Integrated Soil Fertility Management on Local Coconut Hybrid in a Farmer-Managed Coconut-Based Cropping System

By
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Abstract

An integrated soil fertility management or ISFM on-farm trial was conducted at Barangay Tawan-tawan, Baguio District, Davao City in 1993 to 1999 to know the effects of organic and inorganic fertilizers on the vegetative growth, nutrient status and yield performance of intercropped Catigan dwarf x Laguna tall (CATD x LAGT) coconut hybrid better known as PCA 15–1 or CATLAG.

Vegetative growth of CATD x LAGT palms revealed that ammonium sulfate + NaCl and goat manure + NaCl produced significantly bigger girth size on the first year and more number of leaves and living fronds on the second and fourth year, respectively. These treatments also enhanced early flowering (>50% @ 4.5 years) and yield (51-53 nuts/tree/yr @) 5 years from field planting) in hybrid palms. The organic fertilizers, i.e. goat manure and coconut husk, become more effective in their effect on the vegetative and reproductive characters of palms when combined with a Cl source (NaCl). The application of Cl nutrient contributed to the better performance of palms during the drought condition. The application of goat manure resulted in improved levels of soil nutrients as K, Ca, Mg and P, increased percent base saturation and lower soil acidity.

The use of local hybrid, PCA 15-1 and ISFM-based low cost production inputs such as ammonium sulfate, goat manure/coco waste (husk) and common table salt as well as intercropping suitable crops under young coconuts is a profitable package of technologies capable of improving and sustaining coconut farm productivity in the Philippines.

INTRODUCTION

One of the five major concerns to support the new Agriculture and Fisheries Modernization Act’s (AFMA) Research, Development and Extension (R, D & E) Agenda is the enhancement of sustainable agriculture and environmental management of our natural resources. According to Prasad (1997), the ultimate goals or ends of sustainable agriculture are to develop farming systems that are productive and profitable, conserve the natural resource base, protect the environment and enhance health and safety in the long run.

Fertilization has proved to be beneficial to the coconut in all coconut growing areas in the world. In the Philippines, several workers reported very encouraging results (Mendoza and Prudente, 1972; Magat et al, 1975; Prudente and Mendoza, 1976; Margate et al, 1978 and Prudente et al, 1979), particularly on nitrogen and chlorine fertilization. Specifically, the application of fertilizers supplying N, Cl and S significantly improved nut production and copra yield per palm, three and two years, respectively after fertilization (Magat et al, 1980).

While chemical or mineral fertilizers usually produced significant and quick improvements on the yield of coconut, they also reduce the soil productivity, particularly the lowering of pH and the destruction of soil structures in the long range (Secretaria and Maravilla, 1992). With the high cost of

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inorganic fertilizers, coupled with the growing consciousness on the bad effects of injudicious application of inorganic fertilizers on our environment, better fertilizer management practices are being tried in coconut farming. Hence, the use of organic fertilizers in coconut in combination with inorganic fertilizers better known as integrated soil fertility management or ISFM for exploration and testing.

Several studies on organic fertilization (Cadigal et al, 1983, 1987; Cadigal and Prudente, 1983; Secretaria and Maravilla, 1992) had been conducted in coconut showing the positive effects of organic farming. It strongly appears that organic fertilizer is more of a soil conditioner in the early years (1-3) of application and as a fertilizer supplying about 25% of the nutrient requirement of coconut (N, P, K and S) at 4-5 years from initial regular annual application (Magat, 1991).

Considering the importance of enhancing soil fertility and moisture conservation, research efforts are now geared towards an integrated system of soil fertility management to sustain crop productivity by optimizing all possible fertilizer sources (organic and inorganic) of plant nutrients required for crop growth and development. Hence, this study was conducted at farmer's field in Davao City, Philippines from October 1993 to December 1999.

OBJECTIVES

1. To assess the effects of inorganic and organic fertilization (animal manures and farm by-products) on the vegetative and reproductive characters of local hybrid at farmer's field;
2. To generate a feasible and inexpensive fertilization practice and a coconut-based cropping pattern that could increase coconut productivity through increased soil fertility level;
3. To determine the economics of various fertilizer treatments and intercropping practice; and,
4. To validate, demonstrate and transfer to farmer's field appropriate research technology for improved and sustained farm productivity.

MATERIALS AND METHODS

Experimental Material

One year old Catigan dwarf x Laguna tall (CATD x LAGT) hybrid seedlings were used as materials. The seedlings were obtained from a nursery study on the effects of different polybagging media on the growth of these seedlings. These were planted at two farmer's fields (about 0.5 km away from each other) located at Barangay Tawan-tawan, Baguio District, Davao City. The farmer-cooperators were Messrs. Timoteo Adon and Efren Pedroso Sr., both residents of Brgy. Tawan-tawan, Baguio District, Davao City.

Experimental treatments and design

Five treatments were tested as follows:
- T1 - Control (No fertilization)
- T2 - Inorganic fertilizers (Ammonium sulfate \{ AS \} + NaCl)
- T3 - Goat manure (GM) + NaCl
- T4 - Coconut waste (CW) + NaCl
- T5 – NaCl

The study was laid out in randomized complete block design (RCBD) with three replicates and nine (9) experimental palms per plot. The seedlings were planted in a 9 x 9 meter distance triangular system. Since the seedlings were subjected to different treatments (from previous study)
and, therefore, of different growth performance, grouping of relatively homogeneous seedlings was considered as replicate to eliminate error to this factor.

**Fertilization rate**

The inorganic fertilizers (ammonium sulfate and NaCl) were applied once a year using the following recommended dosage per palm basis (The Coconut Committee, 1993):

| Palm Age          | Ammonium sulfate | NaCl   |
|-------------------|------------------|--------|
| At field planting (FP) | 150 g            | 160 g  |
| 6 months          | 200 g            | 200 g  |
| 1 year            | 500 g            | 480 g  |
| 2 years           | 750 g            | 720 g  |
| 3 years           | 750 g            | 1.25 kg|
| 4 years           | 1.00 kg          | 1.35 kg|
| 5-6 years         | 1.50 kg          | 1.70 kg|

As for treatments 3, 4 and 5, the rate of NaCl was the same as in treatment 2, while rate of goat manure (in kg) applied once a year (during the start of rainy season) was as follows:

| Age:            | FP   | 0.5yr | 1yr | 2yrs | 3yrs | 4yrs | 5yrs |
|-----------------|------|-------|-----|------|------|------|------|
| GM*             | 1    | 2     | 3   | 4    | 6    | 8    | 10   |

* Based on PCA's on-farm fertilizer trials

For treatment 4, coco wastes (particularly coconut husk - about 50 pieces of whole nut husk split into 4-6 pieces) were placed around the base of the palms in addition to the application of NaCl.

**Chemical analysis of fertilizer materials**

| FERTILIZER MATERIAL (in %) | BASED ON ACTUAL ANALYSIS (in %) |
|---------------------------|---------------------------------|
|                           | N     | S     | Na    | Cl    | K     | Ca    |
| Ammonium sulfate          | 20    | 24    | 0     | 0     | 0     | 0     |
| Sodium chloride           | 0     | 0     | 50    | 50    | 0     | 0     |
| Coco waste (husk)*        | 0.3   | 0.2   | 0     | 0.95  | 1.8   | 0.16  |
| Goat manure               | 1.5   | 1.5   | NA    | NA    | 3.0   | NA    |

* % dry matter (Eroy et al., 1990) NA - Not analyzed

**Land preparation and field planting**

Land preparation, i.e. plowing, harrowing were undertaken by the farmers. On the other hand, field lay-outing, i.e. staking for planting of seedlings was managed by the researchers and assisted by the farmer-cooperators. Field-planting of coconut seedlings was done by the farmers and some laborers of the PCA-Davao Research Center.
**Intercropping the coconuts**

In the early stage of the palms, the farmers were given the option to use the vacant spaces in between the rows of palms for intercropping provided all areas would be intercropped. The choice of intercrops was decided by the farmers in consultation with the researchers depending on the farmers' needs, profitability and market opportunities of the intercrops.

During the first two years from field planting, peanuts (20 x 60cm distance) and corn (20 x 70 cm) were planted in replicate 1 and II while rice (20 x 60 cm) and corn in replicate III. Side-dress application of urea (45-0-0) was done in rice and corn while peanut was not fertilized. On the third year, banana was planted with a distance of 4 x 4 m in between rows of coconut palms in replicate III and in replicate I and II on the fourth year. Banana was fertilized with ammonium sulfate and potassium chloride (0-0-60).

