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# NOTES ON OIL PALM PRODUCTIVITY. I. PRODUCTIVITY AT TWO CONTRASTING SITES

**I.E. HENSON***

*Yields at an inland and a coastal site planted two years apart, were examined from the start of bunch harvest up till the tenth (inland) or twelfth (coastal) years after planting. Both monthly and annual trends in bunch dry matter production were examined in terms of the development of yield 'cycles' and yield levels, respectively. Cycles were most pronounced at the more productive coastal site. There was evidence for external factor(s) modifying timing of yield peaks. Differences in yields between sites involved differences in bunch and female inflorescence numbers; the later due mainly to altered sex ratios.*

*The yield differences were accompanied by differences in vegetative dry matter production, dry matter partitioning and standing biomass, and involved variation in both radiation interception (via differing leaf area indices) and photosynthetic conversion efficiency. The contribution of genotypic variation to the observed differences was not determined.*

## INTRODUCTION

It is well established that bunch yields of oil palm in West Malaysia are higher on 'coastal' than on 'inland' soils; a fact generally attributed to the higher fertility and better soil water supply of the coastal sites. In a previous paper (Henson and Chai, 1998), the total productivities of two such sites were examined during a selected period, often regarded to be years when FFB yields attain their peak, and following which a decline might be expected on the basis of yield trends previously observed in oil palm (Redshaw and Siggs, 1995).

This report provides further information on productivity at these sites in terms of the

* Palm Oil Research Institute of Malaysia,
P.O Box 10620, 50720 Kuala Lumpur, Malaysia.
Present Address: 21 Hurrell Road, Cambridge CB4 3RQ, UK.

development and components of bunch yields, standing dry matter and partitioning of dry matter above-ground.

## MATERIALS AND METHODS

Details of the sites, methods of measurement and calculation of results have been described previously (Henson, 1997; Henson and Chai, 1998). In addition to presenting results of FFB yields harvested and recorded as monthly totals, the production of bunch dry matter (BDMP*), calculated monthly from FFB as described by Henson (1997), is also presented. The latter includes an adjustment to reflect the higher energy content of the dry matter (non-oil equivalent dry matter) as well as providing an estimate of the dry matter produced as opposed to harvested, during each monthly period.

## RESULTS

### Annual Bunch Production

FFB yields at the two sites during the first eight years of harvest are shown in *Figure 1.* Yield at the coastal site had virtually peaked by year four while at the inland site it continued to rise till the eighth year. During the first 50 months of harvest cumulative yield at the coastal site was 66% higher than at the inland site but after 90 months the difference had fallen to a 35% gain at the coastal site *(Table 1).*

