

# **COCONUT YIELD AND PROFITABILITY UNDER TWO PRACTICAL FERTILIZER OPTIONS : COMMON SALT (SODIUM CHLORIDE) AND MULTI-NUTRIENT 14N-0P<sub>2</sub>O<sub>5</sub>-20K<sub>2</sub>O-15Cl-4.5S-0.02B APPLICATIONS ON BEARING TREES (*Technology Notes*)**

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## **A. INTRODUCTION**

As early as 25 years ago, the general deficiency in nutrient chlorine (chloride) of coconuts in the Philippines was identified through the nationwide field survey and confirmed by on-farm fertilizer trials using the foliar diagnosis by PCA Researchers (Magat 1978, Magat et al 1981. The three fertilizer sources of chloride (Cl) tested (KCl, NaCl and NH<sub>4</sub>) to correct the nutrient deficiency were all found similarly effective, but NaCl (common salt) was cheaper and practical for farmers (Magat 1993).

Intensive basic and applied field studies on the usage of NaCl on coconut at different growth stages and on different planting materials (tall variety and hybrids) were done by the researchers of the PCA-Davao Research Centers to understand the influence of its application on the growth, nut yield, copra weight and yield over time. All studies were consistent that common salt is a general and ideal fertilizer for coconut, both for corrective and maintenance fertilization. On local tall varieties like the Laguna tall, for a 5 yr period, the average annual response to common salt application (2 kg/tree/yr) on bearing palms in terms of nut yield is 30.5%, copra weight per nut, 30 % and copra yield per tree, 69% Magat and Margate 1990). While on coconut hybrids as CATD x LAGT, average annual response : 65% in nuts; 31% copra weight per nut; and 65% in copra yield per tree (Secretaria and Magat 2008).

As a component of the National Coconut Productivity Program (NCPP), together with the Coconut Replanting Project (CRP) and Coconut Intercropping Project (CIP), the Salt Coconut Fertilization Project (SCFP) was initiated in 2008 which is projected to increase the average coconut yield of 0.90 t copra/ha per year by 25% in the first year and 50-100% (1.35 – 1.80 t copra/ha/year after the second year

Due to the variability in soil conditions and climatic factors in the different coconut regions and provinces, and farming practices likewise, there were other widespread nutrient deficiencies identified in many coconut areas such as: nitrogen (N), potassium (K), phosphorus (P), magnesium (Mg), sulfur (S) and boron (B) as identified by PCA FIELD RESEARCH in 1981 and 1993. A long-term research on identifying and developing a multi-nutrient fertilizer for coconut-based cropping/agroecosystem was launched in 1993 which concluded in 2007. The final S & T report on the findings of the PCA landmark 15-yr research was presented and reviewed by scientific bodies in 2008 (Magat et al 2008), particularly at the DA's National Research Symposium, Diliman, Quezon City.

The key results of this work were eventually presented to the PCA Governing Board through the PCA Management in January 2009. The Board asked Dr Magat to prepare a map showing the needs for the Coconut grade multi-nutrient fertilizer (MNF) in the coconut provinces which is now available (Magat 2009) and members of the PCA Board had been provided a copy each.

Later, there were inquiries on the production economics on the utilization of common sea salt (cheapest and practical effective fertilizer at 2 kg/tree/yr, ) and now the research identified coco-specific multi-nutrient fertilizer developed by the PCA found to achieve higher coconut yield levels ( 3 – 4 tons copra/ha/yr ), at a long term application of 1 kg MNF/tree/yr.

The production economics and profitability under varying prices of fertilizer inputs, coconut (copra price) with the subject fertilizer options are presented, together with unfertilized coconut palms situations, in the ensuing sections. This effort of the researchers-authors aims to provide all concerned a better understanding of the profitability or economic benefits from the two fertilizer options expected to be used extensively in coconut farms in the country in the coming years because of the firm and intensive R & D support done in generating appropriate fertilization practices.