On the fourth year, the same short season crops, i.e. peanut and corn were planted. At the same time, some fruit crops (durian and lanzones) were planted at 7 x 14 m distance under coconut and banana. On the sixth year, most of the old bananas planted were cut to avoid light competition between coconut and this intercrop.

**Gathering of data**

The following growth indices on coconut were gathered every six months after initial data recording at field planting time:
1) Girth circumference (up to third year)
2) Number of leaves produced and total living fronds (up to fourth year)
3) Height of palms (up to third year)
4) Number and time of flowering palms

On the fourth year from field planting, yield of early bearing palms was estimated based on the three oldest bunches (Magat, 1995). The data gathered from the intercrops was not only on their yield. Cost of production was also recorded for economic analysis.

**Soil and leaf analyses**

Soil sampling and analysis was done at the beginning of the study, 3.5 years thereafter and at 6 years from field planting to determine the soil fertility of the farmers’ field during the duration of the study.

Leaf sampling and analysis was done annually at leaf rank number 4 starting in 2.5 years, 3.5 years and 6 years from field planting and at leaf rank number 9 in third to sixth year.

**RESULTS AND DISCUSSION**

**Vegetative growth characters**

The effects of fertilizer treatments on the vegetative characters of CATD x LAGT (PCA 15-1), the first local hybrid produced by PCA, was noted. In the first year of growth, girth size was the only character significantly affected by the treatments with palms fertilized with inorganic fertilizers (AS + NaCl) having the biggest girth circumference (Table 1 and Fig. 1). Palms treated with goat manure, coco waste combined with NaCl and NaCl alone showed comparable girth size with the inorganic fertilized palms but were statistically the same with those of the unfertilized palms. From the second to the third year, girth size was no longer affected by the different fertilizer treatments.
For plant height, no significant response of palms was observed from the first to the third year (Table 1). However, generally the palms with AS + NaCl and goat manure + NaCl were the tallest compared to the palms given other treatments. The shortest palms were observed in two treatments: (1) without any fertilizer; and, (2) NaCl alone.

The number of leaves and total living fronds produced per year were significantly affected by the treatments on the second and fourth year after field planting, respectively (Table 2). The highest number of leaves and living fronds produced were observed in palms applied either with AS + NaCl or goat manure + NaCl which were both significant over the control palms.

The improved leaf production rate and total living fronds observed in palms with AS and goat manure applications, combined with NaCl, indicates that goat manure could be a substitute for ammonium sulfate as source of nitrogen nutrient. This result confirms earlier findings on the potential of goat manure as an effective source of nutrient for coconut palms (Cadigal et al, 1987; Secretaria and Maravilla, 1992). Furthermore, the effectiveness of goat manure is enhanced when combined with NaCl as exemplified in this study and recommended in the previous studies (Secretaria and Maravilla, 1997; Margate et al, 1997).

**Flowering observation**

The palms that first flowered came from treatments with goat manure + NaCl and ammonium sulfate + NaCl in three years from field planting. Regular monitoring of the flowering of palms every three months starting on the third year showed early precocity of CATD x LAGT palms in treatments with inorganic fertilizers (AS + NaCl) and goat manure + NaCl as manifested in the higher percentage of flowering palms with these treatments (Fig. 2). The palms with treatments of coco waste + NaCl and NaCl alone started flowering at 3.5 years while the unfertilized palms flowered at 4.5 years from planting. It could be observed that in 4.5 years from planting, hybrid palms reached more than 60% flowering when fertilized with inorganic fertilizers (AS + NaCl), goat manure and coco waste both combined with NaCl in contrast with only about 10% flowering for non-fertilized palms. This result confirms again earlier studies on the effect of inorganic and organic fertilizers on the precocity of hybrid palms which shows that compared with inorganic fertilization, the combination of inorganic and organic fertilizers enhanced early flowering in coconut. Consequently, earlier nut production is expected from these palms (Figs. 3 & 4).

**Yield of palms**

Nut yield of hybrid palms was initially estimated in the fourth year based on the three oldest bunches (Magat, 1995). The palms treated with AS + NaCl produced higher number of nuts/tree/year compared to other treatments. Although the number of nuts/tree/year for palms with goat manure + NaCl was lower than that of coco waste + NaCl and NaCl alone, the former had more bearing palms than the latter treatments. This finding substantiates the previous result that earlier and higher productivity could be obtained from palms fertilized with ammonium sulfate and goat manure combined with NaCl.

The yield response of CATD x LAGT hybrid further indicates its higher productivity as compared to local tall variety ‘Laguna’ (LAGT) where initial yield of palms from this variety with the same fertilizer rates of ammonium sulfate and NaCl showed a lower number of nuts (59) per tree per year (Margate et al, 1996).

In the succeeding years, the palms produced lower number of nuts/tree/year as a result of the dry spell experienced by the palms on the last quarter of 1997 to second quarter of 1998. It is interesting to note, however, that palms fertilized with organic materials such as goat manure and coco husk combined with the common table salt (NaCl) still had higher number of nuts/tree/year and more bearing palms than those with ammonium sulfate + NaCl, particularly on the sixth year (Table
The palms with organic materials such as coconut husk and animal manures known to improve the soil structures in terms of their bulk density and water holding capacity (Secretaria and Maravilla, 1996) could have benefited from these naturally-occurring fertilizers during the drought period, resulting in better yield performance of palms than those fertilized with inorganic material, i.e. ammonium sulfate. Likewise, the role of Cl element in increasing the tolerance of coconut palms to drought in addition to improving the growth and yield of hybrid palms (Margate, 1983) contributed to this good observation. This present finding also proved positively the earlier claim that when palms fertilized with organic materials lacked Cl element, they were adversely affected in terms of vegetative and reproductive performance.

The essential nature of chloride as a major drought factor was confirmed by Braconnier and d’Auzac (1989) as cited by Secretaria & Maravilla (1997). They found that the Cl-ion is involved in drought resistance phenomena and that its presence enables coconut palms to keep their stomata open longer during the day and attain a highly negative water potential; hence, benefiting from a sufficient water drawing capacity to maintain cell turgidity. These two actions enable optimization of the balance between transpiration and assimilation, thereby leading to better stress tolerance. On the other hand, soil with high organic matter such as from naturally occurring fertilizers had higher capacity to retain water. This improved physical condition of the soil allows for better root development, thus absorption of water and nutrients is greatly enhanced (Mangawang, 1993).

At the end of the sixth year from field planting, actual nut harvesting was done on the experimental palms. Among the treated palms, those fertilized with goat manure + NaCl showed higher number of nuts per palm and heavier whole nut weight (Table 3). This was followed by palms with NaCl alone and coco waste + NaCl. From the initial nut harvest, samples of five nuts of CATD x LAGT (regardless of treatments) were analyzed for their nut components. The analysis showed that the average whole nut of this hybrid is about 1,130 g with 32% husk, 16% water, 16% shell and 35% fresh meat. Based on the guide on estimation of nut to copra conversion factor or NCFF (Magat, 1995), about 3.25 to 3.5 nuts are needed to produce a kilo of copra from this hybrid population.

**Leaf nutrients**

Leaf analysis results from leaf rank number 4 of 2.5 and 3.5 years old hybrid palms showed significant effect of the fertilizer treatments on the Na and Cl levels since NaCl was used as one of the inorganic fertilizers in all treatments except in the control (Table 4). All treated palms had significantly higher Cl levels than the unfertilized palms. This explains the excellent performance of the treated palms in terms of their vegetative growth. As to leaf Na level at 2.5 years old, the T2 gave the highest level of Na while the other treated palms had Na level comparable with T2 but still statistically the same with the level of unfertilized palms. A year after (3.5 years), the level of Na for T4 and T5 became statistically the same with T2 level.

At six years old, hybrid palms showed significant effect of fertilizer treatments on leaf N, Na, Cl, B and Mn. It is interesting to note that the highest leaf N content was observed on palms treated with goat manure + NaCl followed by those fertilized with AS + NaCl. This again clearly indicates that goat manure could substitute ammonium sulfate as a source of N for the hybrid palm. This also explains the good vegetative and yield performance of palms fertilized with goat manure + NaCl. The N levels of all treated palms were low (below critical levels). However, considering that the actual appearance of coconuts were normal, the low N leaf levels could be due to the dilution effect especially that they produced more leaves.

