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CONTENTS

I. ISLANDS REGION AGRONOMY TRIALS

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Trial 107 RESPONSE TO FERTILISER OF MATURE SECOND GENERATION PALMS AT BEBERE PLANTATION.

PURPOSE

To provide information about the responses of oil palm to fertiliser, that will be used in making fertiliser recommendations.

DESCRIPTION

Site Fields D8 and D9, Bebere Plantation.

Soil Young, coarse textured, freely draining, formed on alluvially redeposited pumiceous sands, gravel and volcanic ash.

Palms 16 selected progenies - 5 from High Bunch Number families and 11 from families with medium sex ratios.
Planted in January 1983 at 135 palms/ha.
Treatments started in January 1984.

DESIGN

There are 72 treatments, comprising all factorial combinations of N and P at three levels and K, Mg, and Cl each at two levels (Table 1). The recorded palms are 16 different selected progenies arranged in the same array in each plot. Plot isolation trenching was completed in 1995.

Table 1. Rates of fertilizer used in Trial 107

	Feb 85 -Dec 88			From Jan 89		
	Level			Level		
	0	1	2	0	1	2
	(kg/palm/yr)			(kg/palm/yr)		
Sulphate of Ammonia (SoA)	0.0	1.0	2.0	0.0	2.0	4.0
Triple Superphosphate (TSP)	0.0	0.5	1.0	0.0	1.0	2.0
Sulphate of Potash (SoP)	0.0	1.8	-	0.0	3.6	-
Kieserite (Kies)	0.0	2.0	-	0.0	3.0	-
Sodium chloride (NaCl)	-	-	-	0.0	4.0	-

Note: Treatments are factorial combinations of levels of these fertilisers.

Sulphate of Ammonia & sulphate of potash are applied as two equal doses per year.

There are 72 plots, each consisting of 36 palms of which the central 16 are recorded. The recorded palms are of 16 identified progenies arranged in a fixed spatial configuration in each plot. The 72 treatments are replicated only once and are randomised amongst the 72 plots. High order interactions provide the error term in the statistical analysis.

At three months after planting all palms received 0.25 kg Sulphate of Ammonia and nothing else during the first twelve months. At 12 months (January 1984) half of the plots were given an application of Sulphate of Ammonia (1 kg/palm) as a treatment (establishment nitrogen).

The treatments that are described in Table 1 were started in February 1985 and modified in 1989. The sodium chloride treatment that was started in 1989 is applied orthogonally over the earlier establishment nitrogen treatment. Its purpose is to see whether a deficiency of chlorine is limiting the yield or affecting the response to other fertilisers.

Frond 17 Leaflet and rachis tissue was not sampled for chemical analysis in 1995.

RESULTS

The average plot yield in Trial 107 in 1995 was 23.0 tonnes FFB/ha. This is considerably lower than the average plot yield in 1993 which was 27.0 tonnes FFB/ha but is similar to the mean yield recorded in 1994 (23.4 t/ha). The mean number of bunches per hectare was only 951 in 1995 compared to 1756 in 1994. Mean single bunch weight was 24.2 kg in 1995 compared to 13.6 in 1994.

The FFB yield in 1995 was increased by application of Sulphate of Ammonia (Table 2), however this is a trend only and is not significant at $p<0.05$. The marked response to application of Sulphate of Ammonia that had developed since 1991 has decreased (Table 3). The reason for the lower yields and reduced response to Sulphate of Ammonia application is not apparent, however it is unlikely to be due to nutritional factors.

Plot isolation trenches were dug in 1995 to minimise interplot poaching of applied nutrients. The root pruning which occurred as a result of trenching has probably contributed to a reduction in yield in 1995 as compared to the plantation yield of 29.1 t/ha for palms of the same age in 1995. In September 1995 plantation labour mistakenly applied Sulphate of Ammonia to the entire trial at the rate of 1kg/palm.

The aggregated data from January 1993 to December 1995 reflects the significant increase in FFB yield brought about by Sulphate of Ammonia application (Table 4).

Leaflet and rachis tissue were not sampled for analysis in 1995.

Table 2. Main effects of N, P, K and Mg on yield and yield components in 1995 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	22.0	22.9	24.2	ns	1.143	12.0
Bunches/ha	935	925	994	ns	40.6	14.8
Bunch weight (kg)	23.5	24.7	24.4	ns	0.478	6.8
	P0	P1	P2			
Yield (t/ha/yr)	23.6	23.0	22.6	ns	1.143	12.0
Bunches/ha	977	954	923	ns	40.6	14.8
Bunch weight (kg)	24.1	24.1	24.5	ns	0.478	6.8
	K0	K1				
Yield (t/ha/yr)	23.1	23.0		ns	0.933	12.0
Bunches/ha	939	964		ns	33.2	14.8
Bunch weight (kg)	24.6	23.9		ns	0.390	6.8
	Mg0	Mg1				
Yield (t/ha/yr)	22.2	23.9		ns	0.933	12.0
Bunches/ha	928	975		ns	33.2	14.8
Bunch weight (kg)	23.9	24.5		ns	0.390	6.8
	Cl0	Cl1				
Yield (t/ha/yr)	3.8	22.3		ns	0.933	12.0
Bunches/ha	987	915		*	33.2	14.8
Bunch weight (kg)	24.1	24.4		ns	0.390	6.8

Table 3. FFB yield response to nitrogen application from 1986 to 1995 (Trial 107).

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age (from planting)	4	5	6	7	8	9	10	11	12	13
N0	17.3	24.2	25.9	26.3	27.9	23.5	24.9	24.5	22.6	22.0
N1	17.0	25.4	25.9	27.8	28.6	23.9	27.0	27.4	23.5	22.9
N2	17.8	25.3	26.1	28.0	28.1	23.4	27.0	29.0	24.1	24.2
significance	ns	ns	ns	*	ns	ns	*	***	ns	ns

Table 4. Main effects of N, P, K, Mg and Cl on yield and yield components from 1993 to 1995 (Trial 107).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	23.0	24.6	25.8	***	0.704	10.0
Bunches/ha	1251	1271	1346	*	40.5	10.9
Bunch weight (kg)	18.5	19.4	19.3	ns	0.561	10.2
	P0	P1	P2			
Yield (t/ha/yr)	24.4	24.6	24.5	ns	0.704	10.0
Bunches/ha	1308	1288	1273	ns	40.5	10.9
Bunch weight (kg)	18.7	19.1	19.3	ns	0.561	10.2
	K0	K1				
Yield (t/ha/yr)	24.4	24.6		ns	0.575	10.0
Bunches/ha	1280	1299		ns	33.1	10.9
Bunch weight (kg)	19.1	19.0		ns	0.458	10.2
	Mg0	Mg0				
Yield (t/ha/yr)	24.2	24.7		ns	0.575	10.0
Bunches/ha	1294	1285		ns	33.1	10.9
Bunch weight (kg)	18.8	19.3		ns	0.458	10.2
	Cl0	Cl1				
Yield (t/ha/yr)	24.7	24.3		ns	0.575	10.0
Bunches/ha	1314	1265		ns	33.1	10.9
Bunch weight (kg)	18.9	19.3		ns	0.458	10.2

Samples of leaf and rachis for nutrient analysis were not taken in 1995.

Trial 119 NITROGEN/ANION FERTILISER TRIAL AT MALILIMI PLANTATION.

PURPOSE

To investigate the response of oil palm to the application of various combinations of inorganic fertiliser with a view to providing information that will be useful in developing fertiliser recommendations.

DESCRIPTION

Site Malilimi Plantation, Fields A7 and A8.

Soil Young coarse textured freely draining soils formed on alluvially reworked andesitic pumiceous sands and gravel with some intermixed volcanic ash.

Palms Dami commercial DxP crosses.
Planted in October 1985 at 135 palms/ha.
Treatments started in May 1989.

DESIGN

There are twelve treatments (Table 5), made up from muriate of potash or kieserite (or neither of these) combined with nitrogen from one of three sources (or no nitrogen). The three nitrogen sources are: diammonium phosphate, ammonium sulphate, and ammonium chloride. The twelve treatments are replicated in four randomised complete blocks, giving a total of 48 plots. Each plot has 36 palms of which the central 16 are recorded.

Table 5. Rates of fertilisers, and resulting combinations of elements used in Trial 119. (Treatment numbers are in brackets.)

	Nil	Muriate of potash	Kieserite
Nil	--- (1)	K+Cl (5)	Mg+S (9)
Diammonium phosphate	N+P (2)	N+P+K+Cl (6)	N+P+Mg+S (10)
Ammonium sulphate	N+S (3)	N+S+K+Cl (7)	N+2S+Mg (11)
Ammonium chloride	N+Cl (4)	N+2Cl+K (8)	N+Cl+Mg+S (12)

Diammonium phosphate = 3.9 kg $palm^{-1}$ $year^{-1}$
Ammonium sulphate = 3.8 kg $palm^{-1}$ $year^{-1}$
Ammonium chloride = 3.0 kg $palm^{-1}$ $year^{-1}$
Muriate of potash = 4.2 kg $palm^{-1}$ $year^{-1}$
Kieserite = 3.7 kg $palm^{-1}$ $year^{-1}$

RESULTS

The average plot yield in 1995 was high at 30.2 t/ha/year.

The overall treatment effects on bunch number and single bunch weight was significant for both the 1995 data and the cumulative data for 1993 to 1995 (Table 6), however the overall treatment effect on yield in 1995 was not significant.

The chloride containing fertilisers, ammonium chloride and muriate of potash, increased the single bunch weight (Table 7). The application of muriate of potash in the absence of nitrogen fertiliser also significantly reduced the number of bunches produced.

From the cumulative yield data for 1993 to 1995, the chloride containing fertilisers, ammonium chloride and muriate of potash, increased the single bunch weight. Ammonium chloride in the absence of base fertilisers also significantly reduced the number of bunches produced. Kieserite applied in the presence of nitrogen fertiliser increased the FFB yield by increasing the single bunch weight.

Although general conclusions are difficult due to the poor design of the trial, it would appear that i) chlorine containing fertilisers increase the single bunch weight, possibly by increasing bunch moisture content, ii) chlorine containing fertilisers especially ammonium chloride tend to reduce the numbers of bunches produced, iii) plot yields in this trial are high even in the control plots, and it is unlikely that there are any limiting nutrients at this site. The consultant biometrician from IACR - Rothamsted, UK, has analysed the trial using a number of techniques none of which show any results different to the methods used here.

Table 6. Effect of fertiliser treatments on yield and yield components in 1994 and 1992 to 1994 (Trial 119).

Treatment		1995			1993 to 1995		
		Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number/ha	Bunch weight (kg)
1	Nil	29.3	1370	21.4	29.6	1499	19.7
2	DAP	32.2	1615	19.9	33.1	1751	18.9
3	SoA	30.3	1485	20.6	31.0	1660	18.8
4	AC	29.8	1281	23.3	31.1	1476	21.1
5	MoP	30.7	1321	23.2	31.7	1457	21.8
6	MoP + DAP	34.9	1487	23.5	34.5	1632	21.8
7	MoP + SoA	29.6	1337	22.1	32.1	1551	20.7
8	MoP + AC	30.4	1287	23.4	30.1	1363	22.2
9	Kies	27.8	1309	21.2	30.3	1514	20.1
10	Kies + DAP	30.7	1395	21.9	33.4	1620	20.6
11	Kies + SoA	28.1	1357	20.9	30.8	1582	19.5
12	Kies + AC	28.8	1240	23.1	31.3	1429	21.9
	significance	ns	*	***	ns	**	***
	s.e.	2.344	102.6	0.868	1.514	83.4	0.780
	cv%	10.7	10.3	5.4	6.6	7.5	5.2

Table 7. Treatment contrasts for yield and yield components in 1995 (Trial 119)

	CONTRAST	1995 Yield (t/ha/yr)	1995 Bunch Number	1995 SBW (kg)	1993 to 1995 Yield (t/ha/yr)	1993 to 1995 Bunch Number	1993 to 1995 SBW (kg)
1	- N (- K & Mg)	29.3	1370	21.4	29.6	1499	19.7
	+ N (- K & Mg)	30.8	1460	21.2	31.7	1629	19.6
2	DAP + SoA (- K & Mg)	31.3	1550 **	20.2 ***	32.0	1706 *	18.8 **
	AmC (- K & Mg)	29.8	1281	23.2	31.1	1476	21.1
3	DAP (- K & Mg)	32.2	1615	19.9	33.1	1751	18.9
	SoA (- K & Mg)	30.3	1485	20.6	31.0	1660	18.8
4	- Mg (- N)	29.3	1370	21.4	29.6	1499	19.7
	+ Mg (- N)	27.8	1309	21.2	30.3	1514	20.1
5	- Mg (+ N)	30.8	1460	21.2	31.7	1629	19.6 *
	+ Mg (+ N)	29.2	1331	22.0	31.8	1544	20.7
6	- K (- N)	29.3	1370	21.4 *	29.6	1499	19.7 **
	+ K (- N)	30.7	1321	23.2	31.7	1457	21.8
7	- K (+ N)	30.8	1460	21.2 **	31.7	1629	19.6 **
	+ K (+ N)	31.6	1370	23.1	32.2	1515	21.3

Trial 120 NITROGEN/ANION FERTILISER TRIAL AT DAMI PLANTATION.

PURPOSE

To investigate the response of oil palm to the application of various combinations of inorganic fertiliser with a view to providing information that will be useful in developing fertiliser recommendations.

DESCRIPTION

Site Dami Plantation, Field 9.

Soil Young very coarse textured freely draining soils formed on alluvially reworked andesitic pumiceous sands and gravel.

Palms Dami commercial DxP crosses.
Planted in 1983 at 135 palms/ha.
Treatments started in April 1989.

DESIGN

There are twelve treatments (Table 8), made up from muriate of potash or kieserite (or neither of these) combined with nitrogen from one of three sources (or no nitrogen). The three nitrogen sources are: diammonium phosphate, ammonium sulphate, and ammonium chloride. The twelve treatments are replicated in four randomised complete blocks, giving a total of 48 plots. Each plot has 25 palms of which the central 9 are recorded.

Table 8. Rates of fertiliser and resulting combinations of elements used in Trial 120. (Treatment numbers are in brackets.)

	Nil	Muriate of potash	Kieserite
Nil	--- (1)	K+Cl (5)	Mg+S (9)
Diammonium phosphate	N+P (2)	N+P+K+Cl (6)	N+P+Mg+S (10)
Ammonium sulphate	N+S (3)	N+S+K+Cl (7)	N+2S+Mg (11)
Ammonium chloride	N+Cl (4)	N+2Cl+K (8)	N+Cl+Mg+S (12)

Diammonium phosphate = 3.9 kg $palm^{-1}$ $year^{-1}$
Ammonium sulphate = 3.8 kg $palm^{-1}$ $year^{-1}$
Ammonium chloride = 3.0 kg $palm^{-1}$ $year^{-1}$
Muriate of potash = 4.2 kg $palm^{-1}$ $year^{-1}$
Kieserite = 3.7 kg $palm^{-1}$ $year^{-1}$

RESULTS

The average plot FFB yield in 1995 was high at 28.6 t/ha/year.

The overall treatment effects for 1995 and the 1993 to 1995 cumulative data were not significant (Table 9). Despite this, partitioning of the treatment variance suggests that application of kieserite in the presence of the nitrogen fertilisers increased the FFB yield by increasing the number of bunches produced (Table 10).

Table 9. Effect of fertiliser treatments on yield and yield components in 1995 and 1993 to 1995 (Trial 120).

Treatment		1995			1993 to 1995		
		Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)	Yield (t/ha/yr)	Bunch number /ha	Bunch weight (kg)
1	Nil	27.7	1184	23.5	28.3	1254	22.3
2	DAP	30.2	1282	23.4	28.4	1252	22.7
3	SoA	28.4	1235	22.9	27.0	1187	22.7
4	AC	27.5	1154	24.0	28.9	1232	23.5
5	MoP	29.4	1179	24.9	28.0	1234	22.7
6	MoP + DAP	28.6	1162	24.7	30.1	1264	23.8
7	MoP + SoA	30.8	1294	23.9	31.5	1369	23.1
8	MoP + AC	29.8	1267	23.6	29.8	1317	22.7
9	Kies	26.3	1113	23.7	27.7	1193	23.3
10	Kies + DAP	25.8	1154	22.6	29.3	1342	21.9
11	Kies + SoA	27.7	1201	23.1	30.7	1344	22.9
12	Kies + AC	30.9	1273	24.3	31.6	1324	23.9
	significance	ns	ns	ns	ns	ns	ns
	sed	2.760	118.1	1.360	1.718	77.9	0.794
	cv%	13.5	13.7	8.0	8.2	8.5	4.8

Leaflet samples only were taken for chemical analysis in 1995. The treatments did not have any significant effect on the concentrations of leaflet nutrients in 1995 (Table 11).

The application of muriate of potash increased the concentration of calcium in the leaflet and rachis tissue. The concentration of calcium in the rachis tissue was increased by application of ammonium sulphate. The application of kieserite in the presence of nitrogen fertiliser decreased the concentration of calcium in leaflet tissue.

Table 10. Treatment contrasts for yield and yield components (Trial 120)

	Contrast	1995			1993 to 1995		
		Yield (t/ha/yr)	Bunch Number	SBW (kg)	Yield (t/ha/yr)	Bunch umber	SBW (kg)
1	- N (- K & Mg)	27.7	1184	23.5	28.0	1254	22.3
	+ N (- K & Mg)	28.7	1224	23.4	28.1	1224	23.0
2	DAP + SoA (- K & Mg)	29.3	1259	23.2	27.7	1220	22.7
	AmC (- K & Mg)	27.5	1154	24.0	28.9	1232	23.5
3	DAP (- K & Mg)	30.2	1282	23.4	28.4	1252	22.7
	SoA (- K & Mg)	28.4	1235	22.9	27.0	1187	22.7
4	- Mg (- N)	27.7	1184	23.5	28.0	1254	22.3
	+ Mg (- N)	26.3	1113	23.7	27.7	1193	23.3
5	- Mg (+ N)	28.7	1224	23.4	28.1 *	1224 *	23.0
	+ Mg (+ N)	28.1	1209	23.3	30.6	1337	22.9
6	- K (- N)	27.7	1184	23.5	28.0	1254	22.3
	+ K (- N)	29.4	1179	24.9	28.0	1234	22.7
7	- K (+ N)	28.7	1224	23.4	28.1	1224	23.0
	+ K (+ N)	29.7	1241	24.1	30.8	1317	23.2

Table 11. Effect of fertiliser treatments on frond 17 leaflet nutrient concentrations in 1995 (Trial 120).

		Element as % of leaflet dry matter					
		Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Chlorine
1	Nil	2.28	0.136	0.79	0.13	0.75	0.51
2	DAP	2.21	0.133	0.84	0.13	0.68	0.42
3	SoA	2.17	0.134	0.82	0.13	0.77	0.46
4	AC	2.11	0.133	0.80	0.14	0.70	0.45
5	MoP	2.27	0.136	0.83	0.14	0.69	0.41
6	MoP + DAP	2.26	0.135	0.80	0.13	0.72	0.42
7	MoP + SoA	2.26	0.136	0.79	0.14	0.78	0.42
8	MoP + AC	2.25	0.138	0.78	0.14	0.74	0.45
9	Kies	2.27	0.135	0.76	0.13	0.75	0.52
10	Kies + DAP	2.28	0.138	0.78	0.13	0.74	0.47
11	Kies + SoA	2.24	0.133	0.82	0.12	0.73	0.51
12	Kies + AC	2.29	0.135	0.85	0.13	0.70	0.49
	significance	ns	ns	ns	ns	ns	ns
	sed	0.056	0.0028	0.042	0.015	0.045	0.057
	cv%	3.6	3.0	7.4	16.1	8.8	17.6

Table 12. Treatment contrasts for frond 17 leaflet nutrient concentrations (Trial

	CONTRAST	Nitrogen		Phosphorus	Potassium	Magnesium	Calcium		Chlorine
		Element as % of leaflet dry matter							
1	- N (- K & Mg)	2.28	*	0.136	0.79	0.13	0.75		0.51
	+ N (- K & Mg)	2.16		0.134	0.82	0.14	0.72		0.44
2	DAP + SoA (- K & Mg)	2.19		0.134	0.83	0.13	0.73		0.44
	AmC (- K & Mg)	2.11		0.133	0.80	0.14	0.70		0.45
3	DAP (- K & Mg)	2.21		0.134	0.84	0.13	0.68	*	0.42
	SoA (- K & Mg)	2.17		0.134	0.82	0.13	0.77		0.46
4	- Mg (- N)	2.28		0.136	0.79	0.13	0.75		0.51
	+ Mg (- N)	2.27		0.135	0.76	0.13	0.75		0.52
5	- Mg (+ N)	2.16	*	0.134	0.82	0.14	0.72		0.44
	+ Mg (+ N)	2.27		0.135	0.82	0.13	0.72		0.49
6	- K (- N)	2.28		0.136	0.79	0.13	0.75		0.51
	+ K (- N)	2.27		0.136	0.83	0.14	0.69		0.41
7	- K (+ N)	2.16		0.134	0.82	0.14	0.72		0.44
	+ K (+ N)	2.26		0.136	0.79	0.13	0.74		0.43

Trial 122 NITROGEN AND CROP RESIDUE TRIAL AT KUMBANGO PLANTATION.

PURPOSE

To investigate the response of Oil Palm to applications of Empty Fruit Bunches (EFB), Palm Kernel Cake (PKC), pruned fronds and the combined application of these crop residues and inorganic nitrogen fertilizer. It is hoped that by integrating the application of inorganic fertilizer nitrogen and crop residue, the efficacy of fertilizer nitrogen application will be increased.

DESCRIPTION

Site Field number E12, Division II, Kumbango Plantation, Nr Kimbe, WNBP. The trial is situated about 1.5 km west of the Dagi River on its flat alluvial plain and about 6 km from the coast.

Soil Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and gravel with intermixed volcanic ash.

Palms Dami commercial DxP crosses.
Planted in 1978 at 120 palms/ha.
Trial was initiated in November 1991, treatment applications started in July 1992.

DESIGN

The trial consists of 13 treatments (Table 13) in 4 randomised complete blocks. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 13. Treatments used in Trial 122.

Treatment Number	Crop Residue	Fertilizer Applied (kg/palm/yr)	Fertilizer Placement
1	Nil	3.0kg SoA & 3.0kg Kies	Weeded Circle
2	fronds	3.0kg SoA & 3.0kg Kies	Weeded Circle
3	fronds	3.0kg SoA & 3.0kg Kies	Frond Pile
4	fronds & EFB	3.0kg SoA & 3.0kg Kies	Weeded Circle
5	fronds & EFB	3.0kg SoA & 3.0kg Kies	Frond Pile
6	fronds & EFB	3.0kg SoA & 3.0kg Kies	EFB
7	fronds & PKC	3.0kg SoA & 3.0kg Kies	Weeded Circle
8	fronds & PKC	3.0kg SoA & 3.0kg Kies	Frond Pile
9	fronds & PKC	3.0kg SoA & 3.0kg Kies	PKC
10	Nil	Nil	Nil
11	fronds	Nil	Nil
12	fronds & EFB	Nil	Nil
13	fronds & PKC	Nil	Nil

The EFB is applied with a Giltrap EFB applicator at approximately 50 t/ha. The PKC is applied with a Kuhn spinning disc fertilizer spreader at a rate of 1.8 t/ha.

RESULTS

The overall treatment effect was statistically significant for single bunch weight in 1995 (Table 14). The cumulative data for 1993 to 1995 shows that application of EFB led to significantly higher single bunch weights (Table 15).

The only trend emerging from the applied treatments in 1995 was that application of EFB suppressed yields. EFB was applied at a rate of 120 t/ha in 1995 rather than at the recommended rate of 50 t/ha. Such a high rate of application has most probably resulted in the temporary fixing of much of the applied nitrogen. Anaerobic conditions in the soil surface could also be expected with such a high rate of application of organic matter, killing many of the tertiary and quaternary roots which grow in the organic matter and thus limit the uptake of nutrients.

In the absence of EFB or PKC the application of fertiliser to the frond pile did not result in any decline in yield as compared with fertiliser applied to the weeded circle. The lowest plot yield in 1995 (22.1 t/ha) was recorded in the plot with no crop residue and no fertiliser

Table 14. Effects of treatments on yield and yield components in 1995 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	FFB Yield (t/ha/yr)	Number of Bunches/ha	Bunch weight (kg)
1	Nil	N + Mg	Weeded Circle	26.2	953	27.7
2	fronds	N + Mg	Weeded Circle	26.6	918	29.1
3	fronds	N + Mg	Frond Pile	26.6	908	29.3
4	fronds & EFB	N + Mg	Weeded Circle	21.8	753	29.0
5	fronds & EFB	N + Mg	Frond Pile	23.4	845	27.8
6	fronds & EFB	N + Mg	EFB	22.3	773	28.9
7	fronds & PKC	N + Mg	Weeded Circle	24.3	860	28.2
8	fronds & PKC	N + Mg	Frond Pile	26.1	1028	25.5
9	fronds & PKC	N + Mg	PKC	23.6	913	26.0
10	Nil	Nil	Nil	22.1	818	27.0
11	fronds	Nil	Nil	25.7	975	26.3
12	fronds & EFB	Nil	Nil	24.7	948	26.1
13	fronds & PKC	Nil	Nil	25.2	922	27.2
			significance	ns	ns	*
			sed	2.092	83.0	1.105
			cv%	12.1	13.1	5.7

Table 15. Effects of treatments on yield and yield components for 1993 to 1995 (Trial 122).

Treatment Number	Crop Residue	Fertilizer Applied	Fertilizer Placement	FFB Yield (t/ha/yr)	Number of Bunches/ha	Bunch weight (kg)
1	Nil	N + Mg	Weeded Circle	24.4	894	27.4
2	fronds	N + Mg	Weeded Circle	26.3	930	28.3
3	fronds	N + Mg	Frond Pile	24.5	857	28.6
4	fronds & EFB	N + Mg	Weeded Circle	25.9	848	30.6
5	fronds & EFB	N + Mg	Frond Pile	26.5	910	29.2
6	fronds & EFB	N + Mg	EFB	25.5	882	28.9
7	fronds & PKC	N + Mg	Weeded Circle	25.8	942	27.5
8	fronds & PKC	N + Mg	Frond Pile	25.2	897	28.1
9	fronds & PKC	N + Mg	PKC	26.1	923	28.3
10	Nil	Nil	Nil	25.2	916	27.5
11	fronds	Nil	Nil	25.3	911	27.8
12	fronds & EFB	Nil	Nil	26.9	931	28.9
13	fronds & PKC	Nil	Nil	25.6	942	27.3
			significance	ns	ns	**
			sed	1.118	49.35	0.787
			cv%	6.2	7.7	3.9

Leaf and rachis tissue were not sampled in 1995.

This trial is difficult to analyse using standard techniques. Miss Janet Riley, Head of Overseas Biometrics at IACR - Rothamsted has analysed the trial using a number of techniques but the end result of each analyses is the same with no significant yield responses.