## **B. BASIC WORKING BASIS OF ANALYSIS REFERENCED TO PCA'S FIELD RESEARCH DATA**

### **B.1. FERTILIZERS APPLIED (RECOMMENDED per tree) BY YEAR FOR A 5-YEAR CROPPING PERIOD**

Table 1.1 shows: for the common salt option, the application is 2.0 kg/tree per year for the first three (3) years, while in the case of the multi-nutrient 14-5-20 (14%N, 5%P<sub>2</sub>O<sub>5</sub>, 20% K<sub>2</sub>O, 15% Cl, 4.5% S and 0.02% B), at 3 kg, 2 kg, 1 kg, for the first year, second year and the next three years, respectively. Thus, for the three (3) years cropping period, these are a total of 8 kg for both NaCl and MNF fertilizer options.

**Table 1.1. Annual application rate per tree of common salt (NaCl) and multinutrient fertilizer 14-5-20 (MNF).**

Component Crop/Stage	NaCl	MNF
	Rate/tree (kg)	Rate/tree (kg)
Nut-bearing Coconut:		
Year 1	2	3
Year 2	2	2
Year 3	2	1
Year 4	1	1
Year 5	1	1

## B.2 FERTILIZERS APPLIED PER HECTARE FOR THE 5-YEAR PERIOD CROPPING

On a per ha basis, for the common salt (sodium chloride) option, for the first three (3 years), an annual quantity of 246 kg/ha ( about 6 bags, 40 kg.bag) is required and 123 kg/ha (about 3 bags) for the next two years of the five (5) year cropping period (Table 1.2). For the next option, the MNF fertilizer grade annual needs per ha: 369 kg (7.4 bags); 246 kg (5 bags); 123 kg (2.5 bags), with a 50 kg/bag capacity reference, for the years 1, 2 and next three years for the 5 year cropping period.

**Table 1.2. Annual application rate per ha with 123 trees (@ 9 m x 9 m square planting.**

<b>COCONUT @ 123T/HA</b>				
<b>YEAR</b>	<b>Sodium Chloride</b>		<b>Multinutrient Fertilizer</b>	
1	246	kg/ha	369	kg/ha
2	246	kg/ha	246	kg/ha
3	246	kg/ha	123	kg/ha
4	123	kg/ha	123	kg/ha
5	123	kg/ha	123	kg/ha

## C. ECONOMIC PRICES AND YIELD ASSUMPTIONS USED IN THE COMPUTATIONS

### C.1. Production Output and Input Prices

The prices of the coconut production output ( copra) at four price levels and production inputs of fertilizer material options (NaCl and MNF) used and labor cost are indicated for the five year cropping cycle (Table 2).

**Table 2. Increasing copra prices with the next years ( 5 cropping years), fertilizer prices of the two fertilizer options (common salt and multinutrient 14-5-20 fertilizer), and labor cost assumed.**

9X9M SQ  
 Harvesting P3.30/tree 6x/yr  
 Piling & hauling, 2 m.d., 6x/yr  
 Copra making (splitting, scooping, drying, sacking)

#### PRICES

YEAR	Copra price at 10% increase				40 kg/bag	50 kg/bag	PER 1000 NUTS		
	Price 1	Price 2	Price 3	Price 4	NaCl	MNF	wage rate	Dehusking	Copra making
1	17.50	21.0	25.2	30.2	7.00	27.00	100	80	120
2	18.38	22.1	26.5	31.8	7.35	28.35	100	80	120
3	19.29	23.2	27.8	33.3	7.72	29.77	100	80	120
4	20.26	24.3	29.2	35.0	8.10	31.26	100	80	120
5	21.27	25.5	30.6	36.8	8.51	32.82	100	80	120

## **C.2 YIELD PROFILE UNDER THREE CROPPING CONDITIONS: UNFERTILIZED (UF), COMMON SALT APPLICATION (CSA), AND MULTI-NUTRIENT CROP NUTRITION MANAGEMENT (MNF)**

