.5%E x 6	36.5 (117)	1686 (88)	40.5(111)	1857(89)

			Estate A	Estate B
Task size	1/2Sd4	:	529	600
	1/4Sd4 + stim	:	700	750
Stand per ha		:	404	430
Number of tappings		:	80	80
( )		:	%	

Table 8 shows that for the 1/3 cut, yield per tapper increased by 17 percent although yield per ha reduced by 7 percent. For the 1/4S cut, yield per tapper was increased by 11-17 percent while yield per ha reduced by around 12.0 percent (Table 9). Earnings could amount to nearly RM 40 per day at a yield level of 40 kg per tapper.

DISCUSSION

The long term outlook for rubber appears bright due to increased demand for the commodity largely from the expanding economies of China, India and Eastern Europe. Rubberwood also adds much value to the crop at prices of around RM 20,000 per hectare at replanting albeit having declined of late. At rubber price currently hovering around 700 sen per kg (SMR CV) and oil palm price stabilising at RM1400 per ton CPO, planting rubber in areas considered marginal for oil palm appears likely to result in higher returns than from oil palm. The areas in the Group considered marginal for oil palms but acceptable for rubber are the districts of Bahau and Segamat, the state of Kelantan and probably other areas characterised by low annual precipitation of around 1500mm or extremes in weather pattern wherein prolonged drought and monsoonal climate pervade and shallow and/or lateritic soils on undulating to steep terrain. Rubber trees are able to withstand these harsh conditions better than oil palms because of their deeper taproot system. Rubber yields of 1710 to 2000 kilogramme per hectare have been obtained from these areas which have produced mediocre oil palm yields of between 17-20 tons per hectare FFB. Whilst period of immaturity may be delayed by about one year in low rainfall areas compared with more favourable environs, rubber yields obtained therefrom remain similar if not better than districts with higher rainfall as the latter tends to interfere with tapping.


Chop down oil palm to plant rubber in Bahau and Segamat districts (Region 1)

Promising new rubber clones like PB 347 and PB350 and some of the RRIM 2000 series clones are likely to increase profitability even further through higher latex and/or rubberwood yield than PB 260. The innovative short cut exploitation systems can prolong lifespan of trees as well as raise yield and earnings of tappers.

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IMPACT OF PHOSPHATE ROCK AND LEGUME PLANTING SYSTEM ON P UPTAKE AND DRY MATTER PRODUCTION OF *MUCUNA BRACTEATA* UNDER OIL PALM

(Paper offered for MSSS Conference on Strategies for Enhanced Soil and Crop Quality -April 2006)

Patrick Ng, H. C., Goh, K. J., Gan, H. H. and Zaharah, A. R.

INTRODUCTION

It has been shown that phosphate rock is required for quick establishment of conventional legumes such as *Pueraria javanica* (PJ) and *Calapogonium* caeruleum in oil palm plantations to maximize their beneficial effects on soil and water conservation and to recycle P (Goh and Chew, 1995). However, PJ generally dies off by the third year due to heavy shading by the maturing palms. In the late eighties, a shade tolerant, perennial legume *Mucuna bracteata* (MB) was introduced to the oil palm plantations from India due to its many desirable characteristics (Mathews, 1998) and potential positive effects on soil fertility (Kothandaraman *et al*., 1989). However, interest in this legume only took off recently when it became economically feasible to establish it from seeds (*Figure 2*).

Figure 2: Establishing *M. bracteata* with clipped seeds is economically feasible

Currently, the available reports on this legume were mainly concerned with its cultural practices or growth and litter production (Ng *et al*., 2005). Little is known of its P requirement and best planting system in oil palm plantations. Moreover, with zero burn replanting technique, the residues from the previous oil palms will supply about 58 kg P ha^{-1} (Khalid *et al*., 2000), which is more than 15 times the P requirement of legumes in the first year. Thus, this paper aims to investigate the effect of medium reactive phosphate rock on P uptake and dry matter production of MB planted pure or mixed with PJ.