Trial 125 **SOURCES OF NITROGEN FERTILISER TRIAL AT KUMBANGO PLANTATION.**

PURPOSE

To investigate the relative effects of different types of nitrogen fertiliser available in PNG, on oil palm. Of particular interest is the effect of the various nitrogen fertilisers on potassium and magnesium nutrition. The results of the trial will be used in formulating fertiliser recommendations.

DESCRIPTION

Site — One or more of field numbers c4, c5 or c6 , Division II, Kumbango Plantation, Nr Kimbe, WNBP.

Soil — Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and gravel with intermixed volcanic ash.

Palms — Dami commercial DxP crosses.
Planted in April & May 1993 at 135 palms/ha.
Treatment applications will start 36 months after planting.

DESIGN

The design of this trial has been changed on the advice of biometricians from the Pacific Regional Agricultural Programme and IACR - Rothemsted.

There will be 15 fertiliser treatments and 3 control plots in each replication (Table 16). The 18 treatments will be replicated four times in a randomised complete block design. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 16: Treatments used in Trial 125

Fertiliser	Level (kg/palm/year) 1	2	3
Ammonium Chloride	2.0	4.0	8.0
Sulphate of Ammonia	2.6	5.2	10.3
Urea	1.2	2.4	4.7
Ammonium Nitrate	1.5	2.9	5.8
Di-ammonium Phosphate	3.0	6.0	12.0
3 x control plots			

Each rate of fertiliser at the same level contains the same amount of nitrogen.

PROGRESS

This trial was approved in the PNGOPRA Scientific Advisory Board meeting in November 1993. The design was changed in February 1996. The site has been remapped and plot and palm labelling is being carried out.

Experimental fertiliser treatments will be started by the end of 1996. Until this time the palms will have received a standard immature palm fertiliser input. Frond 17 leaflet, rachis and cross-section sampling will be carried out prior to treatments being applied.

Trial 126 FACTORIAL FERTILISER TRIAL AT MALILIMI PLANTATION

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage. This trial was also designed to investigate further the yield responses seen in Trial 119, ie. was the response due to potassium or chlorine?

DESCRIPTION

Site Malilimi Plantation, WNBP.

Soil Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sand and volcanic ash. Palaeosols are common.

Palms Dami commercial DxP crosses.
Planted in 1985 at 120 palms/ha.
Treatments are to be started in May 1996.

DESIGN

There are 72 treatments comprising all factorial combinations of sulphate of potash (K), sulphate of ammonia (N) each at three levels and triple superphosphate (P), kieserite (Mg) and sodium chloride (Cl) each at two levels (Table 17). The 72 treatments will be replicated only once and will be divided among two blocks. The 3 factor interaction '2x2x2' will be partially confounded with blocks. Third and higher order interactions will provide the error term in the statistical analysis. Each of the 72 plots consists of 36 palms (6x6) of which the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms.

Table 17. Fertiliser rates to be used in Trial 126.

Fertiliser	Level (kg/palm/year)		
	0	1	2
Sulphate of potash	0.0	3.0	6.0
Sulphate of ammonia	0.0	3.0	6.0
Triple superphosphate	0.0	4.0	---
Kieserite	0.0	4.0	---
Sodium chloride	0.0	4.0	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The sulphate of ammonium and sulphate of potash will be split into two applications per year, while the other fertilisers are applied once per year.

PROGRESS

This trial was approved in the PNGOPRA Scientific Advisory Board meeting in November 1993.

The trial was physically initiated in 1994. Site selection, a detailed site survey and site mapping was carried out in May and June 1994. Plot selection was carried out in June 1994. Pre-treatment yield recording was conducted in 1995.

Experimental fertiliser treatments will start in May 1996.

Frond 17 leaflet sampling was carried out for each plot in December 1994, and subsequently analysed for nutrient element content (Table 18). This analysis will be used as pre-treatment data for the control of residual variance in later statistical analysis. It should be noted that the whole site has been receiving a fertiliser schedule which comprises nitrogen and magnesium amelioration

Table 18. Summary statistics for pre-treatment frond 17 leaflet tissue analysis (Trial 126).

Element	Values	Minimum	Mean	Maximum	Standard Deviation
Nitrogen	72	2.26	2.39	2.58	0.057
Phosphorus	72	0.138	0.146	0.152	0.003
Potassium	72	0.65	0.81	0.95	0.065
Magnesium	72	0.09	0.13	0.18	0.018
Calcium	72	0.68	0.85	1.04	0.075
Chlorine	72	0.28	0.34	0.45	0.037

Trial 204 FACTORIAL FERTILISER TRIAL AT NAVO PLANTATION

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Site Navo Plantation, Area 8, Blocks 10 and 11.

Soil Very young coarse textured freely draining soils formed on air fall volcanic scoria.

Palms Dami commercial DxP crosses.
Planted in 1986 at 120 palms/ha.
Treatments started in May 1989.

DESIGN

There are 36 treatments, comprising all factorial combinations of N and P at three levels and K and Mg each at two levels (Table 19).

Table 19. Rates of fertiliser used in trial 204.

	Level (kg /palm/year)		
	0	1	2
Ammonium chloride	0.0	3.0	6.0
Triple superphosphate	0.0	2.0	4.0
Muriate of potash	0.0	3.0	---
Kieserite	0.0	3.0	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The ammonium chloride is split into two applications per year, while the other fertilisers are applied once per year.

There are 72 plots, each plot consisting of 36 palms (6x6), of which the central 16 are recorded. The 36 treatments are replicated twice and are grouped into two blocks. The trial was designed as a 3x3x2x2x2 factorial trial, but one 'x2' factor has been left "vacant" and is regarded as replication for the time being. The "vacant" treatment will be used later. The 3 factor interaction '2x2x2' would be partially confounded with blocks. High order interactions provide the error term in the statistical analysis.

RESULTS

The average plot yield in this trial was 28.7 t/ha in 1995. This yield is considerably higher than the average plot yield recorded in the preceding two years, 20.2 t/ha in 1993 and 23.3 t/ha in 1994.

Ammonium chloride application increased FFB yield from 23.3 t/ha to 32.3 t/ha at the highest rate of nitrogen (Table 20). This increase was due to increases in both the number of bunches produced and the single bunch weight. The increase in yield due to ammonium chloride application is greater in 1995 than in the preceding two years.

The cumulative data for the period 1993 to 1995 (Table 21) also shows a significant positive effect on FFB yield which was caused by an increase in both number of bunches and bunch weight.

Table 20. Main effects of N, P, K and Mg on yield and yield components in 1995 (Trial 204).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	23.3	30.4	32.3	***	0.979	11.8
Bunches/ha	1298	1427	1506	**	52.7	12.9
Bunch weight (kg)	18.1	21.4	21.5	***	0.403	6.9
	P0	P1	P2			
Yield (t/ha/yr)	28.5	28.4	29.1	ns	0.979	11.8
Bunches/ha	1384	1405	1443	ns	52.7	12.9
Bunch weight (kg)	20.6	20.3	20.1	ns	0.403	6.9
	K0	K1				
Yield (t/ha/yr)	28.7	28.7		ns	0.799	11.8
Bunches/ha	1423	1399		ns	43.0	12.9
Bunch weight (kg)	20.2	20.5		ns	0.329	6.9
	Mg0	Mg1				
Yield (t/ha/yr)	28.9	28.4		ns	0.799	11.8
Bunches/ha	1437	1385		ns	43.0	12.9
Bunch weight (kg)	20.2	20.5		ns	0.329	6.9

Table 21: Main effects of N, P, K and Mg on yield and yield components for 1993 to 1995 (Trial

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	21.0	25.3	25.8	***	0.536	7.7
Bunches/ha	1352	1442	1470	**	37.3	9.1
Bunch weight (kg)	15.6	17.7	17.7	***	0.295	6.0
	P0	P1	P2			
Yield (t/ha/yr)	24.2	23.8	24.2	ns	0.536	7.7
Bunches/ha	1409	1413	1442	ns	37.3	9.1
Bunch weight (kg)	17.2	16.9	16.9	ns	0.295	6.0
	K0	K1				
Yield (t/ha/yr)	23.8	24.3		ns	0.438	7.7
Bunches/ha	1417	1426		ns	30.4	9.1
Bunch weight (kg)	16.9	17.1		ns	0.241	6.0
	Mg0	Mg1				
Yield (t/ha/yr)	24.2	24.0		ns	0.438	7.7
Bunches/ha	1434	1408		ns	30.4	9.1
Bunch weight (kg)	16.9	17.1		ns	0.241	6.0

The concentration of potassium in leaflet tissue was decreased by application of ammonium chloride (Table 22). Application of 3.0kg ammonium chloride increased rachis nitrogen but application of 6kg ammonium chloride did not lead to an increase in rachis nitrogen (Table 23). There no other significant differences in 1995. The lack of response is most likely due to the dilution of nutrients with the increase in biomass which occurs with the addition of nitrogen fertiliser.

In conclusion, the main yield limiting nutrient is nitrogen.

Table 22. Treatment main effects on leaflet nutrient concentrations in 1995 (Trial 204).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.28	2.29	2.24	ns	0.047	7.2
Phosphorus	0.139	0.138	0.139	ns	0.002	4.5
Potassium	0.79	0.71	0.73	***	0.018	8.2
Calcium	0.95	0.94	0.95	ns	0.021	7.6
Magnesium	0.18	0.18	0.17	ns	0.007	13.4
Chlorine	0.48	0.50	0.46	ns	0.046	33.0
	P0	P1	P2			
Nitrogen	2.26	2.32	2.23	ns	0.047	7.2
Phosphorus	0.138	0.139	0.138	ns	0.002	4.5
Potassium	0.76	0.73	0.74	ns	0.018	8.2
Calcium	0.94	0.96	0.93	ns	0.021	7.6
Magnesium	0.17	0.17	0.18	ns	0.007	13.4
Chlorine	0.46	0.51	0.47	ns	0.046	33.0
	K0	K1				
Nitrogen	2.28	2.26		ns	0.038	7.2
Phosphorus	0.139	0.138		ns	0.001	4.5
Potassium	0.75	0.73		ns	0.014	8.2
Calcium	0.94	0.95		ns	0.017	7.6
Magnesium	0.18	0.17		ns	0.006	13.4
Chlorine	0.48	0.48		ns	0.046	33.0
	Mg0	Mg1				
Nitrogen	2.28	2.25		ns	0.038	7.2
Phosphorus	0.139	0.138		ns	0.001	4.5
Potassium	0.74	0.75		ns	0.014	8.2
Calcium	0.96	0.93		ns	0.017	7.6
Magnesium	0.17	0.18		ns	0.006	13.4
Chlorine	0.52	0.44		ns	0.046	33.0

Table 23. Treatment main effects on rachis nutrient concentrations in 1995 (Trial 204).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.23	0.24	0.23	**	0.005	8.2
Phosphorus	0.064	0.066	0.064	ns	0.006	29.7
Potassium	1.31	1.33	1.37	ns	0.052	13.6
Calcium	0.44	0.48	0.45	ns	0.019	14.7
Magnesium	0.056	0.056	0.049	ns	0.003	18.8
Chlorine	0.59	0.65	0.64	ns	0.080	44.0
	P0	P1	P2			
Nitrogen	0.23	0.23	0.24	ns	0.005	8.2
Phosphorus	0.067	0.065	0.062	ns	0.006	29.7
Potassium	1.35	1.32	1.33	ns	0.052	13.6
Calcium	0.45	0.49	0.44	ns	0.019	14.7
Magnesium	0.050	0.058	0.054	ns	0.003	18.8
Chlorine	0.58	0.70	0.60	ns	0.080	44.0
	K0	K1				
Nitrogen	0.23	0.23		ns	0.004	8.2
Phosphorus	0.067	0.063		ns	0.005	29.7
Potassium	1.35	1.32		ns	0.043	13.6
Calcium	0.45	0.46		ns	0.016	14.7
Magnesium	0.053	0.054		ns	0.002	18.8
Chlorine	0.62	0.64		ns	0.065	44.0
	Mg0	Mg1				
Nitrogen	0.24	0.23		ns	0.004	8.2
Phosphorus	0.064	0.066		ns	0.005	29.7
Potassium	1.38	1.30		ns	0.043	13.6
Calcium	0.47	0.45		ns	0.016	14.7
Magnesium	0.054	0.053		ns	0.002	18.8
Chlorine	0.68	0.58		ns	0.065	44.0

Trial 205 EFB/FERTILISER TRIAL AT HARGY PLANTATION.

PURPOSE

To investigate the response of Oil Palm to applications of Empty Fruit Bunches (EFB), and to investigate whether the uptake of phosphorus and magnesium from triple superphosphate and kieserite can be improved by applying the fertiliser in conjunction with EFB.

DESCRIPTION

Site Blocks 7 and 8, Area 9, Hargy Plantation, Bialla, WNBP.

Soil Freely draining andosol formed on intermediate to basic volcanic ash.

Palms Dami identified DxP crosses.
Planted in July and August 1993 at 135 palms/ha.
Treatments to start 36 months after planting.

DESIGN

There are eight treatments comprising all factorial combinations of EFB, triple superphosphate and kieserite each at two levels (Table 24). The treatments are replicated six times, with each replicate comprising one block. 36 palm plots (6x6 palms) are used, the central 16 palms are recorded and the outer 20 palms are regarded as guard row palms. The recorded palms comprise 16 different identified Dami DxP progenies which have been arranged in a random spatial configuration in each plot. The 16 progenies are as follows;

Code	Progeny Number	Code	Progeny Number
A	9004093E	I	9009127E
B	9009030E	J	9103073E
C	9009149E	K	9103136E
D	9102109E	L	9010217E
E	9010040E	M	9010190E
F	4091	N	9009110E
G	9008022E	O	9101100E
H	5148	P	9007130E

Table 24. Fertiliser and EFB treatments used in Trial 205.

Treatment	EFB (kg/palm/yr)	Triple superphosphate (kg/palm/yr)	Kieserite (kg/palm/yr)
1	Nil	Nil	Nil
2	Nil	Nil	3.0
3	Nil	3.0	Nil
4	Nil	3.0	3.0
5	230	Nil	Nil
6	230	Nil	3.0
7	230	3.0	Nil
8	230	3.0	3.0

Where application of EFB and the inorganic fertilisers coincide, they will be applied together.

PROGRESS

The trial was planted in July and August 1993. The site was surveyed and mapped, and plot and palm labelling was carried out in 1993.

For the first 36 months, the palms will receive a standard immature palm fertiliser input. Experimental treatments will be applied after this time.

Trials 251 and 252 FACTORIAL FERTILISER TRIALS AT MARAMAKAS AND LUBURUA PLANTATIONS.

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Sites: Trial 251: Fields 2B, 2C, 2D and 3A, Maramakas Plantation.
Trial 252: Block 4, Luburua Plantation.

Soils: Reddish brown clay soil overlying raised coral and showing great variability in depth. The soils are shallow on terrace margins and low ridges and moderately deep in depressions. The soil is freely draining.

Palms: Dami commercial DxP crosses.
Planted in March 1989 (251) and September 1989 (252) at 120 palms/ha.
Treatments started in April 1991.

DESIGN

There are 36 treatments at both sites, comprising all factorial combinations of N and K at three levels and P and Mg each at two levels (Table 25).

Table 25. Rates of fertiliser used in trials 251 and 252.

	Level (kg /palm/year)		
	0	1	2
Ammonium sulphate	0.0	2.5	5.0
Muriate of potash	0.0	2.5	5.0
Triple superphosphate	0.0	2.0	---
Kieserite	0.0	2.0	---

Note: Treatments are factorial combinations of levels of these fertiliser

Annual fertiliser application rates are split into three applications.

These two trials were originally planned as a single 3x3x2x2 factorial trial with two replicates, but because of restricted availability of land, the two replicates were located on two separate sites and regarded as two trials. A site factor is therefore included in the single analysis for these two trials.

There are 36 plots at each site, each plot consisting of 36 palms (6x6), of which the central 16 are recorded.

High order interactions provide the error term in the statistical analysis.

Soil depth was measured by drilling an augur hole beside each recorded palm until the augur struck coral. Soil depth was used as a concomitant variable in an analysis of covariance of the 1995 yield data. This analysis of covariance significantly reduces the residual variance.

RESULTS

The data recording of these trials commenced in June 1992. This report is based on data recorded from January 1993 to December 1995.

The yield in these trials was relatively low with the average plot yields being 18.7 t FFB/ha in 1993 and 21.9 t FFB/ha in 1994. Mean yield in 1995 was 17.9 t FFB/ha. The results for 1995 show that application of potassium led to a significant increase in single bunch weight (Table 25) but there was no significant increase in FFB yield even though there was an apparent trend.

The site (Trial 251 & Trial 252) x fertiliser treatment interaction was not statistically significant for any of the three years. Bunch weights were significantly higher at Trial 251 than at Trial 252 in 1995.

The application of sulphate of ammonia had no effect on FFB yield or yield components in 1995 (Table 26) or for the three years 1993 to 1995 combined (Table 27). This lack of response to nitrogen is not surprising as the concentration of nitrogen in the leaflet tissue is relatively high. The nitrogen concentration of the leaflet tissue in these trials is typical of those seen following routine tissue sampling and analysis of Poliamba Estates (Table 28). The data suggest that there is no need to apply nitrogen fertiliser to much of Poliamba estates for the time being. This conclusion probably applies to the smallholder growers as well.

Table 26. Main effects of N, P, K and Mg on yield and yield components for 1995 adjusted for covariate of soil depth (Trials 251 and 252).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha)	17.7	18.0	18.2	ns	0.809	15.6
Bunches/ha	1476	1498	1512	ns	67.4	15.6
Bunch weight (kg)	11.9	12.0	12.0	ns	0.240	6.9
	K0	K1	K2			
Yield (t/ha)	17.3	17.5	19.1	ns	0.810	15.6
Bunches/ha	1534	1424	1529	ns	67.5	15.6
Bunch weight (kg)	11.3	12.2	12.4	***	0.240	6.9
	P0	P1				
Yield (t/ha)	17.8	18.1		ns	0.660	15.6
Bunches/ha	1489	1502		ns	55.0	15.6
Bunch weight (kg)	11.9	12.0		ns	0.195	6.9
	Mg0	Mg1				
Yield (t/ha/yr)	17.4	18.4		ns	0.669	15.6
Bunches/ha	1489	1502		ns	55.8	15.6
Bunch weight (kg)	11.7	12.2		ns	0.198	6.9
	Trial 251	Trial 252				
Yield (t/ha/yr)	18.3	17.6		ns	0.705	15.6
Bunches/ha	1484	1507		ns	58.8	15.6
Bunch weight (kg)	12.3	11.6		***	0.209	6.9

The analysis of the aggregated data for 1993 to 1995 shows a significant response to potassium. FFB yield at Trial 251 is significantly higher than in Trial 252 due to the larger bunch weights at Trial 251.

Table 27. Main effects of N, P, K and Mg on yield and yield components for January 1993 to December 1995 adjusted for covariate of soil depth (Trials 251 and 252).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha)	19.3	19.6	19.7	ns	0.711	12.6
Bunches/ha	1936	1968	1943	ns	61.9	11.0
Bunch weight (kg)	10.2	10.2	10.3	ns	0.178	6.0
	K0	K1	K2			
Yield (t/ha)	18.5	19.5	20.6	*	0.712	12.6
Bunches/ha	1909	1937	2001	ns	62.0	11.0
Bunch weight (kg)	9.9	10.3	10.5	**	0.178	6.0
	P0	P1				
Yield (t/ha)	19.4	19.6		ns	0.580	12.6
Bunches/ha	1936	1962		ns	50.4	11.0
Bunch weight (kg)	10.2	10.2		ns	0.145	6.0
	Mg0	Mg1				
Yield (t/ha/yr)	19.3	19.7		ns	0.588	12.6
Bunches/ha	1951	1947		ns	51.2	11.0
Bunch weight (kg)	10.1	10.4		ns	0.147	6.0
	Trial 251	Trial 252				
Yield (t/ha/yr)	20.7	18.3		***	0.620	12.6
Bunches/ha	1987	1912		ns	53.9	11.0
Bunch weight (kg)	10.7	9.8		***	0.155	6.0

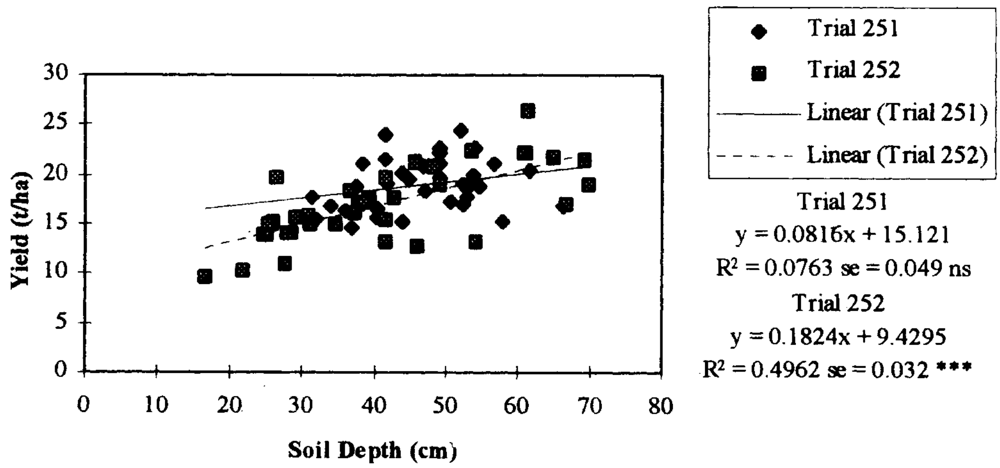
The application of muriate of potash increased the FFB yield by increasing the single bunch weight and the number of bunches produced, however the effect on bunch number was not statistically significant. Although the SITE x K interaction is not statistically significant, the two way table (Table 27) shows that the yield response to muriate of potash was much greater at the Trial 251 site compared to the Trial 252 site even though the leaflet and rachis K levels are similar at each site. Figure 1 shows the effect of soil depth on yield at each site showing that soil depth is limiting yield and suppressing the response to potassium at Trial 252 but not at Trial 251.

Figure 2 shows that soil depth only limits yield when potassium is applied demonstrating that potassium is the main limiting factor and soil depth is the secondary limiting factor at Poliamba.

Table 28. MoP by trial interactions, yield from January 1993 to December 1995, and tissue sampled in 1995 (Trials **251 and252**

	Yield (t/ha)		Rachis K %		Leaflet K %	
	Trial 251	Trial 252	Trial 251	Trial 252	Trial 251	Trial 252
K0	19.5	17.5	0.28	0.30	0.56	0.69
K1	21.1	17.8	0.85	1.02	0.84	0.88
K2	21.6	19.6	1.24	1.20	0.87	0.91
Interaction significance	ns		ns		ns	
sed	1.032		0.077		0.029	
cv%	12.6		22.4		8.7	

Figure 1: Relationship between plot yield and soil depth in Trial 251 and252.



Trial 251

$y = 0.0816x + 15.121$

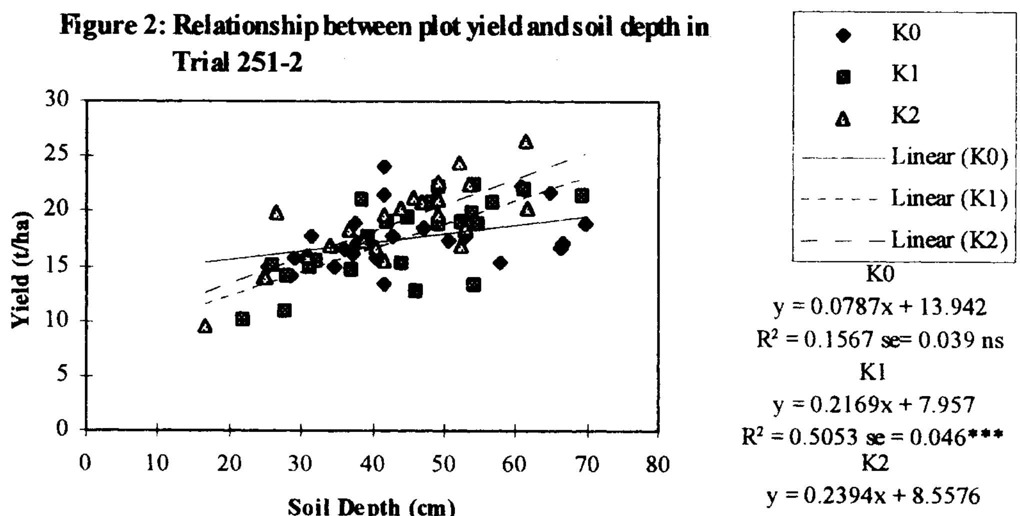
$R^2 = 0.0763$ se = 0.049 ns

Trial 252

$y = 0.1824x + 9.4295$

$R^2 = 0.4962$ se = 0.032 ***

Figure 2: Relationship between plot yield and soil depth in Trial 251-2



K0

$y = 0.0787x + 13.942$

$R^2 = 0.1567$ se= 0.039 ns

K1

$y = 0.2169x + 7.957$

$R^2 = 0.5053$ se = 0.046***

K2

$y = 0.2394x + 8.5576$

$R^2 = 0.6054$ se = 0.041***

Figure 3: Relationship between yield and soil depth at three rates of potassium in Trial 251.

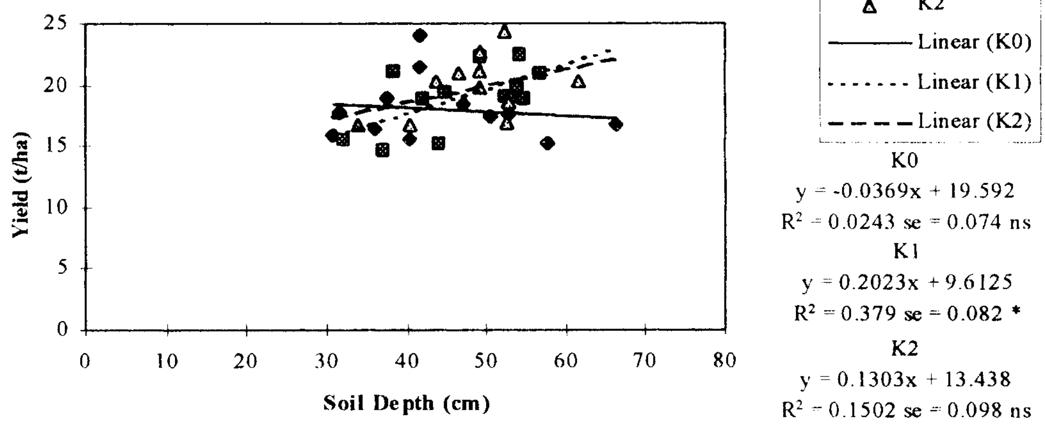
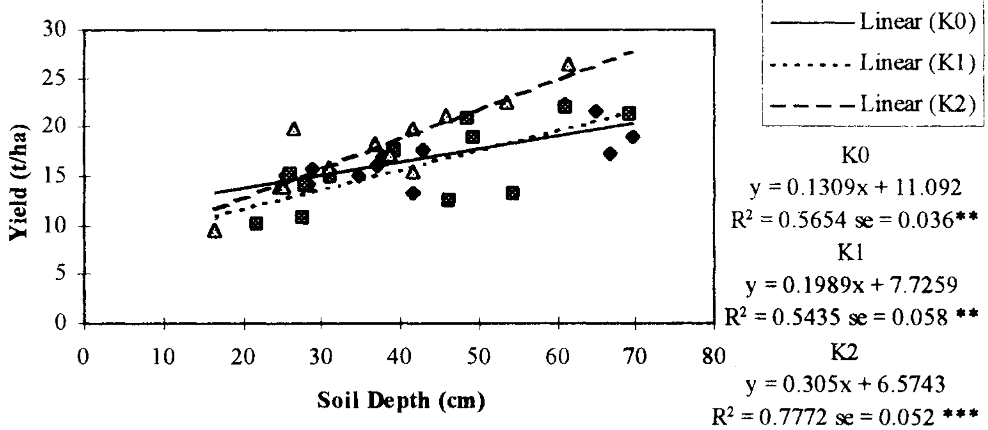


Figure 4: Relationship between yield and soil depth for three rates of potassium in Trial 252



Muriate of potash increased the concentration of potassium in leaflet and rachis tissue (Tables 29 and 30). The increase in potassium concentration seen in rachis tissue is much more pronounced than in the leaflet tissue. Muriate of potash decreased the concentration of magnesium in leaflet and rachis tissue and increased the concentration of nitrogen, phosphorus and chlorine in leaflet and rachis tissue.

