RESPONSE TO INTEGRATED SOIL FERTILITY MANAGEMENT (ISFM) OF HYBRID COCONUT GROWN ON AN INLAND SOIL OF SOUTH COTABATO, PHILIPPINES

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A study to assess the effect of organic fertilizer in comparison with inorganic fertilizers and their combination on MAWA hybrid coconut was conducted at Polonuling, Tupi, South Cotabato from 1985 to 1993.

The application of 1.0 kg (NH4)2SO4 + 1.8 kg NaCl + 1.5 kg CaMgCO3 or the higher dosage (2x) resulted in consistent significant (P0.01) increase in nut production, weight of copra per nut and per tree over the 8 yr period. Yields of coconut applied with corn cob alone (as organic fertilizer) did not vary with the control. But corn cob combined with Cl (NaCl) gave 34-62% increases in nut yield, 16-27% in copra weight per nut and 67-68% in copra yield per tree even as early as the 1st yr of production. Clearly, the improvement in yield was due mainly to the correction of Cl and N deficiencies of the palms.

Two fertilizer recommendations were possible based on yield and profit: (1) lower dosage of 1.0 kg (NH4)2SO4 + 1.8 kg NaCl and (2) 10 kg corn cob + 1.8 kg NaCl. These findings could be applied in areas with similar environmental conditions as in this study and several other coconut populations in the country.

Key words: Hybrid coconut, Cl fertilizer, N fertilization, corn cob as fertilizer, integrated soil fertility management (ISFM)

INTRODUCTION

In the late seventies, field fertilizer trials were conducted only in the Mindanao provinces using chemical or inorganic fertilizers. These trials produced impressive results. But more data are still needed especially for hybrids in practically all parts of the country and local tall in the Visayas and Luzon.

These field trials and those conducted in the research centers revealed positive responses to inorganic fertilization especially when N, Cl, and S were present in the fertilizer materials (Prudente and Mendoza 1976; Magat et al. 1977; Margate et al. 1979; Magat et al. 1986). Improvement in nut and copra production per nut or per palm were common which were observed two years after the initial fertilizer application although slight increases were already noted even in the 1st yr (Padrones et al. 1985). The noted increases in production with inorganic fertilization were always associated with increases in the N, Cl, and S levels in the leaves. The unfertilized palms on the other hand, were generally found to have decreasing yield from year to year.

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Nowadays, however, the use of organic fertilizer in modern crop production has been gaining worldwide acceptance primarily due to environmental concern. Besides, a number of Asian countries like India, Thailand and the Philippines are also concerned with reducing the cost of the government's importation of chemical fertilizers. This is one of the thrusts of the government in conserving foreign exhange earnings. In 1992, the Philippines consumed 1.3 MT of chemical fertilizers of various grades (Mangawang 1993). Of these, 1.13 MT were imported costing $168 M.

Hence research undertakings are gradually being shifted from pure inorganic fertilizer application to organic fertilization or their combinations in an effort to introduce the concept of integrated soil fertility management (ISFM) in coconut farming. ISFM may be defined as the combined use of organic or natural and inorganic or chemical fertilizer in coconut farming aimed at reaching maximum economic yield through a sustainable, economical, environmental friendly and socially acceptable production system (Magat 1991).

This study was conducted to (1) explore other alternative fertilizer source for coconut, (2) to know the effects of pure organic and its combination with inorganic fertilizers on coconut growth and yield and (3) serve as demonstration plots on the effects of fertilizer application and/or non-application on coconut.

The 'Mawa' hybrid was used since it was then the only available hybrid material recommended for the replanting program of the government.

MATERIALS AND METHODS

Experimental site

The study was conducted in an inland-flat area of Polonuling, Tupi, South Cotabato. The soil was characterized as sandy loam with an initial pH of 5.4 and having good internal and external drainage. The area had an average rainfall of 1,590 mm/yr for the last 8 yr (Appendix Table 1).

The study utilized the existing 4-yr old 'MAWA' hybrid coconuts planted in a 9 m x 9 m triangular system.