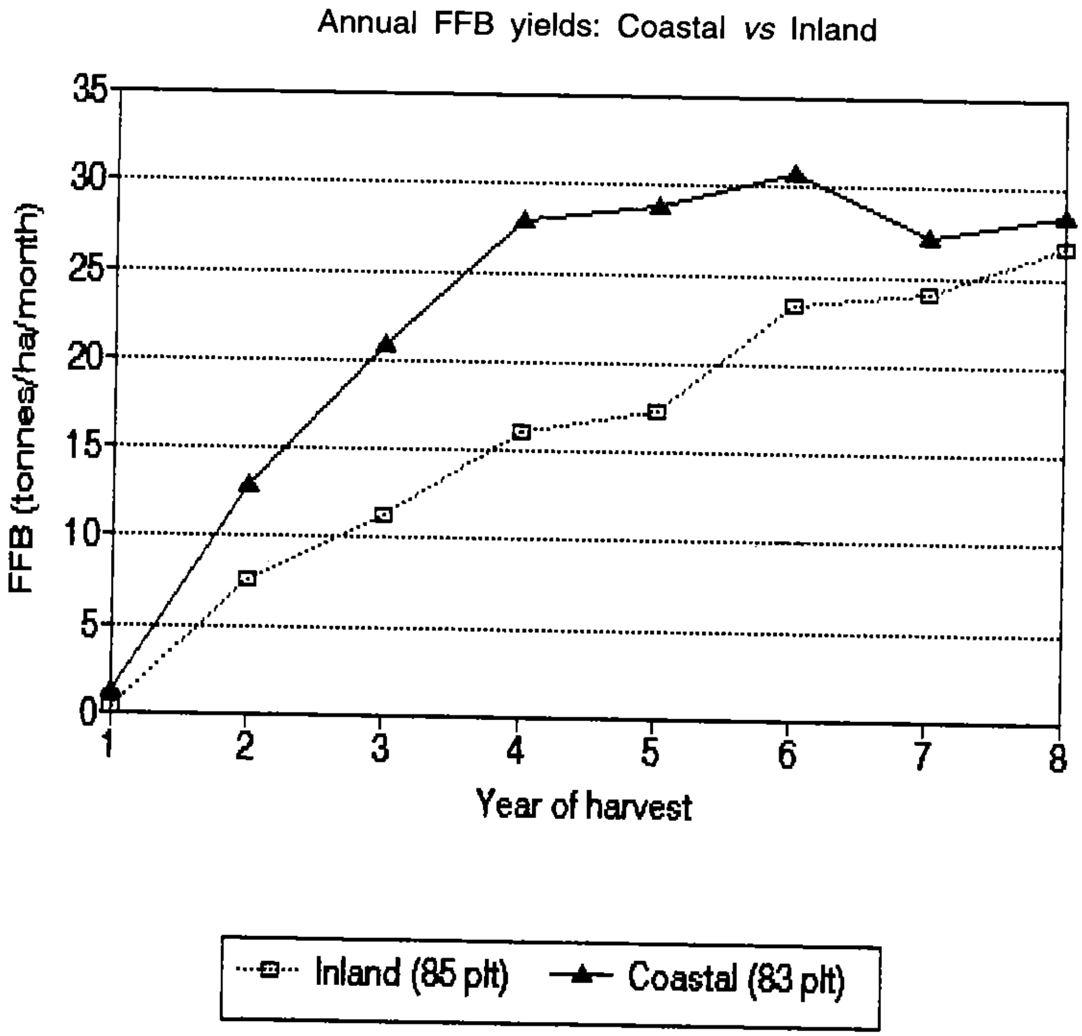



*Figure 1. FFB yields at the coastal and inland sites during the first eight years of harvesting. First harvests were in 1985 and 1987 for the coastal and inland sites respectively.*

TABLE 1. CUMULATIVE FFB YIELDS AT THE COASTAL AND INLAND STUDY SITES (tonnes/hectare)

| | First 50 months | First 90 months |
|---|---|---|
| Coastal | 89.75 | 185.59 |
| Inland | 53.96 | 137.22 |
| Coastal/inland | 1.66 | 1.35 |

The yield differences were almost entirely due to differences in bunch numbers *(Figure 2)*, there being little or no difference in mean bunch weight at a given palm age *(Figure 3)*.

## Monthly Bunch Production

The seasonal yield patterns resulting from plotting monthly running means of FFB yield are shown in *Figure 4*. Monthly yields fluctuated at both sites, the amplitudes initially being generally much greater at the coastal site. Two features of note are: (i) the yield fluctuations at both sites were initially small and increased with time as mean yield levels rose; (ii) cycles at the two sites in the early years were out of phase but became more synchronized with time. This suggests the existence of some external regulating factor common to both sites.

Bunch dry matter production at both sites showed a maximum inverse relationship with past yields when lagged 6-7 months *(Figure 5)*.

## Frond and Inflorescence Production

It is evident from *Figure 2* that female inflorescence production must have been lower at the inland than at the coastal site. Unfortunately, recording of inflorescence and frond numbers was restricted to a relatively short period at the two sites and to sample plots comprising a total of 100 palms per site (Henson and Chai, 1998). Quarterly recording showed that frond production differed little at the two sites, but that the sex ratio (female/total inflorescence number) was higher at the coastal site *(Table 2, Figure 6)*.

