

RESPONSE TO INTEGRATED SOIL FERTILITY MANAGEMENT (ISFM) OF HYBRID COCONUTS GROWN ON A COASTAL-UPLAND SOIL OF ZAMBOANGA CITY, WESTERN MINDANAO, PHILIPPINES

M.I. Secretaria, J.N. Maravilla and R.Z. Margate

An on-farm fertilizer experiment was conducted from 1985-1993 at Guisao, Zamboanga City to determine the effects of inorganic (1.5-3.0 kg $(\text{NH}_4)_2\text{SO}_4$ + 1.5-3.0 kg KCl), organic (commercial Sagana 100) and combined inorganic and organic fertilizers on: the vegetative and yield performance of hybrid coconut and on the fertility status of the soil.

From the 2nd yr of fertilization, effect of all treatments was manifested more on the number of living fronds with increases of 20-43%. Apparent responses were noted from low and high levels of inorganic fertilizers, organic and their combination on nut per palm, copra per nut and copra yield per palm. In the 8 yr of fertilization, the inorganic fertilizers lowered the pH of both topsoil and subsoil while the organic fertilizer improved the organic matter, N and P contents of the soil.

The lower inorganic fertilizer level of 1.5 kg ammonium sulfate + 1.5 kg KCl/tree/yr proved to be the most economical treatment. This treatment and that of the 10 kg Sagana 100 + 1.5 kg KCl were both agronomically effective but the prohibitive cost of commercial organic fertilizer made it uneconomical compared to the former. This finding is likely applicable to coconut areas with similar conditions as the study.

Key words: hybrid coconut, N fertilization, Cl fertilizer, commercial organic fertilizer

INTRODUCTION

Farmers of today have been accustomed to the massive use of chemical fertilizers to increase farm productivity. In 1992, our country consumed 1.13 MT of various grades of chemical fertilizers and imported 1.13 MT amounting to \$168M, thereby draining the national dollar reserves (Mangawang 1993). While the short term effect of this kind of fertilizer is immediate increase in productivity, its continuous and prolonged usage lead to deterioration of soil fertility. Aside from making the soil acidic, compact and polluted with toxic residual chemicals, it destroys the ecological balance between the soil, water and living organisms.

With these destructive side effects, most farmers, particularly coconut farmers are gradually shifting to the use of organic materials (animal manures, plant residues/ parts, farm by-products and organic commercial fertilizers) as sources of plant nutrients.

Several studies have shown the

beneficial effects of organic fertilization (Cadigal et al. 1982; 1985; Salido 1986; Secretaria and Maravilla 1992; Sta.Cruz et al. 1993). However, the effects of organic fertilizers vis-a-vis inorganic fertilizers have not been investigated in a wider range of environmental conditions. Hence, on-farm fertilizer trials nationwide were conducted by Philippine Coconut Authority to determine the effect of inorganic fertilizers (low and high dosages), organic fertilizer and mixed inorganic and organic fertilizer materials on the vegetative and yield performance of local and hybrid coconuts. This report covers on-farm fertilizer trial on 'MAWA' coconut hybrid in Guisao, Zamboanga City, Western Mindanao.

MATERIALS AND METHODS

Experimental Area

The study was conducted in a farmer's field at Guisao, Zamboanga City from 1985 to 1993. The area is of coastal-upland form with a distance of about 2 km from the coastline (Margate et al. 1988). Soil type is clay loam and drainage is good. The site has a type C (moist) climate classification where rain sufficiently distributed with at most 4.5 dry mos.

Experimental Materials, Treatments, and Design

The 'MAWA' hybrid palms aged 4-5 yr old were used in the experiment. So far about 50,000 has. of this hybrid had been planted earlier (1977-83). The following treatments were tested in randomized complete block design (RCBD) with three replicates and 12 experimental palms per plot:

- T1 - Control (no fertilization)
- T2 - 1.5 kg Ammonium sulfate + 1.5 kg KCl/tree
- T3 - 3.0 kg Ammonium sulfate + 3.0 kg KCl/tree
- T4 - 10 kg Sagana 100 organic fertilizer*/tree
- T5 - 10 kg Sagana 100 + 1.5 KCl/tree

*Average content of nutrients: 3.5% N, 3.5% P, 3.5% K + Humus, beneficial microbes, N-fixing bacteria, micro and trace elements, agricultural lime

The palms were fertilized once a year up to the 8th yr of fertilization.

