THE USE OF ORGANIC FERTILIZER IN COCONUT (A RESEARCH NOTE)

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The review revealed varying degree of response to organic fertilization in coconut. However, consistent positive response in terms of growth and yield of coconut was obtained when organic fertilizers were combined with inorganic fertilizer high in chloride — a macronutrient of the crop. It strongly appears that much work is still needed to understand the effect of organic fertilizers alone and organic fertilizers plus inorganic fertilizer (Integrated Soil Fertility Management or ISFM) on the soil properties, leaf nutrients, growth, and yield of coconut.

Keywords: ***natural/organic fertilizers, chemical/inorganic fertilizers, chlorine fertilizers, coconut yield, soil physical and chemical properties, integrated soil fertility management (ISFM)***

INTRODUCTION

Recently, Magat (1993) pointed out that there were strong indications of the need for integrated soil fertility management (ISFM) in agricultural production. As this measure works on the application of the optimum combination of organic or natural fertilizers and mineral/chemical or inorganic sources on crops, such would very likely result to modern and sustainable agriculture — practical, viable, profitable, environment-friendly, and providing a better quality of life to all.

Organic fertilization dates back to the old practice of Chinese farmers who used it to conserve soil fertility and to ease soil cultivation. These soil properties are siginificant due to organic matter which improves the soil physical conditions, soil nutrient status, and soil biological properties (Tennakoon 1988).

The government is pushing for the adoption of organic fertilization by the farmers under the concept of organic farming. This is spearheaded by the Fertilizer and Pesticide Authority (FPA) which teaches the farmers to become less dependent on inorganic or chemical fertilizers and, thereby, reduces the cost of farm inputs. This is also one of the thrusts of the government to curb the drain of the country's dollar reserve.

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In the 80s, there was an increasing demand for organic fertilizers due to rising prices of inorganic fertilizers which was subsequently advanced by worldwide environmental consciousness. Deterioration of soil fertility and hazards of water pollution were ascribed to the application of pesticides and chemical fertilizers. Thus, the concepts of organic farming vis-a-vis sustainable agriculture were promoted in their stead. Organically derived fertilizers like vegetative residues and animal manures in the form of compost were then tested in vegetable and field crops, but compost combined with inorganic fertilizers was found to be the promising treatment (PCARRD 1984).

SOURCES AND CHEMICAL COMPOSITION OF ORGANIC FERTILIZERS

Various organic sources of natural or organic fertilizer include residues from harvests, crop straw, stalks and any vegetable matter, urban or kitchen wastes, brush woods, and animal manures, among others. What makes these materials advantageous is that they are always available (Tennakoon 1988).

According to Fremond et al. (1966), sun-hemp (*Crotolaria juncea*) can produce fresh green material at about 7 MT per hectare and *Crotolaria striata* at 15 to 25 kg/ha. Other commonly used green manures include *Vigna unguiculata* (cowpea), *Sesbania aculeata, Tephrosia purpurea,* and *Phaseolus trilobus.*

The nutrient value of composts varies widely depending upon the nature of the materials being composted. If the initial materials contain blood, slaughterhouse wastes, conserved urine, garbage, and manure or sewage sludge, it will be richer in nitrogen and other nutrients than if it contains mainly straw, litter, corn stalks, ash, dirt, or municipal rubbish as shown in Table 1.

TABLE 1
Analysis of Organic Wastes on Dry Basis (Gotas 1956)

SUBSTANCE	PERCENTAGE BY WEIGHT
Organic matter	25 - 50
Carbon	8 - 50
Nitrogen (as N)	0.4 - 3.5
Phosporus ($P_2 0_5$)	0.3 - 3.5
Calcium (as CaO)	1.5 - 7.0
Ash	20 - 65

Table 2 shows that chicken, duck, and goose had higher N content (%) in the manure than the horse, cattle, pig, and sheep. The horse, sheep, and chicken had higher carbohydrates (%) than the other animals. When dealing with animal manures, carbohydrates were not considered in contributing to the plant nutrients (Loehr 1974).

Table 3 lists other organic fertilizer materials.

Bloodmeal is a N-rich organic material. Groundnut cake, fish guano, and prawn dust are good sources of N, too. Wood ash is a promising source of Ca.