Experimental Design and Treatments

The study was arranged in a randomized complete block design with 5 treatments, 12 palms per plot in 4 replications. The treatments per palm per year were the following:

1. control (no fertilizer)
2. 1.0 kg AS + 1.8 kg NaCl + 1.5 kg dol 1/
3. twice treatment 2
4. 10 kg corn cob 2/
5. 10 kg corn cob + 1.8 kg NaCl + 1.5 kg dol

1/ AS - ammonium sulfate
Dol - dolomite

2/ Corn cob contains 2.11% N, 8.83% water soluble chloride and 1.460 ppm Ca

Soil and Leaf Analysis

Soil samples were collected at the start and end of the study for the chemical and physical analysis, while leaf samples were collected yearly for analysis of N, P, K, Ca, Mg, Na, Cl, S, and B. This was made to follow-up the nutritional development in relation to the yield increase of the palm as influenced by fertilizer application.

Data Gathering

During the first 2 yr of the study growth parameters like girth, number of leaves

produced and leaf count were collected. Later , as the palms produced nuts, yield data on the number of nuts, weight of copra per nut and per tree were gathered. This was done every 60 days. 20 nut samples per plot were taken every harvest for nut and copra yield estimate.

RESULT AND DISCUSSION

Growth of the Palms

The different fertilizer treatments did not affect the growth of the palms in the 1st yr in terms of number of living fronds and leaflet count (Table 1). But starting the 2nd yr, significant effect was already observed on the inorganic fertilizer treatment in terms of the number of living leaves, while the total number of leaves produced for the whole year was significantly increased by both inorganic and organic fertilization applied separately.

Nut Production

Starting the 3rd yr of the study, the two levels of inorganic fertilization (treatments 2 & 3) significantly increased nut production (Fig.1 & Appendix Table 1). This was carried on consistently until the end of the study on the 8 yr. However, the 2 fertilizer levels did not differ significantly from each other despite doubling the dosage. The application of organic fertilizer alone (corn cob) did not significantly differ with the control in all the years of observation. This indicates that organic fertilization does not easily produce immediate effect in perennial crops like coconut in contrast to inorganic fertilizer, and may not be enough to meet the nutritional needs of the palms. However, when the corn cob was combined with the inorganic Cl and Mg sources (treatment 5) significant improvements were observed especially in later years (Fig. 2). Although the yields were still lower than the yield obtained from inorganic-treated plots, the percentage increases over the control ranged from 34 - 109%. This means that the corn cob should be combined with a Cl source to be more effective. The increase in yield with organic + inorganic combination started in the 3rd yr and became more apparent in the 4th yr and on.

Copra Yield per Nut and per Palm

The copra weight per nut or per tree was greatly improved with inorganic fertilization (treatments 2 and 3) starting the

TABLE 1
Growth of palms under the different treatments

TREATMENT	LEAF COUNT (NO.)		NO.OF LEAFLET (rank 9)		LEAVES PRODUCED (NO.)
	YR 1	YR 2	YR 1	YR 2	YR 2
1.Control	20.2	21.7b	202.5	214.2	13.9b
2.1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	21.3	24.4a	199.0	213.9	14.7a
3.Twice Treatment 2	20.2	23.7ab	198.1	222.0	14.9a
4.10 kg corn cob	20.5	23.5ab	191.7	224.4	14.6a
5.10 kg corn cob 1.8 kg NaCl + 1.5 kg Dol	19.0	23.1ab	195.5	221.8	14.4ab
HSD 0.05	ns	2.298	ns	ns	0.6
0.01	-	3.116	-	-	0.8
C.V. (%)	5.8	4.03	4.6	2.5	1.9

ns - not significant
means with the same letter are not significantly different at 5% level (HSD test)