The annual yield in terms of copra considered under unfertilized conditions (unmanaged farming) is at 10 kg copra/tree or 1.23 t copra/ha during the five cropping cycle (Table 3). Obviously, this basis is simplified assumption, albeit annual coconut yield could fluctuates from year-to year by about 2-5%, even without fertilizer application as crop's response to annual variability in rainfall intensity and distribution under rain- fed farming. With the common salt application(CSA), average yields obtained are: during year 1 – 12.5 kg copra/tree (or 1.54 t copra/ha@ 123 trees); years 2 -5 with 15 kg copra/tree (or 1.85 t copra/ha) as shown in Table 3. On the other hand, also presented in in Table 3, the application of multi-nutrient N-P-K-CI-S-B mineral fertilizer (MNF) produces average coconut yields: at year 1 – 15 kg/tree (1.85 t copra/ha); year 2 – 20 kg/tree (2.46 t copra/ha); years 3-5 with 25 kg copra/tree (3.08 t copra/ha).

This clearly shows that the CSA increased coconut yield (copra terms) by 25% and 50% over the unfertilized conditions, at year 1 and in following years (year 2 -5), respectively. In terms of copra, this is average annual yield of 1.78 t/ha achievable by CSA over the unfertilized trees. While, better still, the MNF option increased coconut yield in year 1, year 2 and ensuing years (years 3 to 5) by 50 %, 100%, and 150 % respectively. And this is an average annual yield of 2.71 t copra produced with the application of the MNF option, over 5 year cropping period.

When a comparison of the two fertilizer options on bearing palms (CSA and MNF) is considered, it is noted that the multi-nutrient fertilizer N-P-K-CI-S-B (MNF) application increased copra yield by 20%, 33% and 66% over the common salt (CSA), in years 1, year 2 and year 3 -5, respectively. This means a further increase of the annual average copra yield : 305 kg, 630 kg copra and 1230 kg copra at year 1 , year 2 and following 3 years, respectively, in a five cropping cycle period, with the MNF option over the CSA option.

**Table 3. Annual yield of coconut trees per tree and per ha for the five (5) cropping years under unfertilized conditions, and with the application of the two fertilizer options (sodium chloride and multi-nutrient fertilizer).**

YEAR	Control	
	Copra/tree/year (kg)	Copra/ha (kg)
1	10.0	1230.0
2	10.0	1230.0
3	10.0	1230.0
4	10.0	1230.0
5	10.0	1230.0

YEAR	Sodium chloride	
	Copra/tree/year (kg)	Copra/ha (kg)
1	12.5	1537.50
2	15.0	1845.00
3	15.0	1845.00
4	15.0	1845.00
5	15.0	1845.00

YEAR	Multi-nutrient fertilizer	
	Copra/tree/year (kg)	Copra/ha (kg)
1	15.0	1845.0
2	20.0	2460.0
3	25.0	3075.0
4	25.0	3075.0
5	25.0	3075.0

## D. ECONOMIC INDICES

### D.1 Gross Returns (GR) Per Hectare (PhP/ha)

Table 4 shows the gross returns or gross value bearing coconut production at increasing copra prices linearly increased (4 levels - PhP/kg copra 17.50, 21.0, 25.2 and 30.2) during the five year cropping period/cycle. For the unfertilized conditions, at the lowest copra price level, gross returns achieved at year 1 is PhP21,525 and PhP37,195, respectively. This increase is mainly a result of the higher copra price but not due to increased in copra yield as the yield considered for unfertilized farming is the same throughout the cropping period.

Compared to the common salt application on bearing palms (Table 4), the trees with MNF option resulted in the highest gross returns of PhP32,287 and PhP46,494, respectively at the lowest copra price and highest copra price levels, with the highest gross values obtained in the year 5: PhP 65,409 (Price level 1=PhP 17.50/kg copra) and PhP 113,027 (Price 4 =PhP30.2/kg copra). The increase in gross value with both the CSA and MNF fertilizer options are mainly attributed to the levels of increase in copra yields under the two options relative to the unfertilized conditions (Table 3) and Copra price (Table 2).

