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Coconut Program Area Research Planning and Prioritization

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COCONUT PROGRAM AREA RESEARCH PLANNING AND PRIORITIZATION

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Submitted to

Philipppine Institute for Development Studies (PIDS) and
DA - Bureau of Agricultural Research (DA-BAR)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

ABSTRACT

COCONUT PROGRAM AREA RESEARCH PLANNING AND PRIORITIZATION

CORAZON T. ARAGON

The coconut industry is one of the country's major pillars in employment generation and foreign exchange earnings. However, local production problems, the expansion in coconut hectarage of neighboring countries, and recent developments in biotechnology research on other competing crops that have high lauric oil content might affect its long-term sustainability and viability. In a highly liberalized global trade environment, innovation and creativity in the country's coconut industry are needed for survival (Boceta, 1997). In order for the Philippines to be globally competitive, the country must exert all efforts to increase coconut productivity, lower the cost of processing copra, coconut oil, dessicated coconut, and other coconut products, improve the quality of copra and coconut oil, and develop downstream high-value coconut products through technological developments.

Indonesia has already dislodged the Philippines as the world's largest producer of coconut. Recently, the Philippines' position as the top exporter of coconut oil in the world is also being threatened by the increasing share of Indonesia in the world market. Unless the weaknesses and threats in the Philippine coconut industry are faced, the country's share in the world market for coconut oil will continue to diminish.

This paper, therefore, aims to present an industry profile with focus on domestic production, consumption, external trade, problems/constraints, and market potentials; review past researches on coconut, technologies generated, and the extent of participation of the private and public sectors; identify research and technology gaps for the coconut industry; identify strengths and weaknesses in the institutional structure of research and extension interface, as well as research complementation efforts; and suggest recommendations and R & D agenda for the coconut industry.

COCONUT PROGRAM AREA RESEARCH PLANNING AND PRIORITIZATION

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1.0 INTRODUCTION

The coconut industry is one of the country's major pillars in employment generation and foreign exchange earnings. However, local production problems, the expansion in coconut hectarage of neighboring countries, and recent developments in biotechnology research on other competing crops that have high lauric oil content might affect its long-term sustainability and viability. In a highly liberalized global trade environment, innovation and creativity in the country's coconut industry are needed for survival (Boceta, 1997). In order for the Philippines to be globally competitive, the country must exert all efforts to increase coconut productivity, lower the cost of processing copra, coconut oil, dessicated coconut, and other coconut products, improve the quality of copra and coconut oil, and develop downstream high-value coconut products through technological developments.

Indonesia has already dislodged the Philippines as the world's largest producer of coconut. Recently, the Philippines' position as the top exporter of coconut oil in the world is also being threatened by the increasing share of Indonesia in the world market. Unless the weaknesses and threats in the Philippine coconut industry are faced, the country's share in the world market for coconut oil will continue to diminish.

To address the issue on the global competitiveness of the country's coconut products and in line with the objective of modernizing agriculture as stipulated under AFMA, there is a need to review past research efforts and formulate a research plan for the coconut industry which will be used as basis by the Department of Agriculture-Bureau of Research (DA-BAR) in setting priorities and properly allocating resources among research program areas.

This paper, therefore, has the following objectives:

1. Present an industry profile with focus on domestic production, consumption, external trade, problems/constraints, and market potentials;

2. Review past researches on coconut, technologies generated, and the extent of participation of the private and public sectors;

3. Identify research and technology gaps for the coconut industry;

4. Identify strengths and weaknesses in the institutional structure of research and extension interface, as well as research complementation efforts; and

5. Suggest recommendations and R & D agenda for the coconut industry.

2.0 COCONUT INDUSTRY PROFILE

2.1 World Production of Coconut

The Philippines, Indonesia, and India accounted for 69.6% of the world's coconut production of 9.6 million metric tons (mt) in 1996 (Table 1). FAO statistics covering the period 1980 to 1994 revealed that Indonesia had overtaken the position which the Philippines held for a long time as the largest coconut producer in the world. Hence, the Philippines became the second largest producer of coconut in the world during this period. However, the Asian and Pacific Coconut Community (APCC) recently reported that even India has already surpassed the Philippines in volume of coconut production. In 1996, the biggest coconut producer in the world was Indonesia at 2.72 million mt, followed by India at 2.01 million mt, and the Philippines at 1.97 million mt (Table 1). The world area planted to coconut in that year was placed at 11.6 million hectares, with Indonesia at 3.7 million hectares; the Philippines, 3.1 million hectares; and India, 1.8 million hectares. Globally, coconut productivity averaged at 829 kilograms per hectare, with the Philippines at 638 kilograms per hectare and Indonesia at 726 kilograms per hectare in 1996 (UCAP Weekly Bulletin, 1998). India had the highest coconut productivity with 1,110 kilograms per hectare. This could be explained by effective farm management practices coupled with adequate government subsidies in India and Indonesia.

Table 1. World coconut production and area by major producing country, 1996.

COUNTRY	COCONUT PRODUCTION		COCONUT AREA	
	Volume ('000 MT)	Percent Share	Million Has.	Percent Share
Indonesia	2.72	28.3	3.7	33.6
India	2.01	20.8	1.8	15.5
Philippines	1.97	20.5	3.1	26.7
World Total	9.60		11.6	

Source: APCC, 1997

Moreover, a study conducted by Castillo et. al. (1996) reported that the Philippines' coconut output only grew at a rate of 2.86% per year from 1980 to 1994 as compared with India whose annual growth rate was about 4.39% in the same period. The low average growth rate in Philippine coconut output during this period was attributed to senile trees, poor cultural management practices, and government policies on agrarian reform that affected the ownership of coconut lands. Thailand, which accounted for only 3% of the world coconut production, had also been increasing its production at a faster rate (5%/year) than the three leading world coconut producers. Also, Vietnam, which ranked as the eighth world coconut producer with only 2% share in the same period, registered the highest average growth rate of 11% per year.

2.2 Domestic Production

Coconut production in copra equivalent (2.618 million mt) accounted for 3.83% of the total production of agricultural crops in 1997 (BAS, 1998). In nut terms, coconut production grew minimally at 0.3% per year from 11.94 billion nuts in 1990 to 12.05 billion nuts in 1997 (Table 2 and Figure 1). During the eight-year period under review, high coconut production was recorded in 1995 and in 1996 at 12.18 and 12.05 billion nuts, respectively. The measly positive growth in coconut production during the period 1990-1997 could be attributed largely to the slow growth rates in coconut hectarage (0.9%/year) and in the number of bearing trees (0.3%/year) particularly during the period 1996-1997 (Table 2). On the other hand, coconut productivity was not a contributory factor to the improvement in coconut production in the same period considering that the average annual growth rate in coconut productivity was nil.

Table 2. Philippine coconut production situation, 1990-1997.

YEAR	AREA (Hectares)	NO. OF BEARING TREES	NUT PRODUCTIVITY (Nuts/tree)	COCONUT PRODUCTION ('000 Nuts)	COCONUT VALUE OF PRODUCTION (P)
1990	3,112	290,175	41	11,940,380	18,746,400
1991	3,093	289,603	39	11,290,880	18,968,700
1992	3,077	288,064	40	11,404,900	23,038,100
1993	3,075	277,399	41	11,328,410	23,110,000
1994	3,083	276,497	41	11,207,000	22,862,300
1995	3,064	281,061	43	12,183,090	20,954,900
1996	3,149	284,897	40	11,368,110	27,397,200
1997	3,314	295,999	41	12,052,790	29,529,300
Average	3,121	285,462	41	11,596,945	23,075,863
Annual Growth Rate (%)	0.92	0.31	0.08	0.27	7.44

Source of Basic Data: Bureau of Agricultural Statistics

Southern Mindanao posted the highest coconut production of 3.94 billion nuts (32.7% share) in 1997 (Appendix Table 1 and Figure 2). Southern Tagalog ranked second to Southern Mindanao in terms of coconut production (1.94 billion nuts with 16.1% share), followed by Western Mindanao (1.43 billion nuts with 11.87% share), and Eastern Visayas (1.11 billion nuts with 9.2% share). The regions which exhibited positive average annual growth rates in coconut production from 1990 to 1997 were Cagayan

Figure 1. Trend in coconut production, Philippines, 1990-1997.

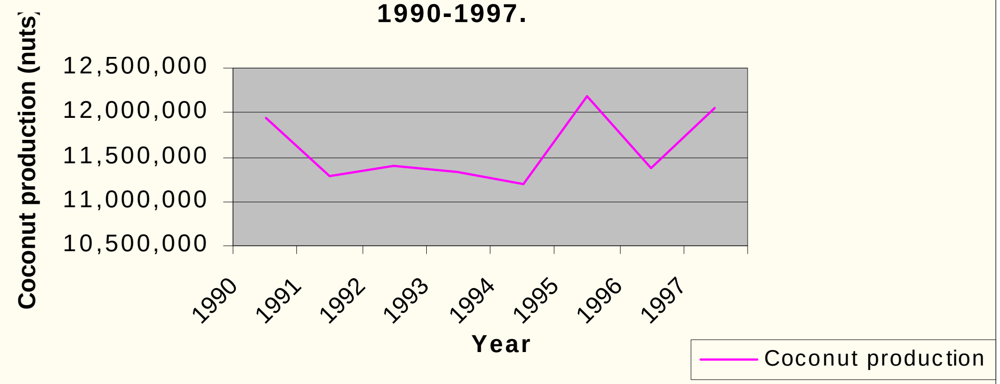
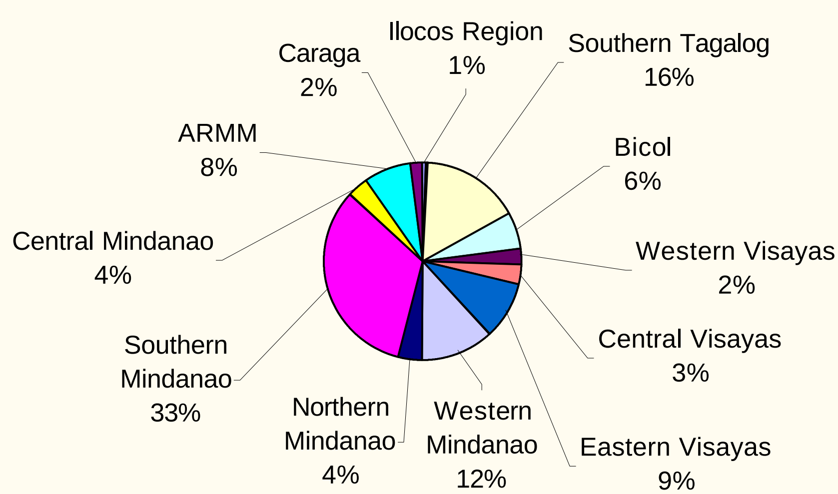


Figure 2. Percentage distribution of coconut production by region, Philippines, 1997.



Valley (13.2%), Central Luzon (6.4%), Eastern Visayas (3.2%), Western Mindanao (2.6%), ARMM (2.5%), Southern Mindanao (0.5%), Southern Tagalog (0.4%), Central Visayas (0.4%), and Bicol (0.1%). Conversely, the regions which posted negative annual growth rates in coconut production in the same period were Caraga (-9.6%), CAR (-4.3%), Northern Mindanao (-2%), Central Mindanao (-1.8%), Ilocos Region (-0.3%), and Western Visayas (-0.2%).

About 25.4% of the country's arable agricultural land (13.025 million hectares) was planted to coconut in 1997 (BAS, 1998). The Philippines had 3.314 million hectares of coconut land in 1997 compared to 3.112 million hectares in 1990 (Table 2). These are sprawled in 67 out of a total of 77 provinces in the country. Coconut hectarage decreased continually from 1990 to 1995, but increased thereafter (Table 1). The declining trend in coconut hectarage during the period 1990-1995 could be explained by the unwarranted cutting of coconut trees due to the log ban which more than offset the increase in newly planted and replanted areas. On the other hand, the expansion in coconut area at the national level from 1995 to 1997 could be attributed to the intensified campaign of the Philippine Coconut Authority (PCA) against violators of Republic Act (RA) 8048 or the Coconut Preservation Act of 1995 which provides for the regulation of cutting of coconut trees and its replenishment, PCA's embarking on a coconut tree planting program, and the Replanting Component of the PCA-World Bank (WB) Small Coconut Farms Development Program (SCFDP) which was implemented until 1996. With regards to the distribution of coconut hectarage among islands, about half (51.12%) of the country's coconut area in 1997 was in the island of Mindanao while 28.64% and 20.24% were in Luzon and Visayas, respectively. Among the 15 administrative regions, Southern Tagalog had the largest coconut hectarage (521,150 hectares with 15.72% share), followed by Southern Mindanao (482,680 hectares with 14.56% share), Eastern Visayas (448,130 hectares with 13.52% share), Bicol (394,140 hectares with 11.89% share), and Western Mindanao (377,200 hectares with 11.38% share) (Appendix Table 2). Among the coconut-producing regions, Cagayan Valley posted the highest annual average growth rate in coconut area (26.6%) during the period 1990-1997. Other regions which exhibited positive annual growth rates were Eastern Visayas (5.2%), ARMM (3.9%), Central Mindanao (2.1%), Northern Mindanao (1.7%), Caraga (1.6%), Central Luzon (1.6%), CAR (1.3%), Bicol (1%), and Western Mindanao (0.1%). It is interesting to note in Appendix Table 2 that Southern Tagalog and Southern Mindanao, the top two coconut-producing regions in terms of coconut production and hectarage, registered negative annual growth rates in coconut hectarage (-0.6% and -0.5%, respectively) from 1990 to 1997. Similarly, Eastern Visayas, Central Visayas, and the Ilocos Region exhibited a declining trend in coconut hectarage.

The total number of coconut bearing trees rose from 290.18 million in 1990 to 295.99 million in 1990 (Table 2). This could be explained by the National Replanting Program which was resumed in 1985 with funding coming from the 9% export tax on coconut products and the Replanting Component of the PCA-WB SCFDP which was implemented starting in 1991. The local tall varieties usually bear fruit seven years after planting while coconut hybrids introduced under the PCA-WB SCFDP bear fruits one or two years earlier than the local tall varieties. Southern Tagalog and Southern Mindanao again recorded the most number of coconut bearing trees with the former having about 59.09 million bearing trees and the latter registering approximately 43.89 million trees (Appendix Table 3). Positive annual growth rates in the number of coconut bearing trees were experienced in eight out of the 15 administrative regions in the country. These consisted of Cagayan Valley (18.1%), Central Luzon (5.9%), Bicol (4.9%), ARMM (3.5%), Western Mindanao (2.5%), Western Visayas (0.9%), and Ilocos Region (0.7%).

The national coconut yield level has more or less remained constant (about 41 nuts per tree or 822 kilograms of copra per hectare per year) during the period 1990-1997 (Table 2). This is considerably much lower than the potential yield obtainable from modern varieties. The potential yield of coconut hybrids is about 16,000 to 22,000 nuts per hectare or about 4,000 to 6,000 kilograms of copra per hectare per year (Santos, et. al., 1999). It was also discussed earlier in section 2.1 that Philippine coconut productivity in 1996 was 88 and 472 kilograms per hectare lower than in Indonesia and India, respectively. Low coconut productivity in the country could be attributed to slow adoption of recommended cultural management practices, persistent use of unselected and genetically poor planting materials, and an increasing number of senile and unproductive trees that need to be replaced (Santos, et. al., 1999).

Coconut productivity also varied among islands and among coconut-producing regions (Appendix Table 4). The island of Mindanao also registered the highest average coconut yield of 41 nuts per tree during the period 1990-1997 compared with Luzon and Visayas with 31 and 30 nuts per tree, respectively. The good yield in Mindanao could be explained by both the younger tree population and more optimal tree spacing than in Luzon and Visayas areas as well as its highly sustainable rainfall (Castillo, et.al., 1996). A comparison of coconut productivity among regions showed that Southern Mindanao posted the highest average coconut productivity at 87 nuts per tree, followed by Central Mindanao at 45 nuts per tree, Ilocos Region at 39 nuts per tree, and Cagayan Valley at 38 nuts per tree in the same period. The average coconut yield in Southern Tagalog was only 31 nuts per tree. During the eight-year period under review, the highest coconut yield in Southern Mindanao was recorded in 1995 at 106 nuts per tree. Except for Southern Mindanao, Southern Tagalog, CAR, Cagayan Valley, and Western Mindanao, all the other regions experienced a declining trend in coconut productivity from 1990 to 1997.

According to Boceta (1997), some 1.1765 million hectares are found in 30 provinces that are considered highly suitable. They can yield more than 2.5 mt of copra per hectare per year. Twenty-two other provinces with 1.17 million hectares can yield 1.5 to 2.5 mt. Only nine provinces, with an estimated total of 49,003 hectares, are deemed capable of producing less than 1.5 mt per hectare per year. He added that these production figures are attainable, given the proper soil nutrient, favorable weather, and proper cultural practices, among other factors.

2.3 Coconut Processing

At the farm level, copra processing is commonly practiced. On the average, about 91% of the coconut production of the Philippines during the period 1990-1997 pass through the copra stage. Village-level processing of other coconut products such as nata de coco, coconut vinegar, coconut oil, coco coir, and coco-charcoal is undertaken by small coconut farmers' organizations (SCFOs) or cooperatives to a limited extent. Large-scale coconut processing is generally done by companies (e.g., coconut oil mills, dessicating plants, oleochemical companies, coconut vinegar processing companies, coco juice processing companies, coconut milk processing companies, coir processing plants, etc.).

On the average, coconut oil production in copra terms accounted for 88.7% of the country's coconut production during the period 1990-1997 (Table 3). In 1990, there were 109 coconut oil mills 1990 with a combined crushing capacity of 5.181 million mt per year (Appendix Table 5). However, due to lack of reliable supply of copra, the number of coconut oil mills decreased to 87 in 1997 with a combined crushing capacity of 4.87 million mt per year (Appendix Table 6). The most concentrated regions in terms of the number of oil mills are the Southern Tagalog Region specifically the Laguna/Quezon area and Northern and Southeastern Mindanao with 30 milling establishments each. Due to the low volume of copra available for crushing, the capacity utilization of the oil milling establishments was low ranging from 35% to 50% during the period 1990-1997 (Table 3).

Table 3. Philippine coconut oil supply, demand and milling capacity, 1990-1997.

(Volume in Thousand Metric Tons - Copra Terms)

YEAR	TOTAL COCONUT PRODUCTION	OIL SUPPLY 1/	OIL DEMAND		COPRA	MILLING CAPACITY	
			Domestic 2/	Foreign 3/6/	CRUSHED	Total 4/	% Utilization 5/
1990	2,629	2,326	386	1,940	2,294	5,181	44.3
1991	2,060	1,833	367	1,466	1,798	5,021	35.8
1992	2,238	1,887	371	1,516	1,852	5,021	36.9
1993	2,182	2,107	410	1,697	2,071	5,350	38.7
1994	2,289	1,899	438	1,461	1,862	5,321	35.0
1995	2,696	2,707	464	2,243	2,670	5,269	50.7
1996	1,968	1,846	460	1,386	1,808	5,069	35.7
1997	2,618	2,274	501	1,773	2,237	4,869	45.9

1/ Domestic and foreign demand.
2/ Includes locally consumed manufactured oil and home-made oil.
3/ Export of coconut oil
4/ Annual Philippine coconut extraction capacity
5/ Percentage of utilization based on total rated capacity
6/ Includes the copra equivalent of coco methyl ester, coco fatty alcohol and coco fatty acid exports
Source : PCA

2.4 Domestic Consumption

The coconut products that are locally consumed consist of manufactured oil, home-made oil, and food nuts. Manufactured oil got the biggest share in the domestic market with 464,000 mt (83%), followed by foodnuts, 61,000 mt (11%), and home-made oil, 37,000 mt (7%) during the period 1990-1997 (Table 5 and Figure 3). Manufactured oil includes edible oil, margarine, shortening, oil for laundry soap, oil for coco-diesel, crude coconut oil used by the oleochemical companies, dessicated coconut and coco cream in copra basis. In 1997, coconut oil for oleochemical manufacture accounted for 25% of local consumption (UCAP Weekly Bulletin, 1997). Expansion in coconut oil requirement for oleochemical production by 26.5% during the period 1996-1997 was partly due to new facilities coming on stream.

Domestic consumption of manufactured coconut oil in copra terms exhibited an increasing trend (4.1%) during the period 1990-1997. Similarly, the domestic consumption of home-made oil and food nuts were on the upswing at a rate of 2.6% and 1.0% per year in the same period.

2.5 External Trade/Exports

Unlike other major coconut producing countries such as Indonesia, India, and Sri Lanka which mostly absorb their coconut production domestically, the Philippines exported a large proportion (79%) of its coconut output during the period 1990-1997 (Table 4). However, although the volume of Philippine exports of coconut products grew at an average rate of 2% per year from 1990 to 1997, domestic consumption of coconut products increased much faster at 3.6% annually (Table 4 and Figure 4). Thus, the share of the country's coconut exports to total coconut utilization decreased from 83% in 1990 to 77% in 1997, or by 6%.

Coconut products are among the top ten agricultural export products in the country. On the average, exports of coconut products generated an aggregate value of U.S.$741.77 million during the period 1990-1997 (Table 6). This accounted for approximately 5.2 % of the country's export earnings in the same period. The coconut export mix consist of traditional and non-traditional coconut products. The largest contribution to the country's export earnings from coconut products came from traditional coconut products with an average of U.S.$667.50 million (90%) during the eight-year period under review. Exports of non-traditional coconut products only accounted for an average of 10% (U.S.$74.27 million) of the total foreign exchange earnings generated by the coconut industry. Revenues from exports of traditional and non-traditional coconut products improved from 1990 to 1997 by an average of 10.4% and 5.5% per year, respectively. The aggregated

Table 4. Total utilization, domestic consumption, and exports of coconut products in copra terms, Philippines, 1990-1997.

YEAR	EXPORTS	DOMESTIC CONSUMPTION (' 000 MT)	TOTAL UTILIZATION
1990	2,146	443	2,589
1991	1,678	422	2,100
1992	1,687	426	2,113
1993	1,885	467	2,352
1994	1,602	497	2,099
1995	2,391	525	2,916
1996	1,497	521	2,018
1997	1,899	562	2,461
Ave.	1,848	483	2,331
%Share, 1990-1997	79	21	100
% Share, 1990	83	17	100
% Share, 1997	77	23	100
Annual Growth Rate (%)	2.0	3.6	1.8

Source of basic data: Market Research & Promotion Division, PCA

Table 5. Domestic consumption of coconut by type of product, Philippines, 1990-1997.

YEAR	DOMESTIC CONSUMPTION			
	Manufactured Oil1/	Homemade Oil	Foodnuts	Total
1990	355,000	31,000	57,000	443,000
1991	331,807	35,000	55,000	421,807
1992	336,174	35,000	55,000	426,174
1993	374,440	36,000	57,000	467,440
1994	400,601	37,000	59,000	496,601
1995	427,049	37,000	61,000	525,049
1996	422,895	37,000	61,000	520,895
1997	464,000	37,000	61,000	562,000
Ave.	388,996	35,625	58,250	482,871
%Share, 1990-1997	81	7	12	100
% Share, 1990	80	7	13	100
% Share, 1997	83	7	11	100
Annual Growth Rate (%)	4.1	2.6	1.0	3.6

1/Includes dessicated coconut & coconut cream in copra basis; starting 1991, includes CNO for oleochemicals' domestic consumption.

Source of basic data: Market Research & Promotion Division, PCA

Figure 3. Average shares in domestic consumption by type of coconut product, 1990-1997.

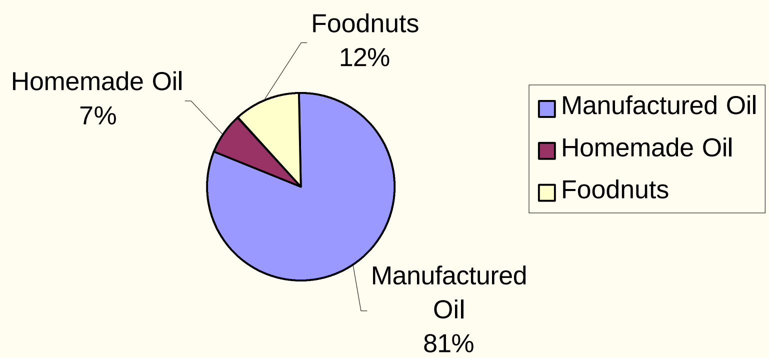


Figure 4. Trend in the domestic consumption and exports of Philippine coconut products, 1990-1997.

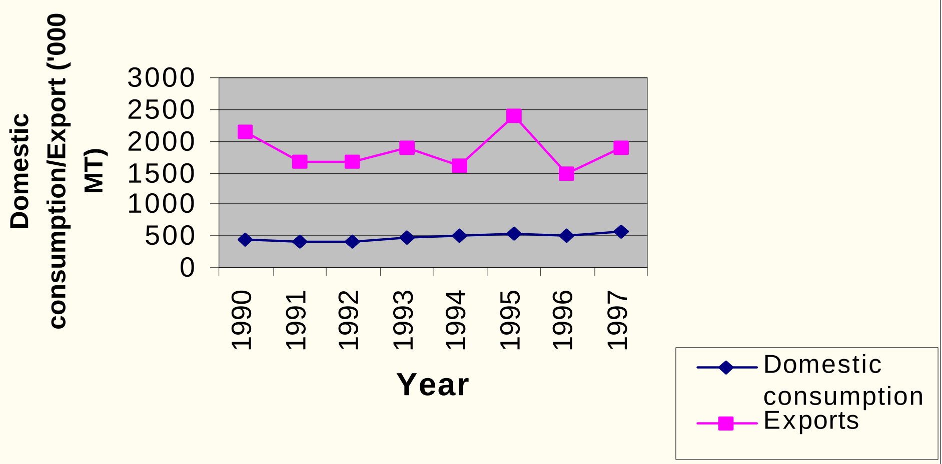


Table 6. Value of exports of coconut products and by-products (traditional and non-traditional) and Philippine export earnings, 1990-1997.

YEAR	VALUE OF EXPORTS OF COCONUT PRODUCTS (FOB US$)			PHILIPPINE EXPORT EARNINGS (FOB US$)	PERCENT SHARE OF COCONUT EXPORT EARNINGS TO PHIL. EXPORT EARNINGS
	Traditional	Non-Traditional	Total		
1990	500,879,630	58,696,767	559,576,397	8,186,030,000	6.8
1991	457,672,566	44,387,927	502,060,493	8,839,510,000	5.7
1992	641,453,851	59,392,620	700,846,471	9,824,300,000	7.1
1993	569,796,719	88,780,984	658,577,703	11,374,810,000	5.8
1994	623,008,906	93,203,859	716,212,765	13,482,860,000	5.3
1995	991,818,860	89,134,121	1,080,952,981	17,447,190,000	6.2
1996	744,188,249	90,757,610	834,945,859	20,542,850,000	4.1
1997	811,142,245	69,860,890	881,003,135	25,227,700,000	3.5
Average	667,495,128	74,276,847	741,771,976	14,365,656,250	5.2
%Share, 1990	89.5	10.5	100.0		
%Share,1997	92.1	7.9	100.0		
%Share, 1990-97	90.0	10.0	100.0		
Annual Growth Rate (%)	10.4	5.5	9.4		

Source of basic data: PCA and NSO

export revenue from traditional and the non-traditional coconut products, on the other hand, grew by an average rate of 9.4% per year during the period 1990-1997 (Table 6).

Coconut oil made up the bulk of the country's exports of traditional products (Tables 7 and 8). It accounted for 58.8% of the total export volume of traditional products, respectively during the period 1990-1997. Coconut oil alone ranked fourth among the country's top ten export products in 1997 (NSO, 1998). Of the total export earnings generated by traditional coconut products during the eight-year period under review, coconut oil had the biggest contribution (78.5%) with dessicated coconut (11.5%), copra meal (8.3%), and copra (1.7%) trailing behind.

Among the traditional coconut products, coconut oil also exhibited the highest growth rate at 14% per year in terms of export revenue during the eight-year period under review (Table 8). Export earnings generated from coconut oil rose from U.S.367.68 million in 1990 to U.S.667.54 million in 1997 due to the rising world price of coconut oil. On the other hand, the volume of Philippine exports of coconut oil was highly erratic during the period 1990-1997 due to year-to-year fluctuations in coconut production arising from climatic changes. Historically, the volume of Philippine coconut oil exports had been dependent on domestic coconut supply. On the average, the Philippines exported 1.014 million mt of coconut oil from 1990 to 1997 (Table 7). The major foreign buyers of Philippine coconut oil were the United States (44%) and Europe (37.4%) (Appendix Table 7). As shown in Appendix Table 7, increasing quantities of coconut oil were exported to the United States during this period. This suggests that the Philippines has already recovered from the massive smear campaign against coconut oil by the American Soybean Association. The increase in the country's exportation to the United States could be attributed to the information campaign which was launched by the United States Council for Research/Information on the medicinal or therapeutic value of coconut oil being a medium chain triglyceride (MCT). Conversely, the volume of coconut oil exports to Europe and other importing countries was lower in 1997 compared to that in 1990.

Coconut oil, as a lauric acid oil, constitutes a measly 6% of the world's oil and fats market (Delmo, 1999). Nevertheless, the Philippines predominantly captures the world market by supplying 65.2% of the total world export volume of coconut oil from 1990 to 1997 (Table 9). On the other hand, Indonesia, which was mentioned earlier as the largest world producer of coconut, accounted for only 20.6 % of coconut oil exportation in the same period. However, Filipino coconut oil producers have to watch out for the growing presence of Indonesia in the international coconut oil market (Delmo, 1999). It can be noted in Table 9 that the volume of coconut oil exports of Indonesia increased much faster at 38.4% per year during the period 1990-1997 than that of the Philippines (3.4% per year).

As regards to copra exportation, the volume of copra exports declined drastically from 91,443 mt worth U.S.$19.35 million in 1990 to only 7,000 mt valued at U.S.$2.8 million in 1997 (Tables 7 and 8). This might be partly attributed to the fact that the domestic price of copra especially during the period 1994-1996 was higher than its export

Table 7. Volume of exports of traditional coconut products, Philippines, 1990-1997.

YEAR	VOLUME OF EXPORTS (MT)				
	Copra	Coconut Oil	Dessicated Coconut	Copra Meal	Total
1990	91,443	1,157,675	74,863	631,421	1,955,402
1991	86,017	890,077	81,486	613,874	1,671,454
1992	39,050	903,612	85,290	498,762	1,526,714
1993	38,814	1,013,816	96,636	535,012	1,684,278
1994	23,700	872,919	75,954	586,173	1,558,746
1995	33,752	1,364,061	73,547	787,512	2,258,872
1996	3,091	829,371	70,379	492,890	1,395,731
1997	7,000	1,080,913	76,792	571,025	1,735,730
Average	40,358	1,014,056	79,368	589,584	1,723,366
% Share, 1990	4.7	59.2	3.8	32.3	100.0
%Share, 1997	0.4	62.3	4.4	32.9	100.0
% Share 1990-1997	2.3	58.8	4.6	34.2	100.0
Annual Growth Rate (%)	-3.2	3.4	1.0	1.2	1.5

Source of Basic Data: Market Research & Promotion Division, PCA

Table 8. Value of exports of traditional coconut producrs, Philippines, 1990-1997.

YEAR	VALUE OF EXPORTS (FOB US$)				
	Copra	Coconut Oil	Dessicated Coconut	Copra Meal	Total
1990	19,350,606	367,684,480	60,312,647	53,531,897	500,879,630
1991	19,687,286	315,988,446	66,903,745	55,093,089	457,672,566
1992	12,733,550	491,916,523	87,632,717	49,171,061	641,453,851
1993	10,570,326	422,570,446	86,793,041	49,862,906	569,796,719
1994	8,643,850	489,266,956	71,068,211	54,029,889	623,008,906
1995	12,879,272	840,311,882	68,682,844	69,944,862	991,818,860
1996	1,354,298	598,146,289	85,918,565	58,769,097	744,188,249
1997	2,799,300	667,542,640	88,288,872	52,511,433	811,142,245
Average	11,002,311	524,178,458	76,950,080	55,364,279	667,495,128
% Share, 1990	3.9	73.4	12.0	10.7	100.0
%Share, 1997	0.3	82.3	10.9	6.5	100.0
%Share, 1990-1997	1.7	78.5	11.5	8.3	82.3
Annual Growth Rate (%)	-0.4	14.0	6.8	0.7	10.4

Source of Basic Data: Market Research & Promotion Division, PCA

Table 9. World coconut oil trade by exporting country, 1990-1997.

EXPORTING COUNTRY	VOLUME OF COCONUT OIL EXPORT (' 000 MT)									PERCENT SHARE (1990-1997)	ANNUAL GROWTH RATE (%)
	1990	1991	1992	1993	1994	1994	1996	1997	Average		
Mozambique	1.5	1.3	2.8	2.0	2.9	2.3	2.4	1.9	2.1	0.1	11.6
Indonesia	194.0	197.6	351.5	258.4	392.9	148.3	378.8	644.3	320.7	20.6	38.4
Malaysia	55.4	42.0	66.4	56.8	60.3	55.2	35.3	33.0	50.6	3.2	-3.6
Philippines	1157.7	890	903.6	1013.8	872.9	1364.0	829.4	1080.9	1014.0	65.2	3.4
Sri lanka	12.2	1.0	2.4	2.6	4.5	9.0	2.4	7.0	5.1	0.3	
Fiji	11.0	6.5	2.4	10.0	4.1	4.0	4.9	3.8	5.8	0.4	
Papua New Guinea	37.9	27.1	40.4	45.5	34.7	33.1	49.6	58.7	40.9	2.6	10.4
Other Countries	147.6	130.2	152.7	101.8	105.2	112.0	85.5	101.7	117.1	7.5	-3.3
World	1617.3	1295.7	1522.2	1490.9	1477.5	1727.9	1388.3	1931.3	1556.4	100.0	3.9

Source of basic data: OIL WORLD

price. Instead of exporting copra at a lower price, copra exporters found it more profitable to sell copra to coconut oil millers and dessicated coconut processors. From 1990 to 1996, the Philippines exported copra to Europe and other countries such as Korea and Bangladesh, among others. However, Europe stopped importing copra from the Philippines in 1997.

On the other hand, exports of dessicated coconut have been improving significantly at an average of 1% and 6.8% in volume and value terms, respectively from 1990 to 1997 (Tables 7 and 8). From 74,863 mt valued at U.S.$60.31 million in 1990, the volume of dessicated coconut exports markedly increased to 76,792 mt worth U.S.$88.29 million in 1997. The bulk of dessicated coconut exports during the period 1990-1997 went to the United States (45%). Other foreign buyers of dessicated coconut in the same year were Europe (26%), and other countries such as Canada and the Middle East, among others. Increasing quantities of dessicated coconut were exported to the United States during the period under review while the volume of dessicated coconut exports to Europe registered a decline over the years (Appendix Table 7). Although there was a decrease in the volume of dessicated coconut exported to Europe by 2,340 mt, a great increase in its export value from U.S.$15.69 million in 1990 to U.S. 19.84 million occurred in 1997 due to the rising export price of dessicated coconut (Appendix Tables 7 and 8). The Philippines and Sri Lanka are the world's largest producers of dessicated coconut. The country's production of dessicated coconut was mainly geared toward the export market.

In the case of copra meal, the volume of exports was erratic during the period 1990-1997 (Table 7). The highest volume of copra meal exports was recorded in 1995 at 787,512 mt valued at U.S.$75.7 million while the lowest was registered in 1996 at 492,890 mt worth U.S.$58.8 million (Tables 7 and 8). Europe was the biggest export market for Philippine copra meal with 85% market share during the period under review. However, the volume of exports of copra meal to Europe exhibited a declining trend (Appendix Table 7). In contrast, the volume of exports of copra meal to other countries such as Japan and Korea rose significantly from 48,046 mt in 1990 to 177,917 mt in 1997 (Appendix Tables 7). During the eight-year period under review, the Philippines exported copra meal to the United States only in 1992 and 1993. On the average, export earnings generated from copra meal amounted to U.S.$62.9 million (Table 8).

With regard to non-traditional coconut products, oleochemicals accounted for 51.1% of the total export earnings generated in 1997 amounting to U.S.$69.86 million (Appendix Table 10). Also included among the top seven major export earners in the non-traditional coconut product category in the same year were as follows: refined glycerine (15.2%), nata de coco (8.7%), coco cream powder (5.3%), alkanolamide (2.7%). makapuno (2.6%), and liquid coconut milk (1.8%).

As shown in Appendix Tables 7 and 8, the volume and value of oleochemicals exportation exhibited a declining trend during the period 1990-1997. This could be attributed to the growing substitutes from other fats and oils in the world market. In contrast, nata de coco exportation substantially increased both in volume and value because it is used as a health food and due to its industrial uses. Other non-traditional coconut products which posted a rising volume of exports from 1990 to 1997 were refined glycerine, alkanolamide, liquid coconut milk, coco cream powder, coconut chips, makapuno, coco water/juice, shortening, coco vinegar, coco coir fiber, coco fiber waste, coconut husk, coco husk chips, coco shell powder, toilet bath soap, laundry soap, and paring oil. New non-traditional coconut products which are finding their way in international trade include special creamed coconut, coco soy sauce, and shampoo.

2.6 Market Prospects

The domestic market prospect for coconut products and by-products is bright as evidenced by the positive growth rate of 3.6% per year in local demand during the period 1990-1997. It is projected that the domestic demand for coconut products and by-products will continue to grow at 3.6% annually in the foreseeable future due to the increase in population and the growing demand of the ornamental plant industry, oleochemical companies, the baking industry, and manufacturing industries (e.g., pharmaceutical companies, companies manufacturing shampoo, soap, detergents, toothpaste, ice cream, etc. as well as car and furniture upholstery companies). According to Ambassador Romero, CIIF President (1999), the potential for growth and development of the Philippine coconut industry is immense given the greater interest in "naturals" (as opposed to synthetics) such as pharmaceutical/medicinal applications, health foods ("nutraceuticals"), cosmetics and personal health care products' and industrial applications, thus creating new coconut-based industries.

As mentioned in the Medium-Term Coconut Industry Integrated Development Plan for CY 1996-2000, the domestic utilization of coconut products is forecast to increase in the following areas:

"1. Coco chemicals - The global concern for environment has filtered into the country so much so that the focus of advertisement for cleaning detergents is biodegradability. This is complemented by a House Bill requiring all soaps and detergents to use 100% coco fatty alcohol, a coconut oil derivative. Approval and subsequent implementation of this bill will result in a big increase in domestic demand.

2. Coconut water - Coco water/juice has been repackaged in plastic cups so that it carries with it buying convenience. This has increased the demand for coco water/juice.

3. Coconut milk - The fast rising demand for nata de coco not only in the domestic demand, but specifically among foreign importers will push the demand for coconut milk since it is the raw material used for the production of nata de coco. Local ice cream manufacturers are also using coconut milk in making ice cream, yoghurt, and frozen desserts. Increased use of coconut milk in the production of ice cream should, however, be further promoted and encouraged. Due to the growing population, household consumption of coconut milk is projected to increase considering that coconut milk is used in

the preparation of various local food dishes. Coconut milk has also found applications in the baking industry for making biscuits, cookies, and cakes.

4. Coir products - The booming ornamental plant industry has created the big demand for coir dust which is used as soil conditioner. Coir dust can be used in the construction business as particle board and cement-bonded board. Coir dust is also used by existing car manufacturing companies in making car upholstery and the furniture manufacturing companies in making pads for bed mattresses and furniture cushions. A local company is also currently manufacturing geotextiles from coir fiber which are used to prevent soil erosion. Coir fiber can also be processed into doormats, sacks, bags, ropes, yarn fishing nets, pillows. mannequin wigs, and coirflex. The manufacture of a locally-designed coconut decorticating machine and equipment using the dry process of husk defibering has helped revive the Philippine coir industry.

5. Coco shell charcoal - Coco shell charcoal briquettes as fuel for food grilling in commercial establishments have provided another dimension in maximizing utilization of coconut."

Philippine coconut products and by-products have also a promising market prospect abroad. This is evident from the growing export earnings from Philippine coconut products and by-products which increased at 9.4% per year during the period 1990-97. The expansion in coconut areas in Indonesia, Vietnam, Thailand, and India is also indicative of the rising demand for coconut products. It was reported in the Medium-Term Coconut Industry Integrated Development Plan for CY 1996-2000 that the volume of Philippine coconut exports is projected to rise in the following growth areas:

"1. Coco chemicals - Global environment concerns underscored by the US Clear Air Act is a significant cue to the country's exporters of coconut crude oil and coco chemicals of the need for a replenishable source of mineral fuel alternative. Similarly, ecological awareness emphasizes the need for biodegradable chemicals in cleaning agents. Food processing, textile manufacturing, and personal care products are shifting to natural synthetic chemicals for medical reasons. According to Boceta (1997), the country will earn more from exporting coconut fatty alcohol than from coconut oil because coconut oil commands a lower price of $530 per mt in the export market compared to coconut fatty alcohol which fetches $1,060 per mt.

2. Coco coir products - The demand for coir fiber in Europe remains big and the Philippines can compete with other producers like India and Sri Lanka if the county can develop cost-effective bailing technology. Moreover, the "Green Movement" shifts consumers' preference from synthetic fibers to natural fibers. One of the potential sources of growth of the Philippine coir industry is the exports of rubberized coir due to the ban on the use of polyurethane in coir upholstery in Europe. Another market development abroad is the increasing world demand for natural fibers such as coir and abaca fibers due to the

decreasing demand for synthetic plastic ropes or twined which are not degradable and thereby cause pollution problems. Coir is also being used in Europe as geotextiles to control erosion for river beds to prevent embankment collapse and in Switzerland to reinforce ski runs. Boceta (1997) added that there is a growing export market for coco fiber and compacted dust in Europe, North America, and even the Middle East.

3. Coconut water- The international demand for coconut water has tremendously increased. Exports of fresh coconuts are now complemented by exports of coco water/juice in can and tetrabrik. The volume of coco water/juice shipped out to Taiwan and Japan can still be increased. Europe can also absorb the country's coco water/juice exports.

4. Coconut oil - Coconut oil is projected to remain as the biggest net foreign exchange earner and to register a significant increase in shipments now that the Philippine International Trade Center has included coconut oil in its list of counter purchase products. Moreover, the commercial production of medium chain triglyceride, a nutrition supplement, will significantly boost demand for coconut oil. In addition, Boceta (1997) reported that the demand for coconut oil may further increase breakthroughs in research and development such as those of Dr. John Kabara of Michigan State University on the anti-microbial properties of coconut oil, which can remedy hepatitis, benign prostate condition, tuberculosis, and ulcer.

5. Nata de coco - The interest of Japan, the United States, and some other countries in nata de coco is a healthy sign that nata de coco will have an increasing demand abroad.

6. Coconut milk - The volume of coconut milk exports in Europe is growing.

7. Dessicated coconut - The traditional export markets for Philippine dessicated coconut are the United States and Western Europe. Potential new markets are China, Eastern Europe, and Japan."

According to Boceta (1997), other market opportunities for Philippine coconut products abroad include the following: the growing population and income of Asia-Pacific countries and Latin America, which offer an alternative to the traditional markets of North America and Europe; the liberalized trade regime under the Uruguay Round of the General Agreement on Tariffs and Trade (GATT), which enables the country's coconut products to compete better in the international market; and the production of plantlets via tissue culture by the Tissue Culture Division of the PCA Albay Research Center, which is a breakthrough and is expected to revolutionize coconut growing and production in the country. Ambassador Romero added (1999) that the export market prospects for coconut products are favorable due to the rising consumer demand for "healthier" oilseed in Europe and North America, the growing demand for copra meal and coconut oil in Asia, and the emerging markets for finished edible products in Eastern Europe considering an increasing trend towards western consumption patterns in Hungary, China, and India.

2.7 Problems Confronting The Coconut Industry

The Philippine coconut productivity is confronted with considerable problems. Low productivity and declining coconut production are the major production-related problems that beset the Philippine coconut industry. These could be attributed to the following reasons:

1. Senility of coconut trees - About 25% of coconut bearing trees are senile or over 60 years old (PCA, 1995);

2. Widespread use of poor or low-yielding coconut varieties due to lack of quality coconut seedlings (Magat, 1999) - More than 98% of the total coconut land area is planted to talls which bear fruits after seven years and reach senility after 60 years (PCA, 1995). Talls yield approximately one-half that of coconut hybrids.

3. Poor agronomic or farm management practices (Magat, 1999) - Most coconut areas are dependent on rainfall or have no irrigation systems. Moreover, only one percent of the coconut parcels regularly receive fertilizer (Manicad, 1993).

4. Unabated cutting of coconut trees in view of the good market for coco lumber- As of 1996, it was reported that 2.5 million hectares, about half of which were believed to be productive, had been cut for the following reasons: a) the log ban which made traditional forest lumber very scarce and thereby opening a big demand for coconut lumber; b) low price of coconut; and c) coverage of the Comprehensive Agrarian Reform in coconut lands where some landlords, in an effort to evade land reform, cut their coconut trees (PCA, 1995). To regulate the cutting of coconut trees, RA 8048 was enacted in 1995. As of July 1998, there were 364 cases of violations investigated, 55 violators of which had been charged and 22 convicted in the intensified implementation of RA 8048 (Coconut News Magazine, 1998).

5. Poor soil nutrition - Through years of cropping and neglect, the soil fertility of most coconut farms in the country has remarkably deteriorated resulting in low coconut productivity (PCA, 1991). The PCA study showed that widespread deficiencies in nitrogen, chloride, sulfur, and potassium caused low yields in many coconut areas in the country. Nutritional deficiency can reduce coconut productivity by about one ton of copra per year.

6. Incidence of pests and diseases - "Cadang-cadang, a viroid disease, kills millions of coconut trees in the Philippines each year. Production loss due to this disease has been estimated at US$ 16 million annually (Manicad, 1993).

7. Natural calamities - The El Niño and the La Niña weather disturbances have an adverse impact on coconut production.

8. Land conversion of coconut lands - In areas where massive felling of coconut trees occurred, coconut lands have been converted to other more profitable crops or to non-agricultural uses.

9. Lack of sustained and adequate resources for infrastructure support, research and extension services especially in the continuing value formation, technical skills, and entrepreneurial skills development of small coconut farmers - For example, PCA (1995).reported that the provision of irrigation support to small farmers and the construction of feeder roads and building facilities which were programmed for 1991 to 1995 were not carried out because of lack of funds.

10. Tenure-related problems - Majority of the producers are small-scale coconut farmers, but there is a small minority who control half of the coconut lands in the country (Manicad, 1993). The landed elite have minimal investments in coconut production and copra drying because they receive income from rental payments and lucrative trading. Furthermore, most of the small coconut farmers have no capital to invest in modern coconut varieties and cannot afford to wait for the seven years maturation of coconut trees that replanting requires. The small coconut farmers lack sustained access to credit from formal sources considering that banks generally consider small farmer-lending risky.

Another production-related problem in the coconut industry is inadequate intercropping in coconut lands. Less than 40% of the coconut farmers in the country practice intercropping (PCA, 1995). Of the 3.1 million hectares planted to coconut, 70% is not intercropped (Coconut News Magazine, 1998). This is partly explained by the fact that many landlords prohibit intercropping because they fear that this will affect coconut productivity and because they fear their land will be easily subjected to land reform (Manicad, 1993). Moreover, another foremost reason for not practicing intercropping is lack of capital among small coconut farmers.

Coconut farmers are also besieged by marketing problems such as the low and unstable farmgate prices that they receive. This is attributed to a number of marketing inefficiencies in the industry such as many layers of middlemen, expensive transport and handling cost, cartelized pricing from coconut processors/exporters, and lack of an effective market information system (PCA, 1995).

Moreover, another major problem facing the coconut industry is the high incidence of poverty among coconut farm families. Statistics show that about 90% of coconut farmers live below the poverty line (Castillo, et. al., 1996). Low income of coconut farm households is attributed to one or a combination of the following factors: 1) low coconut yield; 2) low prices of farm produce; 3) limited market; 4) underutilization of coconut lands; and 5) high cost of farm inputs (Magat, 1999).

With regard to the coconut processing sector, the Philippine oil milling industry is faced with three major problems, namely: 1) negative crushing margins for Metro Manila and Southern Tagalog oil mills due to an inverted market where the low price of copra was higher than the equivalent price of crude coconut oil; 2) low capacity utilization of oil mills because of low coconut and copra production; and 3) low oil yield due to old or inefficient machinery and poor quality copra (Boceta, 1997). Poor quality of copra is partly attributed to poor harvesting practices (i.e., harvesting of immature nuts) (PCA, 1995). The continued use of the "tapahan" method of drying copra despite the development of other copra dryers such as the kukum dryer and the Los Baños multicrop dryer also accounts for the poor quality of copra. This traditional method of drying copra is considered labor intensive, increasingly expensive, and results in the presence of toxic substances such as aflatoxin, which is unsafe for human consumption (Manicad, 1993). Lack of price incentive for high quality product is another reason for poor quality of copra produced. Filipino farmers have a strong disincentive to produce good quality copra at 19% moisture content (12% by Brown-Duvel) when they are offered "pasa" farm-gate prices (Nipa, 1991). This assumes a 20-25% moisture content so the drier the copra is, the more the farmer loses.

The oil extracted from copra also requires drastic refining and deodorizing. In addition, Philippine coconut oil sells at a discount of 2 percent in the world market owing to its low quality. Hence, this situation has been estimated to cost the country US$ 52 million annually in terms of reduced export prices and physical losses (Boceta, 1997).

As regards to the Philippine dessicated coconut industry, the foremost problem of the industry is the high cost of processing due to the high labor cost and the use of obsolete equipment and inefficient processing methods. Currently, the strong competitors of the Philippines in the world market for dessicated coconut are Sri Lanka and Indonesia. The latter has the most modern dessicating plants. It is, therefore, important to encourage dessicating plants to use waste heat technology as a partial source of its heat requirement for blanching and drying of fresh coconut meat in order to substantially reduce their processing cost and, at the same time, add saleable products like coconut shell charcoal, which can be converted into activated carbon, a higher-value product (Boceta, 1997). In addition, they should be encouraged to employ mechanical means of shelling and paring the nuts to improve production efficiency of dessicated coconut processing considering that labor cost in the Philippines is higher than in Indonesia and Sri Lanka. Acosta (1991) reported that the country could not compete with Sri Lanka which produced 60,000 mt at a labor cost of $1/day. The same was true with Indonesia. Labor cost incurred by dessicated plants in the Philippines in 1991 was much higher at $3/day.

On the other hand, Filipino exporters of coconut products are besieged with the following problems: 1) stiff competition of coconut oil with soybean oil and palm kernel oil as well as the biogenetically-engineered rapeseed that produces canola oil, whose chemical composition approximates that of coconut oil and palm kernel oil in the lauric oil market; and 2) threat from the coconut production activities of neighboring countries such as Indonesia, India, Thailand, and Vietnam which are increasing their coconut hectarage (Boceta, 1997).

3.0 STATUS OF RESEARCH AND DEVELOPMENT (R & D) FOR COCONUT

3.1 Profile of the National Research and Development System for Coconut and Research Priorities

The Philippine National Agricultural Research System (NARS) is comprised of two basic structures: the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD), a planning and coordinating body under the Department of Science and Technology (DOST) and the National Agriculture and Resources Research and Development Network (NARRDN) (Dar, 1997). The NARRDN has for its members line agencies and the R & D institutions, state colleges and universities (SCUs), local government units (LGUs), and private institutions.

Research and development (R & D) activities on coconut are coordinated, monitored, and evaluated by PCARRD. A National Coconut R & D Committee created by PCARRD is responsible for setting research priority areas for coconut, evaluating research proposals, and providing assistance in the identification of mature technologies and commercialization modalities. Presently, this committee is composed of a chair from the PCA and 42 members. Of the 42 members, 15 are from the PCA, six (6) from the University of the Philippines at Los Baños (UPLB), five (5) from the Forest Products Research and Development Institute (FPRDI), two (2) from the Visayas State College of Agriculture (VISCA), two (2) from DA-BAR, one each from the head office of the DOST, U.P. Diliman College of Home Economics, U.P. Manila College of Medicine, and the National Power Corporation (NPC), and 13 from the private sector (e.g., the Philippine Coconut Research and Development Foundation or PCRDF, the United Coconut Association or UCAP, the Coconut Industry Reform Movement, the United Coconut Chemicals, Inc., Ashlar Management and Development Corporation, Pilipinas Kao, and United Laboratories).

In the late 1980's PCARRD grouped commodities into three research priority areas. Coconut was classified under Priority I and shared with other 18 priority commodities in the research budget of 80% allotted by PCARRD (Appendix Table 11). This research budget allocation was arbitrarily decided upon by PCARRD.

On the other hand, based on the scoring approach using selected statistical parameters which was adopted by the Science and Technology Coordinating Council (STCC) in 1989 to prioritize commodities, coconut ranked fourth (Appendix Table 12). Sugarcane, cassava, and corn were accorded higher priorities compared to coconut.

Grouped according to four categories, namely: 1) export winners; 2) basic domestic needs; 3) coconut industry; and 4) environment, PCARRD's current R & D priorities are based on DOST's Science and Technology Agenda for National

Development (STAND) (Appendix Table 13). STAND 2000 serves as the mother document in formulating PCARRD's Medium-Term Research and Development Plan (Dar, 1998). The plan envisions an agro-industrialized Philippines sustained by science and technology.

One of the Integrated Research and Development Programs (IRDPs) of "flagship" programs under STAND is the Integrated Coconut R & D Program which aims to accelerate technology development and utilization on the specific areas in production, processing, and marketing (Dar, 1997). It consists of seven R & D subprograms on technology development and utilization on specific areas in agricultural production and technology transfer. To make the country a steady supplier of coconut products and by-products, specific concerns in coconut production primarily focus on enhancing the availability of materials for national planting and replanting programs.The seven subprograms consist of the following: 1) establishment of mini-seedgardens for the production of hybrid coconut seeds; 2) determination of fatty acid, protein, and triglyceride composition of promising coconut hybrids and cultivars; 3) identification and selection of outstanding coconut plantations and mother palms as future sources of planting materials; 4) implementation of the action program on adoption of suitable technologies with emphasis on coconut varieties and hybrids from the MULTILOC project; 5) the makapuno comprehensive and technology development and commercialization; 6) the conduct of the integrated control of coconut mealybug in Palawan; and 7) conduct of socio-economic and marketing studies on coconut. These are implemented by the PCA, UPLB, the DOST- Industrial Technology and Development Institute (ITDI), the State Polytechnic College of Palawan (SPCP), the Don Severino Agricultural College (DSAC), and LGUs.

For the coconut crop sector, emphasis is given to increasing production and stabilizing supply of coconut products and by-products; improving quality of coconut products and by-products; and increasing utilization of cost-effective technologies under local conditions (Dar, 1997). The Integrated Coconut R & D Program adopts the demand-driven or the bottom-up approaches as against the traditional top-down flow in the past. R & D activities of the NARDN, while covering the areas included in the IRDP, are envisioned to support and respond to sustainable development and global competitiveness.

In addition to the Integrated Coconut R & D Program, PCARRD is currently funding the development of the coconut genome map which uses mapping populations developed by PCA. Information generated from this project will enable coconut breeders to be more effcient by using marker-aided selection.

Another DOST agency which provides funding for R & D on coconut processing is the Philippine Council for Industry and Energy Research and Development (PCIERD). Its mandates are: 1) to formulate strategies, policies, programs, and projects for science and technology development; 2) program and allocate government and external funds for research and development; 3) monitor science and technology research for application in the industry, energy, utilities, and infrastructure sectors; and 4) generate external funds to support R & D undertakings. PCIERD's research program on coconut processing aims to: 1) increase utilization of coconut and its by-products; and 2) develop high-value exportable products from coconut aside from the current traditional ones. The following agencies have received funding from PCIERD to undertake researches on coconut processing: PCA, UPLB, DOST-ITDI, FPRDI, the Food and Nutrition Research Institute (FNRI), and U.P. Diliman. Private companies/agencies such as COCOCHEM, CIIF, and the Sagana Small Farmers' Organization also served as research cooperators in these projects.

Apart from PCARRD and PCIERD, the Philippine Council for Advance Science Technology for Research and Development (PCASTRD), which is also under the DOST, provides research funding for researches on coconut biotechnology especially for industrial applications. It has funded some of UPLB's research projects on coconut biotechnology.

The DA-BAR, which was created in 1987, also plans, integrates, coordinates, monitors, evaluates, and sources funds for the department's various research programs and activities (Dar, 1998). Although BAR duplicates the functions of PCARRD, it closely coordinates with PCARRD, being the unit in charge of the overall coordination of the entire agricultural system. As mentioned earlier, two representatives from DA-BAR are members of PCARRD's National Coconut R & D Committee. DA-BAR's R & D priorities are embodied in the National Agricultural Research and Extension Agenda (NAREA) (Dar, 1998). Like the PCARRD approach, NAREA priorities are determined through multi-sectoral and multidisciplinary consultations up to the regional level. The prioritization is commodity-oriented. Under NAREA, ranking of commodities was based on technology generation component. In hillylands, coconut ranks second in terms of research priority while in upland areas, it ranks fourth (Appendix Table 14). The priority research disciplines for crops are: crop improvement; cultural management; farming systems; post production; socio-economics; and biotechnology. The regional priorities on coconut under NAREA are shown in Appendix Table 15 while the researchable and extension areas or concerns on coconut are presented in Appendix Table 16.

The DA's R & D system (DARDS), which is being coordinated by BAR, is composed of agencies, bureaus, and corporations operating 46 national research centers/stations in various parts of the country. In addition, there are three Regional Integrated Agricultural Research Centers (RIACS) that are being coordinated by DA. An average of four Regional Research Outreach Stations (ROSEs) are under each RIAC. The major tasks of the Regional Research Outreach Stations are to conduct applied research, demonstrate technologies, propagate generic materials, and serve as training materials. They have two primary roles, namely, to: 1) link the regional and provincial research, development, and extension programs; and 2) serve as the satellite of the RIACS.

The Philippine Coconut Authority is the lead agency in the national coconut research and development networks established by PCARRD and the DA-BAR.

The agricultural research and development arm of PCA is the Agricultural Research and Development Branch (ARDB) whose mission is to stimulate and promote agricultural research and technology in coconut production for the development, conservation and sustainable use of genetic and farm resources to improve the well-being of the farmers and other industry sectors (PCA, 1997). PCA-ARDB is concerned with six R & D program thrusts, namely: 1) Varietal Improvement; 2) Crop Agronomy, Nutrition, and Farming Systems; 3) Integrated Crop Protection; 4) Biotechnology; 5) Tissue Culture; and 6) Timber and Husk Utilization.

PCA-ARDB has the overall control and direction of three national coconut research centers (i.e., the Albay Research Center, the Davao Research Center, and the Zamboanga Research Center), two coconut seed gardens (i.e., the Coconut Seed Production Center and the Campung Ulay Seed Garden), and a Coconut Breeding Trials Unit (PCA, 1998). It has also a support department, the Agricultural Research and Management Department (ARMD).

The Agricultural Research and Management Department, which is based at the PCA Central Office, provides advisory support and services to research and field operation activities of the Authority (PCA, 1997). There are two divisions under it, namely: the Monitoring, Evaluation, and Documentation Division and the Plant and Soil Analysis Division.

The PCA-Albay Research Center has three technical divisions, namely: Virology-Biochemistry, Entomology-Epidemiology, and Tissue Culture. Its mission is to develop an integrated cadang-cadang disease control and a technique for propagating production palm thru biotechnology, tissue culture, including embryo culture of Makapuno coconut (PCA, 1997). On the other hand, the PCA-Davao Research Center has two technical divisions, namely: the Agronomy and Soils Division and the Crop Protection Division. Its mission is to identify technical problems and generate appropriate technologies in the fields of mineral nutrition, cultural management, coconut intercropping, and pest and disease control with the end view of increasing farm productivity and income of coconut farmers. The PCA-Zamboanga Research Center has two technical divisions, namely: the Breeding and Genetics Division and the Timber Utilization Division. Its mission is to develop genetically improved high-yielding coconut hybrids and the efficient conversion of mature coconut stems and other cellulosic parts into products and by-products of commercial value.

The Coconut Seed Production Center in North Cotobato and the Campung Ulay Seedgarden in Palawan were established to produce high quality seednuts to support the nationwide coconut planting and replanting program of the Authority. The Coconut Breeding Trials Unit located in Capiz is mandated to duplicate the coconut collections and conserve coconut varieties and accessions available at the Zamboanga Research Center to serve as a source of planting materials for the replanting program in the Visayas.

On the other hand, the Product and Market Development Branch (PMDB) is PCA's industrial and research and market development arm. Its mandate is to improve the domestic and export trade of coconut and oil palm products and by-products and sustain investments in the coconut industry through industrial research and market development. The Product and Market Development Branch has the following objectives: 1) to maintain the country's position as a reliable supplier of export quality coconut products in the world market; 2) to enforce existing laws, rules and regulations covering the production, exportation, and distribution of coconut products and by-products; 3) to identify and develop mature coconut processing technologies that are applicable and appropriate at the farm and village levels of operation; and 4) to promote sustained market development for coconut and oil palm products. The three major departments under the Product and Market Development Branch are as follows: 1) the Trade Management and Accreditation Department; 2) the Market and Development Department; and 3) the Product Development Department. The main focus of the Trade Management and Accreditation Department is on enforcement of market regulations and export documentation. On the other hand, the Market Development Department conducts market research and promotion activities to increase consumers' awareness of the various applications from coconut. The Product Development Department undertakes studies on product diversification, development, and improvement.

FPRDI and ITDI, which are both under DOST, also conduct researches on coconut. The former focuses on coconut wood utilization while the latter is concerned with undertaking studies on coconut processing for food and industrial uses. The research interest of the Food and Nutrition Research Institute (FNRI) is on nutrition-related issues concerning coconut consumption.

The SCUs which have taken an active role in conducting researches on coconut are UPLB and VISCA. These SCUs have regional responsibilities in conducting R & D on coconut (Appendix Table 17). On the other hand, the University of Southern Mindanao, the Panay State Polytechnic College, and the University of Eastern Philippines have the responsibility to serve as cooperating agencies in the conduct of R & D on coconut. Aside from these SCUs, the College of Home Economics in UP Diliman also conducts studies primarily on new food uses of coconut and on some industrial uses to a limited extent.

Within UPLB, several units have been actively involved in various disciplines of coconut research. The Farming Systems and Soil Resources Institute (FSSRI) is concerned with researches on coconut-based farming systems. The Institute of Plant Breeding (IPB) and the Department of Horticulture, on the other hand, are preoccupied with coconut varietal improvement including makapuno culture. The development of new food products from different parts of coconut and aflatoxin control are the main focus of coconut research efforts of the Institute of Food Science and Technology (IFST) while the National Institutes of Molecular Biology and Biotechnology and the Institute of Biological Sciences are concerned with biotechnology researches on coconut. On the other hand, the College of Engineering and Agricultural Technology (CEAT) is concerned with the development or fabrication of machinery and equipment for coconut processing. The research interests of the College of Economics and Management (CEM) are on the economic evaluation of coconut technologies and coconut-based farming systems, assessment of the market potential of coconut products, and the analysis of policy-related and socio-economic issues concerning the coconut industry.

The Regional Coconut Research Center (RCRC) which is located at VISCA is in charge of spearheading coconut research and development efforts in the Visayas. Its mandate is to generate and disseminate appropriate technologies which will augment the coconut farmers' income in the Visayas and uplift their general well-being. The Center has four major research thrusts, namely: 1) crop improvement; 2) cultural management and multiple cropping; 3) processing and utilization; and 4) socio-economics and extension.

Three private institutions composed of PCRDF, UCAP, and the United Coconut Planters Bank (UCPB) are likewise actively involved in coconut R & D activities. PCRDF was established to bring coconut research and development to a headway through research, manpower training, and technology transfer. It provides funds for both basic and applied researches in coconut production and utilization as well as socio-economic and policy studies on the coconut industry. Apart from providing research funding to various institutions like UPLB and VISCA, among others, PCRDF also conducts in-house researches. Being accredited by DOST, the Foundation is responsible for coconut research and development. Among its notable R & D activities is the showcasing of farms planted to embryo cultured makapuno. To carry out its goals and facilitate extension/dissemination of coconut technologies, the Foundation has established stronger ties with other government and private institutions, publishes materials on all aspects of coconut production and utilization, and has put up a library which provides reference materials on various aspects about coconut and the industry. One of its publications is the *Philippine Journal of Coconut Studies* which is published twice a year and circulated locally and internationally. Another source of research funding from the private sector is the UCPB-CIIF. UCPB commissions studies on the coconut industry and to a limited extent conducts its own research. On the other hand, UCAP conducts researches on coconut which are externally funded. It also regularly publishes the *Coconut Statistics* yearly, *Coconuts Today*, and the *UCAP Weekly Bulletin* which contains news about the world coconut production and market situation and current statistics on international and domestic prices as well as the volume of export of various coconut products.

3.2 Funding, Manpower and Research Facilities

3.2.1 Funding

Public expenditures for agricultural research in the 1990s increased rapidly in real terms by an average annual growth rate of 8-9% (David, et al., 1998). However, despite this growth, Philippine public expenditure for agricultural research from 1992 to 1996 was still underfunded.

Among agricultural commodities, coconut was one of those which received lower research expenditure allocation compared to other commodities which had less contribution to the economy as measured by their share in gross value added in agriculture (GVA). For example, coconut research had been underfunded during the period 1995-1997 as compared to sugarcane and carabao. This is borne out by a recent study conducted by David, et al. (1998) which showed that the average direct budgetary support for coconut research by the PCA (P 52.98 million/year) was far lower than for sugar research under the Sugar Regulatory Administration (SRA) (P62.67 million/year) and for carabao research under the recently established research center for carabao (PCC) (P136.44 million/year) in the same period (Table 10). Higher budgetary allocations were, therefore, accorded to sugarcane and carabao which were not commensurate with their economic contributions. The estimated research intensity ratio was 0.30% for coconut compared to 0.50% and 3.60% for sugarcane and carabao, respectively. Using the ratio of the share of a commodity group in a country's exports to that commodity's share of world exports, the same study also reported that coconut had a higher comparative advantage with a ratio of 181.2 in 1995 than sugarcane with only 1.5 ratio.

Table 10. Expenditure for research and development by agency, share in GVA, and research intensity ratio for coconut, sugar, and carabao, 1995-1997.

COMMODITY	SHARE IN GVA (%)	RESEARCH INTENSITY RATIO (RIR) (%)	AVE. ANNUAL R & D EXPENDITURE (P Million)
Coconut	5.38	0.30	52.98
Sugarcane	4.27	0.50	62.67
Carabao	0.77	3.60	136.44

Source: David, et al., 1998.

The sources of PCA's research funds are direct budgetary support and project funds obtained from other government agencies (e.g., DOST/PCARRD), foreign donors (ADB, COGENT, GTZ, IPGRI, ACIAR, EC-STD3, INCO-DC, World Bank, FAO-UNDP,and the New Zealand Govenment), and to a minimum extent, private companies (Pilipinas Kao or PILKAO). PCA's direct budgetary support accounted for 40.04% of its research budget during the period 1992-1996 (Table 11). Its research budget grew by an average of 23.27% in the same period mainly because of external grants whose growth (79.45%/year) greatly outpaced that of direct budgetary support (17.39%).

As regards to the SCUs, it is difficult to obtain a complete database on the annual research budget for coconut alone because they do not record research expenditure by commodity. Nevertheless, the research budgets of three selected SCUs engaged in

Table 11. Public expenditures (in million pesos) for research and development of PCA and selected SCUs engaged in coconut R&D activities, 1992-1997.

YEAR	PCA			UPLB			VISCA			USM		
	General Funds[a]	External Funds[b]	Total	Regular Allot.	External Funds	Total	Regular Allot.	External Funds	Total	Regular Allot.	External Funds	Total
1992	28.56	2.03	30.59	87.32	74.25	161.57	17.33	11.09	28.42	9.29	2.16	11.45
1993	32.99	1.95	34.94	90.69	105.78	196.47	19.93	9.77	29.70	13.12	2.92	16.04
1994	38.72	5.35	44.07	76.73	142.03	218.76	19.25	7.05	26.30	8.62	7.23	15.85
1995	45.71	9.38	55.09	108.88	141.79	250.67	19.54	8.45	27.99	8.62	4.26	12.88
1996	54.23	16.14	70.37	123.69	99.30	222.99	23.81	7.50	31.31	9.41	3.93	13.34
1997	59.31	na		120.36	103.86	224.22	24.18	9.61	33.79	9.85	6.81	16.66
Average	40.04[c]	6.97[c]	47.01[c]	101.28	111.17	212.45	20.67	8.91	29.59	9.82	4.55	14.37
% Share	85	15	100.00	47.67	52.33	100.00	69.85	30.15	100.00	68.34	31.66	100.00
Growth Rate (%)	17.39[c]	79.45[c]	23.27[c]	8.26	10.24	7.41	7.30	-0.60	3.85	4.15	41.45	9.72

[a]Includes only the expenditure of the Agricultural R & D Branch. The figures for the Industrial R & D Branch were not given.

[b]Mainly from DOST, COGENT, ADB, PILKAO, GTZ, EC-STD3, INCO-DC,IPGRI & ACIAR.

[c]Only covers figures from 1992 to 1997.

Source: David et al, 1998

coconut R & D activities are presented in Table 11 to show the disparity in research budget allocation among these SCUs. On the average, UPLB's annual research budget (P212.45M) was almost five times higher than the combined research budget of VISCA and USM (P43.96M). In terms of sources of research funds, UPLB received the largest regular research budget allotment and external research grants while USM obtained the lowest budget. The capacity of an institution to generate a large chunk of funding for research regardless of source depends to a large extent on the availability and quality of its manpower and infrastructure facilities. Considering that UPLB has the strongest manpower and infrastructure capacities among the three SCUs, this might account for its having attracted the largest research budget. In view of the fact that Mindanao is a major producer of coconut in the country, there is, therefore, a need to strengthen USM's research manpower and upgrade its infrastructure facilities to improve its capability to attract more research funding especially for coconut research.

In contrast to the other two SCUs, external grants accounted for a higher share (52.33%) of UPLB's total research budget. Although USM generated the smallest research budget from external grants in absolute terms, it exhibited the fastest growth rate (41.45%/year) in terms of attracting external funds from 1992 to 1997, followed by UPLB (10.24%/year). On the other hand, although VISCA has the second strongest research capacity, its externally generated research funds decreased from P11.09M in 1992 to P9.61M in 1997, or by an average of .60% per year. UPLB's regular research budget allotment, likewise, grew more rapidly (8.26%/year) than that of VISCA (7.3%/year) and USM (4.15%/year).

The allocation of government funding for agricultural research across types of expenditures (i.e., personnel, operations, and maintenance, and capital outlay) partly affects the returns to agricultural research (David, et al., 1998). As shown in Table 12, the proportion of PCA's research expenditure for personnel services (62%) tended to be higher than that for its maintenance and operating expenses (36%) as well as for its capital outlay (2%). With regard to SCUs, the same pattern of research expenditure allocation was observed for UPLB and VISCA with personnel services accounting for 71 and 58% of their total research budget, respectively. According to David, et al. (1998),

Table 12. Distribution of average (in %) direct budgetary support for agriculture R & D, PCA and selected SCUs engaged in coconut R & D activities, 1992-1996.

AGENCY/SCU	PERSONNEL SERVICES	MAINTENANCE AND OPERATING EXPENSES	CAPITAL OUTLAY	TOTAL
PCA	62	36	2	100
SCUs				
UPLB	71	29		100
VISCA	58	42		100
USM	9	91		100

Source: David, et al., 1998

The agencies' response to the Salary Standardization Law resulted to the disparity in funds for salary against operational budget, which in turn, left research facilities underutilized and forced these agencies to attract external donors' support. Due to more reliance on external donor support, research projects that were conducted especially at UPLB were based on the research priority areas of the external donors. The opposite pattern was noted for USM. Owing to its fewer research personnel compared to the other two SCUs, USM's budget allocation for personnel services (9%) was much lower than its maintenance and operating expenses (91%).

3.2.2 Manpower Resources

The quality and the number of research outputs depend to a large extent on the availability and quality of human resources in various research institutions and SCUs.

The manpower resources in coconut R & D by institution/agency is presented in Table 13. On the other hand, the minimum manpower requirements for R & D capability in crops research which were set by PCARRD are shown in Table 14. Currently, PCA has a total of 64 researchers (PCA-ARDB, 49; PCA-PMDB, 15). PCA's research manpower is beefed up by four Ph.D. degree holders (i.e., one each in Soils and Plant Nutrition, Plant Pathology/Weed Science, Biochemistry, and Agricultural Engineering) and 31 M.S./MBA degree holders with specialization in various fields. It is apparent from Table 15 that PCA has more than met the minimum number of researchers with M.S./MBA degree, but lacks three Ph.D. degree holders to meet the minimum number of research staff holding a Ph.D. degree.

Table 13. Manpower resources in coconut R & D by institution /agency.

INSTITUTION	NUMBER
PCA	64
UPLB	116
VISCA	8
PSPC	31
ASCOT	13
SLPC	6
FNRI	5
PCRDF	11
TCA	6
USM	18
CLSU	2
ITDI	2
Total	282

Source: PCA

Table 14. Minimum manpower requirements for R & D in crops research.

R & D CENTER/DISCIPLINE	MULTI-COMMODITY				SINGLE-COMMODITY			
	Ph.D.	M.S.	B.S.	Total	Ph.D.	M.S.	B.S.	Total
A. National Research Center	8	11	11	30	7	10	10	27
Post Production or Seed Technology	2	3	3	8	2	3	3	8
Propagation/Production or Improvement or Plant Nutrition	2	3	3	8	2	3	3	8
Processing/Product Development	2	2	2	6	1	1	1	3
Crop Protection	2	3	3	8	2	3	3	8
B. Regional Research Center	6	3	3	12	1	3	3	7
Post Production or Seed Technology	2	1	1	4	1	1	1	3
Propagation/Production or Improvement or Plant Nutrition	2	1	1	4		1	1	2
Crop Protection	2	1	1	4		1	1	2
C. Cooperating Station	4	6	6	16		3	3	6
Post Production or Seed Technology	2	2	2	6		1	1	2
Propagation/Production or Improvement or Plant Nutrition	1	2	2	5		1	1	2
Crop Protection	1	2	2	5		1	1	2

Source: PCCARD, 1992

Table 15. Field of specialization of technical manpower at PCA as of 1999.

AREA OF SPECIALIZATION	NUMBER OF TECHNICAL MANPOWER			
	B.S.	M.S./MBA	Ph.D.	Total
Plant Genetics/Plant Breeding	2	3		5
Agricultural Chemistry/Chemistry/Biochemistry	6	3	1	10
Botany	1			1
Plant Pathology/Weed Science		5	1	6
Plant Pathology/Entomology		4		4
Entomology		4		4
Agronomy/Horticulture	6	2		8
Biology	1			1
Soils and Plant Nutrition			1	1
Ag.Engineering/Forest Products Engineering/ and Other Engineering Degrees	13	2	1	16
Agribusiness Management/Business Management	2	1		3
Agricultural Economics		1		1
Public Administration/Ag. Research Administration	1	1		2
Statistics/Biometry	1	1		2
Total	33	27	4	64

Sources: PCA-ARDB and PCA-PMDB

Table 16. Field of specialization of Ph.D. and M.S. degree technical manpower in crop research in selected SCUs engaged in coconut R & D activities, 1997.

AREA OF SPECIALIZATION	UPLB		VISCA		USM	
	M.S.	Ph.D.	M.S.	Ph.D.	M.S.	Ph.D.
Agronomy	19	4	8	4	10	6
Crop Science	8	30	3	6	2	2
Entomology	14	27	3	4	3	1
General Agriculture						
Crop Protection	111					
Horticulture	15	3	2	1	16	2
Plant Breeding/Genetics	11	29	5	7	5	1
Plant Pathology	13	24	3	4	7	2
Postharvest	1	5	2	3		
Soil Science	15	19	7	9	3	3
Seed Technology	2					
Weed Science	3	4	2	1		
Food Science	10	20	2	6		
Nutrition	9	3			1	
Agricultural Economics	20	18	4	3	5	2
Resource Economics		7	1			
General Economics	9	4		1		
Agribusiness Management	5		4		2	
Environmental Science	3	6	1		2	
Home Economics	5	2			1	1
Social Science	24	12	1	1		
Total	297	217	48	50	57	20

Source: David et al (1998)

In terms of specialization, the PCA has more experts (M.S. and Ph.D. degree holders combined) in Plant Pathology, Entomology, Engineering, and Chemistry-related fields (Table 15). PCA has three M.S. degree holders whose area of specialization is Plant Genetics/Plant Breeding and two in Agronomy and Horticulture, but has no Ph.D. degree holders in these fields. Moreover, it has only one expert each in Soil Science and Plant Nutrition and Agricultural Economics. The latter is based at the Zamboanga Research Center. Hence, the agency has no Agricultural Economist at the PCA Head Office nor in the other PCA research centers. Moreover, it has no Sociologist at the PCA Head Office and in all its research centers. This clearly shows the absence of highly competent Agricultural Economists and Sociologists at the PCA Head Office and in the other PCA research centers who can do a socio-economic evaluation of all technologies developed by the agency prior to commercialization. To further improve the agency's research capability, it is, therefore, critical that PCA should either recruit more technical experts (M.S. or Ph.D. degree holders) in Plant Genetics/Plant Breeding, Agronomy/Horticulture, Soil Science/Plant Nutrition, Sociology, and Agricultural Economics or focus its human resource development plan on graduate degree training of its existing research personnel in these fields.

As mentioned earlier, the SCUs which are actively engaged in R & D activities on coconut are UPLB, VISCA, and USM. A PCARRD-commissioned study conducted by the Research Management Center (1997) reported that among the SCUs, UPLB has the most number of technical experts and has exceeded the minimum research personnel requirement (Table 16). UPLB has 514 highly competent staff (297 M.S. and 217 Ph.D. degree holders) compared to 98 for VISCA (48 M.S. and 50 Ph.D. degree holders) and only 77 for USM (57 M.S. and 20 Ph.D. degree holders). Nevertheless, both VISCA and USM also met the minimum human resource requirement for research institutions. Compared to PCA, VISCA, and USM, UPLB has also more technical experts in all fields of specialization. It is noteworthy to mention, however, that generally, technical experts in the SCUs conduct researches on more than one commodity.

As shown in Table 13, the total number of researchers/faculty members working on coconut in the three afore-mentioned SCUs are as follows: UPLB, 116; USM, 18; and VISCA, 2. It is interesting to note that number of manpower complement working on coconut at UPLB far exceeded that of PCA despite the fact that the latter is the national coconut R & D center. This indicates that UPLB has the largest number of technical experts on coconut.

3.2.3 Research Facilities

The availability and the condition of research facilities also influence the operation of the R & D system or the conduct of research in various research institutions and SCUs. To determine the adequacy of research facilities, PCARRD established a set of minimum infrastructure requirements for its research network members. These are published in Book Series (BS) No. 11/1993.

RMC's study (1997) on the assessment of research facilities of the national and regional R & D centers engaged either in multi-commodity or specialized studies revealed that not even one of the research centers met the standard provision of 144- sq. m. per researcher. With the exception of IPB, experimental fields of all the research agencies were below the minimum standard; laboratory and communication equipment were inadequate; and greenhouses and storage rooms were in dire need of repairs. The study, however, did not cover research centers dealing with studies on a single commodity and on plantation crops. Hence, the assessment did not include PCA's research centers.

As shown in Table 17, all the PCA research centers (experimental fields) and coconut seed gardens met the standard provision of 144 sq. m. per researcher. PCA has the following research facilities: 1) plant tissue analysis laboratory; 2) entomological laboratories; 3) pathological laboratories; 4) virology and biochemistry laboratories; 5) tissue culture and embryo culture laboratories; 6) breeding and genetics laboratory; and 7) coco wood laboratory and processing workshop. However, these research facilities need upgrading.

As regards to the private sector such as PCRDF, the Foundation set up a central laboratory (e.g., with oleochemical laboratory and in-house tissue culture laboratory) manned by a pool of young scientists from various disciplines who were trained to conduct coconut researches. It has also satellite laboratories in various locations of the country (e.g., Kidapawan, Cotobato for its satellite project on sugar from coconut sap; VISCA in Leyte and MS Enverga University in Quezon for its satellite projects on makapuno embryo culture).

Table 17. Land area and manpower resources of PCA research centers And coconut seedgardens.

RESEARCH CENTER/ COCONUT SEED GARDEN	LAND AREA (Has.)	NUMBER OF RESEARCH PERSONNEL	MANPOWER RESOURCES[1]	LAND AREA PER RESEARCHER (Sq.m./researcher)	LAND AREA PER PERSON (Sq.m./person)[1]
Albay Research Center	63	6	43	105,000	14,651
Davao Research Center	189	18	74	105,000	25,541
Zamboanga Research Center	425.44	12	54	354,533	78,785
Coconut Seed Production Center	303		262		11,565
Campung Ulay Seed Garden	500		22		227,273

[1]Includes researchers and laborers.

Source:PCA

3.3 Review of Past and On-Going Researches on Coconut

3.3.1 Past Researches by Research Area and Agency

For the period 1988-1998, a total of 329 studies on coconut had been conducted by various government agencies, SCUs, and private institutions (Table 18). Most of these studies dealt on coconut processing (194), followed by crop production (71), and varietal improvement (32). Crop production research area covers the following sub-research areas: coconut-based farming systems, soil fertility management, weed control/management, mineral nutrition management, integrated pest control, and disease control. In contrast, there were only 23 completed socio-economic and marketing studies on coconut indicating that these research areas had been neglected in the past. A total of nine (9) studies dealt on other research areas such as environmental issues and the use of coconut in animal nutrition, among others.

PCA had the highest number (57) of completed researches among the government agencies undertaking research on coconut during the 10-year period under review. By research area, these were distributed as follows: crop production, 34; coconut processing and product development, 16; varietal improvement, 6; and marketing, 1 (Table 18). Regarding PCA's past researches on crop production, these focused on: sustainable coconut-based farming systems (e.g., coffee, corn, and peanut as intercrops); sequential coconut toddy and nut production in Laguna Tall variety and hybrid coconuts; integrated soil fertility management of inland coconuts including efficiency of trichoderma-activated compost fertilizers on coconut seedlings and response of hybrid coconut to organic and inorganic fertilizer application in four agro-climatic conditions of the Philippines; weed control management practices; mineral nutrition (e.g., chlorine nutrition in coconut and response of hybrid coconuts to increasing sodium chloride rates); integrated pest control against Rhinoceros beetle, coconut spike moth, white slug caterpillar, and rodents; and disease control (e.g., cadang-cadang and Phytophthora diseases) (Appendix Table 18). As regards its completed studies on coconut processing and product development including cocowood timber utilization, these were concerned with the design and fabrication of the coconut husk decorticating machine; development of an integrated charcoal kiln and hot air dryer; testing and evaluation of the modified furnace-type kiln dryer; sawmilling of coconut trunks; design and construction of cocowood houses; the efficacy of various wood preservatives on exposed coconut timber; utilization of coconut sawmill offcuts and slabs for parquet flooring; response of coconut timber to various locally available wood paints; evaluation of clear finishes on coconut wood; control of mold and stain on freshly-sawn coconut lumber; comprehensive evaluation of the gluability of coconut wood; aflatoxin control of copra; feasibility study on the establishment of processing plants for the production of methyl ester (diesel fuel) and base chemicals (medium chain fatty esters) from coconut oil; system optimization and field testing of coconut fast drying technology; development of functional food products from coconut flour; and the fresh-dry process of coconut oil and by-products processing. The latter study aimed to establish and develop a fully operational integrated coconut processing plant that could process the nuts produced into aflatoxin-free copra

Table 18. Number of completed researches on coconut by agency and research area, 1988-1999.

AGENCY	NUMBER OF COMPLETED RESEARCHES/STUDIES									
	Varietal Improvement	Crop Production[a]	Post Production/ Processing/ Product Development	Socio-Economics and Policy	Marketing	Coconut Processing and Marketing	Socio-Economics and Marketing	Crop Production, Processing and Marketing	Others	Total
Government Agencies										
PCA	6	34	16	-	1	-	-	-	-	57
FPRDI	-	-	13	10	-	-	-	-	-	23
ITDI	-	-	14	-	-	-	-	-	-	14
FNRI	-	-	5	-	-	1	-	-	-	6
DA-R4	-	3	-	-	-	-	-	-	-	3
DA-R5	-	1	-	-	-	-	-	-	-	1
DA-R6	-	1	-	-	-	-	-	-	-	1
DA-R8	-	1	-	-	-	-	-	-	-	1
DA-QAES	-	1	-	-	-	-	-	-	-	1
DA-BPI	-	-	1	-	-	-	-	-	-	1
SCUs										
UPLB	15	19	102	-	-	3	2	-	-	141
UPLB MS & PhD	2	6	11	2	-	-	-	-	9	30
U.P. Diliman	-	-	9	-	2	-	-	-	-	11
VISCA	7	2	-	-	-	-	-	-	-	9
USM	-	1	-	-	-	-	-	-	-	1
DSAC	1	-	-	-	-	-	-	-	-	1
Private Sector										
UCAP	-	-	7	-	-	-	1	-	-	8
PCRDF	1	2	15	-	-	-	-	-	-	18
RISE & WIST	-	-	1	-	-	-	-	-	-	1
ASCOT	-	-		-	-	-	-	1	-	1
Total	32	71	194	12	3	4	3	1	9	329

a Includes sustainable coconut-based farming systems, soil fertility management, weed control/management, mineral nutrition management, integrated pest control, disease control.

Note: Refer to Appendix Tables 18-29 for detailed listing of completed projects by agency and research area.

using the improved kukum dryer, good quality oil, and other by-products. On the other hand, PCA's completed studies on varietal improvement dealt with tissue culture of coconut, regional testing of promising coconut hybrids and cultivars, hybridization, and performance evaluation of coconut populations of various local and foreign origin. PCA-ARB's sole marketing study dealt with promotion and marketing of cocowood products.

FPRDI is another research agency which undertook studies on coconut wood utilization. Of the 23 completed studies conducted by the FPRDI for the past ten years, 13 were on the technical aspects of coconut wood utilization while ten (10) were concerned with the socio-economic aspects of coconut wood utilization (Table 18 and Appendix Table 19). The technical studies consisted of preservative treatment of coconut wood poles by the HPSD method; production and properties of cement-bonded board; cocowood design standards; development and evaluation of coco soft lumber core (blockboard) for furniture; effects of bleaches on the finishing quality of coconut and *tangile* for furniture and furniture components; coconut wood for power and telecommunications cross arm; lignin from coconut palm wastes as an adhesive for plywood; production of cocowood grocery pallets; improvement of the two-man rip saw; development of the composing jig for lumber core production and furniture components; and utilization of coir dust for water treatment and for removing heavy metal ions from solutions. The socio-economic studies included the following: feasibility study on the production of cocowood grocery product pallets; feasibility study on the production of coco lumber production (chainsaw FPRDI table saw tandem); socio-cultural dimensions of the coconut trunk utilization industry; delivery of the coconut wood lumbering technology; delivery of the wood treatment technology for coconut lumber and bamboo slats; delivery and utilization of the HPSD treatment technology for green round poles to electric cooperatives in Regions V and VII; transfer of some technologies on coconut wood utilization; analysis of pilot-scale production of cocowood grocery pallets; and situational analysis of Jordan Guimaras for the establishment of charcoal briquetting and other coconut-based industries.

ITDI, on the other hand, conducted 14 studies on coconut processing and product development primarily on non-food applications of coconut in the same period (Appendix Table 18 and Appendix Table 20). The use of oleochemicals as active ingredients in biocides, pharmaceuticals, the plastic industry, and the textile industry comprised the bulk of ITDI's R & D. The studies that were undertaken under this research area were: the synthesis of cocamine betaine; scale-up production of polyglycerol esters; production of polyglycosides; pilot plant production of oleochemicals for the plastic industry; surfactants from CNO; bench-scale production of amine oxide from coco-based chemicals; pilot plant production and application testing of alkyl phosphates as textile auxiliary from coco-based chemicals; scale-up production of triacetin from coconut oil derivative glycerol; synthesis of fourth generation biocides; application testing of medium chain triglycerides; lubricant additives from coco-based chemicals; R & D program on oleochemicals from medium chain fatty acids (C_6 -C_{10}) of coconut oil; and industrial applications of nata de coco.

Six nutrition-related studies on coconut were completed by FNRI from 1988 to 1998 (Table 18 and Appendix Table 21). These included the following: a "lahar" minicolumn test kit for aflatoxin screening of copra meal; micronutrient fortification of priority foods (Vitamin A in cooking oil); therapeutic effects of medium triglycerides in the management of diarrhea; reassessment of nutrient prevalence of cardiovascular diseases in the Bicol Region; and medium chain triglyceride intake and endurance test.

For the past ten years under review, the DA Regional Offices (i.e., Regions 4, 5, 6, and 8), DA-QAES , and BPI conducted a total of eight (8) studies on coconut, seven (7) of which were on crop production, specifically on coconut-based farming systems (Table 18 and Appendix Table 29).

During the 10-year period under review, no socio-economic studies were conducted by ITDI, FNRI, and the DA regional offices as well as BPI. Among these agencies, only FNRI conducted a marketing study.

It is interesting to note that for the past ten years, UPLB undertook a total of 141 studies on coconut (Table 17 and Appendix Table 22). This was more than the total number of completed studies conducted by PCA in the same period. Some of the studies, however, were commissioned by PCA or were undertaken by UPLB in collaboration with PCA. By research area, these studies are distributed as follows: varietal improvement, 15; crop production, 19; postproduction/processing and product development, 102; and socio-economic and marketing, five (5). It is, therefore, evident from these figures that UPLB's past researches on coconut were highly concentrated on postproduction/coconut processing and product development. Socio-economic and marketing studies were accorded the least attention.

UPLB's past studies on varietal improvement from 1988 to 1998 included the following: tissue culture of coconut, inbreeding, selection of outstanding coconut populations, and multi-location testing of improved varieties. To provide planting materials coming from high-yielding tall populations in support of PCA's replanting program, UPLB has been prospecting, characterizing, and evaluating existing coconut stands all over the country for the past three years (Coconut Research, Development and Extension Network, 1999). To date, UPLB has already recommended three open-pollinated local tall populations as sources of planting materials to PCA. On the other hand, UPLB's studies under crop production focused on coconut-based farming systems (i.e., multi-storey cropping under coconut; intercropping with vegetable legumes; and livestock integration), fertilizer trials, effect of using growth hormones on coconut, pest and disease control (e.g, against cadang-cadang, rats, and Lepidopterous pests), factors affecting the quality of immature coconuts during storage, and biophysical characterization of coconut communities in the Bicol Region and Quezon province. On coconut processing and product development, UPLB conducted the following studies: bio-conversion of coconut coir dust into bio-organic fertilizers; growth hormones extracted from coconut water; lipase catalyzed production of specialty fats and monoglyceride laurates from coconut oil; enzymatic interesterification of coconut oil for the production of methyl and ethyl esters; cross-linked beaded cellulose from nata de coco as matrix for dye-ligand chromatography; charcoal and activated charcoals from coconut husks; preparation of agricultural chemicals from coconut fatty acid; production of serum and alternative culture media using coconut water and egg yolk for mammalian cell cultivation; utilization of coconut shell in hardwood manufacture; production of volatile fatty acids from coconut water; production of agro-industrial chemicals from coconut oil; extraction of coconut rubberizing husk fiber; synthesis of new sucrose esters from coconut fatty acids; alcoholic beverages (wine and champagne) from coconut water and sap; bench-scale production of coconut oil and its by-products; demulsification of coconut cream by fermentation; fresh-dry method of cooking oil production; improvement of the Los Baños copra dryer ; production and utilization of nata; development of coconut milk beverage; effect of different additives on the behavior of processed coconut water; utilization of spent liquor of nata for vinegar production; development of coconut wet process at the village level; development of non-fermented coconut products; development of food products from coconut and coconut by-products; utilization of coconut protein isolates; effect of nitrogen level on the shelf-life of buko juice; pilot production of processed buko products; development of instant buko juice drink; development of new export quality food products from makapuno; standardization of processing method and evaluation of different packaging materials and storage conditions for powdered buko juice; effect of bulking agents nd carriers on the processing and stability of powdered buko juice; instant milk coconut extract; hydrolysis of copra meal for agriculture and industrial use; pilot scale production of dextran using coconut water; oil extraction from nata de coco scrappings; control of rancidity in coconut oil form wet processing; fabrication of fractionation column for the production of coco diesel and methyl esters; and monoclonal antibodies for rapid screening of aflatoxin-producing organisms in copra, copra meal, and other coconut meat products. The four marketing studies conducted by UPLB during the past ten years were as follows: marketing study for the cooking oil produced by the UPLB integrated coconut fresh-dry method; the world market for coconut: an economic analysis from the perspectives of the Philippines; marketing of coconut by small producer-groups in Southern Tagalog; and documentation of successful coconut production, processing, and marketing strategies in Luzon. The only socio-economic study conducted by UPLB during this period was on the economics of small ruminants in coconut production systems.

Aside from the researches conducted by UPLB faculty members, a total of 30 M.S. thesis and Ph.D. dissertation on coconut had been written by graduate students at UPLB (Table 18 and Appendix Tables 23-24). Of this total, 11 were on coconut processing/postproduction practices; six (6) focused on crop production; two (2) each on varietal improvement and socio-economics and marketing; and nine (9) on miscellaneous research areas (e.g., environmental issues, use of coconut in animal nutrition, etc.). The policy study on coconut was on the effects of government policies on welfare gains from rice, corn, and coconut research in the Philippines.

Since 1988, U.P. Diliman undertook a total of 11 studies on coconut distributed by research area as follows: nine (9) on coconut processing and product development and two (2) on marketing (Table 18 and Appendix Table 25). U.P. Diliman's researches in the area of coconut processing were concentrated on the physico-chemical characterization of coconut flour produced through the aqueous process; development/standardization and sensory evaluation of new recipes/products from nata de coco; piloting studies of new products from nata de coco; oleochemicals from coconut oil; synthesis of oleochemicals from coconut oil using fungal lipases; antigenotoxicity of coconut oil; determination of the structure of new glycerides from coconut oil; polyurethane plastics from coconut oil; and heteregenous photocatalytic synthesis of fuel alkanes from coconut oil fatty acids using solar energy.

From 1988 to 1998, the Regional Coconut Research Center at VISCA had a total of nine (9) completed researches on coconut, of which seven (7) were on varietal improvement; one on on-farm trials of promising coconut-based cropping systems in established coconut plantations; and one (1) on the utilization of organic fertilizer for banana grown under coconut (Table 18 and Appendix Table 27). Studies on varietal improvement dealt with the following: 1) breeding for improved varieties of coconut; 2) collection and characterization of local and introduced coconut cultivars/hybrids; 3) alternate bearing phenomenon in dwarf coconut cultivars; 5) development of self-pollinating and precocious makapuno-bearing palms using highly self-dwarf coconut cultivars; 6) rapid propagation of hybrid makapuno and 7) regional testing of promising coconut hybrids/cultivars..

Other SCUs which conducted researches on coconut were USM and DSAC. For the past ten years, these SCUs conducted only one coconut research each. USM's study dealt with intercropping under modified densities of mature coconuts in Kabakan, South Cotobato while DSAC's study focused on vitro-culture of makapuno embryo (Table 18 and Appendix Table 29).

The private sector also had its share of coconut research. For instance, UCAP conducted a 10-year project covering the period 1987-1997 entitled "Coconut Oil Research" which was jointly funded by NAFC-DA (P5.5 million) and a UCAP research grant from Harvard University (U.S.$ 500,000). This project focused on the medicinal uses of coconut oil. The project was composed of eight (8) sub-projects, namely: 1) production of structured lipids; 2) nutrition studies; 3) clinical studies; 4) animal studies; 5) production and testing of structured lipids (SL); 6) synthesis/production and testing of monoacylglycerides; 7) application research of monoacylglycerides and structured lipids on certain consumer products; and 8) pre-feasibility study on the production and market potential of structured lipids and monoacylglycerides (Appendix Table 27). As regards to the stressed animal studies, four experiments were conducted as follows: 1) survival rates of rats fed with coconut oil at 5%, 10%, and 20% of the total kcal daily for 30 days from two doses (lethal dose-20 or lethal dose-50) of *E. coli Endotoxin*-induced shock; 2) structured lipids feeding experiments on rats (SL 75:25; SL 85:15; and SL 90:10 vs. commercial feed); 3) survival rates of rats fed with 5% coconut oil from *E. coli Endotoxin*-induced shock; and 4) survival rates of rats fed 5% or 20% of coconut oil from *E. coli Endotoxin*-induced shock.

Among private institutions, PCRDF is the most actively involved in coconut research. From its research funds, the Foundation conducted a total of 18 coconut studies for the past ten years (Table 18 and Appendix Table 28). By research area, these were distributed as follows: varietal improvement, 1; crop production, 2; and coconut processing and development, 15. It can be gleaned from these figures that PCRDF's completed studies were concentrated on coconut processing and product development. The Foundation's study on varietal improvement dealt on tissue culture of makapuno while its crop production studies focused on interplanting schemes with teak tree and with Gmelina. The latter study was undertaken in collaboration with the MS Enerva University. Its coconut processing and product development studies, on the other hand, can be categorized into four sub-research areas, namely: food use, industrial use, agricultural use, and nutrition and medical applications. Specifically, these studies were as follows: acceptability of coconut milk in pandesal and loaf bread; characterization of dietary fiber component of coconut flour from sapal; crude sugar from coconut sap; salad dressing and sandwich spread from coconut cream; preservation of fresh coconut sap; study on the hydroponics using coconut coir as root anchorage; preparation of amphoterics surfactants from coco fatty amines and fatty acids; preparation of sugar alcohols from copra meal; coco methyl ester reactor; antimutagenicity of coconut oil; comparative study of coconut oil, soybean oil; and hydrogenated soybean oil; human tolerance test and bioavailability of monolaurin (in collaboration with PGH); plasma analysis of monolaurin; HIV test using monolaurin; and clinical studies on monolaurin. PCRDF and United Laboratories (UNILAB) formed a team of Filipino experts to conduct clinical studies in order to evaluate the efficacy, safety, and tolerability of monolaurin on persons with HIV at the San Lazaro Hospital. The clinical trial which was conducted by the San Lazaro Hospital was monitored and validated by UNILAB. According to PCRDF, the world's first therapeutic trial on the use of coconut-oil derived monolaurin for HIV treatment has yielded encouraging results (Alarilla, 1999). Monolaurin, a monoglycride derived from coconut oil, has exhibited antiviral action because of its ability to break down the protective coating or envelope surrounding tissues. The mechanism of coco-based monolaurin's effects shows the possibility of synergistic action when combined with antiretroviral drugs. This raises the possibility of a more economical HIV treatment compared to the recommended current practice of combining three to four antiretroviral drugs. The latter expensive combination therapy is estimated to cost half a million yearly.

PCRDF also funded the following studies conducted by a number of government and private institutions as well as private individuals to a limited extent: 1) varying levels of copra meal for lactating cows in early lactation (UPLB); 2) coconut tissue culture (UPLB); 3) FNRI endurance test (FNRI); 4) makapuno expanded field planting of UMAC-1 and UMAC-2 (VISCA-RCRC); 5) field planting establishment of embryo cultured makapuno in Region 8 (VISCA-RCRC); 6) sugar alcohol from coconut (Ateneo/PIPAC); and 7) modified copra dryers in Leyte and Samar (granted to private individuals).

In addition, RISE and WIST conducted a study on fresh coconut processing system while ASCOT implemented the Aurora Coconut Agro-Industrial Research and Development Program (Table 18 and Appendix Table 29).

In the 1980's, private coconut research, particularly on seed, was also given a boost by the government's decision that the seed of the dwarf hybrids should all be purchased from one company (i.e., Eduardo Cojuangco's company) (Pray, 1986).

Other private companies might have conducted their in-house researches on coconut. Much of the research results, however, were used exclusively by the company doing or funding the research.

3.3.2 On-going Researches by Research Area and Agency

A total of 178 on-going studies on coconut has been reported as of January 1999. By agency, PCA has the highest number of on-going studies on coconut (114) with ITDI (18), PCRDF (15), UPLB (10), VISCA (8), and FNRI (5) trailing behind (Table 19). The rest are presently conducting only one (1) to three (3) studies on coconut.

By research area, crop production receives the most attention with 70 on-going studies, followed by varietal improvement (54) and coconut processing and product development (54). This indicates that the main focus of on-going studies on coconut is on increasing coconut productivity and coconut production. Under the coconut processing and product development research area are seven (7) studies on nutrition and medicinal applications of coconut. Again, socio-economics, policy analysis, and marketing are the most neglected research areas in all public and private institutions doing research work on coconut. Presently, there are no on-going studies along these research areas.

Being the national R & D center for coconut, PCA has again the highest number of on-going researches with 114 studies (Table 19 and Appendix Table 30). The emphasis of PCA's studies are on crop production (62). Varietal improvement research area ranks second (39) while post-production/coconut processing and product development research area is given less attention as evident from the fewer on-going studies (13) along this research area..

PCA's on-going studies on varietal improvement include the following: collection and evaluation of coconut cultivars and conservation of genetic resources; hybridization of coconut populations of various local and foreign origin; coconut genotype evaluation in cadang-cadang affected area and breeding for disease resistance; production and utilization of selected planting/replanting materials in the Philippines; establishment of mini-seedgardens for the mass production of hybrid coconut seednuts for the replanting component of SCFDP; development of synthetic variety of coconut; determination of fatty acid, protein profile and triglyceride composition of promising coconut hybrids and cultivars (in collaboration with UPLB); action program on the adoption of suitable technologies with emphasis on coconut varieties and hybrids from the Multiloc Project; PCA-PKI Joint Project on coconut multi-location testing; farmer participatory research to identify multi-purpose uses of coconut and suitable varieties; studies on the embryo culture of coconut; clonal propagation of coconut using various explants; makapuno mass production; coconut tissue culture: optimization of protocols toward increased production of clones; collection, mass propagation, and conservation of "lono" type of coconut in the

Table 19. Number of on-going researches on coconut by agency and research area as of 1999.

AGENCY	NUMBER OF ON -GOING RESEARCHES			
	Varietal Improvement	**Crop Production[a]**	**Post Production/ Processing/Product Development**	**Total**
Government Agencies				
PCA	39	62	13	114
ITDI	-	-	18	18
FNRI	-	-	5	5
DA-R4	-	2	-	2
DA-BAI	-	1	-	1
SCUs				
UPLB	7	-	3	10
VISCA	6	2	-	8
USM	1	1	-	2
Private Sector				
PCRDF	1	2	12	15
UCPB-CIIF	-	-	3	3
Total	54	70	54	178

[a] Includes sustainable coconut-based farming systems, soil fertility management, weed control/ management, mineral nutrition management, integrated pest control, disease control.

Note: Refer to Appendix Tables 30-36 for detailed listing of on-going projects by agency and research area.

Bicol Region; and improvement of coconut biotechnology: and application of DNA marker technology to germplasm characterization and breeding, among others.

PCA's on-going studies on crop production, on the other hand, deal with mineral nutrition management (i.e., effects of annual and intermittent fertilizer application on young and bearing palms); integrated soil fertility management on coconut and various intercrops; combined irrigation and fertilization of young palms and existing stands with coconut-based farming systems under different climatic conditions in Mindanao; integrated contol of major pests (e.g., Rhinocerous beetle; slug caterpillars, mites, and mealy bug); integrated control of major diseases (Phytopthora disease and cadang-cadang); weed management; and sustainable coconut-based farming systems (i.e., varietal response of coconut local tall and hybrids planted with various intercrops to leaf pruning; sequential coconut toddy and nut production in coconut cultivars and hybrids; cattle integration under coconut; evaluation of nitrogen fixing trees as living poles for blackpepper under coconut; growth and yield modeling of coconut; and architectural modeling and radiative climate simulations for predicting productivity of coconut-based farming systems involving selected coconut hybrids in different agro-ecological conditions in the Philippines). The latter study is being conducted by PCA in collaboration with UPLB-FSSRI. On the other hand, PCA's on-going studies under coconut processing and product development are as follows: piloting and commercialization of the prototype coconut husk decorticating machine; design and fabrication of the baling press machine and the coir-woodwool cement board trimmer; production of coir-woodwool cement board decorticating machine, design and fabrication of coconut coir twinning machine; coir decortication and wallboard manufacturing in Davao Oriental; agro-industrial utilization of coir dust; pilot-testing and cruzesterification process in the production of biodiesel; assessment and improvement of existing dryer designs; development studies on alcoholic beverages such as coco wine and champagne (in collaboration with UPLB), and the fresh-dry method of coconut oil and by-products processing which basically uses an improved kukum dryer.

Presently, ITDI has 18 on-going researches (Table 19 and Appendix Table 31). The current focus of ITDI's research concerns is on coconut processing and product development especially on oleochemical production, health food and medicinal applications of coconut, coconut water processing, and modernization of coconut production processes and facilities for high-value products and by-products. Specifically, the on-going studies along this research area are pilot plant production of monolaurin from coco C_{12} fatty acid; pilot plant production of alkyl phosphate; laboratory synthesis of di-alkyl sulfo succinic acid ester from coco-based chemicals for use as wetting agents in the textile industry; pilot plant production of stearates; polyamide derivatives and silicon-based fatty acid ester for the textile industry; scale-up production of di-functional amides (di-ethelene bistearamide); scale-up production and application testing of monolaurin; scale-up production of TMP and PEE; enzymatic splitting of coconut oil; imidazoline derivative; alkyl glucoside; coco-amine betaine; MCT poduction and utilization; accelerated vinegar production; coco beverage powder production; coco water concentrate production; fast drying of coconut meat; and integrated coconut processing (wet process/wet-dry process).

To date, FNRI has five (5) on-going research studies on coconut focusing on its nutrition and health applications (Table 19 and Appendix Table 32). These include the study on the production and utilization of raw-fat coconut flour as functional foods and the study on the nutritional and health benefits of coconut fiber, legumes, oilseeds, rootcrops, and beans. The first study involves strong collaboration between FNRI and other institutions like PCA, ITDI, and the College of Home Economics at U.P. Diliman.

Two DA agencies, namely, DA-R-4 and DA-BAI have three (3) on-going studies that are primarily concerned with demonstration trials of coconut-based farming systems (e.g., cattle integration under coconut and intercropping with rambutan and lanzones) (Table 19 and Appendix Table 36).

As of 1999, UPLB has ten (10) on-going studies on coconut, seven (7) of which are on varietal improvement and three (3) on coconut processing and product development (Table 19 and Appendix Table 33). Studies under varietal improvement are as follows: improvement of coconut embryo culture efficiency for germplasm collection and conservation; identification and selection of outstanding tall coconut plantations and mother palms as future sources of planting materials; development of genome maps and genetic markers for coconut and mango using molecular marker technologies; development of gene constructs and appropriate transformation systems for the fatty acid modification of coconut oil; genetic diversity analysis of coconut talls using molecular markers; determination of fatty acid, protein profile, and triacylglyceride composition of promising coconut hybrids and cultivars; and identification and genetic variability characterization of causal organisms of bud and fruit rots in coconut. As regards to the progress of UPLB's on-going study on the characterization of PCA hybrids and promising local talls in terms of fatty acid profile and protein content, at least two PCA hybrids have already been identified to have higher lauric acid content than the existing varieties (Coconut Research, Development, and Extension Network, 1999). On the other hand, regarding UPLB's studies on the biochemical details of fatty acid synthesis, these are being conducted in collaboration with PCA to shed light on how these pathways can be modified in order to increase the synthesis of desired fatty acids such as lauric acid. Initial genetic studies will be conducted on how these genetic constructs can be incorporated into the coconut genome. These studies and the tissue culture studies on coconut regeneration are being undertaken simultaneously. In cooperation with COGENT, in vitro conservation studies are also presently being conducted by UPLB.

UPLB's studies on coconut processing and product development consist of the following: preparation and ultrafiltration and reverse osmosis membranes from nata de coco and their use in mango processing; enzymatic interestification of coconut and non-lauric oils for the production of specialty oils; and studies on the application of biotechnology-produced lipases on enzyme catalyzed synthesis of flavor esters of coconut oil-based products.

VISCA-RCRC, on the other hand, has eight (8) on-going studies on coconut distributed as follows: six (6) on varietal improvement and genetic conservation and two

(2) on cultural management practices (Table 19 and Appendix Table 34). The latter deals with the effects of planting depth on the growth and yield of coconut grown in hilly areas in Eastern Visayas and the improvement of abaca grown under coconut with the use of creeping legumes. On the other hand, on-going studies on varietal improvement and genetic conservation consist of the following: 1) screening of typhoon-tolerant coconut cultivars and hybrids; 2) mass production of self-pollinating makapuno hybrids through embryo culture; 3) establishment and maintenance of coconut genebank in VISCA; 4) characterization of local and introduced coconut cultivars/hybrids; and 5) assessment of the potential of coconut-based intercropping system as a tool for coconut genetic resources. It is interesting to note that the Center has no on-going research on coconut processing and socio-economic as well as marketing and policy studies. Except for the study on the breeding for improved varieties of coconut which was funded by PCARRD and the current study on self-pollinating makapuno hybrids through embryo culture which is being financed by PCRDF, all the other completed and on-going studies at VISCA were financed or are being funded by the University.

Compared to UPLB and VISCA-RCRC, USM has only two on-going studies on coconut, one of which is on varietal improvement (i.e., rapid propagation of makapuno) while the other one is concerned with coconut-based farming systems (i.e., verification trials of various intercrops under dwarf coconut) (Table 19 and Appendix Table 36).

Among the private institutions, PCRDF has currently the highest number of on-going studies on coconut totaling 15 studies (Table 19 and Appendix Table 35). By research area, these are distributed as follows: varietal improvement, 1; crop production, 2; and coconut processing and product development, 12. The latter research area is further subdivided into four sub-research areas, namely: food use with four (4) studies; industrial use, one (1) study; energy use, three (3) studies; and health and medical applications, four (4) studies. Specifically, the Foundation's on-going studies on coconut processing and product development include the following: coconut vinegar production from coconut sap; pilot testing of coconut sap into sugar; young coconut water development studies; product development for the use of makapuno; performance study on the use of methyl ester as 100% substitute for diesel; coconut methyl ester as fuel using various cuts/fractions; C_6-C_8-C_{10} for solid fuels; enzyme applications for oleochemicals; feeding program for malnourished children using structured lipids and monoglycerides; acceptability test for structured lipids; MCT and structured lipids for Filipino athletes; and anti-microbial and anti-viral studies using monoglycerides in collaboration with UNILAB.

With regard to varietal improvement, PCRDF has been doing research on makapuno embryo culture. Presently, its applied researches on crop production, however, are on field planting of embryo-cultured makapuno and lakatan-makapuno intercropping in Sorsogon.

UCPB is another private institution currently undertaking researches on coconut processing and product development specifically on the energy, health, and medicinal applications of coconut (Table 19 and Appendix Table 36). With funding from the CIIF, the three on-going studies of UCPB are as follows: anti-microbial, anti-viral, and anti-protozoal monoglycerides; anti-cancer property evaluation; and coconut oil and its derivatives as fuel substitutes.

3.3.3 Technologies Generated and Disseminated As Well As Constraints to and Consequences of Adoption

A substantial number of coconut technologies had been developed by various research and academic institutions as well as the private sector over the past ten years. Some of these technologies have already been commercialized and adopted while others are ready for commercialization or are still being piloted on a larger scale.

PCA has developed significant technological breakthroughs (Appendix Tables 37 and 38). The most notable one is the production of plantlets via tissue culture by the Tissue Culture Division of the PCA Albay Research Center using immature coconut flowers, buds or embryos (Coconut News Magazine, 1998). A non-destructive collection of immature inflorescence to conserve the source has also been developed. Hence, the Philippines now leads other Asia Pacific Community countries in coconut tissue culture, a new approach in the propagation of elite, high-yielding and disease-resistant palms. The growing of plantlets from flowers or buds is a radical departure from the traditional propagation using seednuts that are products of cross pollination. This technological breakthrough will allow rapid production of hybrid coconut seedlings for the replanting program of the country's coconut industry. A major problem that may arise from the distribution of plantlets from the PCA Albay Tissue Culture Laboratory is the possibility of producing plantlets infected with cadang-cadang disease due to the prevalence of this disease in the Bicol Region. It is, therefore, important that PCA should put up tissue culture laboratories in its other research centers and develop the research manpower needed to operate the new tissue culture laboratories or transfer some of its existing tissue culture experts from the PCA Tissue Culture Laboratory to the other PCA research centers.

After 15 years of study, nine (9) locally developed hybrids and one local tall (BAYT) were selected by PCA from the pool of 67 hybrids and cultivars established in 11 genetic trials at the PCA-Zamboanga Research Center genebank (PCA-ARDB, 1998). Among the coconut hybrids developed by PCA are the following: PCA 15-1 (CAT x LAG), PCA 15-2 (MRD x TAG), PCA 15-3 (MRD x BAY), PCA 15-4 (CAT x TAG), PCA 15-5 (CAT x BAO), PCA 15-6 (CAT x PYT), PCA 15-7 (MRD x PYT), PCA 15-8 (TAC x BAO), and PCA 15-9 (TAC x TAG). The coconut hybrids generally flower earlier (i.e., 3-4 years earlier from field planting) and bear fruits one to two years earlier than the local cultivars. These coconut hybrids have a potential yield of 16,000 to 22,000 nuts per hectare or about four (4) to six (6) tons of copra per year (Santos, et al., 1999). PCA-ZRC has established the world's largest coconut genebank and database of 120 populations. Under the Multiloc project funded by the DOST, PCA distributed a total of 363,042 seednuts of hybrids and selected coconut cultivars to small coconut farmers for planting/replanting in more than 1,000 hectares in 18 provinces located in Regions I, IV-A, V, VI, IX, X, XI, XII, CARAGA, and ARMM (Tababa, 1999). This project supports

PCA's Coconut Replanting Program. About 400 recipient coconut farmers were provided with technical assistance such as training on nursery management, cultural management, and intercropping practices. Moreover, coconut hybrids were also distributed to coconut farmers nationwide under the 7-year Small Coconut Farms Development Project. Under this project, one private and five PCA-operated seedgardens were established to serve as sources of planting materials. The seedgarden in Palawan was closed due to lack of funding. One of the problems encountered in the implementation of this project was the fact that the Coconut Development Officers (CDOs) themselves had a hard time identifying hybrids and inbreds like PCA 15-1 (Vargas, 1998).

A synthetic variety (Synvar) is currently being developed by PCA through the establishment of selfed lines which is the ultimate strategy in mass propagation of improved planting materials (Carpio and Manohar, 1997).

In addition, the embryo culture technique was further developed and modified by the PCA-Albay Research Center (Coco News Magazine, 1998). Compared to the traditional makapuno-bearing palms that can yield only 2-25% makapuno nuts per bunch, embryo-cultured palms can now produce 75-100% makapuno coconuts (PCARRD, 1998). These research efforts gave birth to the Makapuno Comprehensive Technology Commercialization program, a joint program of PCA, DOST, and PCARRD which was conceived in 1996 in recognition of the importance of makapuno in increasing farmers' income and its potential as a new non-traditional coconut export product. Through this program, more makapuno seedlings will be mass propragated and made available to the public. The program resulted to the establishment of six satellite laboratories at the PCA-Davao Research Center, PCA-Zamboanga Research Center, Cavite State University, PCA-Pangasinan, PCA-Tacloban, and PCA-Albay Research Center (Coco News Magazine, 1998). These laboratories include demonstration farms to showcase makapuno farming. The PCA-Albay Research Center serves as the mother laboratory that provides training and technical assistance to the satellite laboratories and interested clients (PCARRD,1998). As of 1998, the satellite laboratories established one-hectare demonstration farms to showcase the potentials of a makapuno plantation to be able to sell makapuno seedlings at affordable prices this year. Aside from the establishment of the laboratories, a survey, covering 33 provinces of the existing makapuno population in the country, was also conducted (PCARRD, 1998). Results of the survey revealed that there were 20,000 makapuno seedlings in the country as of 1998, the majority of which were located in Batangas, Laguna, and Quezon.

PCA researchers also developed a new scheme for increasing productivity. Researchers at PCA in its Davao and Zamboanga Research Centers found that coconut productivity could be increased using the sequential coconut toddy and nut production (SCTNP) technology (PCARRD, 1998). The SCTNP technology involves the tapping of the first half of the spadix for sap or 'tuba' and allowing the remaining half to produce either eight-month "buko" nut (young coconut) or the matured 12-month nut. "Tuba" can be served fresh (chilled) as a drink or processed into vinegar. Vinegar from coconut is natural and has high acetic acid content that is comparable with commercially or artificially produced vinegar. It was reported by Dr. Severino Magat of PCA that the experience of farmers in Davao showed that this technology is feasible and productive. He added that it can also give farmers higher net profit than nut production alone. Based on three years production, the "Laguna tall" produced an annual net income of P50,000 to P70,000 using the SCTNP scheme while net income from nut production (NP) was estimated at P5,900 per year only. The reason why SCTNP is more profitable to use is because a farmer need not wait for the nuts to mature in order to earn income. Harvesting sap or toddy could yield immediate income for a farmer. Thus, coconut farmers can immediately earn income from their coconuts while the inflorescence is still close and female flowers are still developing. Thus, the technology assures year-round income for the coconut farmers from coconut toddy and nuts. Furthermore, the SCTNP technology does not affect the yield of coconuts because at harvest time of the sap, the female flowers are not yet developed. This technology is widely suitable in tuba-producing areas such as Southern Luzon, Bicol, Visayas, and Mindanao where skilled laborers for sap production or toddy tapping are readily available.

Researchers at the PCA-Zamboanga Research Center also developed and commercialized a coconut husk decorticating machine to make production of coir fibers and dusts easy. The machine costs P80,000 for small coconut farmers and P150,000 for entrepreneurs and commercial establishments (PCARRD, 1998). Fibers produced by the machine are mixtures of long (12.7 cm or more) and short (6.35 cm to less than 12.7 cm) fibers, including fibers less than 6.35 cm. The researchers reported that such quality is considered acceptable in the manufacture of coir-wood-cement board (CWCB). Financial analysis on the production of coir fibers and dusts using the machine shows that the project is profitable, indicating a benefit-cost ratio of 1.17 and an internal rate of return of 25.83%. The investment can be recovered in 1.23 years of operation assuming that all the coir products are absorbed in the market.

Other PCA-developed technologies which have already been commercialized are as follows: 1) the use of common salt (sodium chloride) as an effective and cheap fertilizer for coconut; 2) average fertilizer combination (ammonium sulfate plus KCl) to correct N, S, K + Cl; 3) biological control of coconut pests; 4) integrated pest management in coconut-based farming systems; 5) coconut intercropping systems in coconut-based farming systems; 6) coconut leaf pruning; and 7) kukum dryers (PCA-ARDB, 1998).

The PCA's Timber Utilization Division likewise came up with significant breakthroughs and viable technologies on coconut wood utilization such as in the aspects of logging of coconut palms (e.g., wood quality evaluation of different varieties of coconut), cocowood seasoning, drying, and treatment, cocowood preservation, and downstream processing (e.g., glue-laminated timber, design and fabrication of cocowood furniture component) (Carpio and Manohar, 1997). PCA is also proposing to the Department of Public Works and Highways (DPWH) to field test the use of coco fiber pads for infrastructure construction and civil works. On the hand, technologies on the production of coco wine and champagne from coconut water are presently being piloted by PCA.

To commercialize coconut technologies, PCA conducted training programs to various clientele and also developed eight home pages for eight (8) technologies which include hybrids, makapuno, SCNTP, and decorticating machine, among others (PCA, 1998). Moreover, some of the technologies (e.g., coconut hybrids, fertilizer recommendations, kukum dryers, and coconut intercropping) were introduced by PCA to farmers through its coconut development/production programs.

On the other hand, the FPRDI has developed and commercialized the following coconut wood utilization technologies (FPRDI, undated and Appendix Table 39):

1. <u>High pressure sap displacement (HPSD) treatment of coconut trunk for utility poles</u> - The High Pressure Sap Displacement apparatus is a portable treating machine designed for treating freshly cut poles of coconut trees, either in the cutting area or in any designated place convenient to the user. The HPSD works by forcing out the sap from the living sapwood of a freshly felled tree using a water-borne preservative solution. The HPSD apparatus is very easy to operate, with low maintenance cost and requires shorter treatment time but with a deeper preservative penetration in the wood. Its investment requirement is P120,000.

   Traditional hardwoods used for utility poles are getting scarce. Hence, freshly cut coconut trunks are used as power and telecommunication poles and service drops in the remote areas of the country.

   The technology has been adopted by the Agri-Aquatic Resources and Development Inc. (AARDI) in Calaug, Quezon and by Meralco. In its search for an alternative method in preserving cocopoles, Meralco considered the HPSD technology developed by FPRDI in treating freshly cut timbers with chromated-copper-arsenate (CCA) solution (Buhain, 1997). The experiment which was jointly undertaken by Meralco and the FPRDI in mid-1990 revealed that this method was applicable to coconut timber. In view of this, Meralco embarked on a wide-scale use of HPSD-CCA treated cocopoles in its Rural Electrification projects. Meralco provided the logistical support while the FPRDI provided the technical assistance. The workers were trained by the FPRDI experts before they were allowed to treat. Meralco purchased a 6-cap. HPSD equipment set-up from the FPRDI. Meralco reported that 82% of the CCA-HPSD treated cocopoles are still standing after six years. After careful evaluation of the experiments and pilot installations using the HPSD technology, Meralco concluded that cocopole is an acceptable substitute for wood pole as electric distribution pole.

2. <u>Chainsaw-table saw lumbering system</u> - In 1987, the FPRDI developed the chainsaw-table saw cocolumber processing system and piloted it in Southern Leyte and San Pablo City, Laguna in 1988 (Natividad and Alcachupas, 1997). The processing system involves felling/bucking of coconut trunks by chainsaw; log breakdown or conversion of the log into flitches by chainsaw at the cutting site to facilitate handling and transportation of raw materials; and resawing the flitches to required lumber sizes

using a portable table saw (equipped with carbide-tipped blade) along roadsides or stationary table saw in lumber yards/shops.

The chainsaw- table saw lumbering system is one of the most efficient processing techniques in cocolumber production. The system was designed to meet the needs of cocolumber processors in the rural areas. The chainsaw-table saw cocolumber processing system has the following outstanding features: 1) it requires relatively skilled labor and lower investment cost than the traditional sawmilling system; 2) it produces higher lumber recovery and quality compared to pure chainsawing because the table saw (equipped with carbide-tipped blade) provides an efficient equipment for resawing coconut fltiches to required lumber dimensions; 3) the operation involves portable to semi-portable processing system; and 4) the operation conforms well with the rural setting (i.e., generally poor accessibility of coconut plantations by motorized vehicles and dispersed sources or uncertain long-term log supply from a particular area) (Madrazo and Juson, 1983).

The pure chainsawing method which is commonly used in the Philippines for cocolumber processing is being discouraged due to low lumber recovery (25-30% of log gross volume) caused by wide saw kerf (10-12 mm) and low lumber quality (rough surface with high variation of thickness and width) (Natividad and Alcachupas, 1997). In contrast, the chainsaw-table saw cocolumber processing system entails about 38-46% recovery of better quality lumber depending on the sizes of the lumber output.

The technology was commercially adopted since 1989 by the Quezon Lumber Co. in Lucena City, Quezon; the Daraga Agribusiness Venture, Inc.in Daraga, Albay; the Rances Construction Enterprises in Bagaucay, Tinambac, Camarines Sur; and the MCB Construction and General Services in Sta. Rosa, Laguna (Natividad and Alcachupas, 1997). To date, it is being used by Alwyn Enterprises in Pitugo, Quezon and by hardware business entreprenuers in Laguna (e.g., Los Baños, Bay, Sta. Cruz, and San Pablo), Quezon, and other provinces in the Philippines.

Lumber produced from coconut trunks can be utilized as a raw material base for house construction, furniture-making, and other wood products-based ventures. The total investment requirement of the chainsaw-table saw lumbering system is P1,175,720.

The Alwyn Enterprises, the latest adoptor of the technology, has various outlets of cocolumber (Natividad and Alcachupas, 1997). The company supplies an average of 51,000 board feet (bd ft) a month to different construction sites and hardware in Metro Manila, as well as in the provinces of Bulacan, Nueva Ecija, and Pangasinan. It also supplies raw materials for making cocopallets to the Pallet Resources Corporation.

At present, a significant volume of cocolumber is used in the construction industry (i.e., scaffoldings, form lumber, etc.) (Natividad and Alcachupas, 1997).

However, there are some new emerging cocowood-based industries other than handicrafts (Kilian, 1997). For example, Cocowood of the Philippines, a company based in Tacloban City, Leyte, is engaged in the production of coconut T & G flooring and S & V-cut panelling while another company in Cebu City is reportedly producing coconut furniture for export. Considering the emergence of some new cocowood products which require high quality cocolumber, it is expected that the chainsaw-table saw processing system will gain more acceptance among the small-scale cocolumber processors in the country (Natividad and Alacachupas, 1997). Moreover, cocolumber has a great demand in the export industry as frames for boxes (Dimaano, 1997). It is also used as bases for mirrors, picture frames, and shell products.

However, a drawback of the technology's application in the rural areas is the use of the carbide-tipped blade for the table saw (Natividad and Alacachupas, 1997). This is required to counteract the rapid dulling of cutting tools in sawing coconut wood. Unfortunately, the facilities for the sharpening and retipping of the blade are available only in the urban centers. Spare blades are needed for the continuity of the resawing operation.

3. Cocowood grocery pallets - Pallets are generally used in almost all commercial manufacturing (foods, drugs, chemicals, etc.) and industrial production process. It is basically used for unitized handling system which reduces handling operation activities to a minimum and facilitates delivery of goods which are handled by a variety of mechanical equipment such as lift trucks, conveyors, booms, and slugs. Pallets provide the foundation upon which to assemble loads. Based on research at the FPRDI, coconut wood has been proven to be a suitable material for fabricating pallets.

   Production of grocery pallets from cocowood was also found to be very economical. Better quality and durable pallets can be produced at lower costs using cocowood materials that are comparable to t*angile* and other commercially used species. They even exhibited a longer service life indicating greater efficiency. The component parts of a cocowood pallet consist of edgewood and stringers which can be fabricated depending on the dimensions specified by the ordering clientele. The investment requirement depends on the desired volume.

   Three local companies have been engaged in cocowood pallet manufacture since 1991 (Villavelez, 1997). These are: 1) the CFB Inc. in San Pablo City; 2) the Pasajol Woodcraft also in San Pablo City; and 3) the Philippine Pallet Resources (PPR) whose plant site is located in Bacong, Ilaya, General Luna, Catanauan, Quezon Province. The PPR caters to the pallet needs of all pallet-using industries.

   Present domestic users of cocowood pallets are the following: B-MEG, San Miguel Corporation; Francisco Motors Corporation; Fujitsu Ten Corporation; Energy Stewards; Resins, Inc.; Ever Electrical Manufacturing Corp.; Ashida Phil. Grating

Co., Inc.; Amkor/Anam Pilipinas; SC Johnson and Sons, Inc.; PEMCO; BASF Coatings and Inks, Inc.; Vita Color; and RoGenerix.

4. Cocowood-based wares and cocowoodcraft - Cocowood wares and cocowoodcraft technologies were developed by the FPRDI because of the increasing cost and diminishing supply of traditional wood species. Cocowood can be processed into various fabricated products from housing components to wares and novelty products (e.g., jewelry boxes, flower vases, pen holders, etc.) using simple machines and equipment operations.

   Researches at the FPRDI have proven that cocowood is: a) 50-75% cheaper than the traditional wood; b) has very good to excellent machining properties; c) can be processed using simple machines with special blades (i.e., carbide tipped saws); and d) can make finished products that display a unique appearance. Cocowood also absorbs lacquer easily. Hence, the use of sanding sealer is required to improve the aesthetic value of the finished products. Cocowood wares are known not only in the Philippines, but also abroad. Although these products can compete in both local and foreign markets, most manufacturers target the latter. The investment requirement varies depending on the desired volume. The Davao Ethnokraft Design, a cocowoodcraft manufacturing company located in Davao City, is already selling domestically and exporting coco woodwares or novelties for gifts, housewares, and house and office decors abroad.

5. Charcoal briquetting from coconut shells and husks using the FPRDI mechanical briquettor - Charcoal briquetting is the process of converting ground charcoal or charcoal fines into compact form of fuel with the addition of binder and application of pressure to produce the desired uniform-sized product called charcoal briquettes (Pulmano, 1997). As a form of fuel, briquettes have the advantage of having more heat content volumewise such that it is convenient to handle, being more compact and uniform in size. Compared to ordinary charcoal, charcoal briquettes are also easier to ignite, almost smokeless, and hence more economical.

   The FPRDI mechanized briquettes, a rotary type model, was designed to convert charcoal fines with particle size passing 40 mesh produced from coconut husks or shells to charcoal briquettes. This has an accompanied charcoal binder mixer and a briquette dryer. The briquetting equipment is capable of producing two tons of briquettes per 8-hour operation. About four tons of raw coconut shells or husks are needed to produce one ton of carbonized material. The briquetting plant will require a minimum of six laborers to operate.

   The FPRDI mechanized briquettor was envisioned as an alternative to the very expensive imported briquetting machines. The FPRDI-developed briquetting equipment is about 75% cheaper than the imported one. Its investment requirement is P917,100.

This technology has enabled small-scale investors to engage in the charcoal briquetting business. The current major user of the FPRDI mechanized briquettor is the AUSUR Manufacturing Inc., in Talisay, Tiaong, Quezon.

Poultry raisers are currently the number one users of charcoal briquettes as heaters for chick brooding. The U.S., Europe, Japan, Korea, and Malaysia have also great demand for charcoal briquettes.

6. Composing jig for the production of coco panels for furniture - Technology on the production of coco panels through the use of a composing jig was designed by the FPRDI for small-scale manufacturers of furniture and novelty items (Bauza, 1997). One drawback in the use of cocolumber in furniture making is its narrow width. This is because during sawing, the trunk has to be turned several times to obtain a lumber of uniform density since density variation is very large from the central zone to the peripheral zone. To fully maximize coconut lumber as a furniture component, this may be formed into wide panels by edge gluing the lumber narrows. Edge gluing can be done with the aid of a composing jig, an equipment which can be operated manually or automatically. With the use of the composing jig, lumber narrows can still be used in furniture making instead of just being used as firewood.

   Two composing jigs designed at the FPRDI were fabricated and service-tested at the plant of Jermond International, Inc. in Zamboanga City (Bauza, 1997). One design was an A frame-like structure made from *Apitong* lumber fastened to each other with bolts. Pressure was supplied by means of an inflated water hose canvass by pressing operated press where a hydraulic jack supplies the pressure. The other design was a hydraulically-operated press where a hydraulic jack supplies the pressure. The A-frame composing jig could produce coco panels with a maximum size of 1.2m x 1.5m while the hydraulically-operated composing jig could produce panels with a maximum size of 1.0m x 1.0m. Panels were made by edge-gluing lumber strips using polyvinyl acetate glue. Pressing was done with the use of the composing jig. Panels produced were made into trays, medicine cabinets, slim chests, and other products exported to other countries. The composing jig proved to be very useful to the company since the equipment increased the production of composed panels.

   Based on the feedback from Jermond International, Inc., the A-frame laminating jig is easy to use (Dimaano, Jr., 1997). The pressure applied is consistent. Long or short pieces of wood can be laminated. Unlike the A-frame composing jig, the hydraulically-operated composing jig has a higher production capacity. Its advantages over manual composing are as follows: 1) the pressure applied on the wood can be measured and consistency can be maintained. The disadvantage of this jig is that it is relatively more expensive (P50,000). Furthermore, tightening the nuts and the clamps is a tedious process. Jermond International, Inc. suggested that the jig can be further improved if it can be redesigned such that it would be faster and easier to clamp and tighten the pieces of wood being laminated.

However, the use of coconut lumber alone as raw material for furniture making is still unacceptable to the company due to the following reasons: 1) coconut wood is difficult to machine; 2) it dulls blades of woodworking machines because of its silica content; 3) its dark color is another drawback because the market prefers light-colored panels; 4) coconut lumber for furniture has low tensile strength and coarse grain; 5) the hardness of the wood is uneven; and 6) coconut lumber is difficult to paint and smoothen ((Bauza and Dimaano, Jr., 1997).

According to Mr. Benjamin Dimaano, Jr., the manager of Jermond International Inc., the use of coconut lumber in furniture export has a bright future. Coco lumber is cheap, readily available, and beautiful when varnished. To remedy the problem of low tensile strength, he said that coco lumber can be combined with other wood with high tensile strength such as *lauan*. Combining coco lumber with other wood could cut raw material cost by at least 15 %.

Coco veneer laminated panels - The FPRDI developed the technology on the production of coco veneer laminated panels and introduced this technology to Fancy Panels Enterprises, Inc. located in Davao City in late 1996 (Calolot, 1997). Due to the disappearing supply of Narra veneer laminated panels, the company looked for other substitutes of the renowned Narra veneer laminated panels. The basic manufacturing processes are: 1) preparation and cooking of coco fletches; 2) slicing of coco veneer; 3) lamination over regular plywood; and 4) sanding and finishing. The company produces two kinds of coco veneer panels: 1) regular size (5.5mm x 4 x 8) and 2) others (4.5mm x 4 x 8).

The coco veneer laminated panels are commercially sold by the company in Region 11 (Calolot, 1997). These are mainly used as decorative panels in housing, decorative materials for house and office furniture, and personal accessories such as brief cases. The target markets of the company are the medium-cost and socialized cost housing units. In the medium-cost housing units, coco veneer panel usage ranges from 10 - 20 panels per unit while for the socialized housing units, it is 5 - 8 panels per unit. Considering the low prices and the aesthetic value of the coconut veneer panels, the homeowners find it a good substitute because it is relatively cheaper or affordable than Narra plywood and imported decorative panels. As of 1997, the following were the wood panel prices:

Narra plywood - P550 per 5 mm panel
Imported Decorative Panel - P440 per 5 mm panel
Coco Veneer Laminated Panel - P350 - P370 per 5.5 mm x 4 x 8 panel

The company's production cost in the same year was P252.50 per 5.5 mm x 4 x 8 panel (Calolot, 1997). The cost of coco wood veneer was only 5% of the total cost while the processing cost accounted for 18%. The bulk of the cost was the regular plywood. The company reported that the coco veneer panel business was profitable with a return on investment (ROI) of 23% and a payback period of 4.5 years. The total investment cost (machine, equipment, and infrastructure) directly related to the coco veneer product line amounted to P12 million.

Although coco veneer is simple to manufacture, the Fancy Panels Enterprises, Inc. reported the following manufacturing problems (Calolot, 1997):

1) Difficulty in procuring high quality raw materials - The consistency of grain texture and color (tiger suit) of the coco veneer panels cannot be formally established since the maturity and age level of the batches of coconut trees vary. Thus, the quality of the final product is not consistent since its color and texture are not uniform. Moreover, the second butt has a low recovery since this is relatively softer.

   In addition, the practice of using nails to anchor clothes lines by wives of coconut farmers results in the high risk of nails being embedded in the coco fletches. This imposes unnecessary cost in slicing the coco fletches. Moreover, it is ironic that a 25 centavos worth of nail can excessively damage a P20,000 worth of slicer knife.

2) Extreme care required in handling the coco veneer materials - The coco veneer materials require extreme care in handling. They are highly susceptible to tearing, shredding, breakage, and splits. The handling of the veneer materials requires extra care from workers who are used to casual handling of the other product lines such as plyboard and plywood.

To disseminate the coconut wood utilization technologies developed by the institute, FPRDI conducts training programs upon request of the clientele at the field/factory level and distributed copies of its brochure/leaflet entitled "Coconut Wood Utilization Technologies for Commercialization: A Shopping Guide". Travel expenses of the FPRDI training personnel are shouldered by the requesting parties.

Apart from the afore-mentioned commercialized coconut wood utilization technologies developed by the FPRDI, the institute also developed coir dust resin to remove lead or heavy metal ions from waste water or solutions (Manas, et. al., 1992). The problems of coir dust disposal and industrial waste water containing heavy metals led FPRDI to develop a cation exchange resin from coir dust (Moran, et. al., 1997). Coconut coir dust was converted to cation exchange resin by condensation reaction with formaldehyde with heat and acid. Formaldehyde and sulfuric acid used in producing the coir dust resin are available from local manufacturers. The yield of resin obtained was 89%. Cation exchange resins are insoluble materials capable of exchanging positive ions from solutions.

This technology offers a method of removing pollutants from the coir industry and the automotive battery manufacturing industry (Moran, et. al., 1997). The cation exchange resin from coir dust is initially targeted for the automotive battery manufacturing industry which generates lead-contaminated waste water. As a cheaper method of water treatment, this technology offers a lower initial capital investment than the system currently used by big industries. It is also a cheaper substitute to imported synthetic cation exchange resin. Coir dust resin costs US$3/kg while commercial resin costs US$10/kg. Based on the financial analysis conducted by FPRDI researchers, production of coir dust resin was financially viable. Other potential markets for the cation exchange resin are the leather tanning industry, gold mining industry, and the boiler-using industry.

This technology was piloted by FPRDI at the plant of the Constant Manufacturing Co., an automotive battery manufacturer (Moran, et. al., 1997). Results of the pilot experiments showed that coconut coir dust was very effective in removing lead ions from waste water of this company. However, installation of additional water pumps was necessary to facilitate the treatment process. The percent removal of the lead ions was 94%. The final lead content was .5 ppm compared to an initial lead concentration of 8 ppm.

To date, this technology has not yet been commercialized on a wider scale. A major limitation in using coir dust resin is its bulkiness. Coir dust resin is a bulky material which requires more space for storage and higher treatment column (Moran, et. al., 1997).

For the past ten years, the ITDI-DOST developed 13 coconut technologies which have industrial uses, but 11 of these technologies still need economic evaluation to determine their economic viability prior to their commercialization (Appendix Table 40). These include the following: 1) amino betaine C_8-C_{14} from fatty amines and amphoteric surfactants, a new product based on coco-based chemicals; 2) process for the production of polyglycerol esters at the scale-up level; 3) alkyl polyglycosides from fatty alcohols and glucose; 4) process for the production of poly esters, namely pentaerythritol ester at a scale-up level; 5) surfactants from crude coconut oil for the production of detergents and shampoos through sulfation and phosphorylation reaction of coco fatty alcohols; 6) amine oxide on bench-scale from coco-based chemicals; 7) technology for the production of selected textile auxiliaries from coconut oil-based chemicals, lauryl alcohol, for commercial production; 8) local technology for the production of triacetin from coconut oil derivative glycerol; 9) technology on the synthesis of four generation biocides using coconut fraction; 10) technology on the application testing of MCTs for food application and purification of structured fats; and 11) lubricant additives from coco-based chemicals. ITDI also submitted a sample of the amine oxide from coco-based chemicals to a private company for application testing of the oxide as textile softener and as a secondary surfactant for detergent and shampoo. With regard to the technology on MCT manufacture, there is a need to promote this technology to local industries if found economically profitable. Technological breakthroughs in MCT manufacture would greatly benefit the country since this would facilitate the development of the local MCT industry that can supply specialty fats or MCTs in the world market. The development of the MCT industry in the country, in turn, will increase local demand for crude coconut oil. MCT is now increasingly used in medicinal foods, infant feeding and formulas as well as other products where quick high calorie energy is needed by patients. MCT has more than twice the calorie density of protein and carbohydrates.

ITDI-DOST also developed the cold process in soap-making. This technology has been disseminated by DOST through its regional training programs and through the distribution of leaflets/booklets describing the cold process procedure. Coco soap production employing the cold process is now practiced in several provinces in the country such as Quezon, Laguna, and Davao del Sur, among others. Another coconut technology developed by ITDI which is ready for commercialization is the technology for processing nata de coco into biopolymer. This is an industrial non-food application of nata de coco.

Excluded from the list of ITDI-developed and commercialized coconut technologies is the technology on the pilot plant production of derived oleochemicals for the plastic industry since it still needs further technical evaluation. Hence, this technology is not yet ready for commercialization.

On the other hand, one of the two technologies developed by FNRI from 1988 to 1998 has already been commercialized (Appendix Table 41). FNRI developed the local fortification of Vitamin A in cooking oil wherein the process is done in a closed system with very minimal presence of oxygen to minimize the degradation of Vitamin A. This technology has been successfully transferred to the San Pablo Manufacturing Corp., which is now selling *Minola Edible Oil* fortified with Vitamin A in the local market. Another coconut technology developed by the Institute which is now ready for commercialization is the "lahar" minicolumn test kit for aflatoxin screening of copra meal.

Among the SCUs, UPLB has the most number of coconut technologies developed. Of the 16 coconut technologies developed by UPLB researchers, 12 have already been commercialized, three are being piloted, and one is for fabrication. (Appendix Table 42). The coconut technologies which have been commercialized by UPLB researchers include Cocogro, dehydrated edible coconut meat (DECM), mannannase-treated copra meal, coconut milk yoghurt, coconut filled white soft cheese, coconut water vinegar production, nata de coco, tissue cultured makapuno, embryo cultured makapuno, integrated coconut processing (Los Baños fresh-dry methods including the Los Baños multicrop dryer), expeller for extracting oil from sapal, and method of controlling rancidity in coconut oil from wet processing. Some of these UPLB-developed coconut technologies which have already been commercialized are discussed further below.

Cocogro, which is a natural product containing plant growth hormones/regulators present in coconut water or coconut milk was developed by a researcher at BIOTECH, UPLB. It enhances and promotes plant growth and development. It also increases root proliferation, shoot development, bud formation, and early flowering. Cocogro can be applied on vegetables, legumes, fruit trees, cereal crops, ornamentals, flowering plants, anthuriums, and orchids. It is more effective than synthetic growth hormones in tissue culture of orchids. As of October, 1998, it has been commercialized by BIOTECH at P62.50 for a 125-ml bottle and P125 for a 250-ml bottle. Information about this technology is being disseminated by PCARRD through the publication of *Information Bulletin Series/Leaflet No. 110a/1998* (PCARRD, 1998).

Apart from Cocogro, BIOTECH also lately isolated and screened local strains of microorganisms to produce enzymes that will have relative activity to extract from coconut. The Institute optimized the conditions for the enzymatic extraction of high quality oil, coconut fiber and protein. Oil recovery using the process was pegged at 92-94% compared to the copra process with 70%.

The Los Baños Multi-Crop dryer was developed by Dr. Ernesto Lozada from UPLB-CEAT. This simple and low-cost dryer produces white and clean copra with low moisture content (Lozada, et.al., 1993). It is especially designed for small farms. By having multiple units, it could handle the drying requirement of large farms. It is easy to use, has no moving parts, and can be made of materials that are available at the farms. The Los Baños multi-crop dryer is essentially a well-engineered dryer whose major component is a unique burner that generates clean heat at a controlled rate, continuously and safely for several hours without tending. This feature of the burner allows the farmer to do other farm chores during the day or rest at night, even while the copra making process is continuing. Since the dryer is directly-fired, it is very efficient. It uses only 42% of the shell for fuel in drying down to 8-10% moisture content. It can use a variety of agricultural wastes as fuel such as coconut shell, charcoal (from shell, husk, and wood), corn cob, and peanut shell, among others.

This dryer is mainly exported to Papua New Guinea. It was reported in the Asian-Pacific Coconut Community (APCC) Conference held in Fiji in 1991 that the Papua New Guinea Marketing Board was able to sell all the imported Los Baños multi-crop dryers and that users expressed their satisfaction with its performance due to good quality off white copra produced. Moreover, the coconut farmers in Papua New Guinea were offered US$20 premium per ton of copra produced using the Los Baños multi-crop dryer (MADECOR, 1991). Unfortunately, massive promotion of the Los Baños multi-crop dyer in the local market through PCA assistance had not been undertaken in the past due to lack of support from previous PCA Administrators before the term of PCA Administrator Virgilio David. Only the PCA-developed kukum dryer was promoted by the agency in its various coconut development programs. Currently, local users of the Los Baños multi-crop dryer are not only using it for drying copra, but also for drying other crops such as coffee and corn. It has been integrated to some small-scale oil mills at the village level in the Bicol Region and in Mindanao.

On of the most promising UPLB-developed technology packages that fits small-scale (5,000 nuts/day) oil milling businesses is the fresh-dry coconut processing (Lozada, et.al, 1993). It is one of the alternative oil extraction processing systems suited to village production settings (Coconut News Magazine, 1998). Other oil extraction processing systems are the wet-dry process developed by ITDI and the low pressure oil extraction process. The fresh-dry coconut processing technology has been made viable because of the development of the Los Baños multi-crop dryer, a simple deodorizing system using hot water, and the capability to locally fabricate small expeller processes. The technology package which yields crude oil, edible cooking oil, and copra cake is simple enough to be managed and operated by farmers' cooperatives. This small-scale oil milling enterprise could spin off other manufacturing activities such as soap making, feed milling, and methyl ester production, to mention a few. Through UPLB-CEAT extension activities, 15 cooperatives in the Bicol Region and Mindanao have adopted the Los Baños fresh-dry method of integrated coconut processing. However, some of these cooperatives stopped operating due to lack of capital and raw materials as well as management-related problems.

The makapuno embryo culture technique was started at UPLB and was aimed at rescuing embryos which do not germinate *in situ* due to abnormality of the endosperm. Makapuno seedlings developed through this technique was commercialized by UPLB through the UPLB Foundation, Inc. Among the large buyers of makapuno seedlings was former Speaker of the House Ramon Mitra.

As regards to coco vinegar, and nata de coco processing technologies developed by the UPLB-Institute of Food Science and Technology, these are now widely adopted by small- and large-scale procssors. On the other hand, the technologies on the production of coconut filled white soft cheese and coconut milk yoghurt developed by the Institute have been adopted by only few small-scale processors in Pagsanjan, Laguna. The products of these processors were sold to households within the municipality and were not properly packed. These producers need assistance in terms of using attractive packing materials to increase their sales and produce on a commercial scale since results of a market study conducted by Aragon and Divinagracia (1992) revealed that coconut filled white soft cheese and coconut milk yoghurt are highly acceptable to consumers based on the taste/product tests conducted in Metro Manila, Laguna, and Quezon.

The mannannase-treated copra meal was found to increase the weight of chickens based on experiments conducted at UPLB. However, although there were interested individuals/ investors who went to UPLB to inquire about the technology, so far there are no adopters of this technology. Perhaps, this may be partly attributed to the fact that only technical information have been provided to prospective users. Additional information on the costs and economic benefits of using this technology should have been provided to motivate them to use the technology.

Currently, the technology on dessicated edible copra production developed by UPLB has also not been adopted yet. According to Dr. Lozada of UPLB-CEAT, there is nothing wrong with the technology, but it may not be highly suitable under Philippine conditions since some coconut farmers harvest early while others harvest late. To produce dessicated edible copra of good quality, the nuts must be harvested at the right maturity. This technology has more potential in Sri Lanka where coconut farmers commonly harvest at the right maturity. Coconut varieties in Sri Lanka are also more suitable for dessicated edible copra production than our local coconut varieties.

Presently, a fractionalism column for the production of coco-diesel and methyl esters is being fabricated by UPLB-CEAT. In addition, the following UPLB-developed coconut technologies are still at the pilot testing stage: 1) nutri-beverage production from coconut skim milk; 2) syrup production for bottled buko; 3) centennial wine production; and 3) beta-monoglyceride application as food emulsifier and as an anti-microbial agent in soap. In collaboration with Colgate Philippines, BIOTECH is presently piloting beta-monoglyceride application as an anti-microbial agent in soap. On the other hand, the coconut technologies which are still at the laboratory stage are instant buko juice production, technique for oil extraction from nata de coco scrappings, coco water beverage production, coconut sap syrup production, and copra meal production.

U.P. Diliman has also developed a total of seven (7) coconut technologies for food and industrial uses (Appendix Table 43). However, five (5) of these coconut technologies still need economic evaluation prior to commercialization. These include the following: 1) synthesis of oleochemicals from coconut oil using four fungal lipases; 2) antigenotoxicity of coconut oil; 3) structure of new glycerides from coconut oil; 4) polyurethane plastics from coconut oil; and 5) heterogeneous photocatalytic synthesis of fuel alkanes from coconut oil fatty acids using solar energy. On the other hand, the technology on coconut flour production including other non-traditional exportable coconut items is for technology adaptation at the farm level while the technologies on the production of new food products from nata de coco are available for dissemination.

Another SCU which successfully developed some coconut technologies is VISCA through its Regional Coconut Research Center (Appendix Table 44). VISCA-RCRC developed nine (9) RCRC hybrids which are crossbreds between Baybay Tall as the male parent and dwarf cultivars as female parents (VISCA-RCRC, undated). These include the following: RCRC 1 (MRD x BAY), RCRC 2 (CñO x BAY), RCRC 3 (CAM x BAY), RCRC 4 (TAC x BAY), RCRC 5 (BBO x BAY), RCRC 6 (CAT x BAY), RCRC 7 (LKY x BAY), RCRC 8 (MYD x BAY), and RCRC 9 (ALD x BAY). These hybrids are precocious, high-yielding, resistant to common insect pests and diseases and tolerant to adverse agro-climatic conditions. The RCRC coconut hybrids generally flower earlier (i.e., 2.9-6.4 years after field planting). These coconut hybrids have a potential yield of 3,005 to 12,470 nuts per hectare or about 0.55 to 3.18 tons of copra per year. The yield levels of the RCRC varieties are, however, much lower than those of the PCA varieties. VISCA also developed four (4) makapuno genotypes, namely: VMAC 1 (CñO x MAC), VMAC 2 (MRD x MAC), VMAC 3 (MYD x MAC), and VMAC 4 (MYD x MAC). These are cross breds between UPMAC as male parent and dwarf cultivars as female parents. These genotypes are considered high-yielding and self-pollinating due to the higher percentage of intraspadix overlapping. The percentage makapuno yield ranges from 90.62% to 97.26%. Initial flowering ranges from 36 to 62 months after planting. The VISCA RCRC has established a coconut gene bank with 42 accessions. In addition, VISCA-RCRC had modified a culture medium suitable for its developed makapuno. A modified Y3 medium with lower concentration was observed to be more appropriate and suitable for the culture of these embryos. The embryos grow faster and the seedlings are ready for potting in less than a year. A simple and rapid propagation technique to double seedling production from makapuno embryos was also developed by the center. Other coconut technologies developed by VISCA-RCRC are as follows: 1) appropriate techniques to sustain soil fertility using cheap and indigenous organic materials; 2) suitable and promising annual and perennial crops as intercrops; 3)charcoal coal-making technology; and 4) low-cost and efficient technique in copra processing such as the VISCA dryer. VISCA-RCRC's low-cost charcoal making technology has a higher percentage (27%) charcoal recovery compared to the traditional technique (10-15%). It also produces high quality charcoal with less breakarage. With this, it is also possible to make charcoal out of coconut husk, husk with shell and leaflets. On the other hand, the semi-direct type of copra dryer developed by VISCA-RCRC is made of low-cost construction materials. It has 2,000 nuts capacity which allows equal heat distribution on the drying platform. It only requires 40-60% of the total husk to convert the coconut meat into copra.

Aside from government agencies and SCUs, the private sector also developed a number of coconut technologies. For instance, PCRDF developed a technology whereby coco coir fiber is used as materials or root anchorage for hydroponics. However, it is still at the pilot stage. The Foundation has also successfully tested the chemical process of producing methyl ester from coconut oil which can be used for running vehicles. Further experiments, however, are still being done to determine whether coconut methyl ester can serve as 100% substitute for fuel diesel. Moreover, the Foundation has also set-up a pilot plant to demonstrate the technique and procedures on how to produce sugar from fresh coconut sap. Based on an initial run which was conducted in Brgy. Wakas in Tayabas, Quezon, the addition of lime preserved the freshness of the sap.

Another example of a technology generated by the private sector is the coco fiber technology developed by Justino Arboleda which involves the manufacture of coconut fiber mats and nets for preventing soil erosion using coconut fiber and coconut dust as raw materials. These products could also be used as fertilizer, pesticide, and planting medium. Coconut fiber mats and nets are manufactured in his factory in Capo, Camalig, Albay. According to Arboleda, coconut mats control erosion and absorb water, thus reducing its consumption (a plus for golf courses). It also serves as an effective medium for plants to grow, enabling their roots to take strong hold of the soil (Nuyda, 1999). His coco fiber technology is already in use in Germany and Japan and working very well abroad, but Filipinos are just starting to take notice of its potential.

The N & A Parpana Engineering also fabricated and commercially sold a locally-designed decorticating machine and auxiliary equipment which uses the dry process of husk defibering (Agribusiness Weekly, 1991).

Oleochemical companies and other private companies doing their in-house research might have developed also a number of coconut technologies while others might have directly funded or commissioned some SCUs or research institutions to undertake researches to develop coconut technologies for them. However, these technologies are only for the company's exclusive use and hence, a company secret. An example is the study on the utilization of coconut shell in hardwood manufacture which was commissioned by Papilon, a foreign-owned private company, to UPLB and FPRDI. A technology which makes the coconut shell pliable to enable it to flatten was developed for exclusive use of Papilon in hardwood furniture making.

Moreover, a leading oil refinery has entered the margarine sector with a highly innovative product (Coconut News Magazine, 1998). Its margarine contains MCT and is packed with Pro Vitamin A and B1. This will, therefore, provide health benefits to consumers since MCT is easily oxidized in the body and dissipated as energy without leaving cholesterol deposits in the tissue.

3.4 Strengths and Weaknesses of the Institutional Structure of Research and Extension Linkage

In a Mini-Seminar cum Workshop on Sustainable Agricultural Technology Transfer for the Coconut Industry which was conducted by PCA on January 27-28, 1998, it was reported that the major problem in the process of technology transfer in the PCA set-up was the weak linkage or coordinative efforts between the agency's research and extension branches resulting to inadequate flow of research information and slow technology transfer to users and beneficiaries (PCA, 1998). The present set-up of PCA and the seeming individuality in operations of the PCA branches are, therefore, limiting factors in the process of technology utilization (Magat, 1998). It was also reported that there was overlapping of functions among PCA branches (Liongson, 1998). For example, The Agricultural Research and Development Branch is concerned with the whole agriculture R & D system at PCA from generation/innovation, transfer, and utilization of technology. The Field Operations Branch (FOB) through the Coconut Extension Training Center (CETC) is also involved in technology transfer through trainings of both the implementors and the farmers. Moreover, the Field Operations Branch is involved in piloting and adoption/utilization.

Furthermore, it was reported during the workshop that the resulting research and technology oftentimes did not reach the intended end-users, but instead ended up being fed to academic journals or in library shelves (Carpio, 1998). Also, there was limited participation of the private and social sectors in research generation which resulted to the huge disparity between research priorities and the needs of the farmers and private businesses. Most of the technologies were conceptualized only at the researchers' level without considering the coconut farmers' needs and environment.

The extension-farmer linkage was likewise found weak due to several factors. Firstly, it was noted that PCA's method of transferring technology which was more of technology push rather than "technology pull" was not effective (PCA,1998). PCA tried to push technologies to the farmers without taking into consideration what technologies that can be pulled from them which they can share. Apart from problems on mobility, overworked PCA research and extension personnel, and lack of appropriate training on technology transfer of Regional Technical Staff and the field extension workers, delays in the release of funds to implement government projects also hampered the agency's efficient transfer of technologies to coconut farmers.

As discussed in sections 3.3.1-3.3.3, there were collaborative efforts between the public and the private sectors in coconut research undertakings. From the private sector, PCRDF had the widest participation not only in research and development activities, but also in extension activities as well. It established satellite laboratories in Leyte, Sorsogon, and Quezon and also distributed coconut technology calendars to disseminate information on available coconut technologies.

As regards to private companies, their participation in research activities conducted by the public sector has been generally minimal. This might partly explain why some coconut processing technologies developed by UPLB researchers have not been adopted by the private sector. Another reason might be the weak research-extension interface at UPLB. The Office of the Vice-Chancellor for Research and Extension lacks technical personnel who can package promotional materials featuring the technical advantages and the economic benefits that can be derived from UPLB-developed coconut technologies to attract potential private investors to adopt the technologies. Most often, interested individuals directly contacted the researchers who developed the technologies. As mentioned earlier, only the technical features of the technology, however, were presented to them by the UPLB researchers. In contrast, FPRDI collaborated closely with private companies in piloting the coconut wood utilization technologies developed by the Institute, which in turn, resulted to the eventual adoption of these technologies.

3.0 Conclusion and Recommendations

During the period 1995-1997, coconut research had been underfunded as compared to sugarcane and carabao which had less contribution to the economy as measured by their share in gross value added in agriculture. The average direct budgetary support for coconut research by the PCA (P 52.98 million/year) was far lower than for sugar research under the Sugar Regulatory Administration (P62.67 million/year) and for carabao research under the recently established research center for carabao (P136.44 million/year) in the same period. On the other hand, the estimated research intensity ratio was 0.30% for coconut compared to 0.50% and 3.60% for sugarcane and carabao, respectively.

External grants contributed greatly to PCA's total research budget considering that the agency's direct budgetary support accounted for 40.04% of its research budget during the period 1992-1996. Its research budget grew by an average of 23.27% in the same period mainly because of external grants whose growth (79.45%/year) greatly outpaced that of direct budgetary support (17.39%).

As regards to the SCUs engaged in coconut R & D activities, UPLB's annual research budget , on the average, (P212.45M) was almost five times higher than the combined research budget of VISCA and USM (P43.96M). In terms of sources of research funds, UPLB received the largest regular research budget allotment and external research grants while USM obtained the lowest budget. UPLB's regular research budget allotment, likewise, grew more rapidly (8.26%/year) than that of VISCA (7.3%/year) and USM (4.15%/year). Considering that UPLB has the strongest manpower and infrastructure capacities among the three SCUs, this might account for its having attracted the largest research budget. In view of the fact that Mindanao is a major producer of coconut in the country, there is, therefore, a need to strengthen USM's research manpower and upgrade its infrastructure facilities to improve its capability to attract more research funding especially for coconut research.

The proportion of PCA's research expenditure for personnel services (62%) tended to be higher than that for its maintenance and operating expenses (36%) as well as for its capital outlay (2%). With regard to SCUs, the same pattern of research expenditure allocation was observed for UPLB and VISCA with personnel services accounting for 71 and 58% of their total research budget, respectively. UPLB's and VISCA's response to the Salary Standardization Law resulted to the disparity in funds for salary against operational budget, which in turn, left research facilities underutilized and forced these agencies to attract external donors' support. Due to more reliance on external donor support, research projects that were conducted especially at UPLB were based on the research priority areas of the external donors. The opposite pattern was noted for USM. Owing to its fewer research personnel compared to the other two SCUs, USM's budget allocation for personnel services (9%) was much lower than its maintenance and operating expenses (91%).

For the period 1988-1998, a total of 329 studies on coconut had been conducted by various government agencies, SCUs, and private institutions. Most of these studies dealt on coconut processing (194), followed by crop production (71), and varietal improvement (32). In contrast, there were only 23 completed socio-economic and marketing studies on coconut indicating that these research areas had been neglected in the past. Although PCA had the highest number (57) of completed researches among the government agencies undertaking research on coconut during the 10-year period under review, UPLB undertook a total of 141 studies on coconut. This was more than the total number of completed studies conducted by PCA in the same period. Some of the studies, however, were commissioned by PCA or were undertaken by UPLB in collaboration with PCA. UPLB's past researches on coconut were highly concentrated on postproduction/coconut processing and product development while PCA's completed studies focused on crop production. Socio-economic, policy, and marketing studies were accorded the least attention by both agencies.

To date, there are 178 on-going studies on coconut being undertaken by the public and private sectors. PCA has the highest number of on-going studies on coconut (114) with ITDI (18), PCRDF (15), UPLB (10), VISCA (8), and FNRI (5) trailing behind.

By research area, crop production receives the most attention with 70 on-going studies, followed by varietal improvement (54) and coconut processing and product development (54). This indicates that the main focus of on-going studies on coconut is on increasing coconut productivity and coconut production. Again, socio-economics, policy analysis, and marketing are the most neglected research areas in all public and private institutions doing research work on coconut. Presently, there are no on-going studies along these research areas.

The emphasis of PCA's current studies is on crop production and varietal improvement. Post-production/coconut processing and product development research area is given less attention as evident from the fewer on-going studies along this research area. On the other hand, most of UPLB's on-going studies on coconut deal with varietal improvement.

The private sector's participation in coconut R & D is also growing. In the 1980's, the private sector's role in coconut R & D was in the mass production of dwarf coconut hybrids. The present concern of coconut research studies being conducted by both UCAP and PCRDF is in the nutritional and medical applications of coconut. PCRDF's coconut studies for the past ten years were concentrated on coconut processing and product development and to a limited extent on crop production and makapuno embryo culture.

PCRDF has also funded studies conducted by a number of government and private institutions. Likewise, Pilipinas Kao funded some research projects of PCA. Other private companies (e.g., oleochemical companies) might have conducted their in-house researches on coconut. Much of the research results, however, might have been used exclusively by the company doing or funding the research.

Although a substantial number of coconut technologies have been generated for past ten years, there are no existing socio-economic studies undertaken to assess the constraints to and impact of technology adoption. The constraints analysis will be useful in providing feedback to researchers on whether there is a need to modify the technologies developed and to policy makers in improving the credit and extension delivery system/mechanism. An updated nationwide socio-economic survey of coconut households is likewise very important for planning purposes and to serve as a source of baseline information for impact studies. A major weakness of a SCFDP impact study recently conducted by a private group is the lack of baseline information to document the socio-economic situation of the coconut farming households including the productivity of their coconut farms before the implementation of the SCFDP. An evaluation of the operation and impact of government programs will provide useful information to program implementing agencies regarding the flaws or conversely the success factors in program implementation and the benefits derived from the program. Hence, such as study will serve as basis for deciding either to discontinue the program under study, improve the implementation mechanism, or replicate/expand the program in other locations.

So far, there is no existing comprehensive study on the domestic utilization of various traditional and non-traditional coconut products/by products. Such a study will also be useful in designing market promotion plans/strategies to expand local consumption of coconut products. In view of the decreasing share of coconut oil in the world oil and fats market, the government should focus its attention on increasing the domestic consumption of coconut products.

In addition, completed marketing studies are few and fragmented. Hence, updated micro-level (domestic) market studies on coconut products/by products and intercrops are lacking. Owing to constant changes in market conditions locally and abroad, such market studies should be regularly updated. An action market research on non-traditional coconut products which are ready for commercialization is also in order to assess their market potential. Market information that will be generated from these studies will be direly needed for the implementation of the Maunlad program nationwide.

Due to the highly globalized trade environment, there is a need to assess the comparative/competitive advantage of Philippine coconut products. For planning purposes, demand, supply, and price forecasting models for various coconut products must also be developed. Price, demand, and supply forecasts generated from these models will be of great use to policy makers and private investors as well. Apart from the domestic market studies, market trends and prospects of coconut products in the export market must also be examined.

Moreover, there is no updated in depth study on the market structure, conduct, and performance of the coconut industry. Presently, there is a dearth of updated and reliable information on the total number of coconut farmers and other key players in the industry. Such a study will serve as the basis for designing government interventions including marketing policies to improve the performance of the industry.

Policy researches on the coconut industry are almost nil. Important policies that might affect the development of the coconut industry should be looked into. These include among others the Comprehensive Agrarian Reform Program (CARP), RA 8048 (Coconut Conservation Act), and trade policies such as the tariff barrier reduction and the phytosanitary regulations under the GATT-WTO.

Based on these considerations, it is recommended that increased funding should be allocated to socio-economics, marketing, and policy research areas along the following research topics:

<u>Socio-economics and Marketing Research Area</u>

1. Characterization of the socio-economic and biophysical environment of the coconut production and processing sector (regional studies)
2. Constraints to adoption of coconut technologies (regional studies)
3. Impact assessment of coconut technologies (regional studies)
4. Evaluation of the operation and impact of government programs at the regional and national levels
5. Micro-level profitability/investment analysis of new coconut products
6. Action market development research/studies by type of non-traditional coconut product
7. Assessment of the domestic and export market potential of traditional and non-traditional coconut products (includes supply, demand, and price analysis including forecasting models)
8. Micro-level market studies on coconut intercrops and livestock integrated under coconut
8. Market structure, conduct, and performance of the coconut industry

9. Role of women and children in coconut production, postproduction, and processing activities
10. Comparative/competitive advantage of Philippine coconut products
11. Risk assessment of coconut technologies

Policy Studies

1. Trade policies (e.g., GATT-WTO)
2. Investment policies
3. Fiscal policies
4. Monetary and credit policies
5. Policy issues related to IPR and biotechnology research on coconut

Researches to increase coconut productivity and explore new uses of coconut must be continuously pursued and funded owing to the country's low coconut productivity as compared with other major coconut-producing countries such as Indonesia and India, the low income of coconut farm households, and the decreasing share of coconut oil in the world oil and fats market.

To complement the afore-mentioned R & D priorities, facility upgrading and human resource development particularly in the social science fields (e.g., economics, sociology, etc. especially at PCA, VISCA-RCRC, and USM) must be given adequate funding by DA-BAR. The limited number of socio-economic and marketing studies on coconut could be largely attributed to the lack of manpower resources in the social science fields.

Owing to low adoption of coconut technologies, research-extension linkage as well as extension-farmer linkage must be further enhanced. Participatory approach should be adopted in research planning and technology transfer. This means that potential users/beneficiaries (e.g., coconut farmers and processing firms) of technologies should be included in the research conceptualization process and in technology piloting. This will facilitate wider adoption of technologies that will be developed from coconut researches considering that these studies will be market-oriented and market driven. For an effective and sustainable technology transfer system, close collaboration between the research branches of PCA (ARDB and PMDB) and the agency's extension branch (FOB) should be strengthened. Likewise, there is a need to build a strong and working network among PCA units and non-PCA agencies like NGOs, local government units, academic institutions, and traders who are potential players in an effective and sustainable technology transfer system.

As a research funding and implementing agency from the private sector, PCRDF has actively participated in research activities conducted by the public sector (e.g., government agencies and academic institutions). However, research collaboration between the public sector and private companies is still weak. To minimize bureaucratic red tape and the research cost to be shouldered by the public sector, public-private research complementation efforts must be further strengthened especially between

UPLB and private companies which are the potential users/beneficiaries of coconut technologies developed by the public sector. Some coconut processing technologies were only developed by UPLB researchers from laboratory-scale experiments. To test the technical and the financial feasibility of these technologies on a larger scale prior to commercialization, these coconut technologies need to be piloted in the plants of private companies which have advanced laboratories and more equipped facilities. Among government agencies, it was FPRDI which collaborated closely with private companies in piloting the coconut wood utilization technologies developed by the Institute, which in turn, resulted to the eventual adoption of these technologies. On the part of PCA, the agency should encourage increased participation of the private sector in establishing and operating seedgardens to mass produce the new hybrid coconut varieties.

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Appendix Table 1. Coconut production by region, Philippines,1990-1997.

REGION	COCONUT PRODUCTION (' 000 MILLION NUTS)								ANNUAL GROWTH RATE (%)
	1990	1991	1992	1993	1994	1995	1996	1997	
CAR	1.45	1.47	1.45	1.45	1.45	1.45	1.00	1.01	-4.3
Ilocos Region	83.73	86.37	82.55	79.02	77.66	78.39	79.60	81.66	-0.3
Cagayan Valley	18.55	19.66	20.92	23.23	28.49	30.90	41.69	42.90	13.2
Central Luzon	2.03	1.72	1.58	1.53	1.50	1.60	2.60	2.71	6.4
Southern Tagalog	1,957.58	1,889.88	1,933.82	1,859.32	1,821.85	1,790.88	1,571.23	1,942.72	0.4
Bicol	745.16	736.75	759.12	734.31	710.52	703.70	598.46	723.49	0.1
Western Visayas	299.04	213.52	238.15	250.01	243.42	229.13	264.02	273.85	-0.2
Central Visayas	417.51	325.25	332.46	328.85	345.32	358.00	399.87	412.12	0.4
Eastern Visayas	969.70	773.70	825.62	820.35	792.61	796.62	805.5	1,113.29	3.2
Western Mindanao	1,238.29	1,261.81	1,265.45	1,215.35	1,238.39	1,560.04	1,379.19	1,431.31	2.6
Northern Mindanao	552.32	504.66	498.84	471.38	497.66	487.94	473.98	476.21	-2.0
Southern Mindanao	3,856.79	3,863.87	3,877.59	3,945.57	3,931.64	4,472.02	4,167.82	3,942.42	0.5
Central Mindanao	516.62	530.81	502.37	505.14	505.17	504.24	447.40	451.89	-1.8
ARMM	806.62	753.25	728.81	774.63	773.39	931.79	915.17	938.07	2.5
Caraga	475.29	327.98	336.19	318.28	237.93	236.39	220.56	219.14	-9.6
Philippines	11,940.38	11,290.88	11,404.90	11,328.41	11,207.00	12,183.09	11,368.11	12,052.79	0.3

Source of basic data: Bureau of Agricultural Statistics

Appendix Table 2. Coconut hectarage by region, Philippines, 1990-1997.

REGION	COCONUT AREA (' 000 HAS)								ANNUAL GROWTH RATE (%)
	1990	1991	1992	1993	1994	1995	1996	1997	
CAR	0.23	0.24	0.24	0.25	0.25	0.23	0.25	0.25	1.3
Ilocos Region	13.45	13.44	13.43	13.39	13.17	13.16	13.39	13.13	-0.3
Cagayan Valley	6.35	6.35	6.37	6.37	6.37	6.51	18.55	18.27	26.6
Central Luzon	2.25	2.13	2.16	2.15	2.12	2.18	2.56	2.47	1.6
Southern Tagalog	542.54	542.48	532.42	532.15	529.48	522.33	521.27	521.15	-0.6
Bicol	366.85	366.66	372.60	372.20	371.95	370.34	379.19	394.14	1.0
Western Visayas	114.03	108.17	108.68	108.70	108.70	100.87	112.39	110.00	-0.4
Central Visayas	136.56	136.69	135.32	135.22	135.79	138.80	109.87	112.54	-2.4
Eastern Visayas	334.20	330.38	327.32	327.29	338.01	299.07	319.69	448.13	5.2
Western Mindanao	375.48	368.99	362.83	362.63	362.84	377.53	371.08	377.22	0.1
Northern Mindanao	212.73	212.25	213.34	212.51	212.71	211.99	212.15	238.52	1.7
Southern Mindanao	501.41	501.93	501.45	501.46	501.18	505.44	483.47	482.60	-0.5
Central Mindanao	100.24	98.00	96.35	96.57	95.68	95.61	120.51	112.30	2.1
ARMM	187.32	187.31	185.87	186.10	185.81	202.36	235.85	241.88	3.9
Caraga	218.33	218.25	218.36	218.28	218.62	218.05	248.78	241.80	1.6
Philippines	3,111.97	3,093.27	3,076.74	3,075.25	3,082.65	3,064.46	3,148.98	3,314.39	0.9

Source of Basic Data: Bureau of Agricultural Statistics

Appendix Table 3. Number of coconut bearing trees per region, Philippines,1990-1997.

REGION	NUMBER OF COCONUT BEARING TREES (' 000 TREES)								ANNUAL GROWTH RATE (%)
	1990	1991	1992	1993	1994	1995	1996	1997	
CAR	47	47	47	47	47	47	47	47	0
Ilocos Region	2,052	2,051	2,049	2,026	2,055	2,080	2,100	2,148	0.7
Cagayan Valley	576	577	585	600	604	604	1,350	1,333	18.1
Central Luzon	115	110	109	141	140	140	142	165	5.9
Southern Tagalog	62,201	62,213	61,184	59,980	59,423	58,908	58,908	59,088	-0.7
Bicol	21,242	21,325	21,326	20,847	21,242	21,387	23,341	29,043	4.9
Western Visayas	8,177	7,961	7,952	8,191	7,692	7,719	7,799	8,659	0.9
Central Visayas	13,491	13,488	13,135	13,030	13,285	13,285	13,285	13,178	-0.3
Eastern Visayas	34,427	34,133	33,797	33,581	36,660	36,666	36,694	40,643	2.5
Western Mindanao	34,233	33,620	33,545	31,980	32,877	32,932	32,932	33,579	-0.2
Northern Mindanao	15,144	15,079	15,064	14,714	14,716	14,611	14,611	14,685	-0.4
Southern Mindanao	51,948	52,555	53,203	46,495	41,920	42,202	43,115	43,886	-2.2
Central Mindanao	11,110	11,033	10,984	10,960	10,920	10,920	10,973	10,713	-0.5
ARMM	20,692	20,692	20,335	20,911	20,973	25,618	25,618	25,783	3.5
Caraga	14,721	14,719	14,749	13,896	13,943	13,942	13,982	13,049	-1.7
Philippines	290,175	289,603	288,064	277,399	276,497	281,061	284,897	295,999	0.3

Source of Basic Data: Bureau of Agricultural Statistics

Appendix Table 4. Nut productivity per tree per region, Philippines, 1990-1997.

REGION	NUT PRODUCTIVITY (NUTS/TREE)									ANNUAL GROWTH RATE (%)
	1990	1991	1992	1993	1994	1995	1996	1997	Average	
CAR	31	31	31	31	31	31	21	21	29	0.4
Ilocos Region	41	42	40	39	38	38	38	38	39	-0.5
Cagayan Valley	32	34	36	39	47	51	31	32	38	3.9
Central Luzon	18	16	14	11	11	11	18	16	14	-0.3
Southern Tagalog	31	30	32	31	31	30	27	33	31	0.3
Bicol	35	35	36	35	33	33	26	25	32	-0.2
Western Visayas	37	27	30	31	32	30	34	32	32	-1.2
Central Visayas	31	24	25	25	26	27	30	31	27	-1.0
Eastern Visayas	28	23	24	24	22	22	22	27	24	-1.3
Western Mindanao	36	38	38	38	38	47	42	43	40	1.8
Northern Mindanao	36	33	33	32	34	33	32	32	33	-1.0
Southern Mindanao	74	74	73	85	94	106	97	90	87	2.4
Central Mindanao	47	48	46	46	46	46	41	42	45	-0.3
ARMM	39	36	36	37	37	36	36	36	37	-0.7
Caraga	32	22	23	23	17	17	16	17	21	-3.7
Philippines	41	39	40	41	41	43	40	41	41	0

Source of Basic Data: Bureau of Agricultural Statistics

Appendix Table 5. Philippine coconut oil mills summary of regional dispersal, 1990.

AREA/REGION	NO. OF MILLS	PERCENT SHARE	CRUSHING CAPACITY Copra Terms		PERCENT SHARE
			MT/Day	MT/Year	
Metro Manila	20	18.35	2,745	823,500.000	15.89
Laguna/Quezon Area (Southern Tagalog)	36	33.02	3,305.50	991,650.00	19.14
Bicol	5	4.59	1,310.00	393,020.00	7.51
Sub-Total (Luzon)	61	55.96	7,360.50	2,208,150.00	42.62
Visayas Area (Eastern and Western Visayas)	17	15.60	2,013.00	603,900.00	11.66
Mindanao Area (Northeast & Southeast Mindanao)	29	26.61	7,877.00	2,363,100.00	45.61
Others(Pangasinan & Palawan)	2	1.83	20.00	6,000.00	0.11
Total (Philippines)	109	100.00	17,270.50	5,181,150.00	100.00

Source: PCA

Appendix Table 6. Philippine coconut oil mills summary of regional dispersal, 1997.

AREA/REGION	NO. OF MILLS	PERCENT SHARE	CRUSHING CAPACITY Copra Terms		PERCENT SHARE
			MT/Day	MT/Year	
Metro Manila	6	6.9	670	201,000	4.1
Laguna/Quezon Area (Southern Tagalog)	30	34.5	3,207	961,800	19.8
Bicol	7	8.0	2,485	745,500	15.3
Sub-Total (Luzon)	43	49.4	6,361	1,908,300	39.2
Visayas Area (Eastern and Western Visayas)	14	16.1	2,406	721,800	14.8
Mindanao Area (Northern & Southeast Mindanao)	30	34.5	7,464	2,239,200	46.0
Total (Philippines)	87	100.0	16,231	4,869,300	100.0

Source: PCA

Appendix Table 7. Volume of exports of Philippine traditional coconut products by type and by country of destination, 1990-1997.

YEAR	COPRA				COCONUT OIL				COPRA CAKE/MEAL PELLETS				DESSICATED COCONUT			
	United States	**Europe**	**Others**	**Total**	**United States**	**Europe**	**Others**	**Total**	**United States**	**Europe**	**Others**	**Total**	**United States**	**Europe**	**Others**	**Total**
								(In Metric Tons)								
1990	-	26,985	64,458	91,443	402,541	581,448	173,686	1,157,675	-	583,375	48,046	631,421	34,074	19,895	20,893	74,863
1991	-	14,285	71,732	86,017	429,055	277,907	183,115	890,077	-	602,675	11,198	613,874	34,361	21,743	25,382	81,486
1992	-	13,500	25,550	39,050	443,884	298,354	161,375	903,612	10,350	473,886	14,526	498,762	39,643	22,522	23,125	85,290
1993	-	13,114	25,700	38,814	494,985	340,300	178,530	1,013,815	5,620	494,263	35,129	535,012	39,596	29,917	27,123	96,636
1994	-	1,500	22,200	23,700	357,219	342,393	173,307	872,919	-	562,028	24,145	586,173	35,961	16,986	23,006	75,954
1995	-	18,548	15,204	33,752	501,226	564,039	298,796	1,364,061	-	514,883	272,629	787,512	32,076	15,799	25,672	73,547
1996	-	2,931	160	3,091	401,849	259,699	167,823	829,371	-	408,214	84,676	492,890	34,146	17,856	18,377	70,379
1997	-	-	7,000	7,000	474,636	456,429	149,848	1,080,913	-	393,108	177,917	571,025	36,843	17,555	22,394	76,792
Average	-	11,358	29,001	40,358	438,174	390,071	185,810	1,014,055	1,996	504,054	83,533	589,584	35,838	20,284	23,247	79,368
Market Share (%)																
1990-97	-	28	72	100	43	38	18	100	-	85	14	100	45	26	29	100
1990	-	30	70	100	35	50	15	100	-	92	8	100	46	27	28	100
1997	-	-	100	100	44	42	14	100	-	69	31	100	48	23	29	100
Annual Growth Rate (%)	-			-3.1				3.4				1.2				1.0

Source of Basic Data: Foreign Trade Division, NSO

Appendix Table 8. Value of exports of Philippine traditional coconut products by type and by country of destination, 1990-1997.

YEAR	COPRA				COCONUT OIL				COPRA CAKE/MEAL PELLETS				DESSICATED COCONUT			
	United States	Europe	Others	Total	United States	Europe	Others	Total	United States	Europe	Others	Total	United States	Europe	Others	Total
	(In ' 000 FOB US Dollars)															
1990	-	6,414	12,937	19,351	126,670	188,439	52,576	367,685	-	50,335	3,197	53,532	28,023	15,688	16,602	60,313
1991	-	3,222	16,466	19,688	154,227	96,536	65,226	315,989	-	54,642	451	55,093	29,219	17,347	20,338	66,904
1992	-	4,306	8,428	12,734	247,286	160,231	84,400	491,917	880	46,990	1,301	48,291	40,786	22,555	24,292	87,633
1993	-	3,443	7,127	10,570	207,820	139,049	75,701	422,570	486	46,132	3,246	49,378	36,097	26,444	24,253	86,794
1994	-	491	8,153	8,644	200,514	189,098	99,655	489,267	-	51,879	2,151	54,030	34,594	15,191	21,283	71,068
1995	-	7,079	5,801	12,880	317,962	335,186	187,165	840,313	-	46,584	23,361	69,945	29,801	14,642	24,240	68,683
1996	-	1,287	68	1,355	292,714	185,645	119,788	598,147	-	48,901	9,868	58,769	41,422	21,526	22,971	85,919
1997	-	-	2,799	2,799	297,637	274,961	94,944	667,542	-	37,074	15,438	52,512	43,129	19,844	25,316	88,289
Average	-	3,749	-	11,003	230,604	196,143	97,432	524,179	683	47,817	7,377	55,194	35,384	19,155	22,412	76,950
Market Share (%)																
1990	-	33	67	100	34	51	14	100		94	6	100	46	26	28	100
1997	-	-	100	100	45	41	14	100	67	71	29	100	49	22	29	100
Annual Growth Rate (%)	-			-0.4				14				0.7				6.8

Source of Basic Data: Foreign Trade Division, NSO

Appendix Table 9. Volume of exports of Philippine non-traditional coconut products/by products by commodity, 1990-1997.

COMMODITY	VOLUME OF EXPORTS (MT)								AVERAGE ANNUAL GROWTH RATE (%)
	1990	1991	1992	1993	1994	1995	1996	1997	
Coco chemicals1/	101,556	53,193	81,826	88,506	74,789	77,951	69,105	57,503	-3.6
Crude glycerine	1,993	1,234	-	-	-	-	-	-	
Refined glycerine	1,835	2,678	905	8,086	12,134	9,833	10,755	9,102	114.0
Coco acid oil	4,798	1,684	706	38	3,385	1,840	6,275	2,731	1247.0
Alkanolamide	1,208	1,931	2,787	2,565	3,114	3,530	2,943	1,566	9.7
Fresh coconuts	7,279	4,554	5,146	5,406	3,667	4,776	7,148	4,611	-1.0
Matured coconuts	1,003	601	2,937	356	710	-	220	-	
Husk nuts	35	86	84	98	971	-	19	-	
Liquid coconut milk	136	531	702	1,143	902	896	773	858	51.6
Coco milk/cream powder	-	506	540	737	964	824	1,360	1,227	19.0
Special creamed coconut	-	-	-	-	-	10	-	67	
Coconut chips	24	335	380	-	13	224	202	321	
Toasted coconuts	70	-	-	-	5	-	-	-	
Macapuno	-	420	472	444	606	611	913	647	10.7
Frozen coco meat	-	199	147	180	157	96	157	153	0.9
Bukayo	2	25	4	2	1	nil	nil	nil	
Coco candy	-	-	-	-	-	-	10	-	
Coco jam	-	-	-	-	-	nil	12	30	
	-	-	-	-	-	190 5/	60 5/	-	
	-	-	-	-	-	25 6/	-	-	
Nata de coco	200	356	635	14,303	15,832	6,091	6,100	5,139	320.0
Shortening	-	135	185	84	-	-	139	180	
Margarine	-	-	-	-	-	-	nil	1	
Coco vinegar	228	286	398	451	494	314	343	256	4.9
Coco water concentrate2/	-	-	-	-	-	-	18,000	nil	
Coconut juice/water2/	-	303,552	716,979	1,807,047	3,501,087	2,171,568	2,218,162	1,823,281	54.7
Coco soy sauce	-	-	-	-	-	-	nil	578	
Ubod3/	3	-	1,000	10	10	-	-	2	
Coco coir fiber		635	174	1,019	511	958	926	1,008	
Coco coir fiber waste	266	-	208	120	59	83	801	1,028	
Coco fiber dust	-	-	-	-	-	132	324	131	
Coconut husk	27	147	30	445	695	610	545	427	251.0
Coco husk chips	12	64	100	287	158	431	187	194	107.0
Coco husk powder	-	-	-	-	-	4	32	6	

Appendix Table 9. Volume of exports of Philippine non-traditional coconut products/by products (Cont'd)

COMMODITY	VOLUME OF EXPORTS (MT)							
	1990	1991	1992	1993	1994	1995	1996	1997
Coco chips	24	