APPENDIX

TABLE 1
Yield of palms as influenced by fertilizer treatments 1/

TREATMENT	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8
			NUT PER TREE (No.)			
1.Control	28.3c	33.6b	32.3b	37.7c	36.8b	33.8c
2.1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	53.0ab	84.7a	80.3a	99.2a	95.0a	76.6ab
3.Twice treat	2 56.0a	89.2a	93.6a	97.3a	106.9a	85.2a
4.10 kg corn cob	26.6c	28.4b	32.0b	35.7c	35.1b	30.6c
5.10 kg corn cob	37.9bc	54.4ab	67.5a	71.1b	63.9b	57.1b
HSD 0.05	16.97	37.34	30.951	19.2	29.7	19.9
0.01	21.975	48.351	40.078	24.9	38.5	25.8
C.V. (%)	18.6	28.5	22.5	12.5	19.5	15.6
			COPRA PER NUT (g)			
1.Control	216.9c	244.2	223.2b	177.7b	218.0b	212.6c
2.1.0 kg AS + .1.8 kg NaCl + 1.5 kg Dol	269.9a	285.8	307.3a	244.0a	297.6a	295.8a
3.Twice treat. 2	283.3a	292.9	305.4a	244.0a	301.2a	313.1a
4.10 kg corn cob	231.1c	262.4	231.5b	186.8b	223.5b	223.7b
5.10 kg corn cob 1.8 kg NaCl + 1.5 kg Dol	267.3ab	284.1	291.7a	230.8a	289.3a	296.4a
HSD 0.05	33.622	ns	26.829	24.8	30.5	19.9
0.01	43.531	-	34.741	32.2	39.5	25.8
C.V. (%)	5.9	12.9	4.4	5.1	5.1	4.1
			COPRA PER TREE (kg)			
1.Control	6.1c	8.3b	7.3c	6.7c	8.0c	7.2b
2.1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	14.3ab	24.2a	24.8ab	24.2a	28.3a	22.7a
3.Twice treat. 2	15.8a	25.7a	28.4a	23.5a	32.1a	26.6a
4.10 kg corn cob	6.1c	7.3b	7.7c	6.7c	7.9c	6.8b
5.10 kg corn cob	10.2bc	15.6ab	19.6b	16.4b	18.4b	17.0a
HSD 0.05	4.591	10.279	8.54	4.32	7.3	6.156
0.01	5.945	13.310	11.058	5.60	9.4	7.97
C.V. (%)	19.4	28.1	21.6	12.4	17.1	17.0

1/
YR 3 = 4 harvests
YR 4 = 5 harvests
YR 5 = 6 harvests
YR 6 = 6 harvests
YR 7 = 5 harvest
YR 8 = 5 harvests
means having the same letters are not significantly different at 5% level (HSD test)