TABLE 2. INFLORESCENCE PRODUCTION AND ABORTION AT COASTAL AND INLAND SITES

| | Coastal | Inland |
|---|---|---|
| | Number per palm per year | |
| Number of new fronds opened | 25.01 | 25.79 |
| Number of female inflorescences | 12.53 | 11.89 |
| Number of male inflorescences | 9.48 | 12.37 |
| Number of hermaphrodite infl. | 0.03 | 0.17 |
| Number of aborted inflorescences | 2.97 | 1.35 |
| Total surviving inflorescences | 22.04 | 24.43 |
| Sex ratio | 0.569 | 0.487 |
| % abortion | 11.88 | 5.23 |

Notes:

a) Periods of measurements: Coastal, 33 months (8-12 years after planting): Inland, 18 months (9-10 years after planting).

b) Frond 'production' was lagged by nine months.

c) Sex ratio was calculated as female/total inflorescence number.

Actual numbers of female inflorescences at the inland site appear to have been overestimated by counts in the sample plots as they were higher than expected on the basis of bunch numbers harvested subsequently from the whole field *(Table 3)*. By contrast, the estimates of female inflorescence numbers obtained at the coastal site were in good agreement with harvest data. This may reflect the greater homogeneity of growth at the coastal site.

The inflorescence abortion rate was apparently higher at the coastal site *(Table 2)*. However, the rate was difficult to estimate precisely as assumptions were required with respect both to the rates of inflorescence development and the stage of growth at which abortion occurs, both of which may be subject to considerable variation (Chang *et al*., 1993, 1995). However, in neither case was the mean abortion rate very high. Periods during which maximum and minimum abortion rates were calculated to occur are given in *Table 4*.