Leaf and Soil Sampling

Leaf sampling was done every year to determine the leaf nutrient levels of N, P, K, Mg, NaCl, S and Boron as affected by the different fertilizer treatments.

Soil sampling and analysis was done at the end of the study to know the effects of organic and inorganic fertilizers on soil fertility status.

Data Gathering

Vegetative growth characters such as girth, number of leaves produced, total living fronds and leaflet count were collected periodically. Likewise, yield attributes e.g. nut per tree, copra per nut and per palms were gathered and evaluated.

RESULTS AND DISCUSSION

Vegetative Growth Characters of 'MAWA' Hybrid Palms

Growth characters such as girth size, leaf produced within 6 mo, total living fronds and leaflet count (at leaf rank 4) of palms showed no significant differences at the 1st yr of observation (Table 1). However, the application of first and second levels of inorganic fertilizer produced already 13 and 19% increase in girth over the control, while the combination of Sagana 100 and KCl produced 17% increase. In the 2nd to 4th yr, the fertilizer treatments manifested significant differences in leaf count. The double dosage of inorganic fertilizers and combined inorganic and organic fertilizers produced significantly higher leaf count

TABLE 1
Vegetative growth of palms as influenced by different fertilizer treatments

Treatment	Girth (cm)	L/let Count(no)		Leaf Count (no)			Leaves Produced (no)			
	Yr1	Yr1	Yr1	Yr2	Yr3	Yr4	Yr1*	Yr2	Yr3	Yr4
T1 - Control	71.4	112.7	22.2	14.3b	19.4b	23.0c	7.2	8.1	13.8	15.0
T2 - 1.5kg Ammosul + 1.5 Kg KCl	80.6	118.8	21.2	18.8ab	25.4ab	27.5b	7.1	8.2	14.9	15.9
T3 - Twice T2	84.8	112.0	23.8	20.5a	28.1a	31.3a	8.1	8.9	15.9	17.1
T4 -10kg Sagana 100	77.9	119.2	23.1	17.1ab	23.9ab	25.9bc	7.1	8.2	14.5	15.5
T5 - T4 + 1.5kg KCl	83.6	115.9	26.1	20.3a	25.3ab	29.1ab	8.1	8.9	15.5	16.4
HSD .05	ns	ns	ns	5.4	6.2	6.1	ns	ns	ns	ns
.01	-	-	-	7.4	8.3	8.3	-	-	-	-
C.V. (%)	9.0	8.0	10.3	10.6	8.6	6.8	6.0	8.7	5.1	5.2

* Six (6) months production only

ns - not significant

Treatment means with the same letter are not significantly different at 5% level

TABLE 2
Effect of the different fertilizer treatments on soil chemical properties

I. TOPSOIL TREATMENT	pH	Organic Matter (%)	N (%)	P (ppm)	Ext.K (ppm)	Exchangeable Bases (m.e./100 g of soil)			
						Ca	Mg	Na	K
T1 - Control	5.9a	1.66	.08	5.33	478.33b	14.76	6.15	.04	.25b
T2- 1.5kg AS + 1.5kg KCl	4.6b	1.66	.08	4.67	1121.67ab	6.67	3.91	.02	.32ab
T3- Twice T2	4.4b	1.66	.08	3.67	2533.33a	5.40	2.37	.02	.32ab
T4- 10kg Sagana 100	5.7ab	2.17	.11	16.00	308.33b	11.60	5.10	.03	.01b
T5- T4 + 1.5kg KCl	5.8a	2.17	.11	12.00	1755.00ab	16.83	6.04	.03	.54a
Stat. sig.	**	ns	ns	ns	**	ns	ns	ns	**
C.V. (%)	5.1	24.7	61.3	45.5	24.7	38.0	67.8	44.4	33.7
II. SUBSOIL									
T1- Control	5.7	.83	.04	3.67	127.33b	21.27	8.90	.05	.05b
T2- 1.5kg AS + 1.5kg KCl	5.0	1.00	.05	3.00	921.67ab	14.87	7.58	.03	.19ab
T3- Twice T2	4.7	1.00	.05	2.67	1510.00a	13.13	5.87	.02	.27a
T4- 10kg Sagana 100	5.1	.67	.03	7.00	168.33b	13.43	5.67	.03	.04b
T5 - T4 + 1.5kg KCl	5.9	1.00	.05	4.67	450.0ab	20.13	8.13	.03	.16ab
Stat. sig.	ns	ns	ns	*	ns	ns	ns	**	
C.V. (%)	11.7		43.6	41.9	74.3	39.5	47.6	41.6	46.5