MATERIALS AND METHODS

The treatments were a factorial combination of two legume planting systems and four P rates to the legumes. The two legume planting systems were a) pure MB (pure system) at a density of 556 plants ha^{-1}, and b) the above plus four kg of PJ per hectare (mixed system) planted in two drills (*Figure 3*). The P rates applied to the legumes were 0, 27, 80 and 160 kg P ha^{-1}. The P fertilizer came from Al Hassa mine, Jordan. It has 13.2% total P and 4.0% citric soluble P. The P fertilizer was applied in three rounds in a proportion of 20%, 40% and 40% at 2, 5 and 9 months after planting of the legumes, respectively. The treatments were replicated twice with replicates nested in the legume planting systems. The soil type at the trial site was Bungor series (Typic Paleudult).

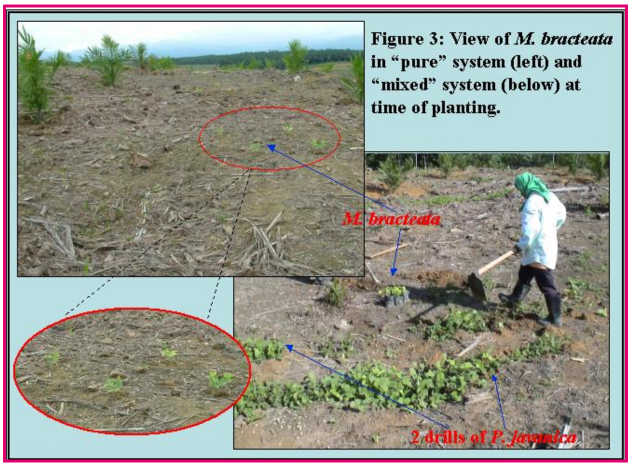
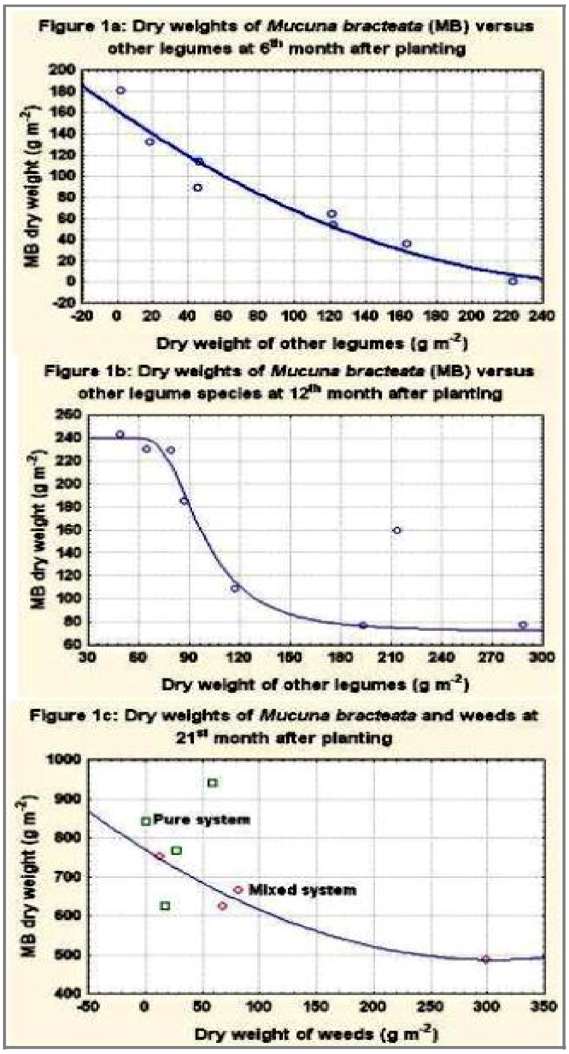


Figure 3: View of *M. bracteata* in "pure" system (left) and "mixed" system (below) at time of planting.

Figure 4 : View of trial area at the same location at 1, 13 and 23 months after planting

The legumes were sampled at 6^{th}, 12^{th} and 21^{st} month after planting using a random quadrant of 1 m^2 per plot to measure their biomass and P contents. At each sampling, the biomass of the other vegetation such as grasses was also taken. The plant samples were dried in an oven at $80^{o}C$ and their dry weights were determined without any sub-sampling. The samples were digested using the wet digestion method and P concentrations determined with vanado-molybdophosphoric acid colorimetric method.