As for Na and Cl elements, all treated palms had significantly higher levels than unfertilized palms with AS + NaCl and coco husk + NaCl treated palms having the highest level for Na and Cl, respectively. For B, it strongly appears that Cl application had a depressive effect on B level, since the treated palms had lower B level, while the unfertilized palm had the highest B level. However, for Mn, there seems to be a positive effect of Cl application on Mn level with the highest from AS +
NaCl and cocohusk + NaCl treatments, the lowest from unfertilized treatment. No significant effect of fertilizer treatments was observed on Zn, Cu and Fe.

**Effect on soil properties**

Benchmark information of the soil revealed that the organic matter, like available P was considered low; but adequate in K. Hence, the use of NaCl for this experiment to supply Cl to the palms (Table 5). The soil was very strongly acidic with pH level ranging from 4.7 to 5.0 (Table 5). After about four years of fertilization, some changes on the pH level could be observed; i.e. pH level in all treatments increased to moderately acidic level. Among the treated palms, those with inorganic fertilizers (AS + NaCl) had the lowest pH level of 5.5 indicating a more acidic level compared to the other treatments. This was brought about by the release of H⁺ ions by ammonium sulfate in the soil. But with the application of organic fertilizers as in T3 and T4, soil was maintained at moderate acidity. Even without fertilization, the soil pH increased over the benchmark value due to nutrient recycling of bases Ca, Mg, K and O.M while P was further reduced in all treatments. The extractable K was maintained especially with goat manure treatment at 250 ppm. Besides the inherent capacity of the soil to improve pH, the application of organic fertilizer (goat manure, cocowastes) supplies beneficial microorganisms favorable to the soil.

At the end of sixth year, generally the soil of the experimental palms became extremely acidic (particularly that of ammosul + NaCl) except for those with the goat manure + NaCl treatment where pH level was higher (strongly acidic) than the others, both for top and subsoil levels. It could be noted that at this pH level of soil from goat manure + NaCl treatment, higher values for most of the elements were observed e.g. P, extractable K, exchangeable bases (Ca, Mg, Na, K) and base saturation point. Such acidity level is still suitable for coconut growing compared to the higher acidity level of the other treatments. These factors could have contributed to the better soil fertility level of palms with goat manure + NaCl due to its accumulation or residual effect; and, consequently, better vegetative and yield performance of the palms.

**Intercropping under coconuts**

Corn + peanut (Fig. 5), corn + rice and corn + peanut + rice cropping patterns were tried by the farmer-cooperators in one to two years from field planting which proved to be a profitable coconut-based cropping systems. This intercropping practice helped the farmers earn some income while the coconut palms were still on their pre-bearing stage (Table 6).

In the third year, some intercrops were again planted by the farmer-cooperator in the interrows of young CATD x LAGT palms. However, compared with the previous year’s income from intercropping, a lower income was realized due to the damage to the intercrops (corn, rice and peanut) by insects (larval stage).

In the fourth year, several intercropping patterns were introduced by the farmer-cooperators. Four coconut cropping systems involving high value tropical fruits and short season crops were done on the first two replicates, as follows:

- Coconut + banana + lanzones
- Coconut + banana + corn (Fig. 6)
- Coconut + banana + durian + peanut + corn
- Coconut + banana + durian + peanut (Fig. 7)

Only banana + corn were planted under coconut palms on the third replicate.
These coconut–based cropping systems could have proven to be a very profitable production strategy were it not for the drought that occurred from the last semester of 1997 to first semester of 1998. Consequently, no income was realized by the farmers from its short season crops in the fourth to fifth year. A small amount of income was realized from banana planting in the fifth year.

This CBFS practice in farmer’s field showed that a number of considerations must be met to ensure high economic benefits. Some of these are: 1) suitable environmental condition (favorable climate + soil); 2) appropriate technology; 3) available planting materials; 4) right attitude of farmers; 5) favorable market for farm produce 6) available working capital (Magat, 1999).

**Economic analysis**

Based on the economic situation of 1994-99 during the early years of bearing, treatments with goat manure + NaCl with various coconut-based cropping pattern gave the highest total net benefit (for 6 years) of P44,034.90/ha followed by inorganic fertilizers (AS + NaCl) treatment with P38,240.90 (Table 7). Figure 8 shows the status of experimental palms as affected by the fertilizer treatments at six years old. Using the dominance analysis [used to indicate that one alternative is superior to another in producing higher benefits (outputs) with equal or lower costs (inputs){ DARM 1990}] the treatments with inorganic fertilizers, goat manure + NaCl and coco husk + NaCl were not dominated, meaning their net benefits were higher (following increasing total variable costs) compared to those with lower total cost. The NaCl alone was the only dominated treatment. Hence, further analysis showed marginal rate of return (MRR) for the undominated treatments were 137%, 147%, 159%, respectively.

The MRR measures the return a farmer can expect to gain from each additional unit of investment in a new technology after deducting the cost of investment (DARMS, 1990). It should be 100% or more for a new technology to be economical and profitable. An MRR of 100% means that every P1.00 invested, the farmer can expect to recover the P1.00 plus an additional P1.00. Thus, we can observe from this result that the organic materials (goat manure + cocohusk) + NaCl gave higher MRRs than the inorganic fertilizer treatment. Hence, organic fertilizers are more profitable to use and, at the same time, can substitute for the commercial N-containing inorganic fertilizer (Ammosul) as source of nutrients.

**CONCLUSION AND RECOMMENDATIONS**

The application of recommended rates of inorganic fertilizers (ammonium sulfate and NaCl) and combination of organic (goat manure) + NaCl improved significantly the vegetative growth characters of local hybrid palms CATD x LAGT (PCA 15-1). Likewise, these two fertilizer treatments enhanced early flowering and yield of hybrid palms as compared to palms with coco waste (husks)+ NaCl, NaCl alone and the control.

The fertilizer treatments affected significantly the leaf nutrients Na and Cl as early as 2.5 years of fertilization. In the sixth year, leaf N, Na, Cl, B and Mn were significant affected by fertilizer treatments particularly those palms with AS + NaCl and goat manure + NaCl treatments. This explains the better performance of these palms in terms of their precocity and yield compared to the other treated palms. Improved soil conditions (P, extractable K, exchangeable bases and base saturation point) of the experimental palms with the accumulation or residual effect of organic fertilizer (goat manure) + NaCl likewise contributed to its good performance.

The recommended rates of inorganic and organic fertilizers for better performance of local hybrid palms at the different stages for this particular place of study and similar locations are as follows:
| Palm Age          | Ammonium sulfate + NaCl or | Goat manure + NaCl |
|------------------|---------------------------|-------------------|
| At field planting| 150 g                     | 160 g             |
| 6 months         | 200 g                     | 1 kg              |
| 1 year           | 500 g                     | 2 kg              |
| 2 years          | 750 g                     | 3 kg              |
| 3 years          | 1.00 kg                   | 4 kg              |
| 4 years          | 1.25 kg                   | 6 kg              |
| 5 years & more   | 1.50 kg                   | 8 kg              |
|                  |                           | 10 kg             |

The application or use of goat manure combined with Cl fertilization would be practical if goat manure is available in the farm such as in coconut and goat raising farming system. While for coconut husks which are always available in coconut farms, mulching 50 pcs per palm + common table salt which is cheap and very affordable (same rate as indicated at above table per fertilization schedule) would be a very practical and inexpensive fertilization practice.

Intercropping of profitable short season crops e.g. peanut, corn and rice, annual crop like banana in the interrows of young coconut provides early income for the farmers even at pre-bearing stage of coconut. The success and profitability of CBFS as experienced in this study depends on several factors, namely: favorable environment (climate, occurrence of pest, etc), appropriate technology, right attitude of farmers, available market and working capital.

These results strongly indicate that the use of low cost production inputs such as ammonium sulfate or goat manure/coco husk combined with NaCl as sources of nutrients could improve the vegetative growth and enhance early reproductive performance of CATD x LAGT hybrid palms. The integration of inorganic and organic fertilizers better known as integrated soil fertility management scheme proved to be an economical and profitable production management system for coconut. In addition to this, intercropping practice under young coconuts using some profitable short season crops could help improve and sustain coconut farm productivity in the Philippines.