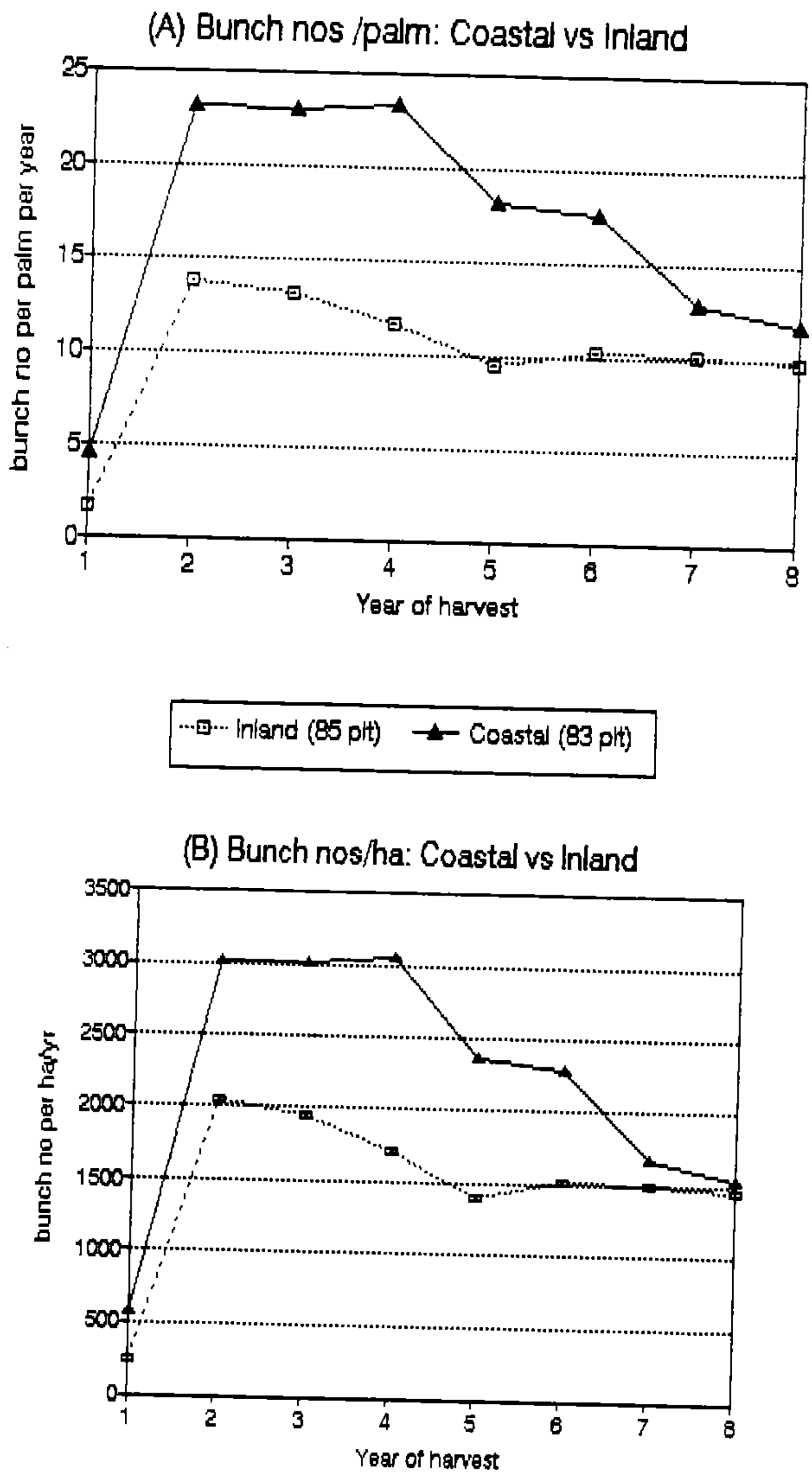



*Figure 2. Bunch numbers per palm (A) and per hectare (B) at the coastal and inland sites during the first eight years of harvest. Other details are as for Figure 1.*