**Table 4. Gross returns (gross value) in coconut production as influenced by two fertilization options (CSA and MNF) and unfertilized conditions (annual per ha, PhP)**

year	Control			
	Price 1	Price 2	Price 3	Price 4
1	21,525.00	25,830.00	30,996.00	37,195.20
2	22,601.25	27,121.50	32,545.80	39,054.96
3	23,731.31	28,477.58	34,173.09	41,007.71
4	24,917.88	29,901.45	35,881.74	43,058.09
5	26,163.77	31,396.53	37,675.83	45,211.00

year	Sodium chloride			
	Price 1	Price 2	Price 3	Price 4
1	26,906.25	32,287.50	38,745.00	46,494.00
2	33,901.88	40,682.25	48,818.70	58,582.44
3	35,596.97	42,716.36	51,259.64	61,511.56
4	37,376.82	44,852.18	53,822.62	64,587.14
5	39,245.66	47,094.79	56,513.75	67,816.50

year	Multi-nutrient fertilizer			
	Price 1	Price 2	Price 3	Price 4
1	32,287.50	38,745.00	46,494.00	55,792.80
2	45,202.50	54,243.00	65,091.60	78,109.92
3	59,328.28	71,193.94	85,432.73	102,519.27
4	62,294.70	74,753.63	89,704.36	107,645.23
5	65,409.43	78,491.32	94,189.58	113,027.50

## D.2 Production Cost Per Hectare (PhP/ha)

Under unfertilized conditions of bearing coconut palms, using the labor cost, requires an average annual expense of PhP3,880 per ha at a yield level of 1.23 t copra from 123 trees (Table 5). This table 5 also indicates that with the application of option 1 (CSA), the annual fertilizer cost (NaCl) per ha: year 1 to 3 – PhP 1,722 to 1, 896 @ 2 kg NaCl/tree; and year 4 and 5 – PhP 996 to 1, 046 @ 1 kg/tree. These are 17% -18% of the total production cost - (PhP 10,084 – 10,302 per ha). In the case of option 2 (MNF), the annual fertilizer cost (multi-nutrient 14-5-20): year 1 - PhP 9,963 (3 kg MNF/tree); year 2 – PhP 6,974 (2 kg MNF/tree); and years 3 to 5 – PhP3,661 to PhP4,036, lowered application rate (@ 1 kg/tree. Relative to the total coconut production cost of fertilized bearing palms, these MNF application are: year 1 – 60%; year 2 – 54%; years 3 to 5 – at 40% to 38% of the total cost (TC).

There is a decreasing annual rate of MNF application (3 to 1 kg/tree) from year 1 to year 3 and onwards ( year 4 and 5) and common salt application (CSA) as PCA research results (Magat et al 2008) revealed positive effects on yield of residual fertilizers earlier applied over time.

**Table 5. Cost of Fertilization and other production inputs as influenced by two fertilization options (CSA and MNF) and unfertilized conditions.**

COCONUT (Control)										
	RW Coco	PEST	PEST APP	FERT APP coco	FERT coco	9X9M	Piling	Dehusking	Copra making	TOTAL
					Control	Harvesting				COST
1						2435.4	1200	98.4	147.6	3881.4
2						2435.4	1200	98.4	147.6	3881.4
3						2435.4	1200	98.4	147.6	3881.4
4						2435.4	1200	98.4	147.6	3881.4
5						2435.4	1200	98.4	147.6	3881.4

COCONUT (Sodium Chloride)										
					FERT coco	9X9M	Piling	Dehusking	Copra making	TOTAL
	RW Coco	PEST	PEST APP	FERT APP	cocoNaCl	Harvesting				COST
1	2700	1100	200	400	1722.00	2435.4	1200	123.0	184.5	10064.9
2	2700	1100	200	400	1808.10	2435.4	1200	147.6	221.4	10212.5
3	2700	1100	200	400	1898.51	2435.4	1200	147.6	221.4	10302.9
4	2700	1100	200	400	996.72	2435.4	1200	147.6	221.4	9401.1
5	2700	1100	200	400	1046.55	2435.4	1200	147.6	221.4	9451.0