Treatment means with the same letter(s) are not significantly different at 5% level

** Highly significant at 1% level

* Significant at 5% level

ns Not significant

over the control but did not differ with the other fertilizer treatments. Palms applied with organic fertilizer alone did not differ with the control but brought about certain improvements when supplemented with Cl.

Leaves produced did not manifest significant variation up to the 4th yr of fertilization. Numerically, however the

double rate (3 kg/tree each) of Ammosul + KCl manifested the highest number of leaves produced followed by the combined organic fertilizer + KCl. This could be attributed to highly significant increase in leaf N, K, Cl and S on the 3rd yr.

Based on girth size observed in the 1st yr and on leaf count in the 2nd yr, it was

evident that the palms responded to the treatments (organic or inorganic) when N, K and Cl were applied (Treatments 2, 3 and 5) as palms were deficient in these prior to fertilizer application.

Yield Performance of 'MAWA' Hybrid Palms

Nut production started on the 5th yr of fertilization. At this stage, the fertilizer treatments significantly affected copra (per nut and per palm) but did not affect the number of nuts per palm (Fig.1 & Annex Table 1). Treatments 3, 4 and 5 significantly increased weight of copra/nut over the control but only treatment 3 manifested significant difference with respect to copra/palm. The double rate of inorganic fertilizer gave 10% and 87% heavier copra/nut and copra/palm, respectively over the unfertilized palms.

Clearly, the effect of organic fertilizers on yield of hybrid palms was manifested as early as the 5th yr of regular fertilization. Although statistically not significant, yield increase of organic fertilizer over the control was 40% and 54% in terms of nut and copra production per palm, respectively. Nevertheless, when organic fertilizers was combined with Cl source (KCl), appreciable improvement in nuts/palm by (58% increase) and copra per palm (by 74% increase) over the non-fertilized palms was observed. This suggests that organic fertilizer alone is less effective for coconut if applied singly but becomes more effective if supplied with Cl. Apparently, it indicates that **Sagana 100** organic fertilizer can substitute for ammonium sulfate as source of N.

During the 6th to 8th yr of fertilization (1991-93), the hybrid palms suffered from long dry spell. The palms experienced about 8-9 mo of dry season during these years with an average rainfall ranging from 78-116 mm/mo (Annex Table 2). This amount is far below from the ideal amount of rainfall for coconut which is 125-192 mm/mo (UCAP 1979).

The effect of this natural calamity can be reflected in the very low nut and copra yields (Fig.1). But even then, a definite trend on the effect of fertilizer treatments can be discerned. The higher rate (3 kg/tree of inorganic fertilizers) gave the highest nut and copra yield, significant over the unfertilized palms but not with the other treatments (1992). While the yield of single inorganic fertilizer were comparable with T3, it did not significantly differ from non-fertilized treatments. This indicates the need

for correction of nutrient deficiencies to increase yield resulting in low production cost per unit yield (nut or copra).

The consistent higher nut and copra production in T2, T3 and T5 could be associated with their much improved levels of leaf N, Cl, S, and K contents compared to other treatments over the years (Fig.2). The Cl source in T5 could have contributed much to the beneficial effect of this fertilizer combination on productivity of the palms, as observed in earlier studies (Magat et al. 1975; Margate et al. 1978).

At the final year, although not statistically analyzed, data on yield showed a higher nut and copra production in treatment with combined organic and KCl fertilizers than the double dosage of inorganic fertilizers. This could be attributed to significantly higher leaf P, K, and Cl in treatment 5 (1993 results). Such observation may imply that a combination of inorganic and organic fertilization or a substitution of organic N source for Ammosul, a form of ISFM could be used in long-term fertilization towards farm sustainability and productivity.