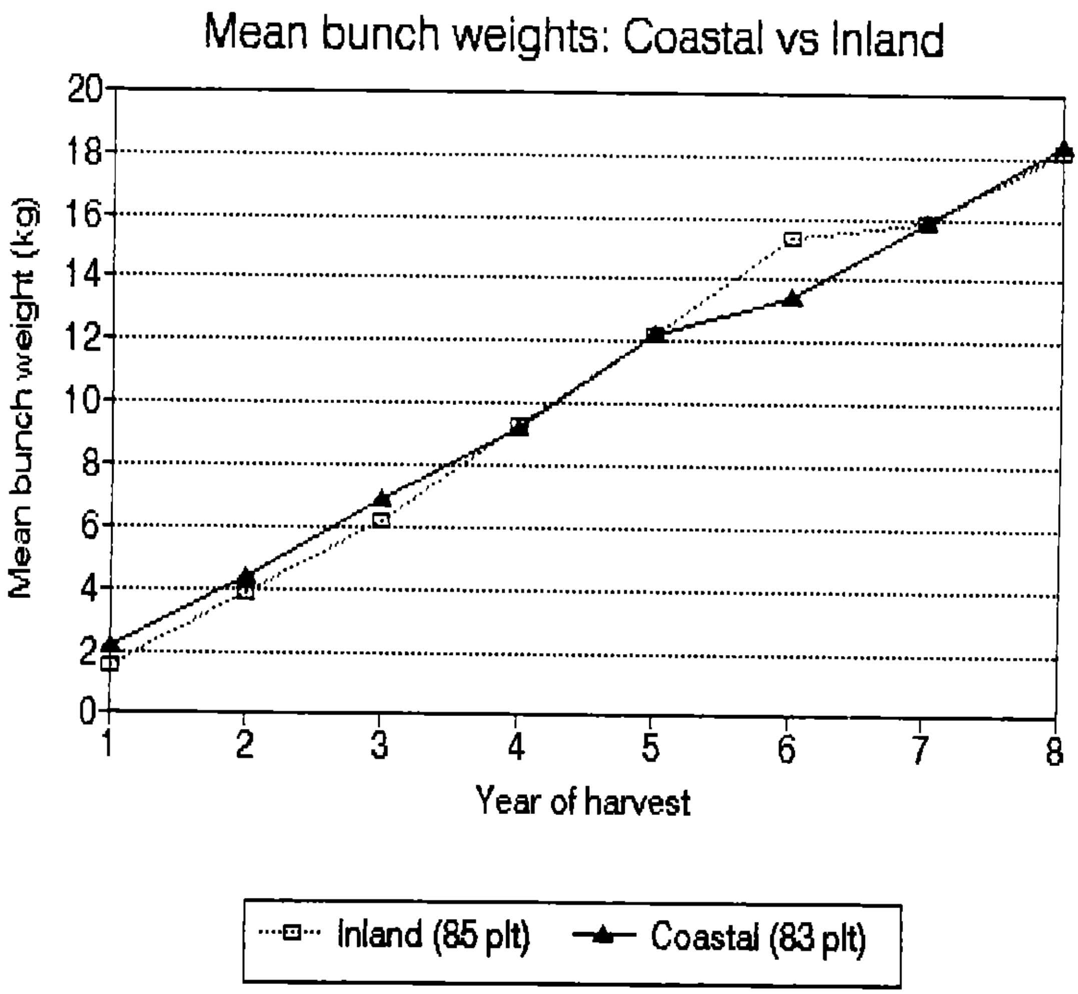
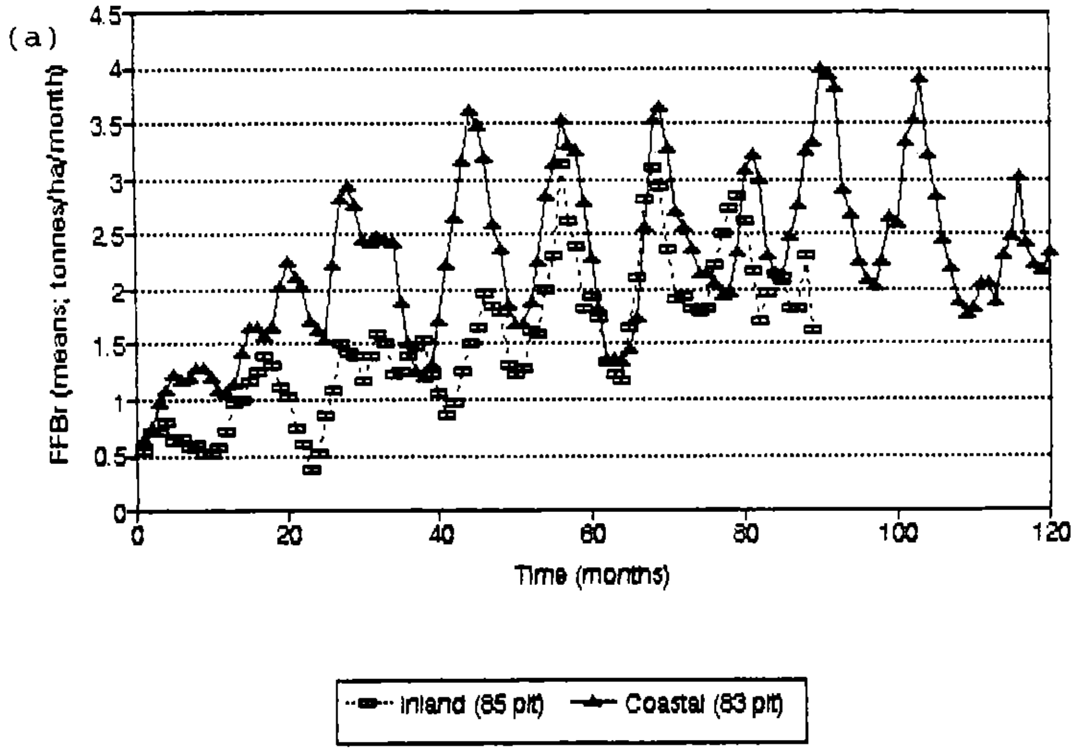