The application of sulphate of ammonia increased the concentration of nitrogen in the rachis tissue, however these increases were very small over base levels that were relatively high.

The application of kieserite increased the concentration of magnesium in leaflet and rachis tissue. Phosphorus concentration in both leaflet and rachis tissue was greater at Trial 252. Leaflet potassium levels were significantly greater at trial 252 than 251.

Table 29. Treatment main effects on leaflet nutrient concentrations in 1995 (Trial 251 and Trial 252).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.49	2.64	2.64	ns	0.079	10.5
Phosphorus	0.162	0.163	0.164	ns	0.0009	1.9
Potassium	0.78	0.80	0.80	ns	0.020	8.7
Calcium	1.18	1.14	1.15	ns	0.021	6.2
Magnesium	0.33	0.32	0.32	ns	0.010	10.4
Chlorine	0.70	0.70	0.72	ns	0.023	11.2
	K0	K1	K2			
Nitrogen	2.47	2.66	2.64	*	0.079	10.5
Phosphorus	0.161	0.163	0.164	*	0.0009	1.9
Potassium	0.62	0.86	0.89	***	0.020	8.7
Calcium	1.16	1.16	1.15	ns	0.021	6.2
Magnesium	0.39	0.30	0.28	***	0.010	10.4
Chlorine	0.64	0.73	0.75	***	0.023	11.2
	P0	P1				
Nitrogen	2.56	2.62		ns	0.064	10.5
Phosphorus	0.161	0.164		**	0.0007	1.9
Potassium	0.80	0.78		ns	0.016	8.7
Calcium	1.15	1.16		ns	0.017	6.2
Magnesium	0.33	0.32		ns	0.008	10.4
Chlorine	0.71	0.71		ns	0.019	11.2
	Mg0	Mg1				
Nitrogen	2.60	2.58		ns	0.065	10.5
Phosphorus	0.163	0.162		ns	0.0008	1.9
Potassium	0.81	0.77		ns	0.016	8.7
Calcium	1.18	1.14		*	0.017	6.2
Magnesium	0.31	0.34		**	0.008	10.4
Chlorine	0.71	0.71		ns	0.019	11.2
	Trial 251	Trial 252				
Nitrogen	2.54	2.64		ns	0.113	10.5
Phosphorus	0.161	0.165		***	0.0008	1.9
Potassium	0.75	0.82		***	0.017	8.7
Calcium	1.17	1.14		ns	0.018	6.2
Magnesium	0.32	0.32		ns	0.009	10.4
Chlorine	0.70	0.72		ns	0.020	11.2

Table 30. Treatment main effects on rachis nutrient concentrations in 1995 (Trial 251 and Trial 252).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.26	0.27	0.28	*	0.005	6.1
Phosphorus	0.080	0.069	0.072	*	0.0042	19.9
Potassium	0.88	0.81	0.75	ns	0.053	22.4
Calcium	0.50	0.50	0.52	ns	0.017	11.9
Magnesium	0.10	0.10	0.10	ns	0.009	31.0
Chlorine	0.51	0.50	0.45	*	0.025	17.6
	K0	K1	K2			
Nitrogen	0.26	0.27	0.28	*	0.005	6.1
Phosphorus	0.060	0.072	0.088	***	0.0042	19.9
Potassium	0.29	0.93	1.22	***	0.053	22.4
Calcium	0.55	0.49	0.47	**	0.017	11.9
Magnesium	0.15	0.08	0.07	***	0.009	31.0
Chlorine	0.26	0.54	0.66	***	0.025	17.6
	P0	P1				
Nitrogen	0.27	0.27		ns	0.004	6.1
Phosphorus	0.064	0.083		***	0.0034	19.9
Potassium	0.77	0.85		ns	0.043	22.4
Calcium	0.50	0.51		ns	0.014	11.9
Magnesium	0.10	0.10		ns	0.007	31.0
Chlorine	0.48	0.50		ns	0.020	17.6
	Mg0	Mg1				
Nitrogen	0.27	0.27		ns	0.004	6.1
Phosphorus	0.076	0.071		ns	0.0035	19.9
Potassium	0.85	0.78		ns	0.044	22.4
Calcium	0.51	0.50		ns	0.014	11.9
Magnesium	0.09	0.11		*	0.008	31.0
Chlorine	0.49	0.48		ns	0.020	17.6
	Trial 251	Trial 252				
Nitrogen	0.27	0.27		ns	0.004	6.1
Phosphorus	0.066	0.081		***	0.0037	19.9
Potassium	0.79	0.84		ns	0.046	22.4
Calcium	0.50	0.51		ns	0.015	11.9
Magnesium	0.11	0.09		*	0.008	31.0
Chlorine	0.50	0.47		ns	0.022	17.6

Trial 401 FACTORIAL FERTILISER TRIAL AT KAUTU PLANTATION

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Site Kapiura Estates, Kautu Plantation, Fields 1F and 1G.

Soil Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and volcanic ash.

Palms Dami commercial DxP crosses.
Planted in 1986 at 135 palms/ha.
Treatments started in May 1989.

DESIGN

There are 36 treatments, comprising all factorial combinations of N and P at three levels and K and Mg each at two levels (Table 31).

Table 31. Rates of fertiliser used in trial 401.

	Level (kg /palm/year)		
	0	1	2
Ammonium chloride	0	3	6
Triple superphosphate	0	2	4
Muriate of potash	0	3	---
Kieserite	0	3	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The ammonium chloride is split into two applications per year, while the other fertilisers are applied once per year.

There are 72 plots, each plot consisting of 36 palms (6x6), of which the central 16 are recorded. Plot isolation trenching was completed in August 1995.

The 36 treatments are replicated twice and are grouped into two blocks. The trial was designed as a 3x3x2x2x2 factorial trial, but one 'x2' factor has been left "vacant" and is regarded as replication for the time being. The "vacant" treatment will be used later. The 3 factor interaction '2x2x2' would be partially confounded with blocks. High order interactions provide the error term in the statistical analysis.

RESULTS

The average FFB yield in 1995 was 22.5 t/ha/year. The yield in 1995 was again considerably lower than in the preceding years, where in 1992 the average plot yield was 26.2 t/ha/yr in 1993 28.0 t/ha/yr and in 1994 was 23.0.

There is no yield increase due to ammonium chloride application in either the 1995 data or the cumulative data (Tables 32 and 33). There was a significant increase in the single bunch weight in 1995 due to application of ammonium chloride. Plot isolation trenches were constructed in 1995. These trenches will eliminate interplot poaching of applied nutrients so that commencing in 1996 the data should show the true fertiliser responses.

Application of kieserite did not increase FFB yield in the 1995 data but the 1993 to 1995 cumulative data shows a significant response to application of kieserite. This response to kieserite was due to an increased single bunch weight which was significant in the 1995 data but not significant in the cumulative data even though there was a large increase in bunch weight from 18.7 to 19.6 kg.

Neither triple superphosphate or muriate of potash application had any effect on yield in 1995.

Leaf and rachis samples were not analysed in 1995.

Table 32. Main effects of N, P, K and Mg on yield and yield components in 1995 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	22.2	22.9	22.5	ns	0.657	10.1
Bunches/ha	1042	1051	998	ns	32.2	10.8
Bunch weight (kg)	21.4	21.8	22.6	*	0.447	7.1
	P0	P1	P2			
Yield (t/ha/yr)	22.1	22.8	22.7	ns	0.657	10.1
Bunches/ha	994	1045	1052	ns	32.2	10.8
Bunch weight (kg)	22.3	21.8	21.7	ns	0.447	7.1
	K0	K1				
Yield (t/ha/yr)	22.3	22.7		ns	0.537	10.1
Bunches/ha	1010	1051		ns	26.3	10.8
Bunch weight (kg)	22.1	21.7		ns	0.365	7.1
	Mg0	Mg1				
Yield (t/ha/yr)	22.4	22.7		ns	0.537	10.1
Bunches/ha	1042	1018		ns	26.3	10.8
Bunch weight (kg)	21.6	22.3		*	0.365	7.1

Table 33. Main effects of N, P, K and Mg on yield and yield components for 1993 to 1995 (Trial 401).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	24.0	24.7	24.7	ns	0.399	5.6
Bunches/ha	1298	1306	1251	ns	31.1	8.4
Bunch weight (kg)	18.6	19.0	19.0	ns	0.373	6.8
	P0	P1	P2			
Yield (t/ha/yr)	23.9	24.9	24.7	ns	0.399	5.6
Bunches/ha	1242	1305	1308	ns	31.1	8.4
Bunch weight (kg)	19.4	19.1	18.9	ns	0.373	6.8
	K0	K1				
Yield (t/ha/yr)	24.2	24.8		ns	0.326	5.6
Bunches/ha	1264	1306		ns	25.4	8.4
Bunch weight (kg)	19.2	19.1		ns	0.305	6.8
	Mg0	Mg1				
Yield (t/ha/yr)	24.0	25.0		**	0.326	5.6
Bunches/ha	1289	1280		ns	25.4	8.4
Bunch weight (kg)	18.7	19.6		ns	0.305	6.8

Trial 402 FACTORIAL FERTILISER TRIAL AT BILOMI PLANTATION

PURPOSE

To provide fertiliser response information that will be useful in developing strategies for fertiliser usage.

DESCRIPTION

Site: Kapiura Estates, Bilomi Plantation, Division 2, Field 11C.

Soil: Young coarse textured freely draining soils formed on alluvially redeposited andesitic pumiceous sands and volcanic ash.

Palms: Dami commercial DxP crosses.
Planted in early 1987 at 120 palms/ha.
Treatments started in May 1990.

DESIGN

There are 36 treatments, comprising all factorial combinations of N and P at three levels and K and Mg each at two levels (Table 34).

Table 34. Rates of fertiliser used in trial 402.

	Level (kg /palm/year)		
	0	1	2
Ammonium chloride	0.0	3.0	6.0
Triple superphosphate	0.0	2.0	4.0
Muriate of potash	0.0	3.0	---
Kieserite	0.0	3.0	---
		(Tonnes/ha/yr)	
EFB	0	50	---

Note: Treatments are factorial combinations of levels of these fertilisers.

The ammonium chloride is split into two applications per year, while the other fertilisers are applied only once.

EFB applications started in mid 1993. EFB is applied with a Giltrap EFB applicator.

There are 72 plots, each plot consisting of 36 palms (6x6) of which the central 16 are recorded.

The 72 treatments are replicated once and are grouped into two blocks. The 3 factor interaction '2x2x2' would be partially confounded with blocks. High order interactions provide the error term in the statistical analysis.

RESULTS

The average plot yield in 1995 was 23.1 t/ha/year. The 1995 average plot yield was lower than in the preceding three years. In 1992 the average plot yield was 31.0 t/ha/yr in 1993 was 28.2 t/ha/yr and in 1994 was 25.7 t/ha/yr. The reasons for the decline in plot yield in this trial are not known for certain but may have been as a result of the high rates of application of EFB.

Ammonium chloride application increased the single bunch weight in 1995 (Table 35) and in the cumulative data for 1993-95 (Table 36).

Application of EFB started in mid 1993. Although the trial plan states that EFB would be applied at a rate of 50t/ha, the plantation practice in 1994 an 1995 was to apply almost 120 tonnes of EFB per hectare. Applying this much organic matter has most probably led to a reduction in yield as the large quantity of organic matter would most likely have tied up much of the applied nitrogen fertiliser. Anaerobic conditions would also have been created which would have limited root growth and uptake of nutrients.

Table 35. Main effects of N, P, K and Mg on yield and yield components in 1995 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	23.2	22.6	23.5	ns	0.754	11.3
Bunches/ha	1114	1065	1053	ns	43.5	14.0
Bunch weight (kg)	20.9	21.3	22.5	**	0.422	6.8
	P0	P1	P2			
Yield (t/ha/yr)	23.3	23.0	23.1	ns	0.754	11.3
Bunches/ha	1099	1061	1072	ns	43.5	14.0
Bunch weight (kg)	21.2	21.8	21.6	ns	0.422	6.8
	K0	K1				
Yield (t/ha/yr)	22.8	23.4		ns	0.615	11.3
Bunches/ha	1077	1078		ns	35.5	14.0
Bunch weight (kg)	21.3	21.8		ns	0.345	6.8
	Mg0	Mg1				
Yield (t/ha/yr)	23.2	23.0		ns	0.615	11.3
Bunches/ha	1080	1074		ns	35.5	14.0
Bunch weight (kg)	21.6	21.6		ns	0.345	6.8
	EFB0	EFB1				
Yield (t/ha/yr)	22.8	23.4		ns	0.615	11.3
Bunches/ha	1069	1086		ns	35.5	14.0
Bunch weight (kg)	21.4	21.7		ns	0.345	6.8

Table 36. Main effects of N, P, K and Mg on yield and yield components from 1993 to 1995 (Trial 402).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	25.2	25.8	26.1	ns	0.477	6.4
Bunches/ha	1514	1490	1477	ns	35.1	8.1
Bunch weight (kg)	16.7	17.3	17.7	**	0.254	5.1
	P0	P1	P2			
Yield (t/ha/yr)	25.5	25.9	25.6	ns	0.477	6.4
Bunches/ha	1505	1494	1482	ns	35.1	8.1
Bunch weight (kg)	17.0	17.4	17.3	ns	0.254	5.1
	K0	K1				
Yield (t/ha/yr)	25.5	25.9		ns	0.389	6.4
Bunches/ha	1500	1488		ns	28.6	8.1
Bunch weight (kg)	17.0	17.4		ns	0.207	5.1
	Mg0	Mg1				
Yield (t/ha/yr)	25.7	25.7		ns	0.389	6.4
Bunches/ha	1500	1487		ns	28.6	8.1
Bunch weight (kg)	17.2	17.3		ns	0.207	5.1
	EFB0	EFB1				
Yield (t/ha/yr)	25.4	25.9		ns	0.389	6.4
Bunches/ha	1470.0	1517.0		ns	28.6	8.1
Bunch weight (kg)	17.3	17.2		ns	0.207	5.1

Leaf and rachis samples were not analysed in 1995.

II SMALLHOLDER DEMONSTRATION TRIALS.

ISLANDS REGION

(G. King)

Trial 128 **BENCHMARK/DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS IN THE HOSKINS SCHEME.**

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Site Experiment 128 is located on OPIC's Hoskins Smallholder Oil Palm Project (Figure 5) covering areas west (Dire) and to the east (Galilo/Galai areas) of Kimbe town. The 28 blocks selected in pairs are located at Dire, Sarakolok, Tamba, Kapore, Kavui, Buvussi, Mai, Siki, Kwalakesi and Kavutu. At Kavui and Buvusi there are 2 and 3 pairs respectively. Demonstration trials have also been established at Moramora Vocational School, Hoskins Secondary School and Ponini Vocational Centre. Details of each block are given in Table 38.

Palms Dami commercial DxP planting material.
Planted in various dates the between 1980 and 1990 at 120 palms/ha.
Treatments started in July 1994.

DESIGN

Each of the 2 paired smallholder blocks provide a single replicate. There are three treatments (Table 37). With the first pair, half of the block will receive no fertiliser at all (control) and the remaining half receive the recommended (demonstration) type and amount of fertiliser for the smallholder. With the second pair, half of the block will again receive no fertiliser at all (control), and the remaining half will receive a generous amounts (2kg) of <u>all</u> main types (N, P, K, MG) of fertiliser. At the school blocks all three treatments are included in the one block.

Table 37: Treatments used in Trial 128

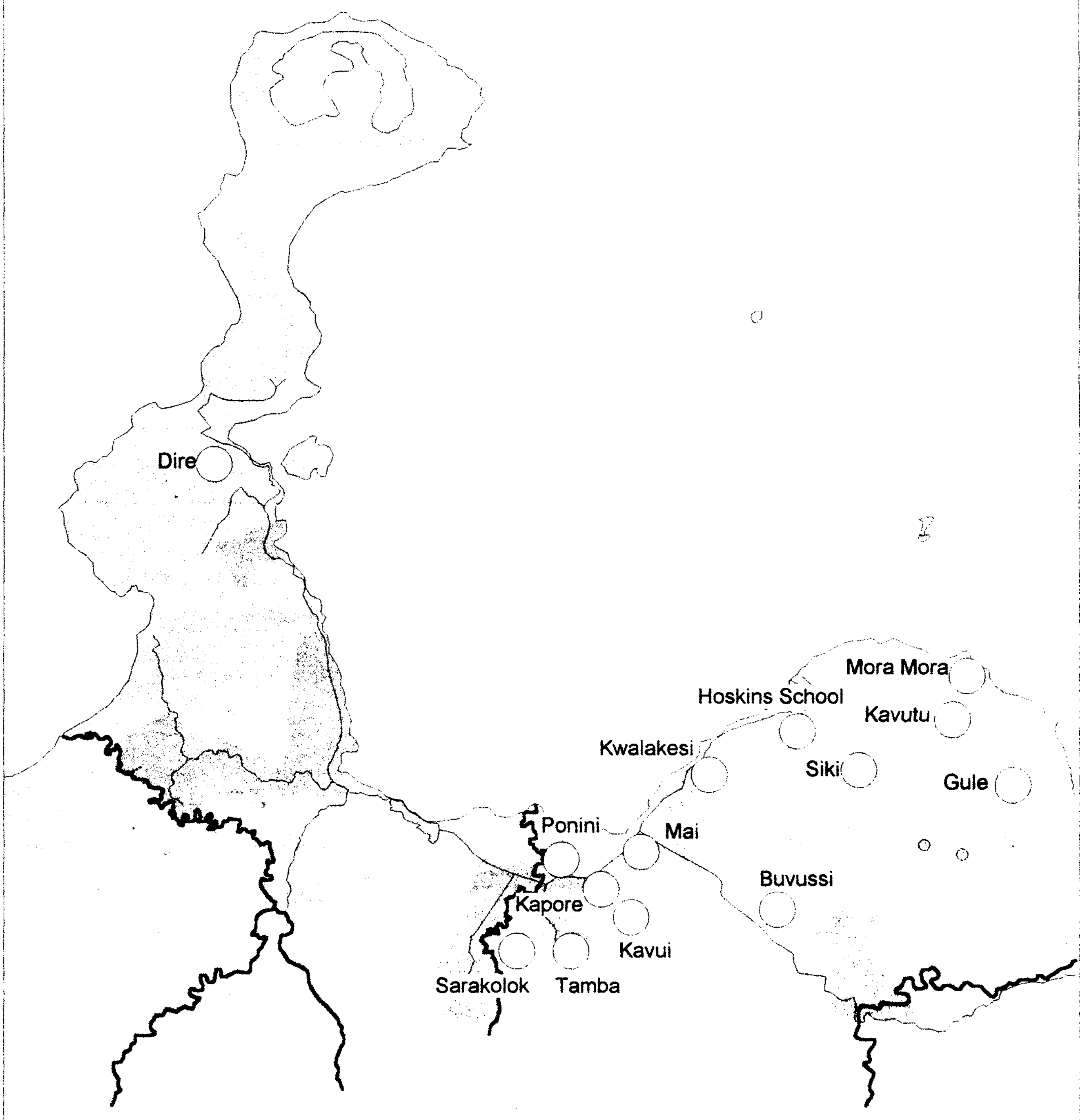
	Type of Fertiliser (kg/palm/year)			
Treatment Colour Code	Ammonium Chloride	Triple Superphosphate	Muriate of Potash	Kieserite
Red	0	0	0	0
Yellow	2	0	0	0
White	2	2	2	2

Fertiliser is applied twice a year in May and November. The whole block is harvested in the normal way by the block owner but the bunches from each treatment are put in separate nets and the weight of the nets from each colour code are recorded on the docket at the time of pick up. The OPRA recorders count the number of bunch stalks cut from each treatment. Frond 17 leaflet and rachis samples were not analysed in 1995.

Table 38. Details of 28 smallholder demonstration blocks in the Hoskins Smallholder Oil Palm Project areas of West New Britain Province in 1995.

Division	Sect	Owner	Block Number	Number of Palms		
				Red	Yellow	White
Kapore	3	H.T. Towakaken	010306	226	227	
Kapore	3	Joseph Pochei	010307	97		93
Tamba	2	A.T.T. Taul	20413	206	365	
Tamba	2	Hambakman	20414	250		240
Tamba	9	Usini Embi	20555	235		197
Tamba	9	Esther Sakius	20556	199	308	
Sarakolok	5	Gima Bagera	30922	268	153	
Sarakolok	5	M. Hendry	30923	268		273
Buvussi	6	Gumagoi Dogoba	41160	250		227
Buvussi	6	Dombul Dekemba	41161	233	345	
Buvussi	5	Wamenvok Holbini	41193	376	332	
Buvussi	5	Vincent Kalaivi	41194	414		326
Buvussi	1	Simon Oleiuba	41399	341	353	
Buvussi	1	Wai Aure	41418	238		566
Kavui	5	K. Tobubu	61682	214		165
Kavui	5	T. Tamaia	61681	177	296	
Kavui	8	Madau Tonatonok	61701	343	382	
Kavui	8	T. Todaungu	61702	358		344
Kwalakesi	VOP	Uba Kilu	130002	234	185	
Kwalakesi	VOP	Dominica Kaipu	130012	121		100
Mai	VOP	Kulu Kuba	140019	120		112
Mai	VOP	Kenda Tavaperry	140091	130	106	
Kavutu	VOP	Peter Magiap	330012	120		111
Kavutu	VOP	Misibil Irima	330037	109	122	
		Moramora Vocational				
		Hoskins Secondary				
		Ponini Vocational				
Siki	LSS	Trial Abandoned				
Siki	LSS	Trial Abandoned				
Dire	VOP	Trial Abandoned				
Dire	VOP	Trial Abandoned				

Figure 5: Distribution of smallholder demonstration sites in the Hoskins scheme, West New Britain.



RESULTS

Table 39: Yield results for Trial 128 in 1995

Division	Sect	Block No.	No months harvesting recorded	Calculated Yield (t/ha/yr)			Actual Yield (t/ha/yr)
				Control	N only	NPKMg	
Kapore	3	10306	10	10.8	12.1		13.7
Kapore	3	10307	9	16.9		18.9	28.8
Tamba	2	20413	6	17.4	12.1		18.0
Tamba	2	20414	7	10.7		13.9	20.5
Tamba	5	20555	8	7.2		6.4	20.4
Tamba	5	20556	9	8.5	10.1		16.5
Sarakolok	5	30922	0	-	-		14.8
Sarakolok	5	30923	8	7.6		12.4	13.8
Buvussi	6	41160	0	-		-	22.0
Buvussi	6	41161	8	9.5	15.3		19.6
Buvussi	5	41193	7	4.5	16.4		17.4
Buvussi	5	41194	6	8.3		10.6	14.9
Buvussi	1	41399	5	8.1	10.5		15.8
Buvussi	1	41418	5	7.6		13.5	15.0
Kavui	5	61681	7	25.6	12.4		40.5
Kavui	5	61682	7	20.8		43.3	30.6
Kavui	8	61701	6	7.3	8.9		18.6
Kavui	8	61702	6	9.4		10.5	14.4
Kwalakesi	VOP	130002	5	5.4		17.3	12.2
Kwalakesi	VOP	130012	5	8.3	6.2		17.8
Mai	VOP	140019	7	13.2		12.6	20.0
Mai	VOP	140091	5	12.5	12.9		13.0
Kavutu	VOP	330012	6	4.3		10.4	12.1
Kavutu	VOP	330037	6	18.5	20.9		21.8
			Mean	11.0	12.5	15.4	20.0
			Maximum	25.6	20.9	43.3	40.5
			Minimum	4.3	6.1	6.4	8.9
			s.e.	1.19	1.19	2.97	1.19

Yield recording commenced in most blocks in July 1995 and the calculated yields given above have been extrapolated to a full 12 month period (Table 39). In most cases the number of bunches harvested was recorded but the recording of bunch weights was unsatisfactory. It has proven to be very difficult to ensure that the fruit truck drivers record the colour coding of the nets on the delivery docket. The calculated yield figures given above should therefore be treated with some caution. The actual yields are derived from the field weights recorded by the processing company.

Due to land disputes in the Talasea area the trial blocks at Dire have been abandoned. The Siki trial blocks have been abandoned due to lack of cooperation by the smallholders concerned. Block 30922 at Sarakolok is owned by a teacher who has been transferred to Bali Island and the block is being maintained by a wantok who harvests infrequently. Block 41160 at Buvussi was harvested regularly and bunch numbers were recorded for each harvest but yields could not be extrapolated from the data as weights were not recorded for any harvest in 1995. No yields were recorded in any of the school trials in 1995.

Trial 210 **BENCHMARK/DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER APPLICATION ON OIL PALM SMALLHOLDINGS IN THE BIALLA SCHEME**

PURPOSE

To determine if there is a requirement for fertiliser input and if so determine the type of fertiliser required. To demonstrate that good agronomic management and correct use of fertilisers can increase or maintain relatively high levels of FFB production.

DESCRIPTION

Site Experiment 210 is located on OPIC's Bialla Smallholder Oil Palm Project (Figure 6) covering areas between Mamota and NBPOD's Kapiura Plantations Pty Ltd in the west to Noau and Hargy's Navo Plantation east of Bialla township. The twelve selected blocks in pairs are located at Lavege, Bereme, Silanga, Matililiu and Noau (Table 41).

Palms Dami commercial DxP planting material.
Planted in various dates the between 1984 and 1991 at 120 palms/ha.
Treatments started in July 1994.

DESIGN

Each of the 2 paired smallholder blocks provide a single replicate. There are three treatments (Table 40). With the first pair, half of the block will receive no fertiliser at all (control) and the remaining half receive the recommended (demonstration) type and amount of fertiliser for the smallholder. With the second pair, half of the block will again receive no fertiliser at all (control), and the remaining half will receive a generous amounts (2kg) of all main types (N, P, K, MG) of fertiliser.