Effects on Soil Fertility

The different fertilizer treatments manifested significant differences in pH values, particularly in the top soil (Table 2). The inorganic fertilizers (low and high rates) showed lower pH compared to the other treatments. This clearly shows that long-term application of chemical fertilizer increases the soil acidity.

Likewise, the organic matter and N contents in soil with synthetic fertilizers were lower (although not significantly different) from that of the organic and mixed organic and inorganic fertilizers (topsoil). Organic matter content in the soil is very important for improved plant growth since it maintains good soil structure, increases cation exchange capacity and serves as reservoir for soil N, improved water retention and its for mineralization provides for a continuous supply of N, P, S to the crop (Subido 1970).

In terms of nutrient sources, inorganic fertilizers provided for a significantly higher amount of K both in the top and subsoil especially in treatments involving KCl fertilizers. On the other hand, the organic and mixed organic and inorganic fertilizers provide higher levels of Ca, Na, P, and N indicating that organic fertilizer may complement if not partially substitute the nutrients of the inorganic fertilizers. Organic

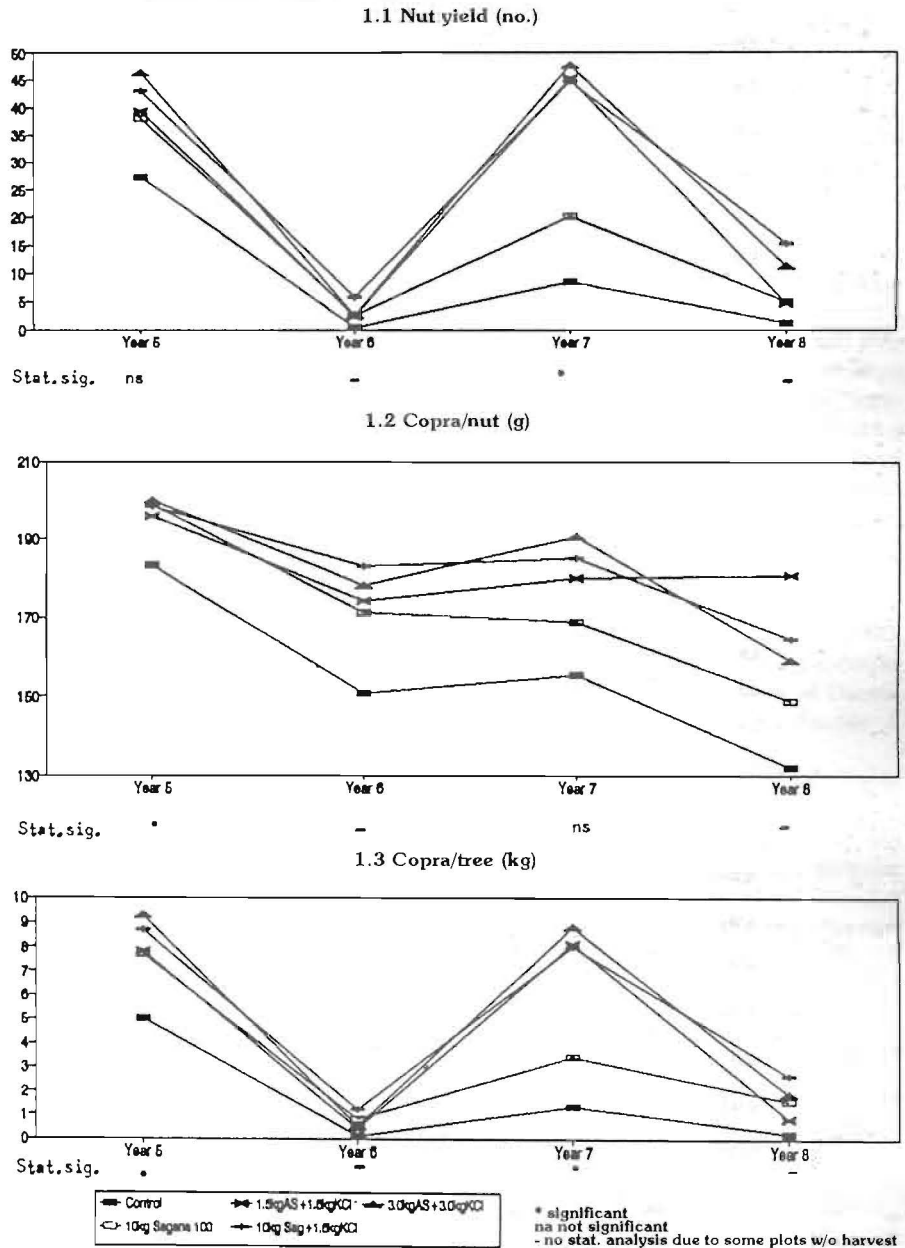


FIGURE 1
Yield of palms as influenced by fertilizer treatments on (1.1) Nut yield, (1.2) Copra weight (1.3) Copra yield

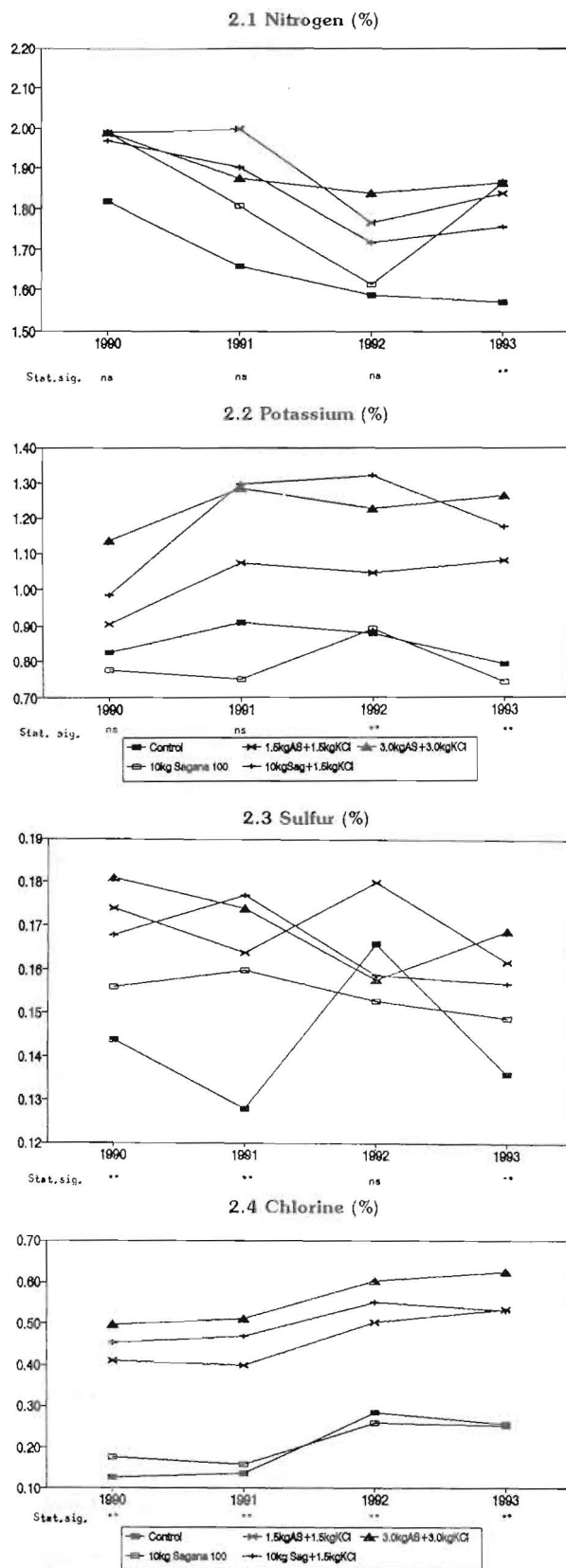
fertilizers can supply about 25% of the nutrient requirement of coconut i.e. N, P, K, S at 4-5 yr from initial yr of regular annual application (Magat 1992).

Economic Analysis

Through a simple cost and return analysis of maximum profit approach, the most economical treatment was determined. It was observed that the moderate rate (1.5 kg/tree) of inorganic fertilizers gave the highest net benefit of P4,294.30/ha (Fig.3). Although the higher rate (3 kg/tree) gave the highest gross income, its net benefit was lesser than the

single dosage due to its higher total cost, hence was dominated (Table 3). The same thing happened in treatment 5. The gross income was similar with the single dosage of inorganic fertilizer but its prohibitive cost and much higher dosage requirement pulled down its net benefit.