Figure 1: Relationship between the dry weights of *Mucuna bracteata* and other legumes or weeds under oil palm



RESULTS AND DISCUSSION

Dry Matter Production

Dry weights of MB increased significantly with time of sampling but this varied with P rates and planting systems. In fact, the dry weights of MB in the mixed planting system were lower than the pure system at all periods of sampling (*Table 1*) and significantly lower in the 21^{st} month. The poorer MB growth in the mixed system in the first year was mainly due to competition from PJ which were planted at a density of 4 kg seeds ha^{-1} and other self-grown legumes from the seeds of previous oil palm planting (*Figures 1a* and *1b*). By the 18^{th} month after planting, the PJ had dieback completely probably due to drought and shading from the maturing palms. It was mainly replaced by other vegetations such as grasses resulting in lower dry weights of MB where competition was stiffer (*Figure 1c*). This scenario of vegetation succession (legume to grasses) was not apparent in the pure system as the dominant legume species in these plots were made up of the shade-tolerant perennial MB. In addition, P rates increased MB dry weight in the pure system up to the 21^{st} month after planting but in the mixed system, the converse was true.

Table 1: Effect of P rates and legume planting system on the dry weight ($g\ m^{-2}$) of Mucuna bracteata under oil palm

P rate	6th month			12th month			21st month		
	Mixed	Pure	Mean	Mixed	Pure	Mean	Mixed	Pure	Mean
0	54	88	71	109	230	170	752	624	688
27	0	132	66	160	243	201	666	767	716
80	64	113	89	77	230	153	625	841	733
160	36	180	108	77	185	131	487	940	713
Mean	38	129	83	106	222	164	632	793	713
SE	46	37	30	65	66	46	99	84	65

P concentration and content

Varying the P rates to the legumes as well as the different planting systems did not affect the P concentration of MB (*Table 2*). However, P concentrations of MB improved significantly with time (*Table 2*) in both mixed and pure systems implying continuous P uptake from the soils (both inherent soil P and P from palm residues) and the applied PR. The P concentrations of MB in the mixed system were 30% higher than in the pure system at the 21^{st} month (*Table 2*). This apparent symbiotic effect could be attributed to the more rapid ground coverage by PJ which would reduce erosion and run-off losses of applied PR (Ling *et al*., 1979) during the early establishment of the palms and legumes (*Table 2*). Averaging the P concentrations of the legumes (MB plus PJ) showed that the mixed system was significantly superior (*Table 2*).

Table 2: Effect of P rates and legume planting system on the P concentrations (%) of legumes under oil palm

P rate	PJ at 6th month			MB at 6th month			MB at 21st month		
	Mixed	Pure	Mean	Mixed	Pure	Mean	Mixed	Pure	Mean
0	0.152	0.159	0.155	0.071	0.113	0.092	0.155	0.139	0.147
27	0.159	0.117	0.138	0.121	0.099	0.110	0.191	0.128	0.160
80	0.136	0.120	0.128	0.146	0.120	0.133	0.171	0.159	0.165
160	0.178	0.148	0.163	0.158	0.126	0.142	0.218	0.142	0.180
Mean	0.156	0.136	0.146	0.124	0.114	0.119	0.184	0.142	0.163
SE	0.018	n.a.	0.013	n.a.	0.018	0.016	0.022	0.014	0.013

The P contents of MB also increased significantly from the 6th month to the 21st month (Table 3). Although the increase was more than ten times, it was not affected by P rates and planting systems.

Table 3: Effect of P rates and legume planting system on the P contents (g P m^{-2}) of legumes under oil palm

P rate	PJ at 6th month			MB at 6th month			MB at 21st month		
	Mixed	Pure	Mean	Mixed	Pure	Mean	Mixed	Pure	Mean
0	0.195	0.073	0.134	0.052	0.097	0.075	1.144	0.849	0.997
27	0.260	0.021	0.141	0.000	0.137	0.068	1.315	0.987	1.151
80	0.162	0.055	0.109	0.073	0.144	0.108	1.061	1.318	1.190
160	0.294	0.000	0.147	0.056	0.219	0.138	1.054	1.283	1.169
Mean	0.228	0.037	0.132	0.045	0.149	0.097	1.144	1.109	1.126
SE	0.107	0.020	0.055	0.052	0.048	0.035	0.274	0.125	0.150

Litter production and its P concentration and content

The litter production was not affected by P rates and it was generally higher in the pure system (*Table 4*) at the 21st month. The latter might be attributed to its higher green dry matter as discussed earlier. Similar results were obtained for P contents in the litter. However, the P concentrations of litter were significantly improved with P rates in both systems implying that MB is capable of recycling P from phosphate rock.