Notwithstanding their nutrient content, sewage and livestock manure are potential carriers of pathogenic microorganisms; *municipal waste and sewage sludge are found to contain heavy metals; bark compost and sawdust may have organic compounds*

TABLE 2
Composition of Different Animal Manures (Loehr 1974)

ANIMAL	WEIGHT HEAD (lb)	TOTAL SOLIDS (lb/day)	SUSP. SOLIDS (lb/day)	N (% by wt) SOLID/LIQUID	PHOSPHATE (% by wt) SOLID/LIQIUD	POTASSIUM (% by wt) SOLID/LIQUID	CARBOHYDRATES (% by wt) SOLID/LIQUID
Horse	950-1400	15.00	12.50	0.50/1.20	0.3/Trace	0.3/1.60	27.10/1.90
Cattle	900-1250	15.00	12.50	0.30/0.90	0.21/0.03	0.18/0.93	16.70/1.30
Pig	100-300	1.70	1.10	0.60/0.30	0.50/0.15	0.12/0.50	15.50/0.30
Sheep	100-150	2.50	2.00	0.65/1.70	0.51/0.02	0.03/0.25	30.70/0.90
Chicken	2.0-4.0	0.12	0.05	1.40/0.50	0.90/	/0.50	30.00/0.10
Duck	3.5-5.0	0.15	0.07	1.50/0.80	0.89/	/0.40	12.00/0.10
Goose	7.5-9.5	0.35	0.10	1.80/0.80	1.20/	/0.70	14.00/0.10

TABLE 3
Approximate Composition of Organic Fertilizers and Manures (Various Sources)

	% COMPOSITION				
MATERIAL	N	P	K	Ca	Mg
Cattle manure	1.2-2.0	0.4-0.6	1.0-1.2	-	-
Goat manure	2.4	0.9	2.0	-	-
Chicken dung	5.0	3.0	2.0	6.0	1.0
Fish guano	6.8	7.1	-	-	-
Prawn dust	6.0-6.4	2.0-3.5	1.0	6.0	1.0
Blood meal	11.5	1.2	-	-	-
Pig manure	3.0	4.0	2.0	-	-
Bat guano	0.5	3.0	0.1	-	-
Sewage sludge	1.0	2.0	0.2	1.0	0.5
Rice straw	0.6	0.1	3.0	-	-
Farm compost	2.0	0.2	1.0	-	-
Coconut husk ash	-	0.6	17.0	0.5	-
Groundnut cake	7.6	1.3	1.2	-	-
Castor oil cake	5.3	1.6	1.0	-	-
Laurel or punnai oil cake	2.7	1.1	1.6	-	-
Marotti oil cake	3.0	1.0	1.0	-	-
Wood ash	-	1.5	4.0	22.0	-
Seaweed	1.1	0.4	0.3	-	-
Silt	0.3	0.3	0.3	-	-
Brushwood compost*	0.4-1.0	0.1-0.2	0.3-0.5	-	-

*Composition ranges after 1 mo and 3 mos.

like terpenoids and phenolics that are harmful or toxic to crops; while others may contribute to groundwater pollution if present in large amount. But these hazards to crop or human health can be avoided through proper management (FFTC 1990).

ORGANIC FERTILIZATION IN COCONUT

Effect on Soil Physical and Chemical Properties and Microbial Population

Compost improves soil aeration due to improved soil structure. The moisture retention capacity of soil is also enhanced by addition of compost. Likewise, the multiplication of the population of soil microorganisms and earthworms as a result of compost application would also enhance the supply of plant nutrients to the palm and improve soil structure (Tennakoon 1988).

The farm by-products as polybagging media for coconut seedlings were found to have teeming fungi population than soil with or without chemical fertilizer. Treatments with coir dust plus soil, pure sawdust, and corn cob and their combination with soil had remarkably increased fungi count from 7th to 12th mo of seedling growth (Secretaria et al. 1993). Fish manure and feather meal alike are known to promote fungal population in the soil.