ACKNOWLEDGMENT

The authors wish to extend their sincere gratitude to the following persons, namely:

1. Messrs. Timoteo Adon and Efren Pedroso – farmer-cooperators for providing their lands to be used as experimental sites and their full cooperation and support to this on-farm study;
2. Labor group of the Agronomy and Soils Division headed by Mr. Edilberto C. Cuisin for their untiring active participation in field activities of this study;
3. Dr. Severino S. Magat, Manager, Agricultural Research Management Dept., PCA and Program Leader of Crop Agronomy, Nutrition and Farming Systems (CANFARMS) for reviewing and contributing to the improvement of the manuscript of this paper,
4. Mr. Romero C. Blancaver, PCA-DRC Manager and Mr. Carlos B. Carpio, Deputy Administrator for Agricultural Research and Development, ARDB, PCA for their continued encouragement and support to this research undertaking;

and above all, to our ALMIGHTY GOD for the wisdom and knowledge He has bestowed on us.
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**Table 1. Vegetative characters of CATD x LAGT hybrid at different growth stages**

| Treatment        | Girth size (cm) | Height (cm) |
|------------------|-----------------|-------------|
|                  | Yr 1 | Yr 2 | Yr 3 | Yr 1 | Yr 2 | Yr 3 |
| T1-Control       | 17.3 b | 41.3 | 65.5 | 164.9 | 289.3 | 435.7 |
| T2-AS+NaCl       | 24.5 a | 62.7 | 102.1 | 166.9 | 328.5 | 513.5 |
| T3-GM+NaCl       | 22.8 ab | 59.1 | 95.1 | 182.7 | 344.2 | 481.4 |
| T4-CW+NaCl       | 23.0 ab | 62.1 | 95.6 | 189.7 | 339.1 | 473.0 |
| T5-NaCl          | 22.4 ab | 54.5 | 92.6 | 177.3 | 340.1 | 366.6 |

| Stat. Sign.      | Coeff of Var.(%) |
|------------------|------------------|
| * ns             | 9.6 14.8 15.7    |
| ns               | ns ns ns 13.3 8.2 11.5 |

ns - Treatment effect is not significant
* - Treatment effect is significant at 5% level of significance
Treatment means with the same letter(s) are not significantly different from each other (HSD test)

**Table 2. Leaf production of CATD x LAGT palms at different growth stages**

| Treatment       | Annual leaf prodn. (no.) | Living fronds (no.) |
|-----------------|--------------------------|---------------------|
|                 | Yr 1 | Yr 2 | Yr 3 | Yr 4 | Yr 1 | Yr 2 | Yr 3 | Yr 4 |
| T1-Control      | 2.5  | 6.9 b | 7.3  | 8.4  | 4.7  | 7.6  | 8.3  | 10.3 b |
| T2-AS+NaCl      | 2.9  | 8.8 a | 9.4  | 10.4 | 5.5  | 9.1  | 11.1 | 13.7 a |
| T3-GM+NaCl      | 3.2  | 8.5 ab| 9.0  | 9.9  | 5.7  | 9.3  | 11.0 | 13.7 a |
| T4-CW+NaCl      | 2.9  | 8.0 ab| 8.4  | 9.1  | 5.6  | 9.4  | 10.4 | 12.9 ab|
| T5-NaCl         | 3    | 7.8 ab| 8.6  | 11.0 | 5.3  | 8.7  | 10.6 | 11.2 ab|

| Stat. Sign.     | Coeff of Var.(%) |
|-----------------|------------------|
| ns              | 10.2 7.1 8.7 12.9 |

ns - Treatment effect is not significant
* - Treatment effect is significant at 5% level of significance
Treatment means with the same letter(s) are not significantly different from each other (HSD test)

**Table 3. Estimated annual nut yield per palm and actual yield of CATD x LAGT palms**

| Treatment             | Annual nut count (average of 3 replicates) | Nuts/palm | Whole nut wt. (g) |
|-----------------------|--------------------------------------------|-----------|------------------|
|                       | 1997 | 1998 | 1999 | Nuts/palm | Whole nut |
| T1-Control            | -    | -    | 1.7 (2) | 0.3 | 850.0 |
| T2-AS + NaCl          | 82 (4*) | 51.0 (12) | 17.0 (14) | 2.9 | 966.7 |
| T3-Goat manure+NaCl   | 56 (4) | 53.1 (11) | 22.4 (17) | 4.6 | 1,350.0 |
| T4-Cocowaste + NaCl   | 64 (1) | 26.4 (5) | 18.5 (15) | 3.2 | 1,183.4 |
| T5-NaCl alone         | 60 (1) | 26.0 (8) | 21.5 (14) | 4.0 | 1,300.0 |

* number of palms with nut harvest

* One actual harvest data
Table 4. Leaf analysis results (in %) of CATD x LAGT palms at different growth stages

| Age fr. FP | Treatment No.       | N    | P    | K    | Ca  | Mg  | Na  | Cl  | S   | Bppm |
|-----------|---------------------|------|------|------|-----|-----|-----|-----|-----|------|
| 2.5 years | T1 - Control        | 1.375| 0.132| 1.640| 0.247| 0.180| .124 b| 0.14 b| 0.137| 8.700 |
|           | T2 - AS + NaCl      | 1.630| 0.126| 1.351| 0.239| 0.208| .363 a| .603 a| 0.141| 7.700 |
|           | T3 - GM + NaCl      | 1.484| 0.126| 1.624| 0.238| 0.200| .262 ab| .528 a| 0.132| 8.300 |
|           | T4 - CW + NaCl      | 1.640| 0.129| 1.510| 0.248| 0.203| .309 ab| .713 a| 0.152| 8.600 |
|           | T5 - NaCl alone     | 1.355| 0.126| 1.483| 0.277| 0.194| .310 ab| .654 a| 0.140| 8.000 |

| Stat. Sign. | ns | ns | ns | ns | ns | * | * | ns | ns |
|-------------|----|----|----|----|----|----|----|----|----|
| Coeff of Var. (%) | 8.2| 6.7| 14.2| 10.2| 8.1| 26.5| 15.4| 5.9| 7.7|

| 3.5 years | T1 - Control        | 1.629| 0.134| 1.561| 0.221| 0.246| .066 b| .124 b| - | 9.9 a |
|           | T2 - AS + NaCl      | 1.797| 0.130| 1.193| 0.224| 0.276| .289 a| .693 a| - | 6.2 c |
|           | T3 - GM + NaCl      | 1.693| 0.134| 1.361| 0.229| 0.285| .184 ab| .636 a| - | 8.4 ab |
|           | T4 - CW + NaCl      | 1.663| 0.134| 1.275| 0.219| 0.279| .229 a| .696 a| - | 8.0 b |
|           | T5 - NaCl alone     | 1.678| 0.132| 1.329| 0.221| 0.269| .209 a| .610 a| - | 8.1 b |

| Stat. Sign. | ns | ns | ns | ns | ns | ** | ** | - | ** |
|-------------|----|----|----|----|----|----|----|----|----|
| Coeff of Var. (%) | 4.7| 4.0| 10.4| 13.9| 8.9| 22.9| 10.6| - | 7.4|

ns - Treatment effect is not significant
* - Treatment effect is significant at 5% level of significance
** - Treatment effect is highly significant at 1% level of significance

Treatment means with the same letter(s) are not significantly different from each other (HSD test)
### Cont'd of Table 4.