Table 4: Effect of P rates and legume planting system on the dry weight (g m^{-2}), P concentration (%) and content (g P m^{-2}) of legume litter under oil palm at 21st month

P rate	Dry Weight (g m^{-2})			P concentration (%)			P content (g m^{-2})		
	Mixed	Pure	Mean	Mixed	Pure	Mean	Mixed	Pure	Mean
0	872	853	862	0.069	0.065	0.067	0.578	0.529	0.553
27	473	903	688	0.077	0.060	0.068	0.349	0.543	0.446
80	482	934	708	0.080	0.087	0.084	0.381	0.897	0.639
160	681	920	801	0.089	0.110	0.099	0.561	1.012	0.786
Mean	627	902	765	0.079	0.081	0.080	0.467	0.745	0.606
SE	245	247	174	0.011	0.010	0.007	0.128	0.266	0.148

CONCLUDING REMARKS

PR increased the dry weight of MB in the pure system but the converse was true for the mixed system due to the dieback of PJ resulting in stiffer competition from grasses. P concentration and content of MB were not affected by P rates and planting systems because MB has deep, extensive root system, which allows it to exploit P from the agro-ecosystem. Application of PR significantly improved the P concentration of litter but its implications to P recycling and P nutrition of oil palm are still being investigated in this on-going study.

ACKNOWLEDGEMENTS

We are grateful to our company and Principals, Messrs. Boustead Plantations Bhd. and Kuala Lumpur Kepong Bhd. for permission to publish and present this paper. We also wish to thank the Senior Manager of Batu Lintang estate, Mr. Fong Ting Wong for the excellent support rendered in carrying out our trial. The diligent work of Encik Ahmad Risaudin of AAR is also acknowledged. Last but not least, we also wish to acknowledge IMPHOS for their partial funding in carrying out the experiment.

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HAR RECEIVES TORAY AWARD

The Head of Agricultural Research, Dr. Soh Aik Chin, was awarded the prestigious Malaysia Toray Science Foundation 2005 Award in November 2005.

This award is a great honour bestowed on Dr. Soh as it is given only to internationally recognised scientists for pioneering work towards new scientific knowledge, technology and contribution to the national economy. The award carries a prize money of RM30,000.

Dr Soh`s speciality of work is in the field of plant breeding. He has published numerous papers in leading international journals as well as been a prolific presenter of papers in both local and international conferences.

Dr Soh`s award has indeed done AAR proud as well as to our Principals, Boustead Plantations and Kuala Lumpur Kepong Plantations.

Syabas Dr Soh!

SOFT OPENING OF TISSUE CULTURE LABORATORY
12 DECEMBER 2005

Canteen

The beginning of a new era for oil palm planting materials

SOCIAL AND PERSONAL

WELCOME!

Mr. David Chuah Eng Leng comes from Taiping, Perak Darul Ridzuan, where he received his primary and secondary education. Upon completing his STPM in 1997, he was offered a chance to study Applied Biology (Biotechnology) at Universiti Sains Malaysia (USM) in May 1998 for his bachelor's degree. His final year project was on the micropropagation of *Phyllanthus* spp (medicinal herbs) through tissue culture techniques. Upon completing his degree in 2001, he received a two-year scholarship offer from the Education Ministry of Malaysia in 2002 to pursue his masters' degree on micropropagation of *Pereskia* spp. He was a tutor in USM teaching plant morphology and histology techniques. He completed his research in February 2005 and started his service at AAR beginning of May 2005 as a tissue culturist.