*Figure 3. Mean single bunch weights at the coastal and inland sites during the first eight years of harvest. Other details are as for Figure 1.*

TABLE 3. FEMALE INFLORESCENCE NUMBERS PRODUCED PER PALM PER QUARTER AND BUNCH NUMBERS HARVESTED EITHER FIVE OR SIX MONTHS SUBSEQUENTLY

| Site | Mean | Std. dev | %CV |
|---|---|---|---|
| Coastal | | | |
| Female inflorescences | 3.009 | 0.655 | 21.8 |
| Bunches (5 month lag) | 3.114 | 0.745 | 23.9 |
| Bunches (6 month lag) | 3.073 | 0.809 | 26.3 |
| Inland | | | |
| Female inflorescences | 2.904 | 0.507 | 17.5 |
| Bunches (5 month lag) | 2.442 | 0.588 | 24.1 |
| Bunches (6 month lag) | 2.469 | 0.612 | 24.8 |

Notes: Inflorescence numbers were determined on samples of 100 palms per site; bunch numbers were from the whole field. Data are means of 14 (coastal) or 9 (inland) quarterly periods.



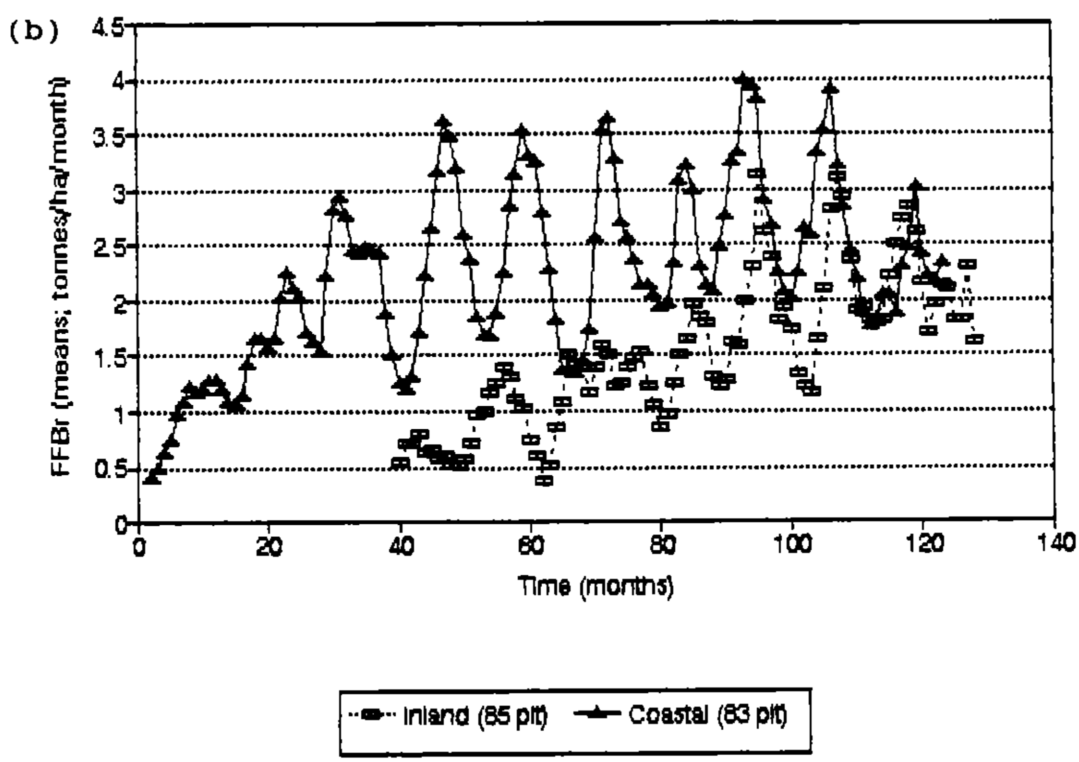
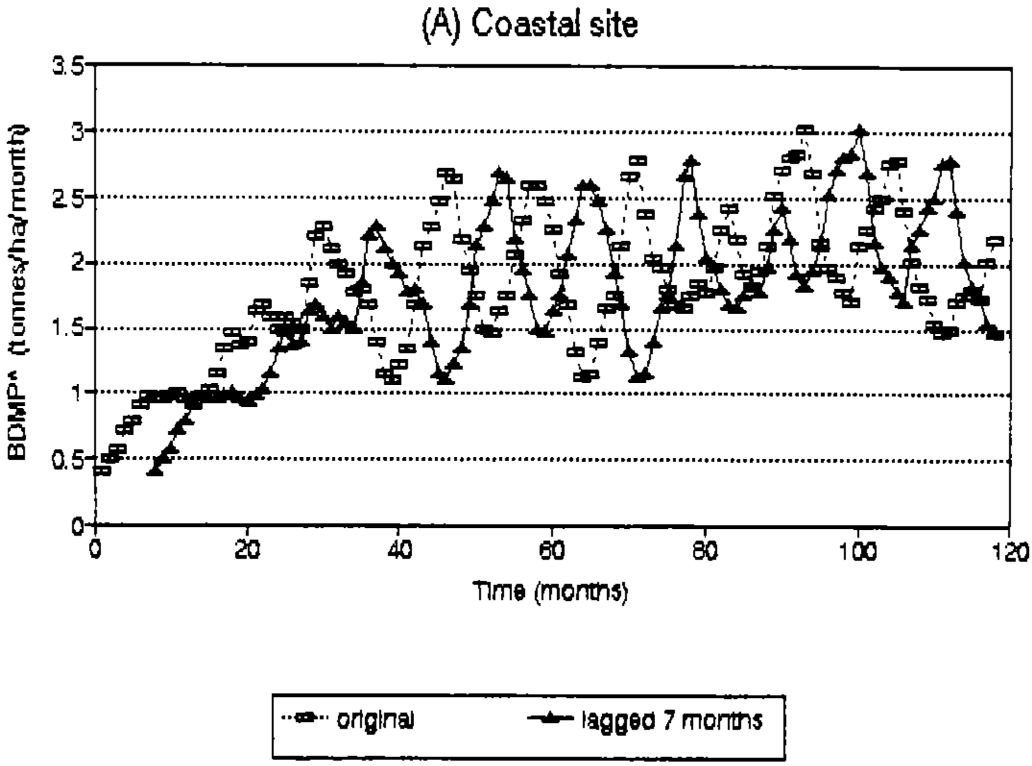