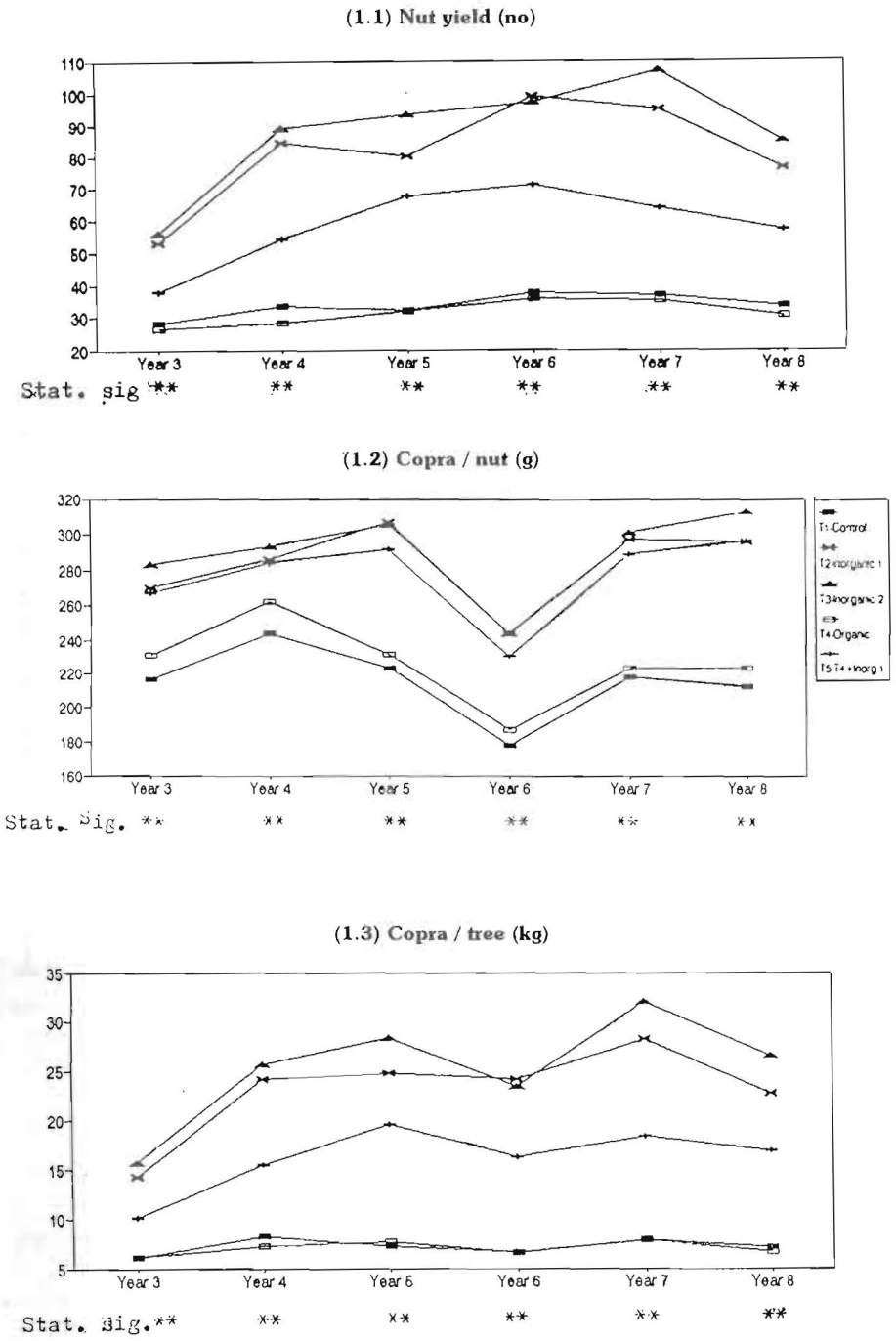

FIGURE 1
Yield of Palms as Influenced by Fertilizer Treatments on (1.1) Nut yield, (1.2) Copra weight and (1.3) Copra yield

1st yr of bearing, that is - the 3rd yr from initial fertilization (Fig. 1 & Appendix Table 1). The increases in copra yield/palm over the control ranged from 134 (yr 3) to as high as 300% (yr 7). Again, the two levels did not differ significantly despite doubling the amount of fertilizers in the higher dosage.

With organic corn cob fertilization still no apparent response was noted. But again when it was combined with Cl and Mg sources (treatment 5) it improved copra yield/nut ranging from 16 to 39% and copra weight/tree from 68 to 168%. These increases in copra yield started in the 3rd yr but more dramatic increase started during the 4th yr. However, these increases were still below par when compared with the inorganic fertilizer treatments.

Hence, unlike in other short-season crops in which organic fertilizer alone immediately affects the present crop being fertilized (Javier 1992; Barroga 1988), in coconut, organic fertilizers have to be combined with a chloride source and other elements deficient in the soil to effect increase in yield in 3 to 4 yr from initial application.

Leaf Nutrients

Only elements (N, Na, Cl, and B) that were significantly affected be fertilizer treatments are presented in (Fig. 3 & Appendix Table 2). N was greatly improved with the application of inorganic fertilizers compared with the control. But the levels were still below the critical levels even with higher dosage. This was consistent in all the years of observation. The organic fertilizers on the other hand, did not increase the N content in the leaves either applied singly or in combination with inorganic chloride and dolomite sources. Again, this suggest that corn cob can not cope with the N requirement of the palms. Phosphorus and K were not generally affected but there was a general tendency for K to be depressed when inorganic fertilizers were added. This could be due to dolomite application which antagonized K. Calcium was likewise increased with the highest level of inorganic fertilization, while Na and Cl increased significantly in treatments involving NaCl (treatments 2, 3, and 5). Sulfur was not significantly affected but B seemed to be depressed by the presence of Cl in some treatments which suggests negative interaction between these two elements.