Dr. Choong Chieh Wean was born in Kuala Lumpur and raised in Klang where he had his primary and secondary education. In 1995, he enrolled into Universiti Pertanian Malaysia (later renamed to Universiti Putra Malaysia) to pursue his tertiary education. In 1999, he graduated with a Bachelor of Science Degree in Biotechnology. He continued his study to Master of Science in the same year in Universiti Putra Malaysia and upgraded the study to Doctor of Philosophy a year later. In August 2004, he graduated with the degree of Doctor of Philosophy in Molecular Biology and Genetic Engineering. Between 2004 and 2005 he worked as a technical support for a scientific equipment sales Company and as a research assistant. He joined AAR in July 2005 as a Biotechnologist.

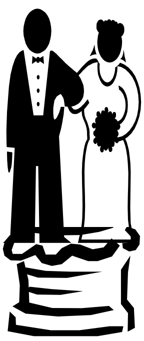
Dr. Shahrakbah Yacob, previously with AAR (1999 – 2001) has rejoined the company after obtaining D.Eng. degree from Kyushu Institute of Technology, Japan. Under the UPM scholarship where he was attached as a lecturer, Dr. Shahrakbah carried out a research on the utilization of biogas and biomass from palm oil industry under the clean development mechanism (CDM). The research was a joint collaboration with FELDA Palm Industries Sdn. Bhd. which led to the installation of Biogas Pilot Plant in Serting Hilir Palm Oil Mill. His service with AAR commenced on the 1st March 2006.

Madam Ho Yuk Wah originated from Kota Kinabalu, Sabah and received her Primary and Secondary education there. She did her Form Six education in South London College and obtained an educational grant from the Inner London Council to pursue a Bachelor's Degree in Biophysical Science majoring in Biomedicine & Radiobiology at University of East London (formerly North East London Polytechnic). She spent a year as a Research Trainee with the Director's Brain Research Group at the Institute of Animal Physiology at Cambridge during her Industrial
Year and worked on brain neurons. She developed a protocol for immunocytological staining of cholinergic neurons which had since been adopted by neuroscientists and mapped the pathway of cholinergic neurons associated with rat supraoptic nucleus. She also succeeded in establishing long term primary cultures of mature bovine neurons. Her research resulted in 12 papers that were published in refereed journals.

She returned to Malaysia in 1986 and worked in Bakasawit Sdn. Bhd. for six months after which she joined United Plantations Bhd. to head their tissue culture facility and was there for more than 19 years. During her stint with UPB, she developed in-house protocols for tissue culture of oil palms, ornamentals, forest trees and bananas. She was responsible for creating Pisang Berangan cv. Intan into a commercial cultivar with clonal plantings nationally and also for export. She joined AAR in January 2006 as a Senior Tissue Culturist.

CONGRATULATIONS

MARRIAGE



- ♥ Cik Noraniah bt. Anday to En. Gazali bin Abd. Ghani on 30/4/05
- ♥ En. Ahmad Risauddin bin Mamat to Cik Shahida bt. Mohd Azmi on 4/6/05
- ♥ En. Taliu bin Mulah to Cik Sarina bt Rosman on 5/6/05

PROMOTIONS

No.	Name	Promoted to
1.	Dr. Kee Khan Kiang	Deputy Head (AA Resources)
2.	Mr. Goh Kah Joo	Deputy Head (AA Research)
3.	Mr. Tan Cheng Chua	Principal Research Officer
4.	Mr. Tey Seng Heng	Senior Research Officer
5.	Mr. Kumar a/l Krishnan	Assist. Research Officer I
6.	Mdm. Lim Lee Hua	Lab. Assistant SG
7	Pn Norimah bt. Mohd Amin	Lab. Assistant I
8.	Cik Norizan bt. Ibrahim	Lab. Techmician IV
9.	Cik Syarida bt. Ismail	Lab. Techmician IV
10.	Miss Santha Kumar a/p Pon-nampalam	Lab. Techmician IV
11.	Mdm. Vanaja a/p Mani	Research Clerk I
12.	Mdm. Lutchumy Poosari	Research Clerk II
13.	Pn. Salniza bt. Seali	Research Clerk III
14.	Mr. V. Sandrasegaran	Research Assistant SG
15.	En. Mohd. Radzi bin Ariffin	Research Assistant I
16.	En. Mohd. Fabli bin Salleh	Research Assistant II
17.	En. Fadzli bin Ali	Research Assistant III
18.	Mr. Muthuraja a/l Sanacey	Research Assistant III
19.	Mr. Segar a/l Ganesan	Research Assistant III
20.	En. Rahman bin Sihing	Research Assistant III
21.	En. Faizal bin Ibrahim	Research Technician IV