Table 40: Treatments used in Trial 128

	Type of Fertiliser (kg/palm/year)			
Treatment Colour Code	Ammonium Chloride	Triple Superphosphate	Muriate of Potash	Kieserite
Red	0	0	0	0
Yellow	2	0	0	0
White	2	2	2	2

Fertiliser is applied twice a year in May and November. The whole block is harvested in the normal way for a smallholder block and the weight of the fruit recorded by the transport company in each project at the time of pick up. Leaflets and rachis of frond 17 were sampled in 1995. Pick up of fruit (FFB) by Hargy's Transport Company and Kapiura Plantations Transport Division started in July with assistance from OPIC.

Figure 6: Distribution of smallholder demonstration sites in the Bialla scheme, West New Britain.

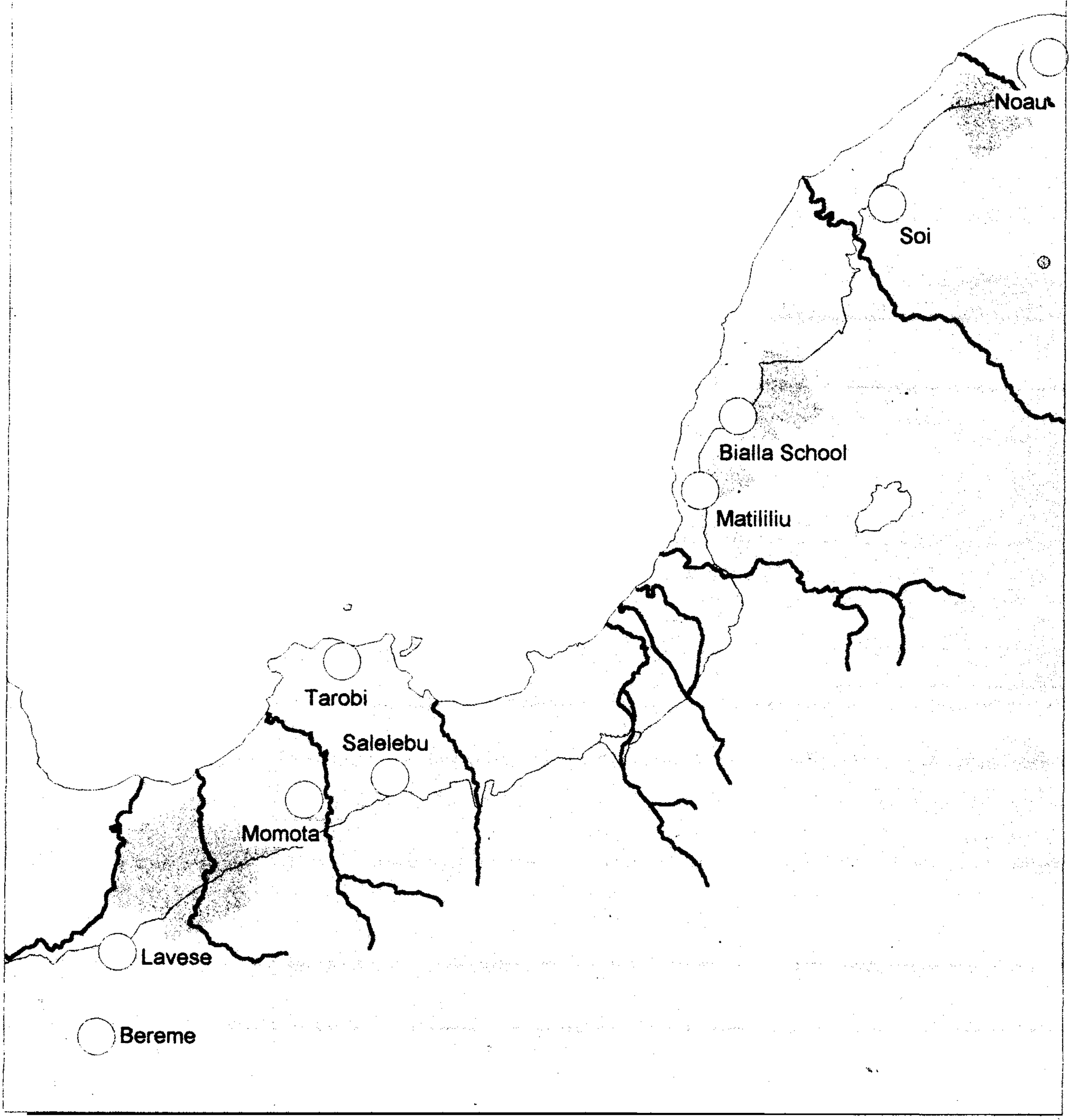


Table 41. Details of 28 smallholder demonstration blocks in the Bialla Smallholder Oil Palm Project areas of West New Britain Province in 1995.

Division	Sect	Owner	Block Number	Number of Palms		
				Red	Yellow	White
Bereme	VOP	Leo Lusi	254-04	79		96
Bereme	VOP	Mathais Avu	254-09	97		93
Lavege	VOP	Emmanuel Moli	251-33	119		85
Lavege	VOP	Albert Vua	251-30	117	114	
Mamota	LSS	Maria Soima	240-0912-8	214		247
Mamota	LSS	Thomas Tingairo	240-0921-8	220	256	
Tarobi	VOP	Francis Lowa	257-023	110		146
Tarobi	VOP	Alphonse Tovili	257-07	108	121	
Salelebu	LSS	Samson Nata	240-447	153		138
Salelebu	LSS	Lou Ruku	240-450	115	114	
Noau	VOP	Enoch Volele	0723	108		129
Noau	VOP	P. Malila	0714	116	116	
Soi	10	Raphael Moute	1653	125		126
Soi	10	Jan Moris	1651	124	120	
Matililiu	VOP	Raiman Vilale	1705	266		267
Matililiu	VOP	Mauli Vilale	1707	114	115	
		Bialla High School	13	99	120	120

RESULTS

1995 yield results for Trial 210 are given in Table 42.

Table 42: Yield results for Trial 210 in 1995

Division	Sect	Block No.	No months harvesting recorded	Calculated Yield (t/ha/yr)			Actual Yield (t/ha/yr)
				Control	N only	NPKMg	
Bereme	VOP	254-04	4	5.7		3.5	11.3
Bereme	VOP	254-09	3	4.8	8.8		8.9
Lavege	VOP	251-33	5	28.0		42.4	24.4
Lavege	VOP	251-30	4	14.9	6.5		25.8
Mamota	LSS	240-0912-8	6	16.7		21.1	33.2
Mamota	LSS	240-0921-8	6	21.2	21.6		35.3
Tarobi	VOP	257-023	7	23.9		25.7	24.1
Tarobi	VOP	257-07	7	15.3	13.3		20 3
Salelebu	LSS	240-447	0	-	-		-
Salelebu	LSS	240-450	0	-		-	-
Noau	VOP	0723	12	18.7		16.9	17.2
Noau	VOP	0714	12	12.5	14.5		13.7
Soi	10	1653	3	15.8		19.5	14.0
Soi	10	1651	0	-	-		-
Matililiu	VOP	1705	11	18.1	20.9		22.7
Matililiu	VOP	1707	11	25.3		28.5	23.2
Bialla H.S.		13	10	11.3	30.2	16.1	33.0
			Mean	16.6	16.5	21.7	21.9
			Maximum	28.0	30.2	42.4	35.3
			Minimum	4.8	6.5	3.5	8.9
			s.e.	1.81	3.11	3.97	2.22

Yield recording commenced in most blocks in 1995 and the yields given above have been extrapolated to a full 12 month period. In most cases the number of bunches harvested was recorded but the recording of bunch weights was unsatisfactory. As with Trial 128 it has proven to be very difficult to ensure that the fruit truck drivers record the colour coding of the nets on the delivery docket. The calculated yield figures given above should therefore be treated with some caution. The actual yields are derived from the field weights recorded by the processing companies.

The two blocks at Salelebu were established in 1995 and the first fertiliser applications were made in November 1995. Yield recording on these blocks will commence in 1996. Block 1651 at Soi was planted in 1994 and had not commenced bunch production in 1995.

Tissue sampling was completed in August 1995 and the results are given in the following tables.

Table 43. Leaflet nutrient concentrations (% on dry matter) from Control Plots in 1995 (Trial 210).

Block	Ash	N	P	K	Ca	Mg	Cl
254-04	12.14	2.35	0.146	1.12	0.91	0.29	0.18
254-09	13.21	2.12	0.139	1.03	1.03	0.20	0.23
251-33	14.55	1.90	0.126	0.87	0.80	0.18	0.08
251-30	15.09	1.73	0.108	0.69	1.21	0.16	0.20
240-0912-8	14.07	2.47	0.156	0.97	0.96	0.17	0.23
240-0921-8	12.63	2.45	0.143	1.03	0.89	0.15	0.16
257-023	15.21	1.92	0.119	0.83	0.83	0.14	0.11
257-07	12.32	2.55	0.151	0.89	0.98	0.17	0.49
0723	14.13	2.19	0.135	0.93	0.96	0.30	0.32
0714	13.03	2.29	0.137	0.73	1.07	0.24	0.52
1653	11.91	2.56	0.152	0.97	0.99	0.26	0.36
1651	9.71	2.37	0.151	1.26	0.86	0.36	0.08
1705	13.69	2.12	0.130	0.97	0.76	0.17	0.14
1707	14.9	1.99	0.130	0.83	0.88	0.17	0.13
13	14.84	2.45	0.155	0.95	0.89	0.12	0.25
Mean	13.43	2.23	0.139	0.94	0.93	0.21	0.23
Maximum	15.21	2.56	0.156	1.26	1.21	0.36	0.52
Minimum	9.71	1.73	0.108	0.69	0.76	0.12	0.08
s.e	0.392	0.67	0.0036	0.037	0.029	0.017	0.035

Table 44. Leaflet nutrient concentrations (% on dry matter) from Nitrogen only Plots in 1995 (Trial 210).

Block	Ash	N	P	K	Ca	Mg	Cl
254-09	11.79	2.55	0.154	1.05	0.90	0.23	0.43
251-30	13.20	1.88	0.120	0.83	1.12	0.26	0.21
240-0912-8	14.89	2.00	0.122	0.83	0.80	0.17	0.17
257-07	13.46	2.15	0.128	0.83	0.86	0.17	0.41
0723	13.21	2.35	0.134	0.89	0.97	0.24	0.47
1651	9.02	2.55	0.151	1.01	1.02	0.29	0.50
1705	14.43	1.97	0.132	0.79	0.86	0.17	0.32
13	13.99	2.39	0.146	0.97	0.75	0.16	0.26
Mean	12.99	2.23	0.136	0.90	0.91	0.21	0.35
Maximum	14.89	2.55	0.154	1.05	1.12	0.29	0.50
Minimum	9.02	1.88	0.120	0.79	0.75	0.16	0.17
s.e.	0.657	0.094	0.0046	0.034	0.043	0.018	0.044

Table 45. Leaflet nutrient concentrations (% on dry matter) from N,P,K,Mg Plots in 1995 (Trial 210).

Block	Ash	N	P	K	Ca	Mg	Cl
254-04	11.83	2.49	0.150	0.97	1.09	0.27	0.57
251-33	13.86	2.11	0.125	0.71	0.75	0.14	0.35
240-0921-8	13.08	2.43	0.152	0.95	0.94	0.19	0.30
0714	13.89	1.90	0.122	0.79	0.92	0.31	0.29
1653	11.42	2.65	0.158	0.87	1.06	0.32	0.58
1707	12.95	2.30	0.130	0.81	0.86	0.18	0.44
13	12.86	2.45	0.138	0.89	0.83	0.16	0.40
Mean	12.84	2.33	0.139	0.86	0.92	0.22	0.42
Maximum	13.89	2.65	0.158	0.97	1.09	0.32	0.58
Minimum	11.42	1.90	0.122	0.71	0.75	0.14	0.29
s.e.	0.354	0.095	0.005	0.035	0.046	0.028	0.045

Table 46. Rachis nutrient concentrations (% on dry matter) from Control Plots in 1995 (Trial 210).

Block	Ash	N	P	K	Ca	Mg	Cl
254-04	3.52	0.24	0.044	1.16	0.30	0.04	0.09
254-09	3.46	0.22	0.049	1.01	0.40	0.04	0.10
251-33	3.41	0.20	0.081	1.20	0.27	0.03	0.02
251-30	3.60	0.20	0.033	1.07	0.48	0.04	0.08
240-0912-8	4.31	0.25	0.079	1.42	0.47	0.05	0.42
240-0921-8	4.08	0.25	0.079	1.42	0.39	0.04	0.12
257-023	3.51	0.20	0.030	1.14	0.32	0.03	0.06
257-07	4.79	0.24	0.052	1.52	0.53	0.04	0.35
0723	3.74	0.21	0.030	1.16	0.39	0.05	0.17
0714	3.53	0.20	0.033	1.14	0.37	0.08	0.18
1653	3.66	0.25	0.051	1.14	0.52	0.07	0.48
1651	3.09	0.23	0.048	1.16	0.31	0.05	0.02
1705	3.34	0.20	0.030	1.14	0.39	0.04	0.05
1707	4.08	0.21	0.052	1.34	0.41	0.04	0.36
13	4.27	0.24	0.081	1.24	0.50	0.03	0.12
Mean	3.76	0.22	0.051	1.22	0.40	0.04	0.17
Maximum	4.79	0.25	0.081	1.52	0.53	0.08	0.48
Minimum	3.09	0.20	0.030	1.01	0.27	0.03	0.02
s.e.	0.117	0.005	0.005	0.037	0.021	0.003	0.039

Table 47. Rachis nutrient concentrations (% on dry matter) from Nitrogen only Plots in 1995 (Trial 210).

Block	Ash	N	P	K	Ca	Mg	Cl
254-09	4.11	0.26	0.057	1.47	0.45	0.06	0.57
251-30	3.85	0.21	0.037	1.16	0.37	0.04	0.08
240-0912-8	4.12	0.24	0.040	1.20	0.39	0.04	0.21
257-07	3.33	0.20	0.034	1.14	0.29	0.03	0.07
0723	3.66	0.22	0.029	1.18	0.44	0.07	0.49
1651	2.54	0.27	0.050	0.75	0.46	0.07	0.21
1705	3.58	0.21	0.027	1.10	0.31	0.03	0.14
13	3.40	0.24	0.054	1.14	0.39	0.04	0.09
Mean	3.57	0.23	0.041	1.14	0.39	0.05	0.23
Maximum	4.12	0.27	0.057	1.47	0.46	0.07	0.57
Minimum	2.54	0.20	0.027	0.75	0.29	0.03	0.07
s.e.	0.181	0.009	0.004	0.069	0.022	0.006	0.068

Table 48. Rachis nutrient concentrations (% on dry matter) from N,P,K,Mg Plots in 1995 (Trial 210).

Block	Ash	N	P	K	Ca	Mg	Cl
254-04	4.08	0.26	0.048	1.24	0.41	0.05	0.32
251-33	3.60	0.23	0.075	1.16	0.38	0.03	0.25
240-0921-8	4.35	0.25	0.046	1.52	0.37	0.03	0.07
25702	3.84	0.24	0.080	1.22	0.37	0.05	0.15
0714	3.80	0.23	0.052	1.28	0.44	0.06	0.55
1653	3.78	0.23	0.039	1.03	0.48	0.07	0.20
1707	3.86	0.20	0.031	1.24	0.35	0.03	0.06
13	3.59	0.26	0.059	1.16	0.36	0.04	0.20
Mean	3.86	0.24	0.054	1.23	0.40	0.05	0.23
Maximum	4.35	0.26	0.080	1.52	0.48	0.07	0.55
Minimum	3.59	0.20	0.031	1.03	0.35	0.03	0.06
s.e.	0.088	0.007	0.005	0.049	0.016	0.005	0.056

Table 49: Mean leaflet and rachis nutrient concentrations from all plots (Trial 210)

Treatment	Ash	N	P	K	Ca	Mg	Cl
Control Leaflet	13.43	2.23	0.139	0.94	0.93	0.21	0.23
Nitrogen only leaflet	12.99	2.23	0.136	0.90	0.91	0.21	0.35
N,P,K,Mg Leaflet	12.84	2.33	0.139	0.86	0.92	0.22	0.42
Control Rachis	3.76	0.22	0.051	1.22	0.40	0.04	0.17
Nitrogen only Rachis	3.57	0.23	0.041	1.14	0.39	0.05	0.23
N,P,K,Mg Rachis	3.86	0.24	0.054	1.23	0.40	0.05	0.23

Table 49 shows that the addition of ammonium chloride has resulted in an increase in leaflet and rachis chlorine. Leaflet nitrogen increased with the addition of all four fertilisers.

Trial 253: **BENCHMARK/DEMONSTRATION OF RECOMMENDED MANAGEMENT AND FERTILISER PRACTICES ON OIL PALM SMALLHOLDINGS IN THE NEW IRELAND SCHEME.**

PURPOSE

To carry out basic investigations into requirement for fertiliser input in smallholdings and if so determine the type of fertiliser required. This is a missing element trial on village oil palm.

DESCRIPTION

Sites. Experiment 253 is located on OPIC's New Ireland Smallholder Oil Palm The two blocks in which the trials have been established are located at Lossu at South village oil palm (VOP), and Paruai in the North VOP area. Both these blocks are on the east coast of New Ireland.

Palms Dami commercial DxP crosses.
Planted in 1992/93.

DESIGN

Each smallholder block provides a single replicate consisting of 2 hectares. Within this 2 ha there are 6 different treatments in 6 plots (Table 50). The fertiliser types and rates used are given in Table 51.

Table 50: Fertiliser types used in Trial 253.

Fertiliser type	Plot Nº	Treatment
AS + TSP + MOP + KIE	1	Complete: N+P+K+Mg
TSP + MOP + KIE	2	Complete minus N
AS + MOP + KIE	3	Complete minus P
AS + TSP + KIE	4	Complete minus K
AS + TSP + MOP	5	Complete minus Mg
NIL	6	NIL

AS = ammonium sulphate,
TSP = triple superphosphate,
MOP = muriate of potash,
KIE = kieserite

Table 51: Rates of fertiliser applied in Trial 253.

Treatment	Amount of fertiliser (kg/palm/yr)			
	Ammonium Sulphate	Triple Superphosphate	Muriate of Potash	Kieserite
1	2	2	2	2
2	0	2	2	2
3	2	0	2	2
4	2	2	0	2
5	2	2	2	0
6	0	0	0	0

Fertiliser application currently follows plantation (Poliamba Pty Ltd) practice. The whole block is harvested in the normal way for a smallholder block and the weight of the fruit is recorded by OPRA. Leaflets and rachis of frond 17 are sampled each year.

The palms did not start bearing fruit in 1995.

The results of tissue sampling carried out in July 1995 are given in Table 52 for leaflet and Table 53 for rachis.

Table 52: Leaflet nutrient content in Trial 253 in 1995.

Site	Treatment	Ash	N	P	K	Ca	Mg	Cl
Paruai	N,P,K,Mg	6.94	1.97	0.125	0.83	0.76	0.47	0.84
	- N	7.00	1.47	0.104	0.79	0.73	0.52	0.79
	- P	6.23	1.79	0.081	0.83	0.60	0.47	0.73
	- K	5.79	1.73	0.117	0.49	0.66	0.55	0.70
	- Mg	5.96	1.99	0.119	0.79	0.65	0.47	0.77
	Nil	5.84	1.39	0.091	0.65	0.63	0.47	0.59
Lossu	N,P,K,Mg	6.64	2.72	0.158	0.75	1.16	0.41	0.98
	- N	8.19	2.58	0.169	0.79	1.24	0.35	0.81
	- P	7.00	2.61	0.159	0.85	1.30	0.35	0.97
	- K	7.78	2.71	0.164	0.41	1.25	0.45	0.78
	- Mg	6.93	2.71	0.162	0.81	1.31	0.33	0.98
	Nil	7.78	2.51	0.168	0.45	1.32	0.44	0.72

The palms at the Paruai site were planted on Kunai whereas the palms at Lossu were planted in an area of old garden land. At both sites leaflet K was very low in the minus K and control plots. Leaflet nitrogen increased with the application of ammonium sulphate but at Paruai nitrogen levels are still very low. At the Paruai site phosphorus levels are very low and addition of triple super phosphate has increased leaflet phosphorus levels.

The analysis of rachis given in Table 53 also demonstrates that potassium levels are very low. Rachis N and P are very low in the minus P plot at Paruai indicating that phosphorus is limiting at this site.

Table 53: Rachis nutrient content in Trial 253 in 1995.

Site	Treatment	Ash	N	P	K	Ca	Mg	Cl
Paruai	N,P,K,Mg	2.18	0.19	0.039	0.73	0.24	0.12	0.45
	- N	2.39	0.19	0.029	0.75	0.25	0.18	0.64
	- P	2.17	0.07	0.014	0.69	0.19	0.17	0.33
	- K	1.57	0.24	0.029	0.12	0.22	0.21	0.20
	- Mg	2.07	0.27	0.036	0.56	0.20	0.18	0.39
	Nil	1.74	0.20	0.016	0.49	0.17	0.14	0.34
Lossu	N,P,K,Mg	2.43	0.30	0.063	0.56	0.40	0.14	0.51
	- N	2.81	0.30	0.060	0.75	0.48	0.12	0.71
	- P	2.44	0.27	0.057	0.52	0.56	0.10	0.47
	- K	2.87	0.29	0.079	0.10	0.69	0.34	0.54
	- Mg	2.68	0.32	0.060	0.45	0.54	0.12	0.50
	Nil	2.91	0.32	0.091	0.10	0.74	0.34	0.49

III. AGRONOMY AND SMALLHOLDER TRIALS

MAINLAND PROVINCES

(A. T. Oliver)

Trial 305 FERTILISER TRIAL AT AREHE ESTATE

PURPOSE

To provide information about the responses of oil palm to fertiliser that will be used in making fertiliser recommendations on Higaturu soils.

DESCRIPTION

Site Arehe Estate block 78F

Soil Higaturu family. Deep sandy clay loam with good drainage, derived from volcanic ash.

Palms Dami commercial DxP crosses. Planted in 1978 at 130 palms/ha.
Trial started in 1981.

DESIGN

There are 72 plots, each with a core of 16 palms. The numbers and weights of bunches from each individual core palm are recorded at intervals of 14 days In each plot the core palms are surrounded by at least one guard row, which is also trenched.

The 72 plots are divided into two replicates of 36. In each replicate there are 36 treatment combinations, made up from all combinations of three levels each of N and K, and two levels each of P and Mg (Table 54).

Table 54. Types of fertiliser and amounts used in Trial 305.

	Level (kg/palm/year		
	0	1	2
Sulphate of ammonia	0.0	2.0	4.0
Triple Superphosphate	0.0	2.0	
Muriate of potash	0.0	2.0	4.0
Kieserite	0.0	1.0	

RESULTS

There was a statistically significant increase in FFB yield in 1995 caused by application sulphate of ammonia (Table 55). Sulphate of ammonia increased average yields by eight tonnes in 1995, from 20.3 t FFB/ha/yr to 28.7 t FFB/ha/yr with 4 kg of sulphate of ammonia per annum. An increase of 3 tonnes was obtained with only 2 kg of sulphate of ammonia per palm. Over the 8 year period, 1987 to 1995, the average FFB yield was increased by 11 tonnes with 4 kg of sulphate of ammonia (Table 56). A increase of 8 tonnes was obtained with application 2 kg of sulphate of ammonia per palm per year. The increase in yield resulted from an increase in both bunch numbers and single bunch weight.

There was a significant increase in single bunch weight caused by application of muriate of potash, but this did not have any effect on the FFB yield. The absence of a response to Triple Superphosphate and Kieserite application had continued.

The results for the period 1987 to 1995 (Table 56) show a similar trend.

Table55. Main effects of N, P, K, and Mg on yield and yield components in 1995 (Trial 305).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	20.3	24.2	28.7	***	1.01	14.4
Bunches/ha	887	910	1085	***	36	13.3
Bunch weight (kg)	22.7	26.7	26.5	***	0.62	8.5
	P0	P1				
Yield (t/ha/yr)	24.1	24.7		ns	0.83	14.4
Bunches/ha	951	971		ns	30	13.3
Bunch weight (kg)	25.2	25.4		ns	0.51	8.5
	K0	K1	K2			
Yield (t/ha/yr)	23.4	25.1	24.7	ns	1.01	14.4
Bunches/ha	994	947	942	ns	36	13.3
Bunch weight (kg)	23.4	26.4	26.0	***	0.625	8.5
	Mg0	Mg1				
Yield (t/ha/yr)	25.0	23.8		ns	0.83	14.4
Bunches/ha	988	934		ns	30	13.3
Bunch weight (kg)	25.1	25.5		ns	0.51	8.5

Table 56. Main effects of N,P,K and Mg on yield and yield components in 1987 - 1995 (Trial 305)

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	20.7	28.2	31.7	***	1.01	13.1
Bunches/ha	949	28.2	31.7	***	36	11.4
Bunch weight (kg)	21.6	25.0	25.1	***	0.57	8.2
	P0	P1				
Yield (t/ha/yr)	26.6	27.2		ns	0.83	13.1
Bunches/ha	1104	1127		ns	30	11.4
Bunch weight (kg)	23.9	23.9		ns	0.46	8.2
	K0	K1	K2			
Yield (t/ha/yr)	25.7	27.7	27.2	ns	1.01	13.1
Bunches/ha	1156	1103	1087	ns	36	11.4
Bunch weight (kg)	22.1	24.9	24.8	ns	0.57	8.2
	Mg0	Mg1				
Yield (t/ha/yr)	27.2	26.6		ns	0.83	13.1
Bunches/ha	1131	1099		ns	30	11.4
Bunch weight (kg)	23.8	24.0		ns	0.46	8.2

Sulphate of ammonia applications had a significant effect on the concentration of nitrogen in the leaflet and rachis tissue in 1995 (Table 57 and 58). There was also a significant increase in leaf phosphorus as a result of sulphate of ammonia application. The nitrogen concentrations in the leaflet tissues is typical of those seen from the routine tissue sampling and analysis at Sangara. Despite the low leaflet nitrogen level of 2.16% observed with treatments receiving 4 kg sulphate of ammonia per palm per year, an average yield of 28 t/ha was achieved.

Muriate of potash decreased leaflet potassium concentration and increased rachis potassium. The calcium and chlorine concentrations in plant tissue were also increased by application of muriate of potash. A similar responses is seen on the volcanic soils of the PNG Islands region.

Triple Superphosphate application increased phosphorus concentrations in both the leaflet and rachis tissue. The application of Kieserite significantly reduced calcium levels in the leaflet.