In relation to coconut yield, there was a close association with Na, Cl, and N contents in the leaves and the coconut production. It was noted that in treatments where these elements were applied, nut and copra production increased. It is not surprising since N and Cl have been popularly implicated to be responsible for yield increases as observed in earlier studies (Magat and Margate 1990; Magat et al. 1988; Margate et al. 1979; Prudente and Mendoza 1976) while no correlation had been found between K (in KCl) and Na (in NaCl) with yield.

Soil Analysis

At the end of the study the consistent effect of the different fertilizer treatments on the soil chemical properties was evident on soil pH, total K and organic matter contents (Table 2). Treatments 3 and 4 with organic fertilizer application gave identical pH of 6.0

FIGURE 2
Stand of the palms at the end of the study:
a. control
b. 1.0 kg (NH4) 2SO4 + 1.8 kg NaCl + 1.5 kg dolomite
c. 10 kg corn cob + 1.8 kg NaCl + 1.5 kg dolomite

much higher than the control and the inorganic fertilized plots with pH values of 5.9, 5.2 and 5.4, respectively. Indeed, organic fertilizer acted favorably on soil pH while continuous application of inorganic fertilizer tended to make the soil more acidic due to the release of H-ion from ammonium fertilizer. Nevertheless these values were the same or slightly lower than the benchmark pH of 5.4.

Though not statistically significant, the organic matter content of plots receiving organic fertilizers were slightly higher than the control and the inorganic-fertilized plots. These values were however, lower than the benchmark data. But clearly, the addition of organic fertilizer greatly minimized the depletion of organic matter in the soil.

The total K content was significantly lower in treatments with inorganic fertilizer application probably due to the presence of Ca, Mg or Na in the fertilizer materials which could have displaced K.