COCONUT (Multinutrient Fertilizer)										
					FERT coco	9X9M	Piling	Dehusking	Copra making	TOTAL
	RW Coco	PEST	PEST APP	FERT APP	cocoMNF	Harvesting				COST
1	0	1100	200	400	9963.00	2435.4	1200	147.6	221.4	15667.4
2	0	1100	200	400	6974.10	2435.4	1200	196.8	295.2	12801.5
3	0	1100	200	400	3661.40	2435.4	1200	246.0	369.0	9611.8
4	0	1100	200	400	3844.47	2435.4	1200	246.0	369.0	9794.9
5	0	1100	200	400	4036.70	2435.4	1200	246.0	369.0	9987.1

## **7. Net Returns - Profitability Analysis ( per ha) under the a sensitivity analysis (SA) at four copra prices**

7.1 Copra Price Level 1 - for the unfertilized trees, net returns (net income) at copra price level 1 (PhP17.50/kg copra) ranged from PhP17,643 to PhP 22,282 per ha from year 1 to year 5. The net present value (NPV @ 18% interest) is PhP 61,067 for the five year cropping period. For the common salt application (CSA), it is PhP 16,841 to 29,794 with a NPV of PhP74,133. And for the multi-nutrient application (MNF) to coconut trees, the net return is PhP 16,620 to PhP52,499 per ha from year 1 to year 5. It has a NPV of PhP118,918 per ha (5 years cropping).

This also indicates that the MNF option has higher NPV over the CSA option by PhP 44,785 (60.4% higher) at copra price of PhP17.50 /kg copra, thus the former is more profitable. The main determinant of the higher NPV of the coconut trees applied with MNF over the unfertilized and common salt application (CSA) options is clearly the higher productivity of these trees with over the 5 years cropping period or cycle considered.



7.2 Copra Price Level 2 – for the unfertilized trees (control), the net returns for year 1 to 5 increases from PhP21,948 to 26,515 and a NPV of PhP75,709 (5 years). The application of common salt (CSA) generates: year 1 - PhP 22,222/ha; year 2 – PhP 30,469; year 3 – PhP 32,413; year 4 – PhP 35, 451 and PhP 37,643. An NPV (@ 18 % interest of capital) of PhP95,183 is achieved (5 years cropping period).

Over the CSA, the MNF fertilization option generates a difference in NPV of PhP55,063 (57% higher) in 5 years cropping period, indicating higher profitability of the MNF application on bearing palms over the CSA.



7.3 Copra Price Level 3 – for the unfertilized trees, net returns at copra price level 3 (PhP25.2/kg copra) ranged from PhP27,114 to 33,794 per ha from year 1 to year 5. The NPV(at 18% interest) is PhP93,278 for the 5 year cropping period. For the CSA, the net returns is PhP28,680 to 47,062, with a NPV of PhP120,442. And for the MNF application on coconut trees, the net income ranged from PhP30,826 to 84,202 per ha from year 1 to 5. It has a NPV of PhP 187,847 per ha (5 years cropping).

This also shows that the multi-nutrient mineral fertilizer application generates a higher NPV over the common salt application option by PhP67,405 at the copra price of PhP25.2/kg copra, hence the application of the MNF is more profitable (56% higher NPV@18% interest) than the common salt (NaCl) application on bearing trees.



7.4. Copra Price Level 4 (PhP30.20/kg copra) – for the unfertilized trees (control), the net income for year 1 to 5 increases from PhP33,313 to 41,329, with a NPV of PhP114,391 (5 years). The application of NaCl generates: year 1 – PhP36,429/Ha; year 2 – PhP48,389; year 3 – PhP 51,208; year 4 – PhP55,186; and year 5 – PhP58,385. The NPV generated amounts to PhP150,754 (5 years cropping).