Table 57. Main effects of N, P, K, and Mg on leaflet nutrient in 1995 (Trial 305).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.04	2.05	2.16	***	0.03	5.1
Phosphorus	0.130	0.128	0.131	*	0.001	3.5
Potassium	0.76	0.74	0.74	ns	0.016	7.3
Calcium	0.65	0.65	0.64	ns	0.013	6.9
Magnesium	0.16	0.17	0.16	ns	0.005	13.6
Chlorine	0.36	0.35	0.33	ns	0.015	15.4
	P0	P1				
Nitrogen	2.07	2.10		ns	0.025	5.1
Phosphorus	0.128	0.132		***	0.001	3.5
Potassium	0.75	0.74		ns	0.013	7.3
Calcium	0.65	0.65		ns	0.01	6.9
Magnesium	0.17	0.16		ns	0.005	13.6
Chlorine	0.33	0.36		*	0.012	15.4
	K0	K1	K2			
Nitrogen	2.08	2.15	2.03	***	0.03	5.1
Phosphorus	0.131	0.132	0.128	**	0.001	3.5
Potassium	0.78	0.74	0.73	**	0.016	7.3
Calcium	0.63	0.64	0.67	**	0.013	6.9
Magnesium	0.18	0.15	0.16	**	0.005	13.6
Chlorine	0.11	0.42	0.50	***	0.015	15.4
	Mg0	Mg1				
Nitrogen	2.08	2.09		ns	0.025	5.1
Phosphorus	0.130	0.129		ns	0.001	3.5
Potassium	0.74	0.76		ns	0.016	7.3
Calcium	0.66	0.63		**	0.01	6.9
Magnesium	0.16	0.17		ns	0.007	13.6
Chlorine	0.35	0.34		ns	0.012	15.4

Table 58. Main effects of N,P,K and Mg on rachis nutrient concentrations in 1995 (Trial 305)

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.22	0.24	0.24	ns	0.006	8.6
Phosphorus	0.194	0.138	0.101	***	0.008	19.5
Potassium	1.44	1.29	1.19	***	0.05	12.5
Calcium	0.36	0.35	0.35	ns	0.01	12.0
Magnesium	0.06	0.06	0.05	***	0.003	16.1
Chlorine	0.70	0.57	0.51	***	0.05	27.9
	P0	P1				
Nitrogen	0.23	0.23		ns	0.005	8.6
Phosphorus	0.094	0.196		***	0.007	19.5
Potassium	1.29	1.32		ns	0.04	12.5
Calcium	0.35	0.36		ns	0.01	12.0
Magnesium	0.06	0.06		ns	0.002	16.1
Chlorine	0.59	0.60		ns	0.04	27.9
	K0	K1	K2			
Nitrogen	0.23	0.24	0.23	ns	0.006	8.6
Phosphorus	0.126	0.150	0.157	***	0.008	19.5
Potassium	1.04	1.38	1.50	***	0.05	12.5
Calcium	0.30	0.37	0.39	***	0.01	12.0
Magnesium	0.05	0.06	0.07	***	0.003	16.1
Chlorine	0.10	0.73	0.95	***	0.05	27.9
	Mg0	Mg1				
Nitrogen	0.23	0.23		ns	0.005	8.6
Phosphorus	0.144	0.145		ns	0.007	19.5
Potassium	1.29	1.32		ns	0.04	12.5
Calcium	0.36	0.34		ns	0.01	12.0
Magnesium	0.06	0.06		ns	0.002	16.1
Chlorine	0.58	0.60		ns	0.04	27.9

Trial 306 FERTILISER TRIAL AT AMBOGO ESTATE

PURPOSE

To provide information about the responses of oil palm to fertiliser that will be used in making fertiliser recommendations on Ambogo and Penderetta soils.

DESCRIPTION

Site Ambogo Estate block 79B

Soil Ambogo and Penderetta families. Silt loam over sandy loam, with mottling due to seasonally high water table, derived from alluvially deposited volcanic ash.

Palms Dami commercial DxP crosses planted in 1979 at 143 palms/ha. Trialtarted 1982.

DESIGN

There are 81 plots each containing 16 core palms. The numbers and weights of bunches for individual core palms are surrounded by at least one guard row, and a trench.

The 81 plots are a single replicate containing 81 treatments, made up from all combinations of three levels each of N, P, K, and Mg (Table 59). The 81 treatments are divided into three blocks within the replicate, such that the effect of some high order interactions are confounded with block effects.

Table 59. Types of fertiliser and levels used in Trial 306

Fertiliser	Level (kg/palm/year)		
	0	1	2
Sulphate of ammonia	0.0	3.0	6.0
Triple Superphosphate	0.0	0.5	1.0
Muriate of potash	0.0	2.5	5.0
Kieserite	0.0	0.75	1.5

Modifications: Until 1990 sulphate of ammonia rates were half those indicated.

RESULTS

Sulphate of ammonia application increased FFB yields in 1995, and for the period 1987-1995. The FFB yields were lower than the previous maximum by about 4 tonnes, however the response has remained the same (Table 60).

The application of muriate of potash increased single bunch weight but did not effect FFB yield in 1995, or for the period 1987-1995. There were no significant responses to Triple Superphosphate application.

The application of Kieserite, significantly increased single bunch weight over the 8 year period 1987-1995. However, the effect on FFB yield was not significant.

Table 60. Main effects of N, P, K, and Mg on yield and yield components in 1995 (Trial 306).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	18.1	19.8	23.5	***	1.15	20.6
Bunches/ha	761	685	824	**	41	20.2
Bunch weight (kg)	23.9	29.1	28.6	***	0.62	8.4
	P0	P1	P2			
Yield (t/ha/yr)	21.6	19.1	20.7	ns	1.15	20.6
Bunches/ha	798	712	759	ns	41	20.2
Bunch weight (kg)	27.1	26.9	27.6	ns	0.62	8.4
	K0	K1	K2			
Yield (t/ha/yr)	20.3	21.2	19.8	ns	1.15	20.6
Bunches/ha	801	761	707	ns	41	20.2
Bunch weight (kg)	25.4	28.0	28.2	***	0.62	8.4
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	19.3	21.3	20.8	ns	1.15	20.6
Bunches/ha	738	783	749	ns	41	20.2
Bunch weight (kg)	26.4	27.3	27.8	ns	0.62	8.4

Table 61. Main effects of N, P, K, and Mg on yield and yield components in 1987 - 1995, (Trial 306).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	20.0	23.7	26.2	***	0.84	13.2
Bunches/ha	909	925	1024	***	29	11.2
Bunch weight (kg)	22.0	25.6	25.7	***	0.48	7.2
	P0	P1	P2			
Yield (t/ha/yr)	23.7	22.3	23.8	ns	0.84	13.2
Bunches/ha	974	922	961	ns	29	11.2
Bunch weight (kg)	24.3	24.2	24.7	ns	0.48	7.2
	K0	K1	K2			
Yield (t/ha/yr)	22.8	23.8	23.2	ns	0.84	13.2
Bunches/ha	992	941	924	ns	29	11.2
Bunch weight (kg)	23.0	25.3	25.0	***	0.48	7.2
	Mg0	Mg1	Mg2			
Yield (t/ha/yr)	22.3	23.9	23.7	ns	0.84	13.2
Bunches/ha	939	971	948	ns	29	11.2
Bunch weight (kg)	23.6	24.6	24.9	*	0.48	7.2

The nitrogen concentration of the leaflet tissue in the trial is typical of that observed during the routine tissue sampling and analysis at Ambogo Estate. Sulphate of ammonia significantly increased leaflet nitrogen and phosphorus concentrations. Sulphate of ammonia application has significantly reduced rachis concentrations of phosphorus, potassium, magnesium, and chlorine.

Muriate of potash application increased the concentrations of calcium, magnesium and chlorine in the leaflet and rachis tissue. Muriate of potash application had no significant effect on leaflet potassium concentrations, but the rachis analysis showed a large significant increase in the concentration of potassium.

Triple Superphosphate application had no significant effect on leaflet phosphorus, but increased phosphorus concentration in rachis tissue. The magnesium concentration of the leaflet tissue did not change with addition of Kieserite.

Table 62. Main effects of N, P, K, and Mg on leaflet nutrient in 1995 (Trial 306).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.04	2.12	2.20	***	0.03	5.3
Phosphorus	0.133	0.135	0.137	**	0.001	3.5
Potassium	0.85	0.86	0.83	ns	0.02	7.5
Calcium	0.63	0.62	0.62	ns	0.01	7.7
Magnesium	0.22	0.21	0.21	ns	0.006	10.2
Chlorine	0.39	0.40	0.37	ns	0.02	15.8
	P0	P1	P2			
Nitrogen	2.12	2.12	2.12	ns	0.03	5.3
Phosphorus	0.134	0.136	0.136	ns	0.001	3.5
Potassium	0.86	0.85	0.83	ns	0.02	7.5
Calcium	0.60	0.63	0.62	ns	0.01	7.7
Magnesium	0.21	0.22	0.21	ns	0.006	10.2
Chlorine	0.38	0.37	0.40	ns	0.02	15.8
	K0	K1	K2			
Nitrogen	2.15	2.12	2.10	ns	0.03	5.3
Phosphorus	0.137	0.135	0.134	ns	0.001	3.5
Potassium	0.86	0.84	0.84	ns	0.02	7.5
Calcium	0.59	0.63	0.64	***	0.01	7.7
Magnesium	0.21	0.21	0.22	***	0.006	10.2
Chlorine	0.20	0.47	0.49	***	0.02	15.8
	Mg0	Mg1	Mg2			
Nitrogen	2.12	2.12	2.12	ns	0.03	5.3
Phosphorus	0.136	0.136	0.134	ns	0.001	3.5
Potassium	0.86	0.84	0.84	ns	0.02	7.5
Calcium	0.62	0.63	0.61	ns	0.01	7.7
Magnesium	0.21	0.21	0.22	ns	0.006	10.2
Chlorine	0.37	0.41	0.38	ns	0.02	15.8

Table 63. Main effects of N, P, K, and Mg on rachis nutrient concentrations in 1995 (Trial 306)

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.23	0.24	0.25	*	0.006	9.2
Phosphorus	0.236	0.162	0.114	***	0.008	17.6
Potassium	1.56	1.43	1.38	***	0.03	8.5
Calcium	0.30	0.29	0.29	ns	0.01	13.5
Magnesium	0.08	0.06	0.06	***	0.003	18.9
Chlorine	0.69	0.60	0.56	**	0.04	20.8
	P0	P1	P2			
Nitrogen	0.24	0.24	0.25	ns	0.006	9.2
Phosphorus	0.149	0.174	0.188	***	0.008	17.6
Potassium	1.47	1.46	1.45	ns	0.03	8.5
Calcium	0.30	0.30	0.28	ns	0.01	13.5
Magnesium	0.07	0.07	0.06	ns	0.003	18.9
Chlorine	0.64	0.59	0.63	ns	0.04	20.8
	K0	K1	K2			
Nitrogen	0.24	0.24	0.24	ns	0.006	9.2
Phosphorus	0.154	0.172	0.185	***	0.008	17.6
Potassium	1.29	1.51	1.58	***	0.03	8.5
Calcium	0.26	0.31	0.31	***	0.01	13.5
Magnesium	0.06	0.06	0.07	ns	0.003	18.9
Chlorine	0.20	0.78	0.88	***	0.04	20.8
	Mg0	Mg1	Mg2			
Nitrogen	0.24	0.24	0.24	ns	0.006	9.2
Phosphorus	0.177	0.166	0.168	ns	0.008	17.6
Potassium	1.46	1.46	1.46	ns	0.03	8.5
Calcium	0.29	0.30	0.30	ns	0.01	13.5
Magnesium	0.06	0.06	0.07	ns	0.003	18.9
Chlorine	0.59	0.64	0.63	ns	0.04	20.8

Trial 309 POTASSIUM, CHLORINE AND SULPHUR TRIAL AT AMBOGO ESTATE

PURPOSE

To test the response to potassium, chlorine and sulphur.

DESCRIPTION

Site Ambogo Estate block 80H

Soil Penderetta family. Thin dark sandy loam topsoil over sandy loam subsoil, derived from alluvially deposited volcanic ash. Mottling due to a seasonally high water table.

Palms Dami commercial DxP crosses planted in 1980 at 143 palms per hectare. Trial started January 1988, but present treatments startedin June 1990.

DESIGN

There are 25 plots each containing 16 core palms. The numbers and weights of bunches for each individual core palms are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, and a trench.

The 25 plots are divided into five replicate blocks each containing five treatments (Table 64). The trial is laid down on the site of an earlier trial, that was started in 1984, to test effects of EFB. Each treatment used in the present trial has a latin square design.

The treatments are combinations of fertilisers, one of which is bunch ash (BA). The right hand part of Table 64 shows the amount of each element that is applied to each treatment. The effect of an element is found by comparing the yields from two treatments: for example the effect of chlorine is found by comparing the yields from treatment 4 and 5.

The treatments that were used from January 1988 to June 1990 were similar, but there are some important differences. Treatment 3 now receives N and S, but used to receive only K. Treatment 2 now receives N and Cl, but used to receive K and Cl. Thus in comparison of a treatment with either 2 or 3 in order to test the effect of K. The effect will be underestimated if there is a residual effect of the K that was given in the early part of the trial.

Table 64. Types and amounts of fertiliser given in each treatment, and the corresponding amounts of nutrient element in Trial 309.

Treatment	Amount of Fertiliser (kg/palm/year)				Amount of Nutrient (kg/palm/year)			
No.	MOP	BA	SOA	AC	N	K	Cl	S
1	-	-	-	-	-	-	-	-
2	-	-	-	3.2	0.80	-	2.1	-
3	-	-	4.0	-	0.84	-	-	0.96
4	4.4	-	4.0	-	0.84	2.3	2.1	0.96
5	-	8.8	4.0	-	0.84	2.2	-	0.96

RESULTS

Yield data comparisons on the effects of N, S, K, and Cl for 1994 and 1995, are summarised in Table 65.

Fertiliser was not applied until late 1995. The FFB yield in 1995 was much lower than previously. Despite this reduction in yield, significant responses have been observed with applications of nitrogen, sulphur and potassium.

Table 65 shows significant differences between the treatments. In Table 66, yields are showing a declining trend over the five year period. In separating out the effects of different elements and their combinations over 5 years (Table 66), there was a large significant response to ammonium sulphate application (effect of N and S), with a yield increase of 14 t FFB/ha/yr. The effects of potassium and sulphur, is determined by comparing treatment 4 with treatment 2, which gave a significant yield difference of 8 t/ha. The effects of potassium and chlorine application were not significant

The comparison of Individual treatments shows a consistent increase in yield with the ammonium sulphate plus muriate of potash treatment compared to the ammonium sulphate plus bunch ash treatment. This effect is not observed in the comparison of muriate of potash and bunch ash in the absence of sulphate of ammonia. The application of muriate of potash is commonly seen to increase single bunch weight. This effect is not seen following application of bunch ash. In Table 12, treatment 5 and 3 gave the same single bunch weight. In 1995 sulphate of ammonia plus bunch ash produced the highest yield in comparison to the other treatments.

Table 65. Effects of N, S, K, and Cl in different combinations on yield and yield components in 1994 and 1995.

Treatment	1994			1995		
	Yield (t/ha/yr)	Bunches (no/ha)	Bunch wt (kg)	Yield (t/ha/yr)	Bunches (no/ha)	Bunch wt (kg)
4 N S K Cl	27.7	1115	24.9	18.7	746	25.2
5 N S K	26.4	1081	24.5	19.7	876	22.4
3 N S	24.2	992	24.3	18.6	817	22.4
2 N Cl	18.7	878	21.4	14.4	710	20.5
1 Nil	7.1	476	14.4	6.4	436	14.1
sig	***	***	***	***	**	***
sed	1.17	59	1.59	4.09	156	2.86
cv%	9.4	10.3	10.2	26.3	21.7	13.7

Table 66. Effects of N, S, K, and Cl, in different combinations, on yield trends from 1991 - 1995.

Treatment	Yield (t/ha/yr)					
	1991 11	1992 12	1993 13	1994 14	1995 15	1991-1995
4 N S K Cl	31.3	32.5	28.4	27.7	18.6	27.7
5 N S K	28.6	27.8	25.2	24.2	18.6	24.8
3 N S	28.5	27.8	25.2	24.2	18.6	24.8
2 N Cl	24.5	21.7	19.4	18.7	14.4	19.7
1 Nil	16.4	13.6	9.8	7.1	6.4	10.7
Sig.	**	***	***	***	***	***
cv%	17.1	20.1	19.1	9.4	26.3	13.6

Table 67. Mean yield for 1991-1995, and difference in yield for selected comparisons.

Treatment	Yield (t/ha/yr) Mean 1991-95	Selected Comparisons: Comparisons	Difference (t/ha/yr)	Sig
4 N S K Cl	27.7	4-2 (effect of K and S)	8.0	***
5 N S K	26.8	3-2 (substituting S for Cl)	5.1	***
3 N S	24.8	4-3 (effect of K and Cl)	2.9	ns
2 N Cl	19.7	4-5 (effect of Cl)	0.9	ns
1 Nil	10.7	5-3 (effect of K)	2.0	ns
		3-1 (effect of N and S)	14.1	***
		2-1 (effect of N and Cl)	9.0	***
		F sig ***, cv = 13.6, sed = 3.0		

The nitrogen concentrations in the leaflet tissue were all very low (below 2%). Treatment fertiliser did not arrive until late in the year and this delay in applying sulphate of ammonia has most probably caused the fall in leaflet nitrogen. Treatment 2, which supplies Ammonium chloride, had nitrogen concentrations around 2%. Muriate of potash compared to bunch ash increased the concentration of chlorine in the leaflet tissue, whilst leaflet potassium was increased by bunch ash. Tables 68 & 69 shows chlorine containing fertilisers had increased the leaflet and rachis concentrations of both calcium and chlorine.

Table 68. Effects of N, S, K, and Cl in different combinations on leaflet nutrient concentrations in 1995 (Trial 309).

Treatment	Element as % of leaflet dry matter						
	N	P	K	Ca	Mg	Cl	S
4 N S K Cl	1.94	0.128	0.77	0.73	0.21	0.46	0.13
5 N S K	1.97	0.128	0.82	0.67	0.20	0.29	0.13
3 N S	1.89	0.128	0.77	0.69	0.22	0.27	0.12
2 N Cl	2.05	0.139	0.74	0.70	0.22	0.44	0.12
1 Nil	1.89	0.132	0.76	0.68	0.27	0.24	0.12
Sig.	*	*	ns	ns	**	**	*
sed	0.05	0.003	0.04	0.04	0.02	0.06	0.005
cv%	4.3	4.2	7.9	9.1	11.6	28.5	7.0

Table 69. Effects of N, S, K, and Cl in different combinations on rachis nutrient concentrations in 1995 (Trial 309).

Treatment	Element as % of rachis dry matter						
	N	P	K	Ca	Mg	Cl	S
4 N S K Cl	0.24	0.108	1.83	0.38	0.07	1.07	0.04
5 N S K	0.23	0.113	1.51	0.27	0.05	0.31	0.05
3 N S	0.23	0.073	1.26	0.27	0.13	0.21	0.05
2 N Cl	0.40	0.133	1.42	0.34	0.10	1.05	0.04
1 Nil	0.24	0.144	1.30	0.25	0.11	0.36	0.04
Sig.	***	**	***	***	ns	***	*
sed	0.018	0.016	0.10	0.01	0.04	0.08	0.004
cv%	10.9	22.3	10.6	6.3	66.7	21.3	15.7

Trial 310 POTASSIUM, CHLORINE AND SULPHUR TRIAL AT AMBOGO ESTATE

PURPOSE

To test the response to potassium, chlorine and sulphur.

DESCRIPTION

Site Ambogo Estate block 80D5

Soil Ambogo and Penderetta families. Silt loam over sandy loam, with mottling due to seasonally high water tables, derived from alluvially deposited volcanic ash.

Palms Dami commercial DxP crosses planted in 1980 at 143 palms per hectare. Trial started January 1986, but present treatments started in November 1990.

DESIGN

There are 35 plots each containing 16 core palms. The numbers and weights of bunches for each individual core palms are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row, and a trench.

The seven treatments are replicated in five blocks each containing (Table 70). The treatments are a combination of fertilisers. The left half of Table 70 shows the amount of each fertiliser that is applied to each treatment. The effect of an element is found by comparing the yields from two treatments; for example the effect of Cl in the absence of K and S is found by comparing treatments 3 and 1.

Table 70. Amount of each type of fertiliser, and each element, used for each treatment in Trial 310.

Treatment	Amount of Fertiliser (kg/palm/year)					Amount of Nutrient (kg/palm/year)			
No.	Urea	SOA	AC	BA	MOP	N	K	Cl	S
1	1.8	-	-	-	-	0.81	-	-	-
2	-	4.0	-	-	-	0.84	-		0.96
3	-	-	3.2	-	-	0.80	-	2.1	
4	-	4.0	-	4.4	-	0.84	1.1		0.96
5	-	-	3.2	4.4	-	0.80	1.1	2.1	
6	-	4.0	-	-	2.2	0.84	1.04	1.1	0.96
7	-	2.0	1.6	-	-	0.82	-	1.1	0.48

RESULTS

There were no significant differences in FFB yield due to treatment effects in 1995 (Table 71). The only significant treatments effect was on single bunch weight. As seen in Trial 309, the chlorine containing fertilisers increased single bunch weight. The application of sulphate of ammonia plus bunch ash produced a 0.5 tonne yield increase, but the single bunch weights were reduced. The increase in single bunch weight caused by application of chlorine containing fertiliser may be due to an increase in bunch moisture content.

In 1995 it is not possible to differentiate between potassium, sulphur and chlorine responses. In 1994 there was a response to sulphur application.

Table 71. The effects of K, Cl and S on yield in 1995 (Trial 310)

Treatment No.	Elements Supplied	Elements Missing	Yield (t/ha/yr)	Difference from Treat 6 t/ha/yr	%
6	N K Cl S	None	25.7	0	0
4	N K S	Cl	26.2	+0.5	+1.9
7	N Cl S	K	25.7	0	0
5	N K Cl	S	26.0	+0.3	+1.2
2	N S	K Cl	22.8	-2.9	-11.3
3	N Cl	K S	26.3	+0.6	+2.3
1	N (Urea)	K S Cl	22.7	-3.0	-11.7
		sig	ns		
		sed	1.82		
		cv%	11.5		

Table 72. The effects of K, Cl and S on single bunch weights in 1995 (Trial 310)

Treatment No.	Elements Supplied	Elements Missing	Single bunch weight (kg)	Difference from Treat 6 wt (kg)	%
6	N K Cl S	None	28.7	0	0
4	N K S	Cl	26.1	-2.6	-9.1
7	N Cl S	K	27.1	-1.6	-5.6
5	N K Cl	S	29.5	+0.8	+2.8
2	N S	K Cl	25.0	-3.7	-12.9
3	N Cl	K S	29.7	+1.0	+3.5
1	N (Urea)	K S Cl	24.7	-4.0	-13.9
		sig	***		
		sed	0.87		
		cv%	5.0		

In 1995 there were significant treatment effects on the concentrations of nitrogen, phosphorus, potassium, magnesium and chlorine in leaflet tissue. There were no significant treatment effects on the concentrations of calcium and sulphur. The application of bunch ash decreased the leaflet concentrations of potassium and chlorine and other bases. Applications of ammonium chloride and muriate of potash reduced leaflet potassium, and increased the rachis concentrations of both potassium and chlorine. Muriate of potash also increased the concentration of leaflet calcium, and caused a decrease in the already low leaflet nitrogen concentration.

Table 73. The effects of N, S, K, and Cl in different combinations on the leaflet nutrient concentrations in 1995 (Trial 310)

Treatment	Element as % of leaflet dry matter N	P	K	Ca	Mg	Cl	S
6 N S K Cl	2.14	0.137	0.74	0.72	0.19	0.40	0.12
4 N S K	2.19	0.142	0.80	0.64	0.18	0.21	0.13
7 N S Cl	2.28	0.144	0.77	0.71	0.20	0.48	0.12
5 N K Cl	2.29	0.148	0.78	0.69	0.16	0.49	0.12
3 N Cl	2.24	0.148	0.73	0.69	0.18	0.51	0.12
2 N S	2.20	0.142	0.81	0.69	0.20	0.14	0.13
1 N (Urea)	2.24	0.145	0.81	0.67	0.18	0.13	0.13
sig	**	***	**	ns	**	***	ns
sed	0.04	0.002	0.02	0.03	0.01	0.01	0.007
cv%	3.0	2.1	4.4	6.2	8.6	6.5	8.5

Table 74. Effects of N, S, K, and Cl, in different combinations on rachis nutrient concentrations in 1995 (Trial 310).

Treatment	Element as % of leaflet dry matter						
	N	P	K	Ca	Mg	Cl	S
6 N S K Cl	0.29	0.169	1.44	0.37	0.07	0.71	0.04
4 N S K	0.30	0.151	1.38	0.34	0.05	0.33	0.04
7 N S Cl	0.30	0.147	1.41	0.40	0.07	0.85	0.04
5 N K Cl	0.35	0.164	1.47	0.41	0.07	0.87	0.04
3 N Cl	0.32	0.159	1.40	0.41	0.07	0.81	0.03
2 N S	0.29	0.116	1.08	0.30	0.05	0.06	0.04
1 N (Urea)	0.29	0.153	1.23	0.32	0.05	0.23	0.04
sig	ns	ns	*	*	*	**	ns
sed	0.02	0.02	0.11	0.04	0.008	0.22	0.005
cv%	10.7	18.3	13.3	15.7	19.9	62.6	21.1

Trial 311 NITROGEN, POTASSIUM, AND EMPTY FRUIT BUNCH TRIAL AT ISAVENE ESTATE.

PURPOSE

To test the response to nitrogen and potassium fertilisers, with and without EFB, with a view to using EFB to replace or supplement chemical fertiliser.

DESCRIPTION

Site Isavene Estate block 78A

Soil Higaturu family, Deep sandy clay loam with good drainage, derived from volcanic ash.

Palms Dami commercial DxP crosses. Planted 1978 at 128 palms/ha.

DESIGN

There are 32 plots each with a core of 16 palms. The number and weights of bunches from each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row and a trench.

The 32 plots are a single replicate containing 32 treatments, made up of all combinations of four levels each of N and K, and two levels of Empty Fruit Bunch (EFB) (Table 75). Sulphate of ammonia (SOA) is the source of nitrogen, and muriate of potash (MOP) is the source of potassium. The EFB is applied by hand as a mulch between the palm circles. The weights of EFB given in Table 75, are fresh weights ex-mill. When EFB was given for the first time in November 1988, the amount was 333 kg/palm. In September 1990 it was increased to 500 kg/palm and it is intended to apply this amount every two years.

Table 75. Amounts of fertiliser and EFB used in Trial 311.

Fertiliser	Level (kg/palm/year)			
	0	1	2	3
Sulphate of Ammonia	0.0	2.0	4.0	6.0
Muriate of Potash	0.0	2.0	4.0	6.0
EFB (kg/palm/2years)	0.0	500	-	-

Note: sulphate of ammonia and MOP have been applied twice a year since April 1988, and three times a year since 1995.

RESULTS

In 1995, sulphate of ammonia and EFB significantly increased the FFB yield (Table 76). Sulphate of ammonia increased yield by 5 tonnes up to level 1 (2 kg of sulphate of ammonia), and a smaller but steady increase up to level 3 (6 kg of sulphate of ammonia). The trend was similar for the period 1989-1995 (Table 77).

Muriate of potash did not significantly increased yield in 1995. However, averaged over the six year period 1989 to 1995, there was a significant increase in FFB yield, this largely resulted from an increase in single bunch weights.