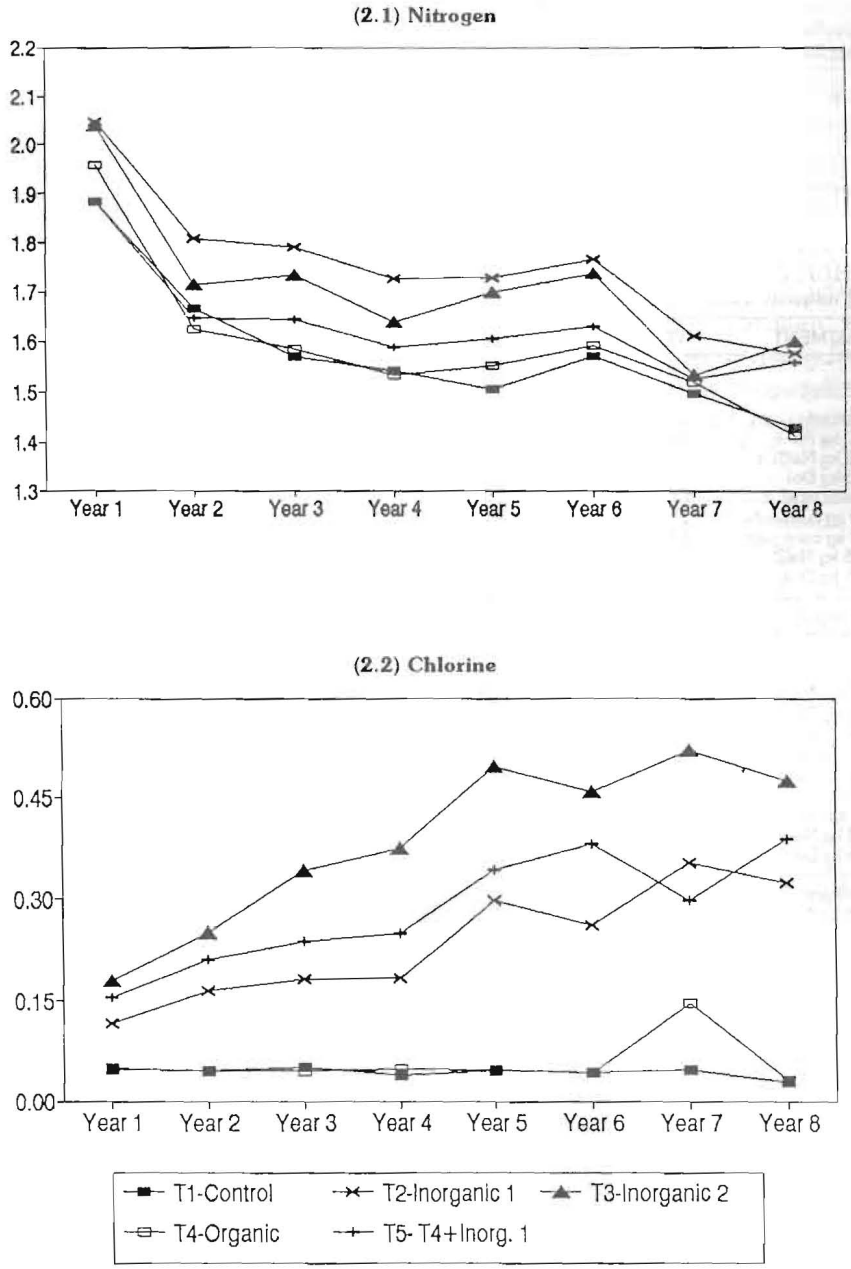

FIGURE 3
Leaf Nutrient Levels of Palms (Leaf#14) as influenced by Fertilizer Treatments (2.1) Nitrogen and (2.2) Chlorine

TABLE 2
Effect of the different fertilizer treatments on the soil physical and chemical properties (before and after the study)

TREATMENT	pH	P (ppm)	K (H2SO4 EXT.) (ppm)	O.M. (%)	EXCH.BASES (m.e./100g) Ca	Mg	Na	K	CEC	BASE SAT'N (%)	B.D. (g/cc)
(Benchmark	5.4	3 0	-	7.58	3.60	5.69	0.06	0.06	27.76	34.11	-)
1. Control	5.9[ab]	6.5	38.8[a]	5.50	1.48[b]	0.55	0.04	0.15	23.10	10.3	1.34
2. 1.0 kg AS + 1.8 kg NaCl + 1 5 kg Dol	5.2[b]	10.0	137.5[c]	6.07	1.50[b]	0.05	0.65	0.05	23.45	10.7	1.50
3 Twice treat. 2	5.4[ab]	8.0	142.5[c]	6.11	2.05[b]	0.83	0.04	0.06	21.19	14.9	1.35
4 10 kg corn cob	6.0[a]	11.8	328.8[ab]	6.53	1.63[b]	0.63	0.04	0.18	20.03	13.1	1.50
5. 10 kg corn cob + 1.8 kg NaCl + 1.5 kg Dol	6.0[a]	8.5	216.3[b]	6.92	3.38[a]	1.07	0.06	0.08	27.45	17.1	1 41
HSD .05	0.7	ns	135.9	ns	1.31	ns	ns	ns	ns	ns	ns
.01	ns	-	ns	-	1.7	-	-	-	-	-	-
C.V. (%)	5.1		25.3	19.1	29.0	36.7	28.2	58.4	28.7	41.1	13 7

ns - not significant
means having the same letter are not significantly different at 5% level (HSD test)

APPENDIX
TABLE 2
Leaf nutrient levels of palms as influenced by the different treatments