| Age fr FP | Treatment No. | N     | P    | K     | Ca    | Mg    | Na    | Cl    | S     | B$_{ppm}$ | Zn$_{ppm}$ | Mn$_{ppm}$ | Cu$_{ppm}$ | Fe$_{ppm}$ |
|-----------|---------------|-------|------|-------|-------|-------|-------|-------|-------|----------|------------|------------|------------|------------|
| 6.0 yrs   | T1 - Control  | 0.990 | b    | 0.998 | 0.379 | 0.126 | c     | 0.049 | b     | 0.144    | 9.3        | 34.9       | 830.0      | b          | 2.2        | 77.2       |
|           | T2 - AS + NaCl| 1.241 | ab   | 0.104 | 0.934 | 0.326 | 0.412 | a     | 0.524 | 0.155    | 4.9        | 38.2       | 1694.7     | a          | 3.4        | 108        |
|           | T3 - GM + NaCl| 1.433 | a    | 0.112 | 1.255 | 0.322 | 0.213 | b     | 0.497 | 0.154    | 7.3        | 50.6       | 864.7      | b          | 3.1        | 114        |
|           | T4 - CW + NaCl| 1.071 | b    | 0.104 | 1.03  | 0.33  | 0.249 | 0.339 | b     | 0.147    | 7.7        | 37.1       | 1116.8     | ab         | 2.8        | 95.6       |
|           | T5 - NaCl alone| 1.188 | ab   | 0.104 | 1.04  | 0.32  | 0.241 | 0.353 | ab    | 0.148    | 7.2        | 24.8       | 1073.1     | ab         | 3.1        | 83.0       |

| Stat. Sign. |           |       |      |      |      |      |      |      |      |         |            |            |            |            |
|             | *         | ns    |      |      |      |      |      |      |      | **       | **          | ns          | **          | ns          |
| Coeff of Var. (%) | 9.6 | 4.3  | 21.3 | 8.8  | 17.3 | 7.8  | 7.6  | 6.4  | 8.3   | 53.1      | 18.7       | 15.7       | 13.9       |

ns - Treatment effect is not significant
* - Treatment effect is significant at 5% level of significance
** - Treatment effect is highly significant at 1% level of significance

Treatment means with the same letter(s) are not significantly different from each other (HSD test)
Table 5. Soil analysis results of experimental area as affected by fertilizer treatments.

| Location       | Treatment   | pH | % O.M. | P ppm | Ext. K ppm | % N | % Sand | % Silt | % Clay | Soil Cls |
|----------------|-------------|----|--------|-------|------------|-----|--------|--------|--------|----------|
| A. Initial (at Field Planting -FP) |             |    |        |       |            |     |        |        |        |          |
| Rep I & II     | Topsoil     | 4.8| 2.0    | 12.0  | 240.0      | 0.10| 25.0   | 30.0   | 45.0   | Clay     |
|                | Subsoil     | 5.0| 1.0    | 8.0   | 220.0      | 0.05| 17.0   | 30.0   | 53.0   | Clay     |
| Rep III        | Topsoil     | 4.7| 2.0    | 10.0  | 248.0      | 0.10| 27.0   | 30.0   | 43.0   | Clay     |
|                | Subsoil     | 5.1| 1.0    | 12.0  | 225.0      | 0.05| 19.0   | 20.0   | 61.0   | Clay     |
| B. 3.5 years from FP | Exch. Bases (m.equiv./100 g soil) | | | | | | | | | |
| Topsoil        | T1- Control | 5.6| 2.30   | 9.0   | 176.7      | 0.12| 1.60   | 0.40   | 0.32   | 0.47     | 2.79    |
|                | T2-AS+NaCl  | 5.5| 2.50   | 4.3   | 156.7      | 0.13| 1.40   | 0.40   | 0.39   | 0.41     | 2.60    |
|                | T3-GM+NaCl  | 6.0| 2.30   | 8.0   | 250.0      | 0.12| 2.40   | 0.60   | 0.51   | 0.84     | 4.35    |
|                | T4-CW+NaCl  | 5.7| 2.50   | 6.3   | 181.7      | 0.13| 1.50   | 0.50   | 0.91   | 0.54     | 3.45    |
|                | T5-NaCl     | 5.8| 2.30   | 5.7   | 122.7      | 0.12| 1.70   | 0.50   | 0.49   | 0.54     | 3.23    |
| Subsoil        | T1- Control | 4.6| 3.54   | 7.0   | 300.0      | 0.17| 1.50   | 0.40   | 0.06   | 0.21     | 2.17    | 22.47  | 24.64  | 8.8    |
|                | T2-AS+NaCl  | 4.3| 3.92   | 4.0   | 330.0      | 0.19| 1.50   | 0.60   | 0.06   | 0.23     | 2.39    | 23.20  | 25.60  | 9.3    |
|                | T3-GM+NaCl  | 5.1| 3.90   | 10.0  | 1080.0     | 0.19| 2.40   | 1.30   | 0.19   | 0.70     | 4.60    | 18.90  | 23.50  | 19.6   |
|                | T4-CW+NaCl  | 4.7| 3.83   | 6.0   | 390.0      | 0.19| 1.60   | 0.50   | 0.15   | 0.27     | 2.52    | 22.70  | 25.22  | 10.0   |
|                | T5-NaCl     | 4.8| 4.04   | 4.0   | 460.0      | 0.20| 1.60   | 0.70   | 0.23   | 0.26     | 2.79    | 22.50  | 25.30  | 11.0   |
| C. 6.0 years from FP | Exch. Bases (m.equiv./100 g soil) | | | | | | | | | |
| Topsoil        | T1- Control | 4.5| 2.37   | 6.0   | 320.0      | 0.12| 2.10   | 0.60   | 0.06   | 0.33     | 3.09    | 24.68  | 27.77  | 11.1   |
|                | T2-AS+NaCl  | 4.5| 2.53   | 4.0   | 260.0      | 0.13| 1.60   | 0.50   | 0.24   | 0.18     | 2.52    | 23.40  | 25.90  | 9.7    |
|                | T3-GM+NaCl  | 4.8| 2.72   | 5.0   | 280.0      | 0.14| 2.40   | 0.90   | 0.31   | 0.31     | 3.92    | 20.70  | 24.62  | 15.9   |
|                | T4-CW+NaCl  | 4.6| 2.68   | 4.0   | 320.0      | 0.13| 1.80   | 0.30   | 0.24   | 0.18     | 2.52    | 20.80  | 23.32  | 10.8   |
|                | T5-NaCl     | 4.7| 2.96   | 7.0   | 365.0      | 0.15| 2.80   | 0.40   | 0.49   | 0.18     | 3.87    | 21.20  | 25.07  | 15.4   |
Table 6. Cost and return (in pesos) analysis on intercropping practices under hybrid coconut at farmer’s field.

| Year | Eco. Index | Intercropping practice | 1994 | 1995 | 1996 | 1998 |
|------|------------|------------------------|------|------|------|------|
|      |            |                        | Corn + peanut (1 ha) | Peanut + rice (0.5 ha) | Ave. of 1 ha |       |
| 1994 |            | Gr. Income             | 15,119.60 | 9,260.00 | 16,253.10 |       |
|      |            | Total Cost             | 3,650.00  | 2,851.00 | 4,334.00  |       |
|      |            | Net Income             | 11,469.60 | 6,409.00 | 11,919.10 |       |
| 1995 |            | Gr. Income             | 12,350.00 | 4,050.00 | 10,933.00 |       |
|      |            | Total Cost             | 4,571.00  | 1,295.00 | 3,910.70  |       |
|      |            | Net Income             | 7,779.00  | 2,755.00 | 7,022.30  |       |
| 1996 |            | Gr. Income             | 8,732.00  | 2,200.00 | 7,288.00  |       |
|      |            | Total Cost             | 8,687.00  | 1,730.00 | 10,417.50 |       |
|      |            | Net Income             | 45.00     | 470.00   | -3,129.50 |       |
| 1998 |            | Banana                 | 5,300.00  | 3,500.00 | 5,867.00  |       |
|      |            | Total Cost             | 2,800.00  | 2,000.00 | 3,200.00  |       |
|      |            | Net Income             | 2,500.00  | 1,500.00 | 2,667.00  |       |

Table 7. Economic analysis * of different fertilizer treatments and various intercropping practices (based on three early bearing years of hybrid coconut)

| Fert. Treatment | Gross Income (PhP) | Total Cost (PhP) | Net Income (PhP) | Dominance Analysis | MRR** (%) |
|-----------------|--------------------|-----------------|------------------|-------------------|----------|
| T1 - No fertilizer | 40,827.30         | 32,744.40       | 8,082.90         |                   |          |
| T4 - Cocowaste +NaCl | 87,807.30         | 50,862.20       | 36,945.10        |                   | 159      |
| T5 - NaCl Alone   | 87,528.90         | 51,703.20       | 35,825.70        | D***              |          |
| T2 - AS + NaCl    | 93,224.10         | 54,983.20       | 38,240.90        |                   | 137      |
| T3-Goat manure+ NaCl | 101,198.10       | 57,163.20       | 44,034.90        |                   | 147      |

* Detailed economic analysis at Appendix A.