The benefits of applying organic matter to the Higaturu series soils are significant. The effects of taking measures to maintain soil organic matter levels is clearly demonstrated in this trial. In 1995 there was a 5 tonnes increase in FFB yield due to application of EFB. EFB increased both bunch numbers and single bunch weights resulting in a yield of 31.4 t/ha.

In the presence of EFB, response to the lower fertiliser levels appeared to be maximised, enabling yields comparable to those at maximum fertiliser input (Table 78). The maximum yield of 37.5 tonnes was achieved with 6kg of sulphate of ammonia and 2kg of muriate of potash.

Table 76. Main effects of N, K, EFB on yield and yield components in 1995.

	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Yield (t/ha/yr)	24.0	29.0	30.6	32.3	**	2.15	14.9
Bunches/ha	852	1007	1006	1077	*	66	13.4
Bunch weight (kg)	28.0	28.6	30.5	30.4	*	0.73	4.9
	K0	K1	K2	K3			
Yield (t/ha/yr)	29.0	28.7	28.2	29.8	ns	2.15	14.9
Bunches/ha	1002	952	956	1032	ns	66	13.4
Bunch weight (kg)	28.6	29.7	29.6	29.5	ns	0.73	4.9
	EFB 0	EFB 1					
Yield (t/ha/yr)	26.4	31.4			**	4.31	14.9
Bunches/ha	942	1030			*	46	13.4
Bunch weight (kg)	28.1	30.6			***	0.51	4.9

Table 77. Main effects of N, K, and EFB on yield and yield components for 1989 - 1995.

	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Yield (t/ha/yr)	26.9	31.3	32.6	34.6	***	0.76	4.9
Bunches/ha	1028	1174	1178	1264	***	38	6.5
Bunch weight (kg)	26.1	26.6	27.8	27.4	ns	0.58	4.3
	K0	K1	K2	K3			
Yield (t/ha/yr)	30.2	30.8	31.4	33.1	*	0.76	4.9
Bunches/ha	1160	1129	1140	1215	ns	38	6.5
Bunch weight (kg)	26.0	27.0	27.7	27.2	ns	0.58	4.3
	EFB 0	EFB 1					
Yield (t/ha/yr)	29.9	32.9			***	0.54	4.9
Bunches/ha	1134	1188			ns	27	6.5
Bunch weight (kg)	26.3	27.7			**	0.41	4.3

Table 78. Interactions between N and K, Nand EFB, K and EFB, on yield for 1991 - 1995.

	Yield (t/ha/year)			
	N0	N1	N2	N3
K0	25.5	30.2	32.1	33.0
K1	24.8	28.1	32.7	37.5
K2	28.3	33.0	31.2	33.3
K3	29.2	34.1	34.4	34.7
EFB0	25.6	28.5	32.2	33.5
EFB1	28.2	34.2	33.0	35.7
	K0	K1	K2	K3
EFB0	28.3	27.1	31.1	33.3
EFB1	32.1	34.4	31.8	32.9

Note: NxK and NxEFB, interactions almost significant at 5% level.
KxEFB interaction significant at 1% level.

The application of sulphate of ammonia significantly increased nitrogen and chlorine levels in the leaflet tissues. A trend of increasing leaflet phosphorus concentration was evident with increasing levels of applied nitrogen. Applications of muriate of potash significantly increased the concentration of chlorine in leaflet tissue, and potassium and chlorine in the rachis tissue.

EFB application significantly increased the concentrations of nitrogen, potassium and phosphorus in the leaflet tissue. In the plantation estates phosphorus levels have generally been declining. An additional benefit of applying EFB is the increase in phosphorus uptake, possibly through microbial activity. Muriate of potash was seen to decrease leaflet potassium concentrations, however EFB increased potassium uptake.

Table 79. Main effects of N, K, and EFB on leaflet nutrient in 1995 (Trial 311).

Element as % of dry matter	Nutrient element & level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	2.08	2.14	2.16	2.32	**	0.05	4.6
Phosphorus	0.129	0.132	0.133	0.137	ns	0.002	4.0
Potassium	0.77	0.75	0.77	0.80	ns	0.015	3.9
Calcium	0.69	0.70	0.67	0.62	ns	0.03	9.0
Magnesium	0.16	0.16	0.15	0.14	ns	0.009	12.1
Chlorine	0.41	0.45	0.47	0.50	**	0.02	7.9
	K0	K1	K2	K3			
Nitrogen	2.22	2.12	2.15	2.20	ns	0.05	4.6
Phosphorus	0.135	0.132	0.132	0.134	ns	0.002	4.0
Potassium	0.80	0.75	0.76	0.77	ns	0.015	3.9
Calcium	0.63	0.66	0.69	0.69	ns	0.03	9.0
Magnesium	0.14	0.15	0.16	0.15	ns	0.009	12.1
Chlorine	0.35	0.47	0.50	0.51	***	0.02	7.9
	EFB0	EFB1					
Nitrogen	2.13	2.22			*	0.04	4.6
Phosphorus	0.130	0.136			*	0.002	4.0
Potassium	0.76	0.79			*	0.01	3.9
Calcium	0.68	0.66			ns	0.02	9.0
Magnesium	0.15	0.15			ns	0.006	12.1
Chlorine	0.45	0.47			ns	0.01	7.9

Table 80. Main effects of N, K, and EFB on rachis nutrient in 1995 (Trial 311).

Element as % of dry matter	Nutrient element & level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	0.22	0.24	0.25	0.26	*	0.01	8.8
Phosphorus	0.07	0.07	0.07	0.07	ns	0.007	19.8
Potassium	1.31	1.34	1.33	1.20	ns	0.09	13.5
Calcium	0.42	0.40	0.38	0.36	ns	0.02	11.1
Magnesium	0.06	0.06	0.05	0.05	ns	0.002	8.7
Chlorine	0.72	0.81	0.81	0.70	ns	0.08	20.2
	K0	K1	K2	K3			
Nitrogen	0.25	0.24	0.24	0.24	ns	0.01	8.8
Phosphorus	0.07	0.06	0.08	0.07	ns	0.007	19.8
Potassium	1.13	1.26	1.44	1.36	*	0.09	13.5
Calcium	0.38	0.39	0.40	0.39	ns	0.02	11.1
Magnesium	0.05	0.06	0.06	0.05	ns	0.002	8.7
Chlorine	0.45	0.75	0.94	0.90	ns	0.08	20.2
	EFB0	EFB1					
Nitrogen	0.24	0.25			ns	0.008	8.8
Phosphorus	0.066	0.075			ns	0.005	19.8
Potassium	1.25	1.34			ns	0.06	13.5
Calcium	0.40	0.38			ns	0.02	11.1
Magnesium	0.06	0.05			**	0.002	8.7
Chlorine	0.76	0.76			ns	0.05	20.2

Trial 312 **NITROGEN, POTASSIUM, AND EMPTY FRUIT BUNCH TRIAL AT ISAVENE ESTATE.**

PURPOSE

To test the response to N and K fertilisers, with and without EFB, with a view to using EFB to replace or supplement inorganic fertiliser.

DESCRIPTION

Site Ambogo Estate block 80E2

Soil Ambogo family, which is of recent alluvially reworked volcanic origin, with silty loam topsoil and sandy loam subsoil, with seasonally high water tables.

Palms Dami commercial DxP crosses. Planted 1980 at 143 palms/ha.

DESIGN

There are 32 plots each with a core of 16 palms. The number and weights of bunches from each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by at least one guard row and a trench.

The 32 plots are a single replicate containing 32 treatments, made up of all combinations of four levels each of N and K, and two levels of EFB (Table 81). Sulphate of ammonia (SOA) is the source of nitrogen, and muriate of potash (MOP) is the source of potassium. The EFB is applied by hand as a mulch between the palm circles. The weights of EFB given in Table 81, are fresh weights ex-mill. When EFB was given for the first time in November 1988, the amount was 333 kg/palm. In September 1990 it was increased to 500 kg/palm and it is intended to apply this amount every two years.

Table 81. Amounts of fertiliser and EFB used in Trial 312.

Fertiliser	Level (kg/palm/year)			
	0	1	2	3
Sulphate of Ammonia	0.0	2.0	4.0	6.0
Muriate of Potash	0.0	2.0	4.0	6.0
EFB (kg/palm/2years)	0.0	500	-	-

Note: sulphate of ammonia and MOP have been applied twice a year since April 1988, and three times a year since 1995.

RESULTS

Yield data for 1995, and for the 8 year period 1989 to1995 are summarised in Tables 82 and 83.

Application of sulphate of ammonia significantly increased FFB yields in 1995. An increase in yield of 2.2 t/ha was achieved with the application of 2kg of sulphate of ammonia per palm per year and a further 3.7 t/ha was achieved with 4kg of sulphate of ammonia. There was no significant yield response to the application of muriate of potash.

Application of EFB resulted in a significant yield increase of 3.2 t/ha. The soils at Ambogo Estate are sandy, and it was expected that EFB applications would be more beneficial than the effects seen in Trial

311 at Sangara.

The effects of the treatments averaged over the period 1989 to 1995 were generally similar to those in 1995 except that the effect of EFB was not significant.

The treatment interactions were not significant.

Table 82. Main effects of N, K, EFB on yield and yield components in 1995 (Trial 312).

	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Yield (t/ha/yr)	21.9	24.1	27.8	28.3	**	1.79	14.0
Bunches/ha	983	953	1081	1142	ns	81	15.6
Bunch weight (kg)	22.2	25.3	25.8	24.8	***	0.41	3.3
	K0	K1	K2	K3			
Yield (t/ha/yr)	25.5	27.2	25.9	23.5	ns	7.79	14.0
Bunches/ha	1070	1096	1040	953	ns	81	15.6
Bunch weight (kg)	23.9	24.8	24.9	24.6	ns	0.41	3.3
	EFB 0	EFB 1					
Yield (t/ha/yr)	23.9	27.1			*	1.26	14.0
Bunches/ha	999	1081			ns	57	15.6
Bunch weight (kg)	24.0	25.1			**	0.29	3.3

Table 83. Main effects of N, K, and EFB on yield and yield components for 1989 - 1995(Trial 312).

	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Yield (t/ha/yr)	26.9	31.1	33.4	33.8	***	1.04	6.6
Bunches/ha	1407	1429	1539	1569	*	52	7.1
Bunch weight (kg)	19.2	21.8	21.7	21.5	**	0.50	4.8
	K0	K1	K2	K3			
Yield (t/ha/yr)	31.2	31.1	31.6	31.2	ns	1.04	6.6
Bunches/ha	1493	1487	1499	1465	ns	52	7.1
Bunch weight (kg)	20.8	20.9	21.1	21.4	ns	0.50	4.8
	EFB 0	EFB 1					
Yield (t/ha/yr)	30.7	31.8			ns	0.73	6.6
Bunches/ha	1483	1489			ns	37	7.1
Bunch weight (kg)	20.7	21.4			ns	0.36	4.8

Sulphate of ammonia continues to be the most effective fertiliser on the Ambogo soils. Sulphate of ammonia significantly increased the nitrogen concentration in leaflet tissue and reduced the concentration of magnesium. Application of sulphate of ammonia reduced the concentration of phosphorus in the rachis tissues. Despite leaflet nitrogen concentrations being at the lower end of the recommended scale, respectable yields are still be achieved.

Muriate of potash significantly increased the concentrations of calcium and chlorine in the leaflet and rachis tissue. Although there was an apparent decline in leaflet potassium with applications of muriate of potash, this was not statistically significant.

Empty fruit bunch application significantly increased the concentrations of nitrogen , phosphorus, and potassium in the leaflet tissue. The results confirmed the importance of maintaining organic matter especially in the sandy soils at Ambogo. Observations at this site show that three months after application, the EFB has completely. It is possible that annual EFB application may be of benefit at this site.

Table 84. Main effects of N, K, and EFB on leaflet nutrient concentrations in 1995 (Trial 312)

Element as % of dry matter	Nutrient element & level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	2.06	2.08	2.13	2.26	**	0.04	4.0
Phosphorus	0.136	0.136	0.139	0.142	ns	0.003	4.0
Potassium	0.84	0.82	0.82	0.80	ns	0.01	2.7
Calcium	0.69	0.67	0.65	0.66	ns	0.02	7.5
Magnesium	0.19	0.18	0.16	0.16	*	0.009	10.0
Chlorine	0.46	0.47	0.50	0.48	ns	0.02	6.4
	K0	K1	K2	K3			
Nitrogen	2.11	2.20	2.10	2.13	ns	0.04	4.0
Phosphorus	0.138	0.141	0.136	0.138	ns	0.003	4.0
Potassium	0.84	0.82	0.81	0.81	ns	0.01	2.7
Calcium	0.61	0.68	0.67	0.69	*	0.02	7.5
Magnesium	0.17	0.17	0.18	0.18	ns	0.009	10.0
Chlorine	0.40	0.50	0.52	0.50	***	0.02	6.4
	EFB0	EFB1					
Nitrogen	2.06	2.20			***	0.03	4.0
Phosphorus	0.135	0.141			**	0.002	4.0
Potassium	0.80	0.84			***	0.008	2.7
Calcium	0.67	0.66			ns	0.02	7.5
Magnesium	0.18	0.17			ns	0.006	10.0
Chlorine	0.47	0.49			ns	0.01	6.4

Table 85. Main effects of N, K and EFB on rachis nutrient concentrations in 1995 (Trial 312).

Element as % of dry matter	Nutrient element & level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	0.24	0.26	0.27	0.26	ns	0.01	8.1
Phosphorus	0.160	0.150	0.124	0.108	*	0.02	23.4
Potassium	1.47	1.47	1.41	1.33	ns	0.13	18.8
Calcium	0.33	0.35	0.36	0.33	ns	0.01	8.4
Magnesium	0.05	0.05	0.05	0.05	ns	0.004	16.2
Chlorine	0.74	0.77	0.82	0.80	ns	0.11	27.2
	K0	K1	K2	K3			
Nitrogen	0.25	0.27	0.27	0.25	ns	0.01	8.1
Phosphorus	0.132	0.144	0.135	0.133	ns	0.02	23.4
Potassium	1.30	1.54	1.46	1.38	ns	0.13	18.8
Calcium	0.30	0.36	0.36	0.34	*	0.01	8.4
Magnesium	0.05	0.05	0.05	0.05	ns	0.004	16.2
Chlorine	0.50	0.92	0.87	0.82	*	0.11	27.2
	EFB0	EFB1					
Nitrogen	0.25	0.26			ns	0.007	8.1
Phosphorus	0.137	0.135			ns	0.01	23.4
Potassium	1.38	1.46			ns	0.09	18.8
Calcium	0.35	0.33			ns	0.01	8.4
Magnesium	0.05	0.05			ns	0.002	16.2
Chlorine	0.75	0.81			ns	0.07	27.2

Trial 317 FERTILISER TRIAL ON LOWER TERRACE KOMO ESTATE MAMBA.

PURPOSE

To test the response to N, P, K, and Mg in factorial combination on Mamba soil, to get information that will help in making fertiliser recommendations.

DESCRIPTION

Site Komo Estate block 27

Soil Dark sandy loam, derived from air fall ash.

Palms Dami commercial DxP crosses. Planted 1985 at 130 palms/ha. Trial started in May 1990.

DESIGN

There are plots, each with a core of 10 palms. The numbers and the weights of bunches from each individual core palms are recorded at intervals of 14 days. The core palms are surrounded by trenches (one meter deep) to separate them from adjoining plots.

The 36 plots are a single replicate containing 36 treatments, made up from all combinations of three levels of N and K and two levels of P and Mg (Table 86).

Table 86. Amounts of fertiliser used in Trial 317.

Type of fertiliser	Level (kg/palm/year)		
	0	1	2
Sulphate of Ammonia	0.0	2.5	5.0
Triple Superphosphate	0.0	2.5	-
Muriate of Potash	0.0	2.5	5.0
Kieserite	0.0	2.5	-

RESULTS

Sulphate of ammonia had no effect on FFB yield. The trend is the same for the aggregate yields for 1991 to 1995. While sulphate of ammonia is the most important fertiliser with respect to the Higaturu soils, it may not be required at Mamba for the time being.

There was an indication of a response to muriate of potash in 1995 and this trend is also reflected over the 5 year period. Application of Kieserite significantly increased FFB yields by 4.5 t/ha. Where magnesium is not applied at Mamba visual symptoms of magnesium deficiency are severe. Kieserite applications will be essential at Mamba especially in stony areas where the symptoms are wide spread throughout the valley.

There was no yield response to application of Triple Superphosphate.

Table 87. Main effects of N,P, K, and Mg on yield and yield components in 1995 (Trial 317).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	19.6	20.2	18.5	ns	1.62	20.4
Bunches/ha	816	791	752	ns	74	23.0
Bunch weight (kg)	23.9	25.8	24.6	ns	1.15	11.4
	P0	P1				
Yield (t/ha/yr)	19.0	19.8		ns	1.32	20.4
Bunches/ha	787	785		ns	60	23.0
Bunch weight (kg)	24.0	25.5		ns	0.94	11.4
	K0	K1	K2			
Yield (t/ha/yr)	17.9	18.6	21.8	ns	1.62	20.4
Bunches/ha	770	738	850	ns	74	23.0
Bunch weight (kg)	23.5	25.2	25.6	ns	1.15	11.4
	Mg0	Mg1				
Yield (t/ha/yr)	17.2	21.7		**	1.32	20.4
Bunches/ha	712	860		*	60	23.0
Bunch weight (kg)	24.1	25.5		ns	0.94	11.4

Table 88. Main effects of N, K, and EFB on yield and yield components for 1991 - 1995.

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	23.5	24.6	22.2	ns	1.35	14.1
Bunches/ha	1058	1060	1019	ns	62	14.6
Bunch weight (kg)	22.1	23.3	21.7	ns	0.71	7.8
	P0	P1				
Yield (t/ha/yr)	23.0	23.8		ns	1.10	14.1
Bunches/ha	1041	1050		ns	50	14.6
Bunch weight (kg)	22.1	22.6		ns	0.58	7.8
	K0	K1	K2			
Yield (t/ha/yr)	21.8	23.3	25.1	ns	1.35	14.1
Bunches/ha	1036	1020	1081	ns	62	14.6
Bunch weight (kg)	21.0	22.8	23.2	*	0.71	7.8
	Mg0	Mg1				
Yield (t/ha/yr)	21.8	24.9		**	1.10	14.1
Bunches/ha	1014	1077		ns	50	14.6
Bunch weight (kg)	21.5	23.2		**	0.58	7.8

Table 89. Main effects of N, P, K, and Mg on leaflet nutrient concentrations in 1995 (Trial 317)

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.47	2.55	2.55	ns	0.06	5.8
Phosphorus	0.150	0.154	0.154	ns	0.002	3.6
Potassium	0.71	0.74	0.77	ns	0.04	13.9
Calcium	0.99	1.00	0.97	ns	0.05	12.3
Magnesium	0.17	0.19	0.16	ns	0.01	19.4
Chlorine	0.48	0.50	0.54	**	0.01	7.0
	P0	P1				
Nitrogen	2.53	2.51		ns	0.05	5.8
Phosphorus	0.151	0.153		ns	0.002	3.6
Potassium	0.73	0.74		ns	0.03	13.9
Calcium	0.98	0.99		ns	0.04	12.3
Magnesium	0.18	0.17		ns	0.01	19.4
Chlorine	0.52	0.51		ns	0.01	7.0
	K0	K1	K2			
Nitrogen	2.56	2.52	2.49	ns	0.06	5.8
Phosphorus	0.155	0.152	0.150	ns	0.002	3.6
Potassium	0.65	0.75	0.82	**	0.04	13.9
Calcium	1.02	0.99	0.95	ns	0.05	12.3
Magnesium	0.21	0.15	0.16	**	0.01	19.4
Chlorine	0.38	0.57	0.58	***	0.01	7.0
	Mg0	Mg1				
Nitrogen	2.50	2.55		ns	0.05	5.8
Phosphorus	0.152	0.153		ns	0.002	3.6
Potassium	0.78	0.70		*	0.03	13.9
Calcium	1.04	0.93		**	0.04	12.3
Magnesium	0.12	0.22		***	0.01	19.4
Chlorine	0.53	0.49		***	0.01	7.0

Table 90. Main effects of N, P, K, and Mg on rachis nutrient concentrations in 1995 (Trial 317).

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.24	0.26	0.27	**	0.007	6.2
Phosphorus	0.070	0.058	0.055	***	0.003	12.2
Potassium	0.82	0.82	0.82	ns	0.08	25.1
Calcium	0.44	0.42	0.43	ns	0.02	13.8
Magnesium	0.12	0.07	0.06	ns	0.04	126.3
Chlorine	0.56	0.56	0.55	ns	0.06	26.6
	P0	P1				
Nitrogen	0.26	0.26		ns	0.005	6.2
Phosphorus	0.053	0.069		***	0.002	12.2
Potassium	0.84	0.80		ns	0.07	25.1
Calcium	0.44	0.43		ns	0.02	13.8
Magnesium	0.10	0.06		ns	0.03	126.3
Chlorine	0.56	0.55		ns	0.05	26.6
	K0	K1	K2			
Nitrogen	0.27	0.26	0.25	ns	0.007	6.2
Phosphorus	0.055	0.061	0.067	**	0.08	12.2
Potassium	0.42	0.82	1.23	***	0.08	25.1
Calcium	0.44	0.45	0.40	ns	0.02	13.8
Magnesium	0.12	0.06	0.06	ns	0.04	126.3
Chlorine	0.22	0.63	0.82	***	0.06	26.6
	Mg0	Mg1				
Nitrogen	0.26	0.25		ns	0.005	6.2
Phosphorus	0.057	0.065		**	0.002	12.2
Potassium	0.88	0.76		ns	0.07	25.1
Calcium	0.47	0.40		**	0.02	13.8
Magnesium	0.05	0.12		*	0.03	126.3
Chlorine	0.60	0.51		ns	0.05	26.6

Trial 318 FERTILISER TRIAL ON RIVER TERRACE KOMO ESTATE MAMBA.

PURPOSE

To test the response to N, P, K, and Mg in factorial combination on Mamba soil.

DESCRIPTION

Site Komo Estate block 39

Soil Dark sandy loam.

Palms Dami commercial DxP crosses. Planted 1985 at 130 palms/ha. Trial started in May 1990.

DESIGN

There are plots, each with a core of 9 palms. The numbers and the weights of bunches from each individual core palms are recorded at intervals of 14 days. The core palms are surrounded by trenches (one metre deep) to separate them from adjoining plots.

The 36 plots are a single replicate containing 36 treatments, made up from all combinations of three levels of N and K and two levels of P and Mg (Table 90).

Table 90. Amounts of fertiliser used in Trial 318.

Type of fertiliser	Level (kg/palm/year)		
	0	1	2
Sulphate of ammonia	0.0	2.5	5.0
Triple Superphosphate	0.0	2.5	-
Muriate of Potash	0.0	2.5	5.0
Kieserite	0.0	2.5	-

RESULTS

Yield data for 1995 and for the period 1991 to 1995 are summarised in Tables 91 and 92.

1995 yield data showed a departure from the previous years results. Except for magnesium application, none of the treatments had an effect on yield or yield components. Kieserite application resulted in an increase in bunch number which resulted in a significant yield increase of 5 t/ha.

There were no significant treatment interactions.

Table 91. Main effects of N,P, K, and Mg on yield and yield components in 1995 (Trial 318).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	17.9	17.7	15.7	ns	2.88	41.4
Bunches/ha	787	745	669	ns	100	33.4
Bunch weight (kg)	22.1	23.6	23.2	ns	2.06	22.1
	P0	P1				
Yield (t/ha/yr)	17.4	16.8		ns	2.88	41.4
Bunches/ha	744	724		ns	81	33.4
Bunch weight (kg)	23.3	22.5		ns	1.68	22.1
	K0	K1	K2			
Yield (t/ha/yr)	14.1	19.0	18.2	ns	2.88	41.4
Bunches/ha	640	791	770	ns	100	33.4
Bunch weight (kg)	21.9	23.7	23.1	ns	2.06	22.1
	Mg0	Mg1				
Yield (t/ha/yr)	14.6	19.6		*	2.35	41.4
Bunches/ha	629	839		**	81	33.4
Bunch weight (kg)	22.7	23.2		ns	1.68	22.1

Table 92. Main effects of N ,P, K, and Mg on yield and yield components for 1991 - 1995 (Trial 318).

	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Yield (t/ha/yr)	20.2	21.7	20.8	ns	2.57	30.1
Bunches/ha	1029	1013	1021	ns	85	20.5
Bunch weight (kg)	19.2	21.2	20.2	ns	1.41	17.0
	P0	P1				
Yield (t/ha/yr)	21.4	20.5		ns	2.10	30.1
Bunches/ha	1034	1008		ns	69	20.5
Bunch weight (kg)	20.5	19.9		ns	1.15	17.0
	K0	K1	K2			
Yield (t/ha/yr)	18.1	22.0	22.6	ns	2.57	30.1
Bunches/ha	942	1042	1078	ns	85	20.5
Bunch weight (kg)	19.0	20.9	20.7	ns	1.41	17.0
	Mg0	Mg1				
Yield (t/ha/yr)	18.8	23.1		*	2.10	30.1
Bunches/ha	940	1102		*	69	20.5
Bunch weight (kg)	19.6	20.8		ns	1.15	17.0

The effects of treatments on the concentrations of nutrient elements in leaflet and rachis tissue are shown in Tables 93 and 94.

Application of sulphate of ammonia had no significant effect on the elements in the leaflet tissues. The nitrogen concentration in leaflet tissue are well above the levels seen at Higaturu. Leaflet phosphate concentrations increased due to the application of Triple Superphosphate.

Muriate of potash had significantly increased leaflet potassium concentration, and depressed calcium and magnesium concentrations. Kieserite application significantly increased leaflet magnesium concentration and depressed potassium. The results shows how complex the relationships are between elements. Care must be taken when recommending fertiliser since any emphasis on a particular single element may result in declining levels of another nutrient and in the long term decline in yields.

Table 93. Main effects of N, P, K, and Mg on leaflet nutrient concentrations in 1995 (Trial 318)

Element as % of dry matter	Nutrient element and level			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	2.48	2.54	2.52	ns	0.04	4.1
Phosphorus	0.157	0.156	0.156	ns	0.002	3.2
Potassium	0.89	0.86	0.96	ns	0.10	28.6
Calcium	0.86	0.84	0.79	ns	0.04	11.6
Magnesium	0.19	0.19	0.19	ns	0.02	27.3
Chlorine	0.52	0.51	0.59	ns	0.05	22.1
	P0	P1				
Nitrogen	2.51	2.52		ns	0.03	4.1
Phosphorus	0.154	0.159		**	0.002	3.2
Potassium	0.98	0.82		ns	0.09	28.6
Calcium	0.80	0.86		ns	0.03	11.6
Magnesium	0.18	0.20		ns	0.02	27.3
Chlorine	0.57	0.51		ns	0.04	22.1
	K0	K1	K2			
Nitrogen	2.52	2.52	2.49	ns	0.04	4.1
Phosphorus	0.158	0.156	0.154	ns	0.002	3.2
Potassium	0.65	0.97	1.08	**	0.10	28.6
Calcium	0.88	0.83	0.77	*	0.04	11.6
Magnesium	0.24	0.17	0.16	**	0.02	27.3
Chlorine	0.48	0.58	0.56	ns	0.05	22.1
	Mg0	Mg1				
Nitrogen	2.49	2.53		ns	0.03	4.1
Phosphorus	0.157	0.156		ns	0.002	3.2
Potassium	1.02	0.78		*	0.09	28.6
Calcium	0.85	0.81		ns	0.03	11.6
Magnesium	0.11	0.27		***	0.02	27.3
Chlorine	0.54	0.54		ns	0.04	22.1

Table 94. Main effects of N, P, K, and Mg on rachis nutrient concentrations in 1995 (Trial 318).