TREATMENT	YR 1	YR 2	YR 3	YR 4	YR 5	YR 6	YR 7	YR 8
				NITROGEN (%)				
1.Control	1.884	1.666	1.570c	1.542b	1.506c	1.571c	1.497	1.430
2.1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	2.047	1.809	1.790a	1.726a	1.729a	1.7267a	1.611	1.578
3.Twice treat. 2	2.039	1.714	1.734ab	1.638ab	1.700ab	1.737ab	1.535	1.601
4.10 kg corn cob	1.957	1.625	1.585bc	1.535b	1.553bc	1.593bc	1.520	1.415
5.10 kg corn cob + 1.8 kg NaCl + 1.5 kg Dol	1.884	1.648	1.644abc	1.589b	1.606abc	1.629abc	1.527	1.560
Stat. Signif.	ns	ns	**	**	**	**	ns	ns
				SODIUM (%)				
1.Control	0.142b	0.153bc	0.117b	0.119b	0.118b	0.088b	0.082b	0.078b
2.1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	0.180a	0.203a	0.241a	0.205a	0.227a	0.173a	0.165ab	0.146a
3.Twice treat. 2	0.187a	0.206a	0.261a	0.217a	0.255a	0.171a	0.195a	0.159a
4.10 kg corn cob	0.150b	0.135c	0.122b	0.106b	0.123b	0.092b	0.107ab	0.074b
5.10 kg corn cob + 1.8 kg NaCl + 1.5 kg Dol	0.187a	0.183ab	0.213a	0.198a	0.219a	0.175a	0.152ab	0.144a
Stat. Signif.	**	**	**	**	**	**	**	**
				CHLORINE (%)				
1. Control	0.050c	0.046c	0.051c	0.039c	0.046c	0.043c	0.047c	0.029d
2. 1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	0.116b	0.165b	0.183b	0.185b	0.298b	0.263b	0.353ab	0.323c
3. Twice treat. 2	0.181a	0.253a	0.341a	0.375a	0.497a	0.458a	0.521a	0.475a
4. 10 kg corn cob	0.047c	0.046c	0.046c	0.048c	0.047c	0.043c	0.146bc	0.031d
5. 10 kg corn cob + 1.8 kg Nacl+ 1.5 kg Dol	0.155ab	0.213ab	0.240ab	0.215b	0.342b	0.381ab	0.298abc	0.398b
Stat. Signif.	**	**	**	**	**	**	**	**
				BORON (ppm)				
1. Control	11.225	11.975ab	12.275a	13.525a	10.725a	11.1a	12.4a	13.5a
2. 1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	9.525	9.750bc	8.775b	10.275b	8.025b	8.3bc	9.9c	11.2ab
3. Twice treat. 2	10.250	8.525c	7.975b	9.350b	7.975b	7.8c	9.6c	9.9b
4. 10 kg corn cob	10.370	13.300a	12.275a	14.200a	10.625a	11.5a	12.2ab	13.2a
5. 10 kg corn cob + 1.8 kg NaCl + 1.5 kg Dol	10.075	10.800abc	10.150ab	10.725ab	8.875b	9.4b	10.3bc	11.0ab
Stat. Signif.	ns	**	**	**	**	**	**	**

Economic Analysis

Based on the economic situation of 1993, the 1st and 2nd levels of inorganic fertilization (treatments 2 and 3) gave the two highest net benefits of P17,833 and P19,734, respectively per ha (Table 3). Between the two levels however, the increase of P1900/ha net benefit realized by the application of the highest inorganic fertilizer level over the lower dosage was not commensurate with doubling the amount of fertilizer input. The production and net benefit did not double by doubling the amount of fertilizer. On the contrary it gave lower marginal rate of return (MRR).

Substituting corn cob for ammonium sulfate in treatment 2 (1st level) to have organic + inorganic fertilzier combination (treatment 5) obtained net benefit of P12,511/ha/yr giving higher MRR of 307%.

The MRR measures the return that is expected from each additional unit of investment in a new technology after deducting the costs. It should be 100 percent or more. An MRR of 100% means that for every P1.00 invested, the farmer can expect to recover the P1.00 plus an additional P1.00.

The dominance analysis shows that organic corn cob alone is dominated. Meaning its net benefit was less than the control with lower variable costs and hence disregarded. In principle, as variable costs increase, the net benefits also increase (DARMS 1990).