In a multi-storey coconut plantation, the microbial activity in the soil is considerably enhanced by the proliferation of beneficial bacteria (including those nitrogen-fixing and phosphate-solubilizing bacteria) and fungi. The indole-3-acetic acid-producing *Escherichia sp.* and gibberellic acid-producing *Aspergillus sp.* have been found in the rhizosphere of the crop mix. For 5 yr, the organic carbon content of the soil went up from 0.2% to 0.9% because of nearly 2 t of dry leaves shed by cacao plants annually (Nelliat 1984).

Palms grown in sandy soil have limited access to nutrients, but the application of organic manures is an important factor in the management of sandy soil for increasing its clay content and cation exchange capacity (CEC). Application of tank-silt or clay soil at least once a year will not only increase the CEC of the sandy soil but also enhance its water retaining capacity. A cheaper way is by the regular application of organic manures of about 50 kg/tree/yr or through green manuring (Mannil 1989), but this figure is extremely high as reported elsewhere. The growing of green manure crops like *Crotolaria juncea, Calopogonium muconoides,* etc. in the interspaces and in the basins of the palms will contribute 20-30 kg green matter basin and 1/3 of the N requirement of coconut palms, when incorporated into the soil after 2-3 mos of growing.

The husk of coconut was observed by Eroy (1991) to supply 40.7% and 66.9% of the Cl and K needs of the palm, respectively. As indicated in Table 3, coconut husk ash has 17% K. Salgado (1936), as cited by Grimwood (1975), reported the K content as high as 25%-35% under average condition. Husk indeed is a useful source of K and a valuable mulch for the conservation of moisture. Table 4 confirms that husk increases the water-holding capacity of the soil and enriches the organic matter content.

The husk can either be piled at the base of the coconut trunk as mulch, or chopped and composted. A layer of husk with the convex side upward is placed 2 m away from the base around the tree to minimize the loss of moisture and heavy growth of weeds. An ideal method is to bury the husks in trenches of 3 x 1.2 x 0.5 m deep along coconut rows. Each layer of husk is covered with a layer of earth (Grimwood 1975). Besides, Cadigal and Magat (1977) found out that mulched husk also improves the physical condition of the surface soil by lowering its bulk density (Table 5).

TABLE 5
Soil Bulk Density (g/cc) as Affected by Husk Utilization (Cadigal and Magat 1977)

TREATMENT (Method of Placement)	SOIL LAYER	
	Surface	Sub-soil
Control (no husk)	1.637	1.843
Husk buried	1.727	1.707
Husk mulched	1.560	1.863
Husk ashed	1.650	1.840
MEAN	1.643	1.813
HSD .05	ns	ns
c.v. (%)	5.80	5.65

ns - not significant

TABLE 4
Organic Matter and Moisture Content of Various Media for Polybagged Coconut Seedlings (Secretaria et al. 1993)

TREATMENT	% ORGANIC MATTER Sampling dates				% MOISTURE Sampling dates			
	1	2	3	4	1	2	3	4
T1a-Soil w/o fert.	0.50	0.75	2.26	2.29	-	-	6.54	7.13
T1b-Soil w/fert.	1.00	1.00	2.18	2.26	-	-	7.18	7.19
T2-Cocohusk* + soil	33.19	49.96	15.95	4.65	-	5.72	7.00	7.74
T3-Sawdust + soil	32.50	22.65	16.28	7.07	-	7.07	6.70	7.68
T4-Coir dust+ soil	19.36	17.63	15.62	6.55	-	12.31	6.98	9.78
T5-Corn cob + soil	40.10	25.24	9.64	5.58	-	5.45	8.20	7.48
T6-Pure cocohusk	85.39	76.58	83.09	52.34	-	7.28	9.15	14.12
T7-Pure sawdust	88.51	75.55	51.18	40.69	-	16.52	10.18	19.40
T8-Pure coir dust	57.74	59.29	74.12	51.03	-	22.73	13.18	14.48
T9-Pure corn cob	40.45	39.24	63.48	58.96	-	10.66	9.92	14.10

*
1 - before fertilization
2 - 2 mos after initial fertilization
3 - 5 mos after initial fertilization
4 - 10 mos after initial fertilization

TABLE 6
Effect of *Eucheuma spinosum* Fertilization on the Growth of Coconut Seedlings (Cadigal and Prudente 1983)[1]