** Marginal rate of return = \[
\frac{\text{Increase in Net Income}}{\text{Increase in Total Cost}} = \frac{\text{NIT2}}{\text{TCT2}} - \frac{\text{NIT1}}{\text{TCT1}} x 100\%
\]

(for un-dominated treatments)

*** Dominated treatment
Appendix A. Detailed economic analysis of fertilizer treatments and intercropping practice

1. AS + NaCl + Intercropping

| Year | Gross Coconut 1 | Income Intercrop 2 | Total Coconut 1 | Cost Intercrop 2 | Net Coconut | Benefit Intercrop |
|------|-----------------|--------------------|-----------------|-----------------|-------------|------------------|
| 1    | -               | -                  | 9,657.00        | -               | -9,657.00   | -                |
| 2    | -               | 16,253.10          | 2,063.00        | 4,334.00        | -2,063.00   | 11,919.10        |
| 3    | -               | 10,933.10          | 2,423.00        | 3,910.70        | -2,423.00   | 7,022.40         |
| 4    | 27,172.80       | 7,288.10           | 8,044.00        | 10,417.50       | 19,128.80   | -3,129.40        |
| 5    | 20,120.40       | 5,867.00           | 6,920.00        | 3,200.00        | 13,200.40   | 2,667.00         |
| 6    | 5,589.60        | -                  | 4,014.00        | -               | 1,575.60    | -                |
| Total| 52,882.80       | 40,341.30          | 33,121.00       | 21,862.20       | 19,761.80   | 18,479.10        |
| G. Total* | 93,224.10    | 54,983.20          | 38,240.90       |                |             |                  |

2. Goat manure + NaCl + Intercropping

| Year | Gross Coconut 1 | Income Intercrop 2 | Total Coconut 1 | Cost Intercrop 2 | Net Coconut | Benefit Intercrop |
|------|-----------------|--------------------|-----------------|-----------------|-------------|------------------|
| 1    | -               | -                  | 9,954.50        | -               | -9,954.50   | -                |
| 2    | -               | 16,253.10          | 2,043.00        | 4,334.00        | -2,043.00   | 11,919.10        |
| 3    | -               | 10,933.10          | 2,297.50        | 3,910.70        | -2,297.50   | 7,022.40         |
| 4    | 25,916.40       | 7,288.10           | 7,562.00        | 10,417.50       | 18,354.40   | -3,129.40        |
| 5    | 24,561.60       | 5,867.00           | 8,574.50        | 3,200.00        | 15,987.10   | 2,667.00         |
| 6    | 10,378.80       | -                  | 4,869.50        | -               | 5,509.30    | -                |
| Total| 60,856.80       | 40,341.30          | 35,301.00       | 21,862.20       | 25,555.80   | 18,479.10        |
| G. Total* | 101,198.10  | 57,163.20          | 44,034.90       |                |             |                  |

3. Coco waste + NaCl plus Intercropping

| Year | Gross Coconut 1 | Income Intercrop 2 | Total Coconut 1 | Cost Intercrop 2 | Net Coconut | Benefit Intercrop |
|------|-----------------|--------------------|-----------------|-----------------|-------------|------------------|
| 1    | -               | -                  | 9,190.00        | -               | -9,190.00   | -                |
| 2    | -               | 16,253.10          | 1,811.00        | 4,334.00        | -1,811.00   | 11,919.10        |
| 3    | -               | 10,933.10          | 2,025.00        | 3,910.70        | -2,025.00   | 7,022.40         |
| 4    | 29,386.80       | 7,288.10           | 7,943.00        | 10,417.50       | 21,443.80   | -3,129.40        |
| 5    | 10,627.20       | 5,867.00           | 4,333.00        | 3,200.00        | 6,294.20    | 2,667.00         |
| 6    | 7,452.00        | -                  | 3,698.00        | -               | 3,754.00    | -                |
| Total| 47,466.00       | 40,341.30          | 29,000.00       | 21,862.20       | 18,466.00   | 18,479.10        |
| G. Total* | 87,807.30    | 50,862.20          | 36,945.10       |                |             |                  |

1 See Appendix B for details
2 See Appendix C for details
3 See Appendix D for details
* For coconut + intercrops
4. NaCl alone + Intercropping

| Year | Gross Coconut\(^1\) | Income Intercrop\(^2\) | Total Coconut\(^3\) | Cost Intercrop\(^2\) | Net Coconut | Benefit Intercrop |
|------|---------------------|------------------------|---------------------|----------------------|-------------|-------------------|
| 1    | -                   | -                      | 9,164.00            | -                    | -9,164.00   | -                 |
| 2    | -                   | 16,253.10              | 1,624.00            | 4,334.00             | -1,624.00   | 11,199.10         |
| 3    | -                   | 10,933.10              | 1,842.00            | 3,910.70             | -1,842.00   | 7,022.40          |
| 4    | 26,535.60           | 7,288.10               | 8,959.00            | 10,417.50            | 17,576.60   | -3,129.40         |
| 5    | 11,502.00           | 5,867.00               | 4,325.00            | 3,200.00             | 7,177.00    | 2,667.00          |
| 6    | 9,510.00            | -                      | 3,927.00            | -                    | 5,583.00    | -                 |
| Total| 47,547.60           | 40,341.30              | 29,841.00           | 21,862.20            | 17,706.60   | 18,479.10         |
| G. Total* | 87,528.90 | 51,703.20 | 35,825.70          |

5. No fertilizer + Intercropping

| Year | Gross Coconut\(^1\) | Income Intercrop\(^2\) | Total Coconut\(^3\) | Cost Intercrop\(^2\) | Net Coconut | Benefit Intercrop |
|------|---------------------|------------------------|---------------------|----------------------|-------------|-------------------|
| 1    | -                   | -                      | 7,747.50            | -                    | -7,747.50   | -                 |
| 2    | -                   | 16,253.10              | 607.50              | 4,334.00             | -607.50     | 11,919.10         |
| 3    | -                   | 10,933.10              | 607.50              | 3,910.70             | -607.50     | 7,022.40          |
| 4    | -                   | 7,288.10               | 607.50              | 10,417.50            | -607.50     | -3,129.40         |
| 5    | -                   | 5,867.00               | 607.50              | 3,200.00             | -607.50     | 2,667.00          |
| 6    | 486.00              | -                      | 704.70              | -                    | 218.70      | -                 |
| Total| 486.00              | 40,341.30              | 10,882.20           | 21,862.20            | 10,396.20   | 18,479.10         |
| G. Total* | 40,827.30 | 32,744.40 | 8,082.90           |

\(^1\) See Appendix B for details  
\(^2\) See Appendix C for details  
\(^3\) See Appendix D for details  
* For coconut + intercrops
Appendix B. Annual yield and gross income from hybrid coconut (copra).

1. Whole nut weight (in g) per palm based on estimated nut count

| Fertilizer Treatment | 4\textsuperscript{th} year | 5\textsuperscript{th} year | 6\textsuperscript{th} year |
|----------------------|----------------------------|-----------------------------|-----------------------------|
| T1 - No fertilizer   | -                          | -                           | 1,445.00                    |
| T2 - AS + NaCl       | 79,264.40                  | 49,301.70                   | 16,434.00                   |
| T3 -GM + NaCl        | 75,600.00                  | 71,685.00                   | 30,240.00                   |
| T4 - CW + NaCl       | 86,400.00                  | 31,241.80                   | 21,892.90                   |
| T5 - NaCl alone      | 78,000.00                  | 33,800.00                   | 27,950.00                   |

2. Copra weight/palm (in kg) based on 21% whole nut weight for CATD x LAGT*

| Fertilizer Treatment | 4\textsuperscript{th} year | 5\textsuperscript{th} year | 6\textsuperscript{th} year |
|----------------------|----------------------------|-----------------------------|-----------------------------|
| T1 - No fertilizer   | -                          | -                           | 0.30                        |
| T2 - AS + NaCl       | 16.65                      | 10.35                       | 3.45                        |
| T3 -GM + NaCl        | 15.88                      | 15.05                       | 6.35                        |
| T4 - CW + NaCl       | 18.14                      | 6.56                        | 4.60                        |
| T5 - NaCl alone      | 16.38                      | 7.10                        | 5.87                        |