Compared to the CSA, the MNF application on bearing coconut trees has higher NPV by a marked difference of PhP82,210 , i.e. 54.5% higher than the common salt application, over the 5 years cropping period. In other words, the application of multi-nutrient 14-5-20 mineral fertilizer is obviously more profitable than common salt application.



## SUMMARY AND CONCLUSION

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## **ANNEX**

### **Annual Profitability Analysis ( Sensitivity analysis at four (4) coconut copra price levels**

Table 8.1 Sensitivity Analysis @ Copra Price Level 1 (PHP/tree)



Table 8.2 Sensitivity Analysis @ Copra Price Level 2 (PHP/tree)

Control						
	@ Price 2	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<b>Gross Returns</b>		210.00	220.50	231.53	243.10	255.26
<b>Production Cost</b>		31.56	31.56	31.56	31.56	31.56
<b>Net Returns</b>		178.44	188.94	199.97	211.55	223.70

**NPV @18**                      615.52  
 Sum of discounted gross benefits =                      714.20  
 Sum of discounted gross costs =                      98.68  
**BCR (18%)**    7.24  
**IRR (18%)**    #NUM!

Sodium chloride						
	@ Price 2	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<b>Gross Returns</b>		262.50	330.75	347.29	364.65	382.88
<b>Production Cost</b>		81.83	83.03	83.76	76.43	76.84
<b>Net Returns</b>		180.67	247.72	263.52	288.22	306.05

**NPV @18**                      773.85  
 Sum of discounted gross benefits =                      1,026.81  
 Sum of discounted gross costs =                      252.97  
**BCR (18%)**    4.06  
**IRR (18%)**    #NUM!

Multi-nutrient fertilizer						
	@ Price 2	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<b>Gross Returns</b>		315.00	441.00	578.81	607.75	638.14
<b>Production Cost</b>		127.38	104.08	78.14	79.63	81.20
<b>Net Returns</b>		187.62	336.92	500.67	528.12	556.94

**NPV @18**                      1,221.54  
 Sum of discounted gross benefits =                      1,528.36  
 Sum of discounted gross costs =                      306.82  
**BCR (18%)**    4.98  
**IRR (18%)**    #NUM!

Table 8.3 Sensitivity Analysis @ copra Price 3 (PHP/tree)

Control						
	@ Price 3	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<b>Gross Returns</b>		252.00	264.60	277.83	291.72	306.31
<b>Production Cost</b>		31.56	31.56	31.56	31.56	31.56
<b>Net Returns</b>		220.44	233.04	246.27	260.17	274.75

**NPV @18**                      758.36  
 Sum of discounted gross benefits =                      857.04  
 Sum of discounted gross costs =                      98.68  
**BCR (18%)**    8.68  
**IRR (18%)**    #NUM!

Sodium chloride						
	@ Price 3	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<b>Gross Returns</b>		315.00	396.90	416.75	437.58	459.46
<b>Production Cost</b>		81.83	83.03	83.76	76.43	76.84
<b>Net Returns</b>		233.17	313.87	332.98	361.15	382.62

**NPV @18**                      979.21  
 Sum of discounted gross benefits =                      1,232.18  
 Sum of discounted gross costs =                      252.97  
**BCR (18%)**    4.87  
**IRR (18%)**    #NUM!

Multi-nutrient fertilizer						
	@ Price 3	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
<b>Gross Returns</b>		378.00	529.20	694.58	729.30	765.77
<b>Production Cost</b>		127.38	104.08	78.14	79.63	81.20
<b>Net Returns</b>		250.62	425.12	616.43	649.67	684.57

**NPV @18**                      1,527.21  
 Sum of discounted gross benefits =                      1,834.03  
 Sum of discounted gross costs =                      306.82  
**BCR (18%)**    5.98  
**IRR (18%)**    #NUM!