BIRTH

Name	Baby	Date
Pn. Umi Kalsum bt. Sabran	Nur Syafinaz (girl)	23/04/05
En. Ibrahim bin Abdullah	Ainie (girl)	25/04/05
En. Roslan Mohd @ Ariffin	Muhammad Shaqis Aiman	28/04/05
En. Ahmad Zulkar-naen bin Hamdin	Muhamad Adam Haiqal (boy) (passed away on 18/02/06)	07/06/05
En. Mohd Faizul bin. Ibrahim	Mohd Zulhilmi Afiq (boy)	28/06/05
Mr. Rajendran a/l Subramaniam	Jitika (girl)	21/07/05
En. Sakari bin Musa	Nur Syazwani Ainaa (girl)	19/09/05
Pn. Sharmie bt. Minka	Nur Syafinaz (girl)	07/10/05
Pn. Zurinawati bt. Awang Saad	Nur Aliah Atikah	04/01/06

2005 AARSC HIGHLIGHTS

Last year was an eventfull year for AAR Sports Club. In harmony with AAR's culture, various events were carried out to further forge closer relationships among our members. Many of the events were family oriented. Among the major events were durian feast (main office and Paloh research station), friendly soccer matches between AAR's different sections and area police departments and estates, annual trip to Kota Kinabalu, sports day at our Paloh research station, family day at AAR's main office compound and annual dinner. Some 300 members and family attended the colourful annual dinner. Different sections presented dances that brought everyone back to the nostalgic '70s. Several research officers showed their singing skills, with Dr. Soh leading the last song, "Rhinestone Cowboy".

Goh,Y.K.

Annual Company Trip May 2005

West meets East. Aiyah, regret didn't go on this annual trip to Kota Kinabalu. Missed those pretty damsels!

Thorn among the roses with the magnificent view of Mt. Kinabalu in the background.

Family Day, 31 August 2005

One… two… go! Staff training for loose fruit collection. Putting yourself in a sack and trying to run away in it isn't easy.

Pull! There's no way we can pull down the old oil palm trees using a rope. Tug-of-war contest.

Staff children discovered a new way of creating localised haze using flour. Looking for sweets in a plate of flour contest.

ANNUAL DINNER-10 DECEMBER'05 2005

Feed me, feed me now!!! AAR family anticipating an exciting colourful annual dinner waiting for the green light to hit the buffet line.

AARSC President (2005/06) delivering his speech

Under the leadership of Dr. Soh, officers have become even more multi-talented. Dr. Soh and Mr. Teo leading some of the young officers singing "Rhinestone Cowboy." Hip (pie) hip(pie) hooray!

Talented members of tissue culture lab. Performing a series of cultural dances to the tunes from the '70s

We wish our staff
Mr. Anbarasu and
Madam Eleanor
"HAPPY RETIREMENT"

The strongest man

A competition was held to determine the strongest man in a village of strong men.

The judge invited any strong man to squeeze all the juice out of a lemon. So the first strong man came forward and gave the lemon a great squeeze. Lemon juice started running out from between the man`s fingers and everybody clapped. Another man came forward. He took the squeezed lemon in his hand and gave it a mighty squeeze and 3 drops of juice trickled out from the mashed lemon. There was a roar of delight! A man with, perhaps the greatest muscles came forward, squeezed the lemon with all his might, and saw half a drop of juice fall on to the floor. The crowd went wild and clapped for 5 minutes. As the judge was about to end the competition, a lean looking man with an empty bag slung over his shoulder stepped forward. Everybody laughed. Thinking it could be fun the judge passed the unrecognisable piece of lemon to the man and waited. The crowd was in a patronising mood and smiled at the man. Putting the squashed lemon in his hand, the thin man gave it a squeeze and 2 drops of juice dropped out of his hand! The crowd stared at him in great disbelief! The astounded judge congratulated him and enquired where he was from and what his profession was.
The man smiled and said he was from the Inland Revenue Department.

Chan,W.H.