3. Copra weight/ha (in kg)

| Fertilizer Treatment | 4\textsuperscript{th} year | 5\textsuperscript{th} year | 6\textsuperscript{th} year |
|----------------------|----------------------------|-----------------------------|-----------------------------|
| T1 - No fertilizer   | -                          | -                           | 465.80                      |
| T2 - AS + NaCl       | 2,264.40                   | 1,676.70                    | 864.90                      |
| T3 -GM + NaCl        | 2,159.70                   | 2,046.80                    | 621.00                      |
| T4 - CW + NaCl       | 2,448.90                   | 885.60                      | 792.50                      |
| T5 - NaCl alone      | 2,211.30                   | 958.50                      | 792.50                      |

4. Gross income from Copra**/ha (in PhP)

| Fertilizer Treatment | 4\textsuperscript{th} year | 5\textsuperscript{th} year | 6\textsuperscript{th} year |
|----------------------|----------------------------|-----------------------------|-----------------------------|
| T1 - No fertilizer   | -                          | -                           | 5,589.60                    |
| T2 - AS + NaCl       | 27,172.80                  | 20,120.40                   | 9,072.00                    |
| T3 -GM + NaCl        | 25,916.40                  | 24,561.60                   | 21,892.90                   |
| T4 - CW + NaCl       | 29,386.80                  | 10,627.20                   | 7,452.00                    |
| T5 - NaCl alone      | 26,535.60                  | 11,502.00                   | 9,510.00                    |

* Obtained from 1999 summarized nut component analysis (NCA) of PHGC 03, Breeding & Genetics Division, PCA-Zamboanga Research Center, Zamboanga City

** Ave. copra price/kg = P12.00
Appendix C. Cost and return of intercropping practices at farmer’s fields

1. Adon’s Farm

1.1 Date planted - Sept. 15, 1994
   Date harvested - Dec. 15, 1994 (peanut)
   - Jan. 5, 1995 (yellow corn)

A. Total Cost included:
   a1) Plowing (2 times) P500 @$1,000.00
   a2) Harrowing (2 times) P80 @$160.00
   a3) Furrowing (1 day) 80.00
   a4) Seeds - Peanut (3.5 bags) 1,225.00
       - Corn (3 kg) P60/kg 180.00
   a5) Insecticide (Hytox) 135.00
   a6) Crop Giant Liquid fertilizer 180.00
   a7) Basal fertilizers (16-20-0) 100.00
   a8) Planting (4 persons at P50/@) 200.00
   a9) Spraying (2 times) 160.00
   a10) weeding (3 persons) 150.00
   a11) Peanut removal from roots 80.00

Total 3,650.00

B. Gross Income from:
   b1) Corn (22 sacks) - 1,115.5 kgs at P3.20/kg 3,569.60
   b2) Peanut (33 sacks) at P350/sack 11,550.00

Total 15,119.60

1.2 Date of planting - March 8, 1995 (peanut & corn)
   - Apr. 15, 1995 (rice)
   Date of harvesting - June 15, 1995 (peanut)
   - July 5, 1998 (corn)
   - Aug. 20, 1995 (rice)

A. Total cost included:
   a1) Contract plowing (3x) P600/plowing 180.00
   a2) Weeding 1,000.00
   a3) Crop giant (2 bags) 152.00
   a4) Insecticide 124.00
   a5) Fungicide (Dithane) 66.00
   a6) Spraying 75.00
   a7) Seeds - peanut 1,050.00
       - rice 304.00

Total 4,571.00

B. Gross Income from:
   b1) Peanut (10 sacks) P360/sack 3,600.00
   b2) Rice (20 sacks) 50 kgs/sack @ P8/kg 8,000.00
   b3) Corn (5 sacks) 50 kgs/sack @P3.00/kg 750.00

Total 12,350.00

1.3 Date of planting - April 1996
A. Total cost included:
   a1) Land preparation 3,500.00
   a2) Labor for planting 350.00
   a3) Seeds - rice 500.00
       - Corn 187.50
a4) Weeding 2,500.00  
a5) chemicals 730.00  

B. Gross Income from:  
b1) Corn 1,782.00  
b2) Peanut 950.00  
b3) Rice 6,000.00  
Total 8,732.00  

2. Pedroso Farm  
2.1. Date of planting - March 16, 1994  
A. Total Cost included:  
a1) Plowing (11 days) @ P60/day/ 660.00  
a2) Harrowing (5.5 days) 330.00  
a3) Planting labor : - peanut 165.00  
- rice 275.00  
a4) Planting materials : - peanut seed 340.00  
- yellow corn seed 100.00  
- rice 300.00  
a5) Weeding 200.00  
a6) Liquid fertilizer (crop giant) 76.00  
a7) Spraying of liquid fertilizer (3 days) 240.00  
a8) Harvesting 165.00  
Total 2,851.00  
B. Gross Income from:  
b1) Peanut (16 sacks) P422.5/sack 6,760.00  
b2) rice (5 sacks) P500/sack 2,500.00  
Total 9,260.00  

2.2. Date of planting - March 16, 1995  
A. Total Cost included:  
a1) Labor - plowing 630.00  
- planting 200.00  
a2) Seeds 175.00  
a3) Fertilizers 290.00  
Total 1,295.00  
B. Gross Income from:  
b1) Rice (5 sacks - 275 kgs) P6/kg 1,650.00  
b2) Corn (18 sacks - 800 kgs) P3/kg 2,400.00  
Total 4,050.00  

2.3 Date of planting: April 1996  
A. Total cost included:  
a1) Land preparation 900.00  
a2) Planting labor 120.00  
a3) Fertilizers (2 bags 14-14-14) 710.00  
Total 1,730.00  
B. Gross Income from:  
b1) Yellow corn (20 sacks) 1,100 kgs @ P2.2/kg 2,200.00  

Note:  
No detailed cost of production and income statement for banana was given by the farmers (only summary)
## Appendix D. Detailed Total Cost (Production) per ha for coconut

### Basis: Total Cost includes:

| Cost   | Frequency                 |
|--------|---------------------------|
| a) Hybrid seednut/pc | P10.00                   |
| b) Fertilizer materials:  |
| Ammosul (21% N, 24% S) /kg | 4.30                     |
| NaCl (60% Cl) /kg | 3.00                     |
| Goat manure / kg | 0.15                     |
| Coconut husk / pc | 0.15                     |
| c) Labor (maintenance)/ man-day | 90.00                   |
| c1) Topbrushing for unfert tree | 8 min/tree, 3 x a year |
| c2) Ringweeding for fertilized tree | 13 min/tree, 3 x a year |
| c3) Mixing organic fertilizer | 7 min/tree, once/yr     |
| c4) Fertilizer appln for inorganic source | 13min/tree, once/yr |
| for organic source | 20 min/tree, once/yr     |
| d) Copra processing | 20% copra gross income |
| e) Number of experimental trees/ha (143 minus 5% ) | 135                     |
| f) Average copra price/kg | 12.00                    |

### 1. AS + NaCl treatment

| Cost   |
|--------|
| a) First year  |
| a1) Hybrid seednuts (143 + 5% (7) for replants) | 1,500.00       |
| a2) Selection, lay-outing, setting of seednuts (2 md) | 180.00         |
| a3) Seedbed maintenance (8 md) | 720.00         |
| a4) Lay-outing, staking, difgging of holes (24 md) | 3,660.00       |
| a5) Planting, initial fertilization (12 md) | 1,080.00       |
| a6) Fertilizer application (at 6mos. & 1 year stage) | 697.00         |
| a7) Fertilizer materials (AS + NaCl) | 833.00         |
| a8) Ringweeding for fertilizer trees | 987.00         |
| **Total** | **9,657.00** |

| Cost   |
|--------|
| b) Second year  |
| b1) Ringweeding of trees | 987.00         |
| b2) Fertilizer materials | 727.00         |
| b3) Fertilizer application | 349.00         |
| **Total** | **2,063.00** |

| Cost   |
|--------|
| c) Third year  |
| c1) Ringweeding of trees | 987.00         |
| c2) Fertilizer materials | 1,087.00       |
| c3) Fertilizer application | 349.00         |
| **Total** | **2,423.00** |

| Cost   |
|--------|
| d) Fourth year  |
| d1) Ringweeding of trees | 987.00         |
| d2) Fertilizer materials | 1,273.00       |
| d3) Fertilizer application | 349.00         |
| d4) Copra processing | 5,435.00       |
| **Total** | **8,044.00** |

| Cost   |
|--------|
| e) Fifth year  |
| e1) Ringweeding of trees | 987.00         |
| e2) Fertilizer materials | 1,560.00       |
| e3) Fertilizer application | 349.00         |
| e4) Copra processing | 4,024.00       |
| **Total** | **6,920.00** |
### 2. Goat manure + NaCl treatment

| Year | Description                                                                 | Cost  |
|------|------------------------------------------------------------------------------|-------|
| a) First year | a1) Hybrid seednuts (143 + 5% (7) for replants) | 1,500.00 |
|       | a2) Selection, lay-outing, setting of seednuts (2 md)                         | 180.00 |
|       | a3) Seedbed maintenance (8 md)                                                | 720.00 |
|       | a4) Lay-outing, staking, digging of holes (24 md)                             | 3,660.00 |
|       | a5) Planting, initial fertilization (12 md)                                   | 1,080.00 |
|       | a6) Fertilizer application (at 6 mos. & 1 year stage)                         | 1,366.00 |
|       | a7) Fertilizer materials (GM + NaCl)                                          | 461.50 |
|       | a8) Ringweeding for fertilizer trees                                          | 987.00 |
|       | Total                                                                        | 9,954.50 |
| b) Second year | b1) Ringweeding of trees                                                      | 987.00 |
|       | b2) Fertilizer materials                                                      | 373.00 |
|       | b3) Fertilizer application                                                    | 683.00 |
|       | Total                                                                        | 2,043.00 |
| c) Third year | c1) Ringweeding of trees                                                      | 987.00 |
|       | c2) Fertilizer materials                                                      | 627.50 |
|       | c3) Fertilizer application                                                    | 683.00 |
|       | Total                                                                        | 2,297.50 |
| d) Fourth year | d1) Ringweeding of trees                                                      | 987.00 |
|       | d2) Fertilizer materials                                                      | 709.00 |
|       | d3) Fertilizer application                                                    | 683.00 |
|       | d4) Copra processing                                                         | 5,183.00 |
|       | Total                                                                        | 7,562.00 |
| e) Fifth year | e1) Ringweeding of trees                                                      | 987.00 |
|       | e2) Fertilizer materials                                                      | 891.50 |
|       | e3) Fertilizer application                                                    | 913.00 |
|       | e4) Copra processing                                                         | 5,783.00 |
|       | Total                                                                        | 8,574.50 |
| f) Sixth year | f1) Ringweeding of trees                                                      | 987.00 |
|       | f2) Fertilizer materials                                                      | 891.50 |
|       | f3) Fertilizer application                                                    | 915.00 |
|       | f4) Copra processing                                                         | 2,076.00 |
|       | Total                                                                        | 4,869.50 |
| Year | Activity | Cost 1 | Cost 2 | Total  |
|------|----------|--------|--------|--------|
| b) 2nd year | Fertilizer materials | 1,305.00 | | 1,305.00 |
| b) 2nd year | Fertilizer application | 506.00 | | 506.00 |
|        | **Total** | **1,811.00** | | **1,811.00** |
| c) 3rd year | Fertilizer materials | 1,519.00 | | 1,519.00 |
| c) 3rd year | Fertilizer application | 506.00 | | 506.00 |
|        | **Total** | **2,025.00** | | **2,025.00** |
| d) 4th year | Fertilizer materials | 1,560.00 | | 1,560.00 |
| d) 4th year | Fertilizer application | 506.00 | | 506.00 |
| d) 4th year | Copra processing | 5,877.00 | | 5,877.00 |
|        | **Total** | **7,943.00** | | **7,943.00** |
| e) 5th year | Fertilizer materials | 1,702.00 | | 1,702.00 |
| e) 5th year | Fertilizer application | 506.00 | | 506.00 |
| e) 5th year | Copra processing | 2,125.00 | | 2,125.00 |
|        | **Total** | **4,333.00** | | **4,333.00** |
| f) 6th year | Fertilizer materials | 1,702.00 | | 1,702.00 |
| f) 6th year | Fertilizer application | 506.00 | | 506.00 |
| f) 6th year | Copra processing | 1,490.00 | | 1,490.00 |
|        | **Total** | **3,698.00** | | **3,698.00** |

4. NaCl alone

| Year | Activity | Cost 1 | Cost 2 | Total  |
|------|----------|--------|--------|--------|
| a) 1st year | Hybrid seednuts (143 + 5% (7) for replants) | 1,500.00 | 180.00 | **1,680.00** |
| a) 1st year | Seedbed maintenance (8 md) | 720.00 | | 720.00 |
| a) 1st year | Lay-outing, staking, digging of holes (24 md) | 3,660.00 | | 3,660.00 |
| a) 1st year | Planting, initial fertilization (12 md) | 1,080.00 | | 1,080.00 |
| a) 1st year | Fertilizer application (at 6mos. & 1 year stage) | 697.00 | | 697.00 |
| a) 1st year | Fertilizer materials (AS + NaCl) | 340.00 | | 340.00 |
| a) 1st year | Ringweeding for fertilizer trees | 987.00 | | 987.00 |
|        | **Total** | **9,164.00** | | **9,164.00** |
| b) 2nd year | Ringweeding of trees | 987.00 | | 987.00 |
| b) 2nd year | Fertilizer materials | 292.00 | | 292.00 |
| b) 2nd year | Fertilizer application | 349.00 | | 349.00 |
|        | **Total** | **2,063.00** | | **2,063.00** |
| c) 3rd year | Ringweeding of trees | 987.00 | | 987.00 |
| c) 3rd year | Fertilizer materials | 506.00 | | 506.00 |
| c) 3rd year | Fertilizer application | 349.00 | | 349.00 |
|        | **Total** | **2,423.00** | | **2,423.00** |
| d) 4th year | Ringweeding of trees | 987.00 | | 987.00 |
| d) 4th year | Fertilizer materials | 547.00 | | 547.00 |
| d) 4th year | Fertilizer application | 349.00 | | 349.00 |
| d) 4th year | Copra processing | 5,307.00 | | 5,307.00 |
|        | **Total** | **7,190.00** | | **7,190.00** |
| e) 5th year | Ringweeding of trees | 987.00 | | 987.00 |
| e) 5th year | Fertilizer materials | 689.00 | | 689.00 |
e3) Fertilizer application 349.00  
e4) Copra processing 2,300.00  
Total 4,325.00  
f) Sixth year  
f1) Ringweeding of trees 987.00  
f2) Fertilizer materials 689.00  
f3) Fertilizer application 349.00  
f4) Copra processing 1,902.00  
Total 3,927.00  
5. No fertilizer treatment  
a) First year  
a1) Hybrid seednuts (143 + 5% {7} for replants) 1,500.00  
a2) Selection, lay-outing, setting of seednuts (2 md) 180.00  
a3) Seedbed maintenance (8 md) 720.00  
a4) Lay-outing, staking, digging of holes (24 md) 3,660.00  
a5) Planting, initial fertilization (12 md) 1,080.00  
a6) Topbrushing of unfertilized trees 607.50  
Total 7,747.50  
b) Second year  
b1) Topbrushing of unfertilized trees  
Total 607.50  
c) Third year  
c1) Topbrushing of unfertilized trees  
Total 607.50  
d) Fourth year  
d1) Topbrushing of unfertilized trees  
Total 607.50  
e) Fifth year  
e1) Topbrushing of unfertilized trees  
Total 607.50  
f) Sixth year  
f1) Topbrushing of unfertilized trees 607.50  
f4) Copra processing 97.20  
Total 704.70
Fig. 1. One year old CATD x LAGT palm applied with ammonium sulfate + common table salt (NaCl)

Fig. 2. Flowering of CATD x LAGT palms under five fertilizer treatments.

- Control
- AS + NaCl
- Goat manure + NaCl
- Cocos sulfate + NaCl
- NaCl

Flowing palms (%) vs Palm age (year from planting)
Fig. 3. Nut development and flower emergence in 3.5 years old palm with goat manure + NaCl fertilizers.

Fig. 4. Three and a half years old CATD x LAGT palm with inorganic fertilizers (AS + NaCl) with fully developed nuts ready for harvesting.
Fig. 5. Coconut + corn + peanut cropping pattern

Fig. 6. Coconut + banana + corn cropping pattern