*Figure 4. Seasonal changes in FFB yields (running means) at the coastal and inland sites. In (a), start of harvest at the inland site is brought forward to coincide with the coastal site, allowing direct comparison at same palm age. In (b), data are plotted in 'real' time.*



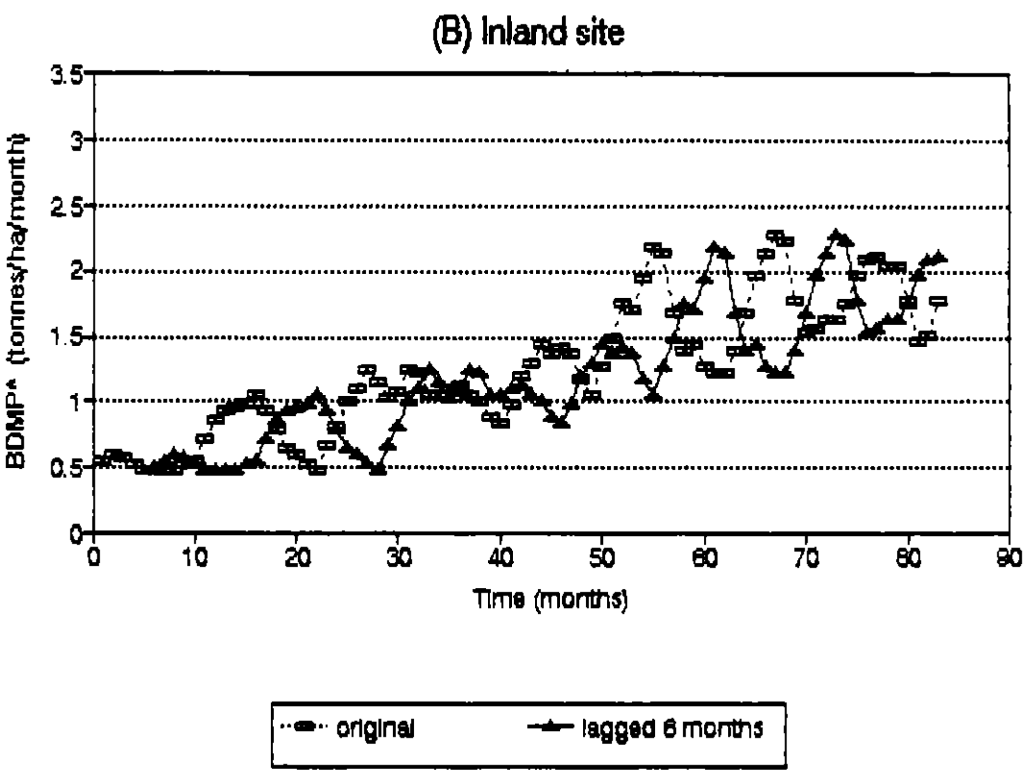
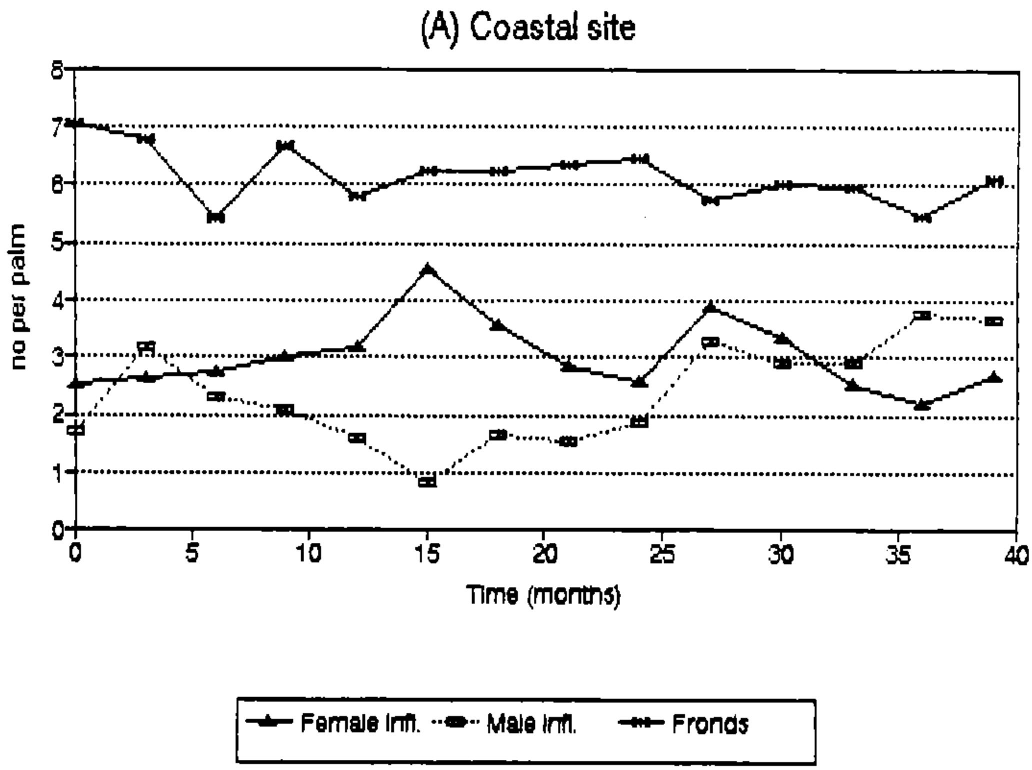




*Figure 5. Comparison of changes in BDMP* and BDMP* lagged by 6-7 months at the (A) coastal and (B) inland sites.*