Treatments 2 and 5 were not dominated, meaning their net benefits were higher (following higher variable cost) compared to those treatments with lower variable costs. Further analysis showed the marginal rate of return (MRR) of 144 and 4%, respectively (Table 3). This parameter measures the returns the farmer can expect



to gain from each additional unit of investment in a new technology after deducting the cost of investment. Thus, an MRR of 144% means that for every P1.00 invested, the farmer can expect to recover his P1.00 investment plus and additional P0.44.

CONCLUSION AND RECOMMENDATION

This on-farm fertilizer trial revealed that integrated soil fertility management is necessary for improved coconut farm productivity. For immediate improvement in the vegetative and yield performance of palms, the use of single dosage (moderate rate) of inorganic fertilizers e.g. Ammonium sulfate + KCl is highly recommended for the coastal areas of Zamboanga. Organic fertilizers combined with inorganic fertilizer is also advisable because of the capabilities of the former to improve the soil fertility status of the palms and provide macronutrients (e.g. N, P, K, S etc.) to palms beneficial to reach profitable yield levels.

Thus, with the high cost of commercial inorganic fertilizers in the market coupled with the increasing awareness of people to the hazards of excessive application of chemical fertilizers, the judicious application of combined organic and inorganic fertilizers offers a sound alternative in increasing coconut productivity of coastal coconut of Zamboanga and other areas in the country with similar conditions.

The agronomic efficiency and economic viability of the ISFM approach is demonstrated in this long-term fertilization work.

REFERENCES

CADIGAL, V.L. and R.L. PRUDENTE. 1982. Utilization of *Euchema spinosum* as fertilizer for coconut seedlings. PCA-DRC, Agro-Soils Div.technical paper.

_____, L.G. OGUIS and J.N. MARAVILLA. 1985. Fertilization of 'MAWA' hybrid seedlings with animal manures and other organic fertilizers. PCA-DRC. Agro-Soils Division technical paper.

MAGAT, S.S. 1992. PCA's experimental results (OFFT) on the application of organic fertilizers to coconut. A report to PCA Administrator Avila.

FIGURE 2 Leaf nutrient levels of palms under different fertilizer treatments

TABLE 3
Economic analysis of the various fertilizer treatments (1992*)

TREATMENT	FERTILIZER Cost (P)	LABOR COST			TOTAL Cost	GROSS Benefit	NET BENEFIT (P)		DOMINANCE ANALYSIS	MRR (%)
		RW/TE	F.A.	C.M.			/Palm	/Ha		
Control	-	9.00	-	9.78	18.78	9.75	(9.03)	(1291.3)		
1.5 kg AS + 1.5 kg KCl	8.85	14.58	2.43	4.86	30.72	60.75	30.03	4,294.3		144
3.0 kg AS + 3.0 kg KCl	17.7	14.58	2.43	5.28	39.99	66.00	26.01	3,719.4	D**	
10 kg Sagana 10 kg Sagana +1.5 kg KCl	30.0 34.8	14.58	3.75	2.04	50.37	25.5	(24.87)	(3,556.4)	D**	

Basis:
 1. Cost of fertilizers:
 Ammsol - P2.70/kg
 KCl - P3.20/kg
 Sagana 100 - P3.00/kg
 2. Labor (maintenance) - P90.00/day
 3. Copra making (C.M.) - P0.60/kg copra
 4. Copra price - P7.50/kg

5. Topbrushing (TB) for unfertilized palms - 8 min/tree (6x a yr)
 6. Ring-weeding (RW) for fertilized palms - 13 min/tree (6x a yr)
 7. Fertilizer application (F.A.) for inorganic fert. - 13 min/tree
 organic fertilizer - 20 min/tree

* Represents a more stable productive year completed w/ other years
 ** Dominated treatments

_____, V. CADIGAL and J. HABANA. 1975. Yield improvement of coconut in elevated inland area of Davao by KCl fertilization. *Phil. Journal of Crop Science*. 1 (1): 60-67.

MANGAWANG, C. (Ed.). 1993. Organic farming: Environment-friendly approach for improved soil productivity. *Phil. Daily Inquirer*. May 25, 1993.