TREATMENT	GIRTH (cm)	HEIGHT (cm)	FUNCTIONAL LEAVES (no.)	TOTAL LEAVES PRODUCED (no.)	LEAFLETS LEAF NO. 3 (no.)
Variety					
MAWA	25.39[a]	178.80[a]	7.67[a]	9.53[c]	35.55[b]
LAGUNA	22.24[b]	162.23[b]	6.33[b]	9.62[bc]	35.75[ab]
CATIGAN	19.78[c]	133.84[c]	5.32[c]	10.57[a]	37.06[a]
HSD .05	1.380	16.199	0.591	0.359	1.342
.01	1.743	20.460	0.747	0.454	1.645
Fertilizer[2]					
control	19.53[b]	138.66[b]	4.80[c]	9.81	34.49[b]
60g Eucheuma	22.61[a]	159.26[a]	6.52[b]	9.87	36.21[a]
90g Eucheuma	24.18[a]	171.23[a]	7.38[a]	10.10	37.29[a]
120g Eucheuma	23.57[a]	164.02[a]	7.06[ab]	9.38	36.49[a]
HSD .05	1.752	20.596	0.750	-	1.703
.01	2.175	25.570	0.931	-	2.114
Variety x Fertilizer	ns	ns	ns	ns	ns
c.v. (%)	7.93	13.23	11.85	4.69	4.80

[1]Means having the same letter(s) are not significantly different
[2]With blanket application of 70 g ammonium sulfate

Effect on Growth and Yield of the Coconut

Philippines

The study of Cadigal and Prudente (1983) showed that the application of 90 g *Eucheuma spinosum* (a seaweed) with 70 g ammonium sulfate increased significantly the growth performance of the seedlings in terms of girth, height, number of functional leaves and leaflets, over the control in three coconut populations (Table 6). In 'MAWA' hybrids particularly, highly significant increases were observed in the same characters of the palm. The authors mentioned that *E. spinosum* is a promising substitute for KCl.

Another study conducted by Cadigal et al. (1983) revealed that *ipil-ipil* could substitute for ammonium sulfate (Table 7). In one of their observations, the application of *ipil-ipil* alone at 500 g improved significantly the girth, number of leaflets and vegetative parts, but not as effective when combined with KCl (500 g dried *ipil-ipil* leaves + 70 g KCl per seedling). This is particularly true since even natural defoliation can only provide the N requirement of coconut partly (Calub 1983). *Ipil-ipil* leaves contain 4.5% - 5.7% N (Bautista et al. 1983). But herbaceous stems and leaves are palatable to cattle, carabaos, and goats which make *ipil-ipil* a common source of protein for animal diet (Calub 1983). The animals in return recycle the nutrient in the form of urine and manure.

The study of Cadigal et al. (1987) revealed that goat manure at the rate of 840 g per seedling gave the widest girth circumference and produced the tallest seedlings comparable with inorganic fertilizers, horse and chicken manures. The accelerated growth and development were correlated with the increase in the leaf Cl and N contents.

In a *Trichoderma*-activated compost study, the application of city garbage plus swine manure produced significantly taller seedlings, wider girth, higher leaf count and dry matter accumulation and significantly higher N uptake at the rate of 606 g/seedling. The compost could also be mixed with ammonium sulfate at 75:25 ratio, but it is capable of substituting the latter wholly for coconut seedlings (Ebuña and Cagmat 1992).

TABLE 7
Effect of Giant Ipil-ipil Leaves and Agrispon (a soil inoculant) on the Growth of Coconut Seedlings (Cadigal et al. 1983)[1]