CONCLUSION AND RECOMMENDATION

The application of inorganic fertilizers produced significant increase in the growth of the palms starting the 2nd yr and on the production starting the 3rd yr (1st year of bearing). Higher dosage of inorganic fertilization proved uneconomical. On the same period, substituting the inorganic N fertilizer with corn cob (organic) to combine organic with inorganic fertilizer did not produce significant effects but increases of 34% on nut, 23% on copra/nut and 67% on copra/palm over the control were already noted. The application of corn cob alone did not improve growth and yield

TABLE 3
Economic analysis per hectare per year (1993)

TREATMENT	COPRA YIELD (kg)	GROSS 1/ INCOME (P)	TOTAL 2/ COST (P)	NET BENEFIT (P)	DOMINANCE ANALYSIS	MRR (%)
1. Control	1029.6	7722.00	2857.14	4864.86		
2. 1.0 kg AS + 1.8 kg NaCl + 1.5 kg Dol	3246.1	24345.75	6512.22	17833.53		761
3. Twice treat. 2	3803.8	28528.50	8794.50	19734.00		81
4. 10 kg corn cob	972.4	7293.00	3094.52	4198.48	D	
5. 10 kg corn cob + 1.8 kg NaCl + 1.5 kg Dol	2431.0	18232.50	5721.43	12511.07		307

1/ copra price = P7.50/kg

2/ Labor (fertilizer application, ring weeding) = P90.00/day

- Ammosul = P2.80/kg
  NaCl = P3.00/kg

- Dolomite = P3.00/kg
  corn cob = P0.20/kg

Copra making (includes harvesting, hauling, copra processing) = P0.83/kg processed copra

APPENDIX
TABLE 3
Rainfall data (mm) from the nearest weather station 3/ around 4 km from experimental site./bm

MONTH/YEAR	1986	1987	1988	1989	1990	1991	1992	1993	AVERAGE
January	19.9	48.7	40.0	76.0	100.1	61.6	48.0	53.0	55.9
February	2.3	113.3	86.1	72.3	3.0	54.0	1.4	105.0	54.7
March	9.3	2.0	70.8	195.3	55.8	103.0	5.2	106.4	68.5
April	39.1	31.7	80.4	270.6	13.9	26.8	11.8	106.4	72.6
May	111.5	143.9	199.6	213.5	213.7	163.2	61.4	122.4	153.7
June	101.3	164.2	144.1	226.3	158.7	250.8	206.9	183.0	179.4
July	289.4	225.0	147.0	230.0	107.4	163.1	223.6	215.4	200.1
August	90.8	213.1	96.8	244.5	110.0	150.4	203.8	182.4	161.5
September	94.8	278.3	166.0	243.3	181.8	88.0	192.1	276.2	190.1
October	148.7	228.2	217.7	213.0	64.5	161.0	327.0	227.2	198.4
November	157.0	185.5	115.0	263.6	185.1	112.4	192.4	118.4	166.2
December	47.9	41.7	107.7	122.7	22.1	40.6	55.6	262.7	87.6
Total	1112.0	1,675.6	1,471.2	2,371.1	1,216.1	1,374.9	1,529.2	1,958.5	1,588.6

3/ Cotton Research and Development Institute (CRDI)

through the years. It has to be combined with an inorganic Cl source to be more effective. This proves that organic corn cob could not cope with the N requirement of the palms when applied without the accompanying Cl.

The coconut farmers are left with 2 fertilizer options depending on their financial capabilities: (1) the pure inorganic fertilization i.e.: 1.0 kg ammosul + 1.8 kg NaCl + 1.5 kg dolomite or (2) the combined organic with inorganic Cl source i.e. 10 kg corn cob + 1.8 kg NaCl + 1.5 kg dolomite.

Although the findings could be at least utilized on the 'MAWA' coconut hybrids planted in similar environmental conditions as in this study, the fertilizer recommendations can be applied in other coconut populations as experienced in the various coconut collections and other trials in the country.

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