MARGATE, R.Z., S.S. MAGAT and J.A. HABANA. 1988. On-farm fertilizer trial (OFFT) in the Philippines. Paper presented at the UNDP/FAO Working Group Meeting in Coconut Nutritional Deficiencies, Improved Coconut Production in Asia and the Pacific. Sept. 28-30, 1988. Davao City, Philippines.

_____, L.M. ALFORJA and J. HABANA. 1978. A long-term KCl fertilization study on bearing coconuts in an inland-upland area of Davao. *Phil. Journal of Coconut Studies*. 3 (4): 1-14. Also in *Oleagineux*. 34 (5):235-242.

United Coconut Association of the Philippines. 1979. Coconut statistics, UCAP, Manila.

SALIDO, R. 1986. Let's fully adopt the new fertilizer technology. *Greenfields*. 16 (10).

SECRETARIA, M.I. and J.N. MARAVILLA. 1992. Fertilization of 'MAWA' hybrids with animal manures and other organic and inorganic fertilizers. PCA Agricultural Research Annual Report. 274 p.

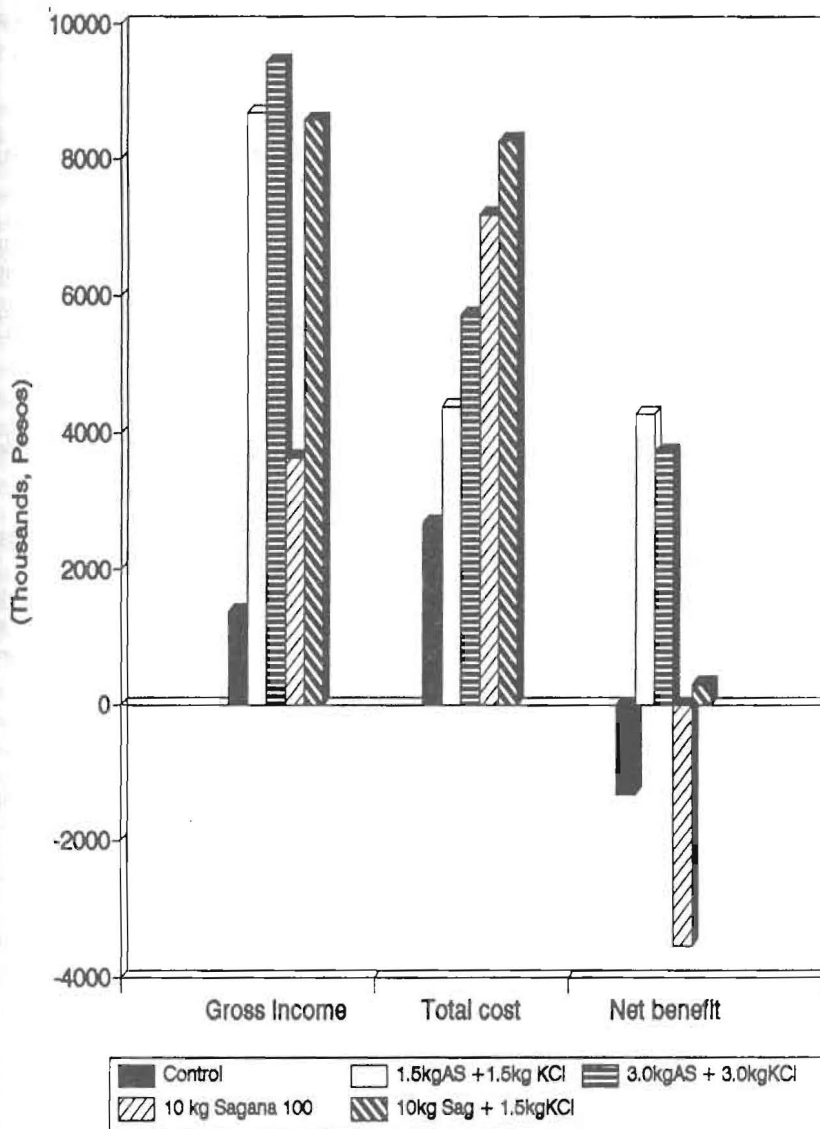


FIGURE 3
Economic analysis of the different fertilizer treatments (per ha per yr, 1992)