TREATMENT	GIRTH (cm)	HEIGHT (cm)	LIVING FRONDS (no.)	TOTAL LEAVES PRODUCED (no.)	LEAFLETS (no.)	VEGETATIVE PARTS (kg/seedling)
1 - control	23.02^{d}	201.03^{b}	7.07^{cd}	11.52^{b}	49.60^{d}	22.00^{d}
2 - 60g AmmoSul + 70g KCl	31.97^{a}	248.38^{a}	8.39^{a}	12.32^{a}	63.02^{a}	40.45^{a}
3 - 250g ipil[2]	23.67^{cd}	212.67^{b}	6.87^{d}	11.90^{ab}	52.93^{bcd}	25.07^{bcd}
4 - 500g ipil[2]	26.64^{bc}	229.50^{ab}	7.51^{bcd}	11.97^{ab}	55.50^{bc}	30.57^{b}
5 - 250g ipil[2] + 70g KCl	27.47^{b}	212.01^{b}	7.39^{bcd}	11.67^{ab}	55.37^{bc}	30.62^{b}
6 - 500g ipil[2] + 70g KCl	28.93^{ab}	242.59^{a}	7.97^{ab}	11.97^{ab}	56.35^{b}	36.65^{a}
7 - 10cc agri-spon (A)	23.19^{d}	205.26^{b}	7.10^{cd}	11.72^{ab}	52.05^{cd}	22.80^{d}
8 - 20cc A	23.29^{d}	209.84^{b}	7.15^{bcd}	11.57^{b}	50.65^{d}	24.62^{cd}
9 - 10cc A + 70g KCl	26.47^{bc}	215.36^{b}	7.77^{abc}	12.00^{ab}	52.87^{bcd}	30.62^{b}
10 - 20cc A + 70g KCl	27.69^{b}	211.15^{b}	6.93^{cd}	12.17^{ab}	54.80^{bc}	29.35^{bc}
HSD .05	3.05	22.906	0.858	0.683	3.816	5.899
.01	3.625	27.225	1.020	-	4.535	7.012
c.v.(%)	4.76	4.29	4.73	2.36	2.88	8.26

[1] Means having the same letter(s) are not significantly different.

TABLE 8
Nut and Copra Production of On-farm Fertilizer Trial at Polonuling, South Cotabato for 6 Harvests (Margate et al. 1993)

TREATMENT	NUT/PALM (no.)	COPRA/NUT (g)	COPRA/PALM (kg)
T1 - Control	33.8^{c}	212.6^{b}	7.2^{c}
T2 - 1.0 kg Ammonium Sulfate + 1.8 kg NaCl + 1.5 kg Dolomite	76.6^{ab}	295.8^{a}	22.7^{b}
T3 - Twice T2	85.2^{a}	313.1^{a}	26.6^{a}
T4 - 10 kg corn cob	30.6^{c}	223.7^{b}	6.8^{c}
T5 - 10 kg corn cob + 1.8 kg NaCl + 1.5 kg Dolomite	57.1^{b}	296.4^{a}	17.0^{b}
Stat. significance	**	**	**
c.v. (%)	15.6	4.1	17.0

The application of animal manures also induced the 'MAWA' hybrids to flower in 3 yr after field-planting (Maravilla 1989). Flowering occurred 6-7 mos earlier than that of the unfertilized coconut. Manure application costs P12.30/palm (goat manure), P9.60/palm (cow manure), and P24.33/palm (chicken manure), while inorganic fertilizer costs P17.97/palm.

The latest results of on-farm fertilizer trials (OFFTs) in Quezon and Camarines Sur showed positive response of local talls to chicken dung (Margate et al. 1993). There were also improvements in nut yield in either chicken dung applied singly or in combination with Cl over the control palms in Aklan and Samar. In the case of hybrid coconuts, a combination of organic and Cl (from inorganic fertilizers) gave higher yield in places like Zamboanga City, Dipolog City, Agusan del Sur, and South Cotabato, although their yields were lower than the pure inorganic fertilizer treatments (Table 8).

India

Animal excreta such as goat dung or cow dung contain considerable amount of plant nutrients. These can be used for manuring coconut palms as an alternative to inorganic fertilizer mixtures. However, there are limitations to the use of organic manure as a nutrient source for coconut. Somarisi (1987) explained that the nutrient content of organic manure is very low and therefore it has to be applied in bulk compared to inorganic fertilizer. *Although organic manures contain N, P, and K, these are not in the proportion required by the plants. Therefore, they should be supplemented with inorganic fertilizers to meet the nutritional* *requirements of the palm.* The cost of application of organic manure may also be higher, but when freely available, its use is recommended.

Husk was found to increase the yield of East Coast Tall. Mulching coconut husk around the base of the palm at 2 m distance improved the yield by 49.6% over control (non-organic fertilizer application). Burying a thousand coconut husk per palm plus coconut leaves in the trenches between rows raised yield by 44.6% over the control. These increases were attributed to the ability of coconut husk to conserve moisture and store water nearly three times its weight. It contains 15% K_2O, and a thousand husks can give 7-8 kg potash. Aside from its importance in coconut nutrition, potash content in the husk is readily soluble and available to the palms (Balasubramanian et al. 1985).

In Lakshadweep, regular manuring was found essential from the beginning of planting to ensure proper growth of the seedlings. The fertilizers were applied in two doses, first in May and next in September. Circular basins of 1.8 m radius and 25 cm deep were dug around the trees where compost or green leaves were applied along with the fertilizer and covered with soil (Krishnamoorthy 1985).

Bavappa (1986) noted additional benefits of organic materials (coir dust, coconut shredding, forest leaves, and cattle manure) plus the recommended dose of NPK improved the initial growth and reduced the mortality of coconut seedlings from 50% to 17% in coastal sandy soil. There was also considerable improvement in the organic carbon status from 0.06% to 0.13 % after 10 yr.

Sri Lanka

Green manure like *Gliricidia sepium* helped the establishment of 2-mo old polybagged seedlings at 100% survival rate. Palms grown in sandy soils, on the other hand, responded to the application of inorganic fertilizer with extra goat dung. The nut production increased by 42% while copra production by 45% at the end of the 5th year (Mahindapala 1989).

Several methods were stressed by Abeywickrama et al. (1983) to minimize damaging effects of drought. The important ones associated with organic fertilization are: **1. mulching** - covering the soil around the palm by a layer of vegetable matter, e.g., coconut fronds, husks, loppings of *Gliricidia, ipil-ipil and sun-hemp;* **2. husk/coir burying** - husk acts like a sponge and can absorb and retain about six times its own weight of water, also retaining moisture for *about 2 mos after rain has ceased;* **3. bio-farming** - addition of organic material (plant and animal) via crops and livestock integrated farming which improves the physical condition, water retention, as well as fertility of the soil.

CONCLUSION

Organic fertilization is indeed a versatile component in a coconut-based farming system. It does not only influence the soil and coconut, but also the farmer as an important element in the system. However, at present there is still a dearth of research-based information as far as organic fertilization on coconut is concerned.

While the government is helping to alleviate the plight of the farmers, technologies remain aloof to them. Organic fertilization, for instance, as a cheaper source of nutrients, has just gained concerns lately. If this is realized by the coconut farmers, the use of organic fertilizer may reduce the cost of their farm inputs, and thus, help increase net profits and conserve the dollar reserve of the country.

Coconut productivity remains low because of dependence of farmers on the natural fertility of the soil. As a perennial crop, coconut takes a long life cycle and calls for abundance of nutrients to sustain growth and yield. Since the demand is continuous, the supply will eventually be depleted. Some researches in coconut-growing countries revealed that organic fertilizers alone or combined with chemical fertilizers (as KCl or NaCl) promote early flowering and increase yield. Organic fertilizers can be obtained by recycling coconut by-products or other sources like animal manures or industrial wastes. However, farmers should be taught proper management of these materials as they may pose danger to humans, coconut, or the environment.

There are still constraints that make organic materials less acceptable, particularly the offensive odor, bulkiness, low nutrient content, labor requirement, and the non-immediate effect on the plant. However, a strong research and development effort can make organic farming in coconut a success.

Better still, the constant efforts on ISFM could provide another acceptable option to farmers in terms of producing high yields and high quality farm produce as a result of sustainable soil and crop nutrition management. The fact that bearing palms require balance levels of the following nutrients based on the annual estimates from the report of Magat (1988): 0.40 kg N, 0.20 kg P_2O_5, 1.20 kg K_2O, 0.50 kg MgO, 0.20 kg S, and 0.90 kg Cl, indicates the need to supplement organic fertilizer with the amounts of nutrients usually deficient in this form of fertilizers by combining with inorganic (chemical) fertilizers.

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