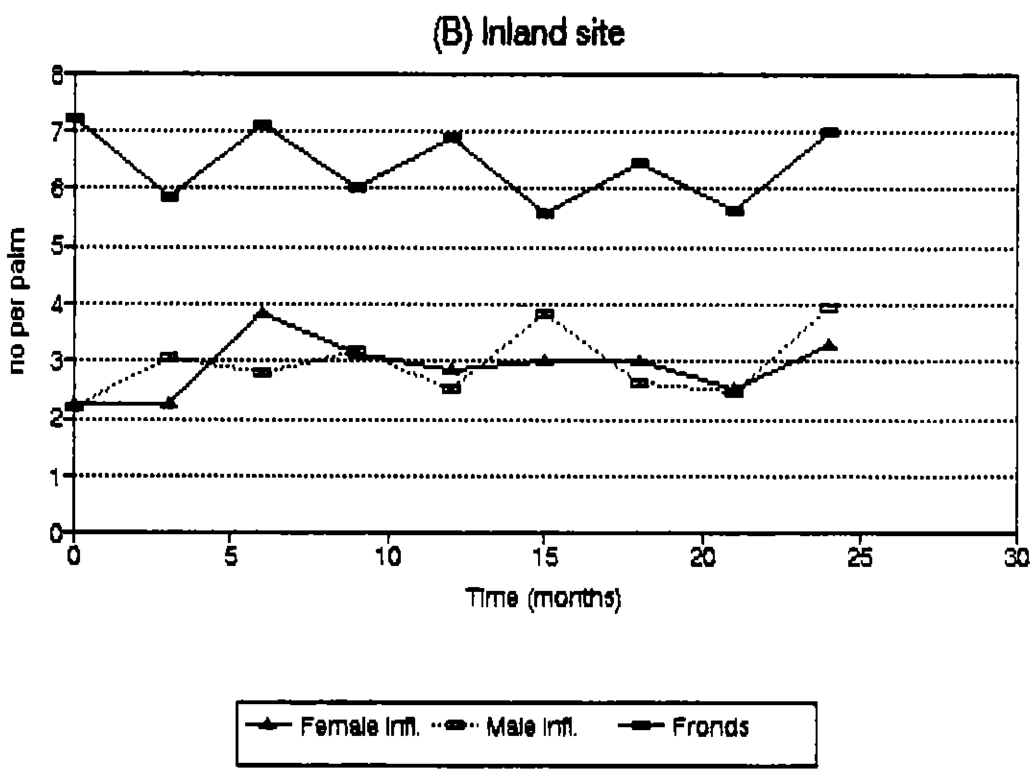




*Figure 6. Seasonal changes in frond 'production' and in numbers of male and female inflorescences anthesising at the (A) coastal, and (B) inland site.*

TABLE 4. PERIODS OF MAXIMUM AND MINIMUM ABORTION RATES AT COASTAL AND INLAND SITES

| | Year | Maximum | Minimum |
|---|---|---|---|
| Coastal site | 1992 | April-June | July-September |
| | 1993 | April-June | July-September |
| | 1994 | Jan-March | July-September |
| Inland | 1993/4 | Dec-February | June-August |
| | 1994/5 | Dec-February | – |

Note: Abortion assumed to occur five months (ca. 10 fronds) prior to anthesis.

### Standing Dry Matter

Above-ground standing dry matter was determined at both sites from the eighth year after planting onwards. *Table 5* shows data for year 10, and includes estimates of root biomass (Henson and Chai, 1997), leaf area index and measurements of biomass of ground flora. Growth of the latter was restricted due to the use of herbicides at both sites.

### Production and Partitioning of Dry Matter

The measurements on the sample plots (Henson and Chai, 1998) provide some information on partitioning as well as on total above-ground dry matter production (non-oil equivalent: TDMP*) *(Table 6)*. As well as bunch dry matter production being highest at the coastal site, above-ground vegetative dry matter production was also greater. Dry matter partitioning between VDM and BDM* was slightly lower at the inland site but appeared to be increasing with age due to bunch production increasing with little change in VDMP.

## CONCLUSIONS

The present observations confirm earlier notions that yield cycling in oil palm in Malaysia is not simply a response to obvious external growth limitations such as water shortages. Cycling cannot be prevented by irrigation (Chan *et al.*, 1985; Chang, 1985 and unpublished results) nor by planting on sites with permanent water tables. It is more likely to be due to endogenous factors, such as internal competition for assimilates (Corley and Breure, 1992). From the present comparisons it was apparent that yield cycling was more pronounced in the higher yielding coastal palms than on the inland site, suggesting a self-amplification of the yield peaks, although the extent to which any genotypic differences may have contributed to this is unknown.

It also appeared that the timing of the peaks was subject to some external regulating

TABLE 5. STANDING DRY MATTER AND LEAF AREA INDEX AT THE COASTAL AND INLAND SITES 10 YEARS AFTER PLANTING

| | Coastal | Inland | Ratio |
|---|---|---|---|
| Standing biomass (tonnes/hectare) | | | |
| Oil palm: | | | |
| above-ground | 52.99 | 40.62 | 1.31 |
| total | 69.30 | 47.49 | 1.46 |
| Ground flora | | | |
| above-ground | 1.89 | 1.42 | 1.33 |
| Leaf area index (palms) | 5.72 | 5.02 | 1.14 |

TABLE 6. DRY MATTER PRODUCTION AND PARTITIONING AT THE COASTAL AND INLAND SITES, 1991-5

| | Years after planting | VDMP (tonnes/hectare/year) | BDMP* | BDMP*/TDMP* |
|---|---|---|---|---|
| a) Coastal | | | | |
| | 8 | 13.58 | 23.34 | 0.63 |
| | 9 | 14.70 | 23.19 | 0.61 |
| | 10 | 16.60 | 28.16 | 0.63 |
| | 11 | 16.44 | 25.84 | 0.61 |
| b) Inland | | | | |
| | 8 | 12.65 | 17.35 | 0.58 |
| | 9 | 13.64 | 20.61 | 0.60 |
| | 10 | 12.55 | 21.99 | 0.64 |

Notes:
VDMP, above-ground vegetative dry matter production.
BDMP*, bunch dry matter production, non-oil equivalent.
TDMP*, VDMP + BDMP*.

factor(s) in that, although the cycles at the two sites were initially out of phase, they became more synchronized with time. Furthermore, the cycles have a 12 month periodicity. Foster (1985) suggested that seasonal dry periods acted to constrain the endogenous cycles, but if so this would not seem to act via soil water (Chan *et al.*, 1985; Chang, 1985) as no soil water deficits were recorded at the coastal site.

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