Element as % of dry matter	Nutrient element and levei			Statistics		
				sig	sed	cv%
	N0	N1	N2			
Nitrogen	0.23	0.26	0.27	**	0.01	10.2
Phosphorus	0.090	0.067	0.068	ns	0.01	31.6
Potassium	0.89	1.00	1.04	ns	0.12	28.9
Calcium	0.35	0.35	0.34	ns	0.03	23.5
Magnesium	0.14	0.07	0.07	ns	0.05	131.4
Chlorine	0.55	0.64	0.63	ns	0.12	48.8
	P0	P1				
Nitrogen	0.25	0.26		ns	0.009	10.2
Phosphorus	0.063	0.086		ns	0.008	31.6
Potassium	1.05	0.91		ns	0.09	28.9
Calcium	0.33	0.36		ns	0.03	23.5
Magnesium	0.07	0.11		ns	0.04	131.4
Chlorine	0.65	0.57		ns	0.10	48.8
	K0	K1	K2			
Nitrogen	0.25	0.25	0.26	ns	0.01	10.2
Phosphorus	0.066	0.073	0.086	ns	0.01	31.6
Potassium	0.47	1.02	1.44	***	0.12	28.9
Calcium	0.40	0.34	0.30	*	0.03	23.5
Magnesium	0.11	0.05	0.11	ns	0.05	131.4
Chlorine	0.38	0.64	0.80	**	0.12	48.8
	Mg0	Mg1				
Nitrogen	0.26	0.25		ns	0.009	6.2
Phosphorus	0.076	0.074		ns	0.008	31.6
Potassium	1.06	0.90		ns	0.09	28.9
Calcium	0.37	0.33		ns	0.03	23.5
Magnesium	0.05	0.13		*	0.04	131.4
Chlorine	0.62	0.60		ns	0.10	48.8

Trial 502B **FERTILISER TRIAL AT WAIGANI ESTATE**

PURPOSE

To test the response to N, P, and K in factorial combination, with and without EFB, with a view to using EFB to replace or supplement chemical fertiliser.

DESCRIPTION

Site Waigani Estate, Field 6503 and 6504.

Soil Plantation family which is of recent alluvial origin.

Site Dami commercial DxP crosses Planted 1986 at 127 palms/ha. Trial started 1994.

DESIGN

Trial 502B relocation is a single replicate split into four blocks, each comprising factorial applications of 4x4x2x2 NPK and EFB treatments. There are 64 plots each containing 16 core palms. The numbers and weights of bunches of each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by one guard row and a trench.

The 64 treatments are made up from all combinations of four levels of N and K, and two levels of P and EFB (Table 95). EFB is applied by hand as a mulch between palm circles.

Table 95. Amount of fertiliser and EFB used in Trial 502B.

Fertiliser	Level (kg/palm/year)			
	0	1	2	3
Sulphate of ammonia	0.0	2.0	4.0	6.0
Triple Superphosphate	0.0	2.0	-	-
Muriate of potash	0.0	2.5	5.0	7.5
EFB	0.0	600	-	-

RESULTS

1995 was the first full year of yield recording in this trial. There was no response recorded to any of the fertilisers treatments. EFB had shown an increase in yield of 0.4 tonnes, but was not statistically significant.

Table 96. Main effects of N, P, K, and Mg on yield and yield components in 1995 (Trial 502B).

	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Yield (t/ha/yr)	19.2	18.9	18.8	18.3	ns	0.82	12.4
Bunches/ha	970	937	937	927	ns	44	13.2
Bunch weight (kg)	19.9	20.2	20.2	19.8	ns	0.47	6.6
	P0	P1					
Yield (t/ha/yr)	18.9	18.6			ns	0.58	12.4
Bunches/ha	944	942			ns	31	13.2
Bunch weight (kg)	20.2	19.9			ns	0.33	6.6
	K0	K1	K2	K3			
Yield (t/ha/yr)	19.4	19.1	18.6	18.1	ns	0.82	12.4
Bunches/ha	963	967	937	905	ns	44	13.2
Bunch weight (kg)	20.2	19.9	19.9	20.1	ns	0.47	6.6
	EFB0	EFB1					
Yield (t/ha/yr)	18.6	19.0			ns	0.58	12.4
Bunches/ha	944	942			ns	31	13.2
Bunch weight (kg)	19.9	20.2			ns	0.33	6.6

Sulphate of ammonia did not have an effect on nutrient concentrations in the leaflet tissues (Table 97). The levels of potassium appear to be low and is a cause for concern. The levels of magnesium are very high which is possible antagonistic to potassium uptake but it is too early to see any meaningful trends.

The application of Triple Superphosphate significantly decreased leaflet phosphorus concentrations. Empty fruit bunch significantly decreased the leaflet calcium concentration.

Table 97. Main effects of N, P, K, and EFB on leaflet nutrient concentrations in 1995 (Trial 502B)

Element as % of dry matter	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	2.29	2.27	2.28	2.30	ns	0.02	2.4
Phosphorus	0.134	0.134	0.135	0.135	ns	0.001	2.0
Potassium	0.56	0.57	0.57	0.55	ns	0.01	6.9
Calcium	0.81	0.81	0.82	0.80	ns	0.02	5.8
Magnesium	0.34	0.35	0.34	0.34	ns	0.01	7.9
Chlorine	0.51	0.51	0.50	0.50	ns	0.01	4.9
	P0	P1					
Nitrogen	2.29	2.29			ns	0.02	2.4
Phosphorus	0.135	0.134			*	0.001	2.0
Potassium	0.56	0.56			ns	0.01	6.9
Calcium	0.82	0.80			ns	0.02	5.8
Magnesium	0.35	0.34			ns	0.01	7.9
Chlorine	0.50	0.50			ns	0.01	4.9
	K0	K1	K2	K3			
Nitrogen	2.30	2.29	2.27	2.29	ns	0.02	2.4
Phosphorus	0.135	0.134	0.133	0.136	ns	0.001	2.0
Potassium	0.56	0.56	0.56	0.58	ns	0.01	6.9
Calcium	0.79	0.81	0.82	0.83	ns	0.01	5.8
Magnesium	0.33	0.34	0.35	0.35	ns	0.01	7.9
Chlorine	0.50	0.49	0.50	0.51	ns	0.01	4.9
	EFB0	EFB					
Nitrogen	2.29	2.29			ns	0.02	2.4
Phosphorus	0.135	0.134			ns	0.001	2.0
Potassium	0.57	0.56			ns	0.01	6.9
Calcium	0.83	0.79			**	0.02	5.8
Magnesium	0.35	0.34			ns	0.01	7.9
Chlorine	0.50	0.50			ns	0.01	4.9

Table 98. Main effects of N, P, K, and EFB on rachis nutrient concentrations in 1995 (Trial 502B)

Element as % of dry matter	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	0.25	0.25	0.26	0.26	ns	0.005	6.0
Phosphorus	0.067	0.066	0.064	0.070	ns	0.04	17.0
Potassium	0.72	0.68	0.69	0.75	ns	0.07	26.1
Calcium	0.34	0.36	0.36	0.37	ns	0.01	7.5
Magnesium	0.15	0.16	0.15	0.15	ns	0.01	12.3
Chlorine	0.54	0.52	0.52	0.54	ns	0.02	13.3
	P0	P1					
Nitrogen	0.25	0.26			ns	0.004	6.0
Phosphorus	0.068	0.066			ns	0.003	17.0
Potassium	0.69	0.75			ns	0.05	26.1
Calcium	0.36	0.36			ns	0.007	7.5
Magnesium	0.16	0.15			ns	0.005	12.3
Chlorine	0.52	0.54			ns	0.02	13.3
	K0	K1	K2	K3			
Nitrogen	0.25	0.26	0.25	0.25	ns	0.005	6.0
Phosphorus	0.067	0.065	0.065	0.071	ns	0.04	17.0
Potassium	0.72	0.69	0.69	0.75	ns	0.07	26.1
Calcium	0.36	0.37	0.36	0.36	ns	0.01	7.5
Magnesium	0.15	0.16	0.15	0.15	ns	0.01	12.3
Chlorine	0.53	0.54	0.52	0.54	ns	0.02	13.3
	EFB0	EFB					
Nitrogen	0.26	0.26			ns	0.004	6.0
Phosphorus	0.068	0.066			ns	0.003	17.0
Potassium	0.73	0.69			ns	0.05	26.1
Calcium	0.36	0.36			ns	0.007	7.5
Magnesium	0.15	0.16			ns	0.005	12.3
Chlorine	0.53	0.53			ns	0.02	13.3

Trial 504 MATURE PHASE FERTILISER TRIAL AT SAGARAI ESTATE

PURPOSE

To test the response to N and K of oil palm in Sagarai Estate.

DESCRIPTION

Site Sagarai Estate, Field 0610, 0611 and 0612.

Soil Tomanau family, which is of recent alluvial origin, with deep clay loam soils and reasonable drainage status. This is the predominant soil family on the Sagarai Estate.

Palms Each plot contains 16 palms each of which is a selected Dami progeny. The palms were planted in January, 1991 at 127 palms/ha and trial started in 1994.

DESIGN

Trial 504 is a mature phase trial. There were 16 selected elite crosses established at random allocation within each of the 64 plots. The selected crosses were received at Sagarai nursery on May, 1990, and planted out in January, in 1991 at 127palms/ha.

There are 64 plots, each with a core of 16 palms. The numbers and weights of bunches from each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded by a guard row, which is also trenched.

The 64 plots are divided into two replicates, each of 32 plots. In each replicate there are 32 treatments, made up of all combinations of four levels each of N and K with two levels currently left vacant (Table 99).

Table 99. Types of fertiliser and amounts used in Trial 504.

Fertiliser	Level (kg/palm/year)			
	0	1	2	3
Sulphate of ammonia	0.0	2.0	4.0	6.0
Muriate of potash	0.0	2.5	5.0	7.5
Vacant	-	-		

RESULTS

This is the first year of yield recording in this trial. There were no significant treatment responses in 1995.

The interactions were significant at the 5% level. Maximum yields of about 25 tonnes were obtained at K1 (2.5kg MOP) alone, N1K3 (2kg SOA + 7.5kg MOP) and N3 (6kg SOA), although interpreting this effect must be done with caution.

Table. 100. Main effects of Nand K on yield and yield components in 1995.

	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Yield (t/ha/yr)	22.0	21.6	21.3	22.3	ns	1.11	14.4
Bunches/ha	2178	2119	2086	2141	ns	98	13.1
Bunch weight (kg)	10.2	10.3	10.3	10.5	ns	0.36	9.9
	K0	K1	K2	K3			
Yield (t/ha/yr)	21.4	22.6	21.8	21.5	ns	1.11	14.4
Bunches/ha	2084	2184	2134	2122	ns	98	13.1
Bunch weight (kg)	10.3	10.5	10.3	10.2	ns	0.36	9.9

Table 101. Effect of N at different levels of K in 1995

Level of N	Yield (t/ha/year)			
	K0	K1	K2	K3
N0	20.2	25.1	21.6	21.3
N1	19.7	21.0	20.5	25.4
N2	20.6	21.6	23.7	19.2
N3	25.1	22.8	21.5	19.9

NxK interaction was significant at 5% level.

The leaflet nitrogen concentrations appear to be satisfactory. There were no significant effects due to the application of ammonium sulphate. There was an indication that application of muriate of potash had an effect on leaflet phosphorus and potassium. Leaflet magnesium concentrations on fresh alluvium appears to be very high.

Table 102. Main effects of N and K on leaflet nutrient concentration in 1995 (Trial 504)

Element as % of dry matter	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	2.45	2.46	2.48	2.44	ns	0.018	2.1
Phosphorus	0.145	0.146	0.147	0.144	ns	0.001	2.3
Potassium	0.55	0.56	0.56	0.57	ns	0.01	6.8
Calcium	0.96	0.99	0.96	0.92	ns	0.04	12.7
Magnesium	0.49	0.48	0.50	0.49	ns	0.01	6.0
Chlorine	0.62	0.64	0.64	0.63	ns	0.01	5.7
	K0	K1	K2	K3			
Nitrogen	2.45	2.45	2.49	2.44	ns	0.018	2.1
Phosphorus	0.144	0.145	0.147	0.146	ns	0.001	2.3
Potassium	0.56	0.55	0.55	0.58	ns	0.01	6.8
Calcium	0.97	0.96	0.94	0.96	ns	0.04	12.7
Magnesium	0.48	0.48	0.50	0.50	ns	0.01	6.0
Chlorine	0.63	0.63	0.64	0.64	ns	0.01	5.7

Table 103. Main effects of N and K on rachis nutrient concentration in 1995 (Trial 504)

Element as % of dry matter	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	0.28	0.29	0.28	0.28	ns	0.005	5.1
Phosphorus	0.080	0.076	0.077	0.084	ns	0.004	13.2
Potassium	1.08	1.16	1.10	1.11	ns	0.06	15.0
Calcium	0.37	0.38	0.37	0.39	ns	0.009	6.8
Magnesium	0.20	0.18	0.20	0.20	ns	0.007	9.6
Chlorine	0.62	0.62	0.64	0.64	ns	0.04	16.0
	K0	K1	K2	K3			
Nitrogen	0.28	0.29	0.29	0.28	ns	0.005	5.1
Phosphorus	0.076	0.084	0.076	0.081	ns	0.004	13.2
Potassium	1.12	1.11	1.09	1.13	ns	0.06	15.0
Calcium	0.38	0.38	0.39	0.37	ns	0.009	6.8
Magnesium	0.19	0.19	0.20	0.19	ns	0.007	9.6
Chlorine	0.60	0.63	0.62	0.66	ns	0.04	16.0

Trial 511 **FERTILISER TRIAL ON INTERFLUVE TERRACES SOILS AT WAIGANI ESTATE**

PURPOSE

To investigate the response to oil palm on interfluve/terraces soils

DESCRIPTION

Site Waigani Estate, Field 8501 and 8502.

Soil Hagita family, texture contrast soils with slowly permeable clay subsoil and very gravelly loam top soil. Gravel may be cemented into massive blocks of laterite. Although these soils are dominantly poorly drained, somewhat imperfectly drained variants with olive grey subsoil colours have been included into this family. Mostly on gently sloping terraces, but also found on spurs and crests on hilly terrain.

Palms Dami commercial DxP crosses. Planted in 1988 at 127 palms/ha. Trial started 1994.

DESIGN

There are 64 plots each containing 16 core palms. The numbers and weights of bunches for each individual core palm are recorded at intervals of 14 days. In each plot the core palms are surrounded bu at least one guard row, which is also trenched.

The 64 plots is a single replicate split into four blocks, comprising factorial applications of 4x4x2x2 NPK and EFB treatments. The 64 treatments are made up from all combinations of four levels each of N and K, and two levels each of P and EFB (Table 104). EFB is applied by hand as a mulch between palm circles.

Table 104. Amount of fertiliser and EFB used in Trial 511.

Fertiliser	Level (kg/palm/year)			
	0	1	2	3
Sulphate of ammonia	0.0	2.0	4.0	6.0
Triple Superphosphate	0.0	2.0	-	-
Muriate of potash	0.0	2.5	5.0	7.5
EFB	0.0	600	-	-

RESULTS

In 1995 there was no significant treatment effects on yield. Muriate of potash application had a significant effect on bunch number.

A number of treatment interaction were significant. These were NxK, NxP, KxEFB. This suggests that on the interfluve soils combinations of these treatments are interdependent, and are required at certain combination levels to sustain reasonable yields.

Table 105. Main effects of N, P, K, and EFB an yield and yield components in 1995 (Trial 511)

	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Yield (t/ha/yr)	24.7	24.0	23.8	25.5	ns	1.03	11.9
Bunches/ha	1742	1643	1630	1810	ns	73	12.2
Bunch weight (kg)	14.2	14.7	14.7	14.2	ns	0.46	9.0
	P0	P1					
Yield (t/ha/yr)	24.2	24.9			ns	0.73	11.9
Bunches/ha	1684	1729			ns	52	12.2
Bunch weight (kg)	14.4	14.6			ns	0.32	9.0
	K0	K1	K2	K3			
Yield (t/ha/yr)	23.4	23.8	25.7	25.2	ns	1.03	11.9
Bunches/ha	1604	1677	1823	1721	*	73	12.2
Bunch weight (kg)	14.8	14.3	14.1	14.7	ns	0.46	9.0
	EFB0	EFB1					
Yield (t/ha/yr)	24.5	24.5			ns	0.73	11.9
Bunches/ha	1707	1706			ns	52	12.2
Bunch weight (kg)	14.5	14.4			ns	0.32	9.0

Table 106. Effect of N at different levels of P in 1995

	Yield (t/ha/year)	
	P0	P1
N0	23.0	26.4
N1	22.6	25.4
N2	25.3	22.4
N3	25.7	25.4

NxP interaction significant at 5% level (*)

Table 107. Effect of N at different levels of K in 1995

	Yield (t/ha/year)			
	K0	K1	K2	K3
N0	20.6	25.2	25.7	27.3
N1	23.4	21.5	26.1	25.0
N2	25.0	23.7	26.0	20.6
N3	24.8	24.6	24.8	27.9

NxK interaction significant at 5% level (*)

Table 108. Effect of EFB on different levels of K

	Yield (t/ha/year)			
	K0	K1	K2	K3
EFB0	23.5	24.8	27.0	22.8
EFB1	23.4	22.8	24.3	27.6

EFBxK interaction significant at 1% level (**)

The KxEFB interaction is shows that a yield of 27 tonnes/ha/yr can be achieved with 5kg of MOP or with 7.5kg MOP + 600kg of EFB.

There were no significant treatment effects on the nutrient concentrations of leaflet tissue. It is expected that 1996 results will show treatment effects.

Table 109. Main effects of N, P, K and EFB on leaflet nutrient concentrations in 1995 (Trial 511)

Element as % of dry matter	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	2.15	2.17	2.20	2.19	ns	0.02	2.9
Phosphorus	0.125	0.127	0.128	0.127	ns	0.001	2.3
Potassium	0.66	0.66	0.66	0.66	ns	0.02	8.4
Calcium	0.86	0.89	0.88	0.88	ns	0.02	5.1
Magnesium	0.36	0.37	0.38	0.36	ns	0.01	8.0
Chlorine	0.52	0.51	0.51	0.51	ns	0.01	7.5
	P0	P1					
Nitrogen	2.17	2.19			ns	0.02	2.9
Phosphorus	0.126	0.127			ns	0.001	2.3
Potassium	0.66	0.66			ns	0.01	8.4
Calcium	0.89	0.86			ns	0.01	5.1
Magnesium	0.37	0.37			ns	0.007	8.0
Chlorine	0.51	0.51			ns	0.01	7.5
	K0	K1	K2	K3			
Nitrogen	2.16	2.15	2.19	2.21	ns	0.02	2.9
Phosphorus	0.126	0.126	0.127	0.127	ns	0.001	2.3
Potassium	0.65	0.66	0.67	0.67	ns	0.02	8.4
Calcium	0.86	0.89	0.87	0.88	ns	0.02	5.1
Magnesium	0.36	0.38	0.37	0.37	ns	0.01	8.0
Chlorine	0.51	0.51	0.52	0.52	ns	0.01	7.5
	EFB0	EFB1					
Nitrogen	2.18	2.18			ns	0.02	2.9
Phosphorus	0.127	0.127			ns	0.001	2.3
Potassium	0.66	0.66			ns	0.01	8.4
Calcium	0.88	0.87			ns	0.01	5.1
Magnesium	0.37	0.37			ns	0.007	8.0
Chlorine	0.51	0.51			ns	0.01	7.5

Table 110. Main effects of N, P, K, and EFB on rachis nutrient concentrations in 1995 (Trial 511)

Element as % dry matter	Nutrient element and level				Statistics		
					sig	sed	cv%
	N0	N1	N2	N3			
Nitrogen	0.26	0.25	0.26	0.25	ns	0.006	7.1
Phosphorus	0.043	0.042	0.041	0.043	ns	0.003	21.8
Potassium	1.46	1.43	1.35	1.42	*	0.03	6.8
Calcium	0.34	0.34	0.33	0.33	ns	0.009	7.3
Magnesium	0.12	0.12	0.12	0.12	ns	0.004	9.8
Chlorine	0.95	0.94	0.89	0.94	ns	0.03	10.2
	P0	P1					
Nitrogen	0.26	0.26			ns	0.004	7.1
Phosphorus	0.042	0.043			ns	0.002	21.8
Potassium	1.41	1.42			ns	0.02	6.8
Calcium	0.34	0.34			ns	0.006	7.3
Magnesium	0.12	0.12			ns	0.003	9.8
Chlorine	0.92	0.94			ns	0.02	10.2
	K0	K1	K2	K3			
Nitrogen	0.26	0.25	0.26	0.26	ns	0.006	7.1
Phosphorus	0.043	0.040	0.043	0.043	ns	0.003	21.8
Potassium	1.41	1.41	1.43	1.42	ns	0.03	6.8
Calcium	0.34	0.33	0.33	0.34	ns	0.009	7.3
Magnesium	0.12	0.12	0.12	0.12	ns	0.004	9.8
Chlorine	0.92	0.93	0.94	0.93	ns	0.03	10.2
	EFB0	EFB1					
Nitrogen	0.25	0.26			ns	0.004	7.1
Phosphorus	0.043	0.042			ns	0.002	21.8
Potassium	1.40	1.43			ns	0.02	6.8
Calcium	0.33	0.34			ns	0.006	7.3
Magnesium	0.12	0.12			ns	0.003	9.8
Chlorine	0.91	0.95			ns	0.02	10.2

IV. ENTOMOLOGY SECTION

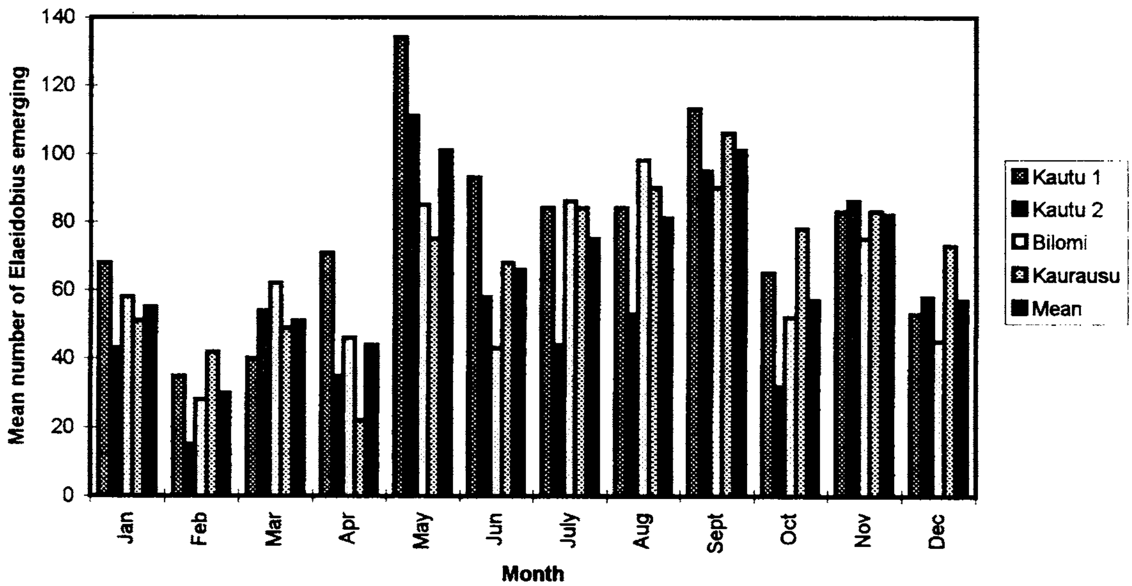
Investigation 603: The Pollinating Weevil, *Elaeidobius kamerunicus*

During 1995 investigations continued into the efficacy of insect pollination of oil palm. Four sites at Kapiura (Kautu 1, Kautu 2, Bilomi and Karausu) were monitored monthly and the mean number of *Elaeidobius kamerunicus* emerging from male spikelets determined. The results of this investigation are shown in Table 111 and illustrated in Figure 7.

Table 111. The mean number of *Elaeidobius kamerunicus* emerging from male spikelets at the four trial sites at Kapiura for each month during 1995.

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Kautu 1	68	35	40	71	134	93	84	84	113	65	83	53
Kautu 2	43	15	54	35	111	58	44	53	95	32	86	58
Bilomi	58	28	62	46	85	43	86	98	90	52	75	45
Kaurausu	51	42	49	22	75	68	84	90	106	78	83	73
Mean	55	30	51	44	101	66	75	81	101	57	82	57

Figure 7. Mean number of Elaeidobius emerging from male spikelets at Kapiura for 1995



The emergence data from the four sites indicate a relatively high weevil population at all sites throughout the year. February had a slightly lower mean emergence relative to the other months, and this is probably explained by the high rainfall experienced during this time of the year in West New Britain.

Weekly counting of inflorescences at the four sites at Kapiura continued, and the mean numbers of male and female flowers at the sites for each month are shown in Table 112. From Table 112 it can be seen that there was a high ratio of male to female inflorescences throughout 1995. Therefore, because of the large pollen supply, adequate levels of pollination would be expected in these areas.

Pollen samples were collected from these four sites during the first quarter of the year, and germination tests on these samples indicated a mean viability of 85%.

Table 112. The mean number of male and female inflorescences per 120, 115, 115, and 116 palms at the four trial sites at Kapiura for each month during 1995.

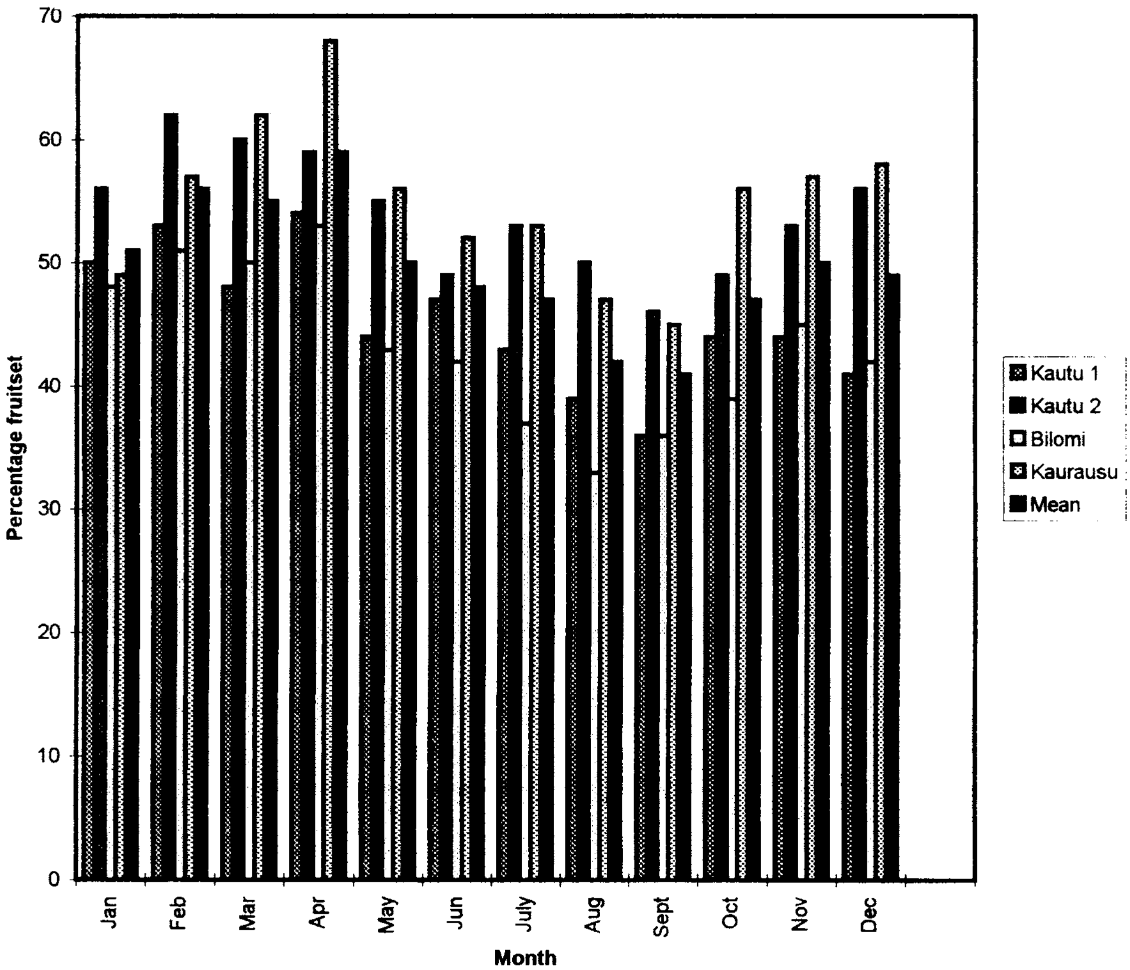
	Mean number of male and female (M:F) inflorescences per 120, 115, 115, and 116 palms respectively at Kautu 1, Kautu 2, Bilomi and Kaurausu per month in 1995			
Site	Kautu 1	Kautu 2	Bilomi	Kaurausu
January	15:7	27:7	20:5	21:11
February	17:7	21:10	18:12	24:10
March	28:8	28:7	24:7	24:8
April	23:5	35:5	27:3	25:8
May	28:6	30:3	25:3	23:9
June	25:11	28:10	19:6	22:13
July	21:7	29:12	19:6	18:10
August	14:8	18:7	16:6	15:6
September	18:3	20:7	19:3	20:3
October	17:4	20:3	18:3	20:2
November	12:4	13:4	12:3	13:3
December	11:3	13:3	12:2	13:3
Mean	19:6	24:7	19:5	20:7

The percentage fruitset levels for the four sites at Kapiura are shown in Table 113 and illustrated in Figure 8. It is apparent that relatively high fruitset levels occurred at all four sites throughout the year. The slight reduction in fruitset during August and September may have been due to the reductions in weevil populations and / or relatively low pollinating efficacy in February. As previously mentioned, this is probably due to the high rainfall in West New Britain during this time. Several workers in other oil palm growing countries have found that similar reductions in fruitset occur because of poor insect pollination during the rainy season, and it has been found that the pollen load of the weevil determines fruitset levels during these periods. The number of rainy days and the availability of the male inflorescence are the major factors that determine the pollen load of the weevil. Persistently heavy rains reduce the load and viability of the pollen carried by the weevils, thereby reducing fruitset. During the rainy season the pollen load of the weevils may be washed off, or the pollen may germinate before being transferred to the female inflorescence.

Table 113. The percentage fruitset levels for each of the four trial sites at Kapiura for 1995

	Percentage fruitset for each for the four sites at Kapiura for 1995											
Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Kautu 1	50	53	48	54	44	47	43	39	36	44	44	41
Kautu 2	56	62	60	59	55	49	53	50	46	49	53	56
Bilomi	48	51	50	53	43	42	37	33	36	39	45	42
Kaurausu	49	57	62	68	56	52	53	47	45	56	57	58
Mean	51	56	55	59	50	48	47	42	41	47	50	49

Figure 8. Percentage fruitset for each of the four sites at Kapiura for 1995



Investigation 601: Sexava chemical control

Sexava damage was widespread in West New Britain during 1995.

At NBPOL Mosa, *Segestes decoratus* was reported to be causing significant damage at Bebere Division 2, and Navarai Plantation; and *Segestidea defoliaria* was reported at Kumbango Division 3. All of these areas were recommended for chemical treatment.

At NBPOL Kapiura, *S. defoliaria* was reported to be causing significant damage at Malalimi, Bilomi Division 1, Kautu Division 2, and Kaurausu Plantation. These areas were also recommended for treatment.

Sexava were also reported to be causing significant damage to smallholder blocks in the Hoskins area. These included 42 blocks at Sarakolok that were damaged by *S. decoratus*, and recommended for chemical treatment whilst *S. defoliaria* was reported to be causing damage at Kapore (14 blocks), Kavui (1 block), and Rikau VOP (16 blocks). All these areas were recommended for chemical treatment.

At Hargy Oil Palms, Sexava caused significant damage to large areas of plantation in the Bialla area, and a number of areas at Navo plantation were also effected. There were widespread outbreaks of *S. defoliaria* in Areas 4 - 11 at Hargy. These areas received chemical treatment, and the situation was brought back under control. There were no reports of new Sexava damage at Hargy or Navo Plantations from November onwards.

Sexava were also reported to be causing significant damage to smallholder blocks in the Central Nakanai and Bialla areas. In the Central Nakanai, 29 blocks at Silanga, 55 blocks at Vasilau, and 42 blocks at Sale / Malassi were recommended for chemical treatment against *S. defoliaria*. In the first quarter of 1995 a total of 73 Smallholder blocks were recommended for chemical treatment at the Tiauru Subdivision at Bialla. There were no reports of new Sexava damage in these areas from November onwards.

Investigation 607: Sexava biological control

The two species of Sexava egg Parasitoid (*Leefmansi bicolor* and *Doirania leefmansi*) continued to be reared at Dami. A new insectary was built at Hargy Oil Palms, and this enabled the parasitoids to be reared at a second location. A total of 377,340 *Leefmansi bicolor* and 1,542,500 *Doirania leefmansi* were released into several areas in 1995. Details of the releases are given in Table 114.

In addition to the rearing and release of egg parasitoids, work continued during 1995 to determine the potential of the Strepsipteran, *Stichotrema dallatorreanum,* as a biological control agent for Sexava. The female of the Strepsipteran parasitises is found in sexava in Oro Province and in a species of Katydid found in the Hoskins area. During 1995 observations continued to attempt to identify the host for the male Strepsipteran, which was thought to be an arboreal ant, *Camponotus* sp. Ant colonies were established in the laboratory and on oil palms at Dami in attempts to investigate this further.

Table 114. Field release details for the two species of Sexava egg Parasitoid (*Leefmansi bicolor* and *Doirania leefmansi*) that were reared at Dami and Hargy during 1995.

Date of release	Location of release	Number of adult parasitoids released	
		Leefmansi bicolor	*Doirania leefmansi*
17 January	Lavege VOP	8 800	-
24 January	Dami	4 400	37 800
25 January	Lavege	8 800	-
9 February	Sege VOP	5 200	-
9 February	Ambusa	10 000	-
23 February	Hargy	35 200	-
6 March	Hargy	4 400	-
6 March	Tiauru sub-division	-	44 000
13 March	Hargy	17 600	-
22 March	Dami	-	44 000
22 March	Hargy	8 800	-
27 March	Dami	-	42 000
27 March	Hargy	4 400	-
29 March	Hargy	8 800	-
3 April	Hargy	8 800	-
3 April	Hargy	8 800	-
5 Aril	Bebere	20 250	27 500
6 April	Hargy	30 800	-
28 April	Cape Gloucester	10 815	424 500
3 May	Bebere	5 600	-
9 May	Sarakolok	11 550	82 500
6 June	Navo	21 945	156 750
13 June	Dami	7 700	-
20 June	Navarai	28 840	148 500
4 July	Rikau VOP	7 700	-
10 July	Dami	7 700	55 000
19 August	Bilomi	-	61 250
7 September	Silanga VOP	6 230	27 500
7 September	Vasilau VOP	11 725	10 000
7 September	Salelebu VOP	13 405	95 750
30 September	Bilomi	15 400	137 500
14 October	Dami	7 700	82 500
23 October	Kumbango	11 130	11 700
2 November	Dami	21 000	53 750
6 November	Dami	3 850	-
Total number released for 1995		***377 340***	***1 542 500***

Investigation 606: Control of Bagworms (Lepidoptera: Psychidae)

Low levels of Bagworms were reported at NBPOL Kumbango and Bilomi Plantations, and at the mill compound at Mosa. Chemical treatment was not recommended for these areas, and hand picking gave good control. There were however more serious outbreaks of Bagworms at Kautu 2, and Kaurausu Plantation during 1995, and chemical treatment of these areas was recommended.

Investigation 608: Rhinoceros Beetle (*Scapanes* and *Oryctes*) control

There were no reports of *Scapanes* damage during 1995. The first report of *Oryctes* causing damage to oil palm in West New Britain occurred in April 1995. *Oryctes* were found be causing damage to young plantings at Numundo plantation. OPRA monitored the damage levels during the subsequent months, and submitted a separate report on the situation to NBPOL. The development of a good cover crop, along with treatments with Furadan granules, and the release of *Oryctes* Baculovirus, kept the situation under control.. The damage levels to the young plantings at Numundo were light during the remainder of 1995.

Investigation 605: Observation of other pests

Leaf-eating caterpillars of the *Acria* moth (Lepidoptera: Xyloryctidae) were reported to be present on oil palm in West New Britain. During 1995 it was reported at Bebere nursery and at a number of other locations. Damage levels were however very low, and no chemical treatment was required. There is usually a high level of infection of these leaf-eating caterpillars by a number of parasitic wasps, and this probably contributes to field suppression of this pest.

The *Papuana* sp of Taro beetle (Coleoptera: Scarabaeidae) was reported from Garu nursery. Damage levels were however very low, and no chemical treatment was required. Hand picking of adult beetles in the nursery, and clearing of the vegetation immediately surrounding perimeter of the nursery, gave adequate levels of control.

In 1995 the Planthopper, *Zophiuma lobulata* (Homoptera: Lophopidae) continued to spread through Coconuts blocks around Kimbe, Mosa, Mai, Buluma, Banuale, Dami and Hoskins. Finschhafen disease of coconut palms was present in these areas, and chemical treatment was required to control the Planthopper vectors of the disease. This was done using trunk injection of monocrotophos. OPRA continued to monitor the situation, and to check whether the pest was also effecting oil palms in these areas.

There were no reports of new pests from Milne Bay, New Ireland or Oro Province.

V. PLANT PATHOLOGY

GANODERMA PROJECT: The development of long term control measures to prevent crop loss to *Ganoderma* infection.

Project Objectives

1. To study the epidemiology of the of basal stem rot caused by *Ganoderma* in order to develop improved control strategies for the disease.

2. To characterise the variability and the nature of the population in Papua New Guinea to enable the implementation of an effective screening programme to identify resistance to *Ganoderma* within oil palm.

Staff Dr. Pim Sanderson, Ms. Carmel Pilotti

Activities: June 1995 to August 1996

1. **Training** Carmel Pilotti was attached to the Biotechnology Unit at the International Mycological Institute from 21st June 1995 to 19th August 1995 for training in molecular techniques for *Ganoderma* characterisation.

2. **Laboratory:** All laboratory equipment was delivered during the latter half of 1995 and the first six months of 1996. The laboratory is now adequately equipped to begin studies on *Ganoderma* however, additional equipment is required for future work.

2. EPIDEMIOLOGY AND FIELD SURVIVAL

2.1 Aim: To study the current extent of *Ganoderma* infection within the oil palm plantation.

Two, approximately one hectare plots were selected in Waigani, the first (Block 6505 HR29, rows 177 - 180) because of the incidence of basal stem rot reported in the first survey, the second (Block 6503 HR1 rows 522 - 528) because two palms had been identified with typical symptoms of Basal stem rot, though without fruiting bodies.

Palms were pushed over with a front-end loader, and each palm cut at the base, infection was recorded and wood samples collected for isolation. Palms were then pushed into the inter-rows and bases were left in the ground.

Blocks are being checked at monthly intervals for the presence of *Ganoderma* on fallen logs or on the stem bases.

2.2 Results:

No infected palms were detected in Block 6505.

Of the 2 palms which had apparant top symptoms in Block 6503, only one had internal basal rot. *Ganoderma* was not isolated from this palm.

Four other palms had typical Basal stem rot although *Ganoderma* was isolated from only one of these palms.

Twenty six palms had fingers of what could conceivably have been old infection sites of *Ganoderma* moving up through the trunk from the basal plate.

Fifty of the palms fractured at the basal plate when pushed over, leaving the root system in the ground, as would be expected if the palm was infected with Basal stem rot. The fracture appeared to occur about 10 - 15 mm above the base of the palm. Protruding from the trunk were numerous vascular bundles which ended at the base of the palms. These were not part of the root system. We believe these to be the vascular bundles originally connected to the first leaves. Similar vascular bundles can be seen associated with old leaf bases in areas of basal rot. At the tip of each protruding vascular bundle was a black abscission layer. Those vascular bundles associated with the *Ganoderma* rot were dark brown and contained obvious lesions from which *Ganoderma* was isolated.

2.3 Discussion: *Ganoderma* was isolated from only one of the six palms with typical symptoms of Basal stem rot suggesting that the *Ganoderma* infection for the other five palms was no longer active.

It appears that the vascular bundles from the early leaves could provide a possible entry point into the basal plate of the palms, for any *Ganoderma* degrading the old leaf bases.

3. LABORATORY STUDIES

3.1 Aim: To study the nature and variation within the *Ganoderma* population

3.2 Introduction: In order to understand the development of aggressiveness within the population and the mode of spread of this disease it is necessary to obtain a clear picture of the mating system and determine the variation within the *Ganoderma* population. Once this information is available we will then be in a position to formulate effective control measures.

3.3 Results: Single spores were collected from oil palm and coconut and used in crossing experiments

The mating system of monokaryons derived from the same basidiome is typically tetrapolar. One in three crosses are successful.

When the monokaryons are outcrossed between families derived from different basidiomes there appears to be no restriction on mating. All crosses are successful, suggesting a multi-allelic system

Initial experiments where dikaryons were backcrossed to the original parents (monokaryons), success depended on the relatedness of the cross. Vegetative compatibility was greatest in closely related isolates while the production of clamps was greatest in non-related isolates.

Rob Miller at IMI has demonstrated in two trials in Malaysia that crossing dikaryotic cultures from different palms are all vegetatively incompatible, while those derived from fruiting bodies from the same palm are compatible. Our results confirmed this.

Mitochondrial DNA RFLPs from monokaryons in the same family group do not vary within the family or the original dikaryon, but vary widely between families. Isoenzyme and secondary metabolite profiles show varying levels of difference within a family and may be of use in following individual monokaryons.

3.4 Discussion: This suggests that *Ganoderma* has developed a highly sophisticated mating system which discourages inbreeding and strongly encourages outbreeding, and that once the dikaryon is formed further crossing is restricted.

Previous work on this program and by Rob Miller has shown that there is extensive mtDNA variation that is not consistent with simple unilinear inheritance. This along with the work of Rob Miller on vegetative incompatibility between isolates from neighboring palms, work which has subsequently been confirmed by the team under Professor Swinburne at Wye, and our work on the mating system, all point very strongly to the suggestion that spores play an important role in the infection cycle, rather than infection arising from root contact. If this is the case, then new control strategies will have to be formulated accordingly.

4. *GANODERMA*SURVEY REPORT 1995-1996 MILNE BAY AND POLIAMBA ESTATES

4.1 Introduction: This report covers *Ganoderma* disease surveys for Milne Bay and Poliamba Estates, carried out by OPRA and MBE staff up to September, 1996. Three surveys have been carried out to date. The first in 1994 covered only 1986 plantings in Milne Bay and was carried out by staff of Milne Bay estates. The second survey in September 1995 covered all three estates Waigani, Hagita and Giligili at Milne Bay and selected estates at Poliamba in New Ireland. The third survey for Milne Bay which included Sagarai commenced in July, 1996 and has been completed. Surveys will be done at six-monthly intervals.

4.2 Disease Survey Results

Disease Incidence In Each Province: Tables 115 and 116 show disease levels in each estate by age group in Milne Bay and New Ireland Provinces.

Mean disease incidence is higher in New Ireland (0.64%, range 0.17-1.17) than in Milne Bay (0.15%, range 0.01-0..53). The highest occurrence of the disease in Milne Bay was observed in 1986 ex-coconut plantings in Waigani (0..53%). There was no difference in the disease incidence between ex-coconut and ex-forest areas for 1987 plantings at Waigani. Incidence in 1987 ex-coconut plantings at Giligili is twice that of ex-forest areas.

Table 115. Summary for Milne Bay Province. 1994,1995 & 1996 Surveys.

ESTATE	YEAR OF PLANTING	HECTARES SURVEYED	TOTAL TO DATE	PREVIOUS CROP/VEG.	% INCIDENCE
WAIGANI	1986	799.9	540	coconut	0..53
	1987	277.1	60	coconut	0.17
	1987	147.5	34	forest	0.18
	1988	521	92	forest	0.14
HAGITA	1986	502.1	154	coconut	0.24
	1987	256.5	67	forest	0.21
	1988	104.1	17	forest	0.13
GILIGILI	1987	414.7	81	coconut	0.15
	1987	132.1	11	forest	.07
SAGARAI	1989	431	6	forest	.011

1990	401	7	forest	.014
1993	558	9	forest	.013

Table 116. Summary for New Ireland Province.

ESTATE	YEAR OF PLANTING	HECTARES SURVEYED	TOTAL INFECTED	PREVIOUS CROP/VEG.	% INCIDENCE
BAIA	1989	14	3	coconut	0.17
LUGAGON	1990	14	6	coconut	0.33
MARAMAKAS	1989	54	70	coconut	1.01
MEDINA	1989	36	54	coconut	1.17
BOLEGILA	1988	71.4	77	coconut	0.85
LIBBA	1990	59.1	24	coconut	0.32

Maramakas and Medina 1989 plantings, had the highest levels of disease in New Ireland.

4.3 **Block Comparisons In Milne Bay:** Figures 9, 10 and 11 show the incidence of infection in surveyed blocks at Waigani, Hagita and Giligili at Milne Bay. P indicates blocks receiving palm oil mill effluent (POME). Over 50% of blocks in Waigani showed an increase in numbers of palms infected in the second survey (1996). The number of diseased palms in all POME blocks increased markedly.

Fig.9. Disease incidence by block in Waigani

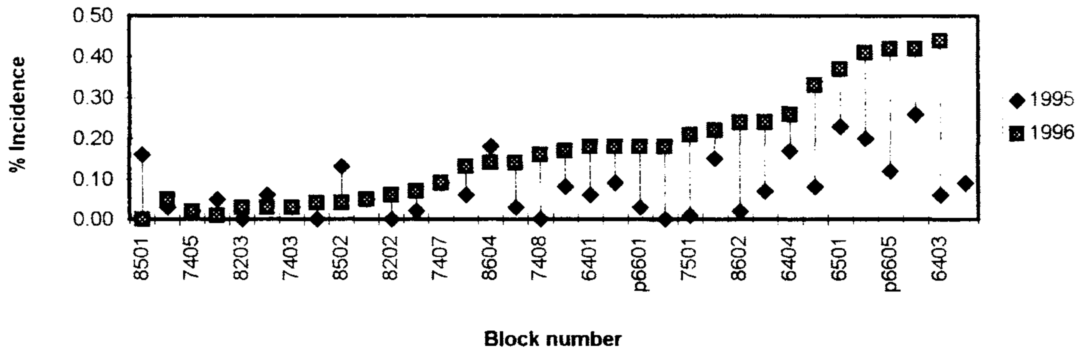


Fig 10. Disease incidence by block in

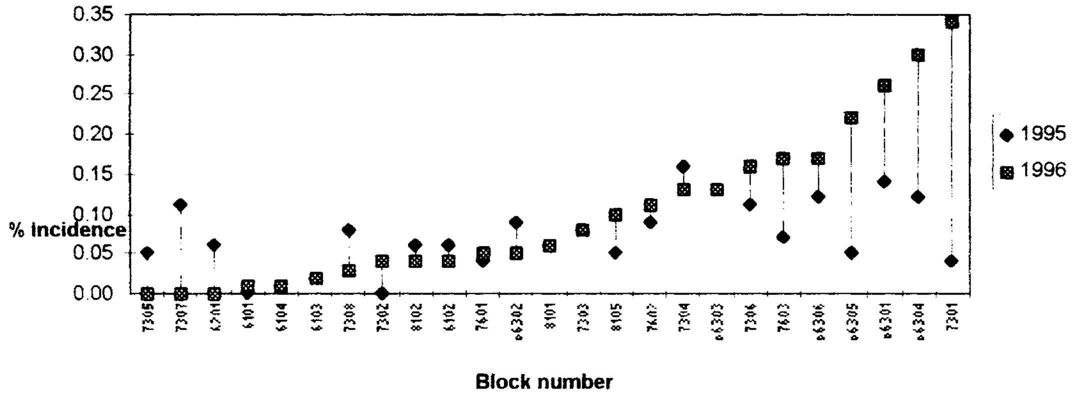
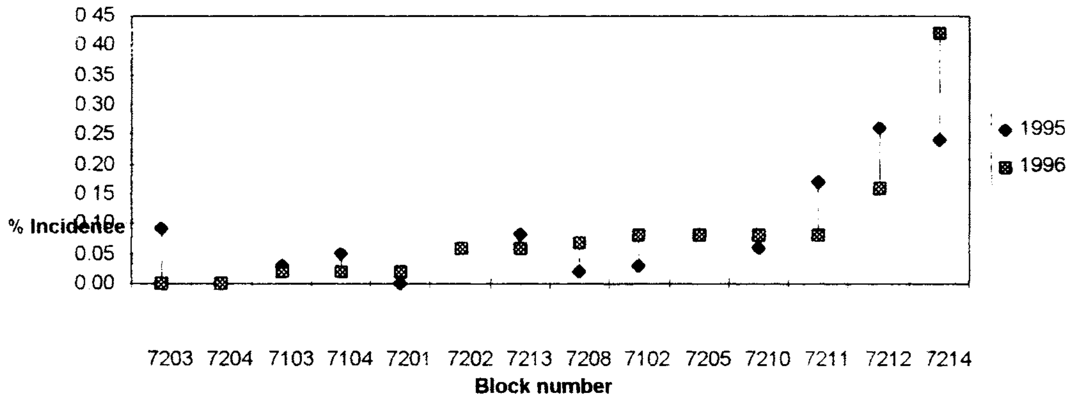
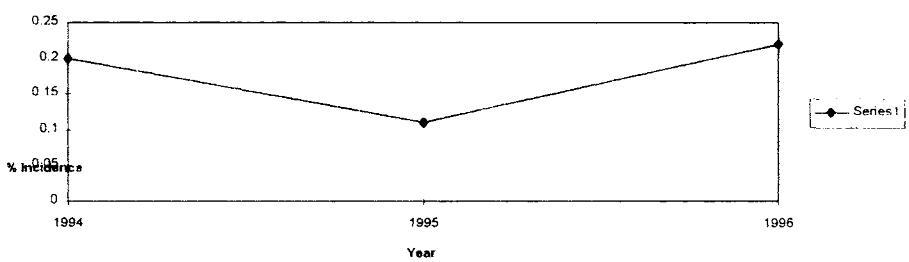


Fig 11. Disease incidence by block in Giligili



Just under 50% of the blocks in Hagita and Giligili estates had a higher disease incidence in 1996 than the previous year. Sixty percent of POME blocks in Hagita showed increased disease levels. The remaining blocks had the same or decreased incidence of basal stem rot.

Fig 12 Average disease incidence in 1986 plantings over three



4.4 Disease Data Collection And Analysis

4.4.1 Survey form: A survey form was prepared to collect information on disease symptoms and other variables in the field. This form will be used for future follow-up surveys by OPRA staff.

All palms identified in the survey by MBE staff were inspected by OPRA staff and data recorded according to the survey form. Selected palms were marked with yellow tape for future study. All other palms were removed according to current control practices.

4.4.2 **Analysis of data:** Table 3 shows that over half the palms examined in the 1995 survey at Milne Bay had visible basal rot. Fifty percent (50%) of 1987 plantings in ex-coconut areas had *Ganoderma* fruiting bodies while 19% of palms in ex-forest areas had fruiting bodies. The number of fruiting bodies present decreased further in the 1988 plantings (13.2%).

Tab 117. Summary of disease data in Milne Bay.

	% with basal rot			% with fruiting bodies			% next to windrow		
Year	1986	1987	1988	1986	1987	1988	1986	1987	198
FOREST	-	61.9	52.8	-	19.0	13.2	-	71.0	8
COCONUT	50.3	61.8	-	54.5	50.9	-	46.9	50.9	34.0

Each symptom of the disease was given a rating from one to six, beginning with the first signs of discolouration of the fronds (pale yellow = 1) to collapsed palm (collapsed = 6). Symptoms were then correlated to the number of basidiophores (fruiting bodies) found per palm. Symptoms were also correlated to the age of the palms in Milne Bay Province. Data presented is for 279 palms.

There was no relationship ($r = -0.098$ and $r = -0.184$) between the degree of disease symptoms and the number of fruiting bodies seen on each palm at both Milne Bay and New Ireland (Figures 11 and 12). Clearly the presence or absence of fruiting bodies is not an indication of the degree of infection. Disease expression was also not related to age of the palm.

Hence, disease expression or symptoms do not necessarily increase with age of the palm and is probably only dependent on the inherent tolerance of the palm to infection.

APPENDIX 1

RAINFALL DATA

Table 117: Rainfall data for main trial sites in 1995

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Dami	302	437	520	165	244	170	82	83	292	118	123	224	2762
Kapiura	104	315	382	322	308	249	177	100	335	142	183	334	2951
Hargy	172	277	597	140	348	123	251	147	194	100	228	368	2945
Lakuramau	135	272	435	162	305	42	250	151	105	144	104	467	2943
Higaturu	289	301	191	174	176	54	62	97	101	264	260	365	2334
Sagarai	149	139	359	221	259	121	83	331	152	170	75	345	2404
Waigani	208	86	502	283	313	200	88	570	147	150	180	353	3080
Hagita	240	59	379	531	242	273	103	435	124	149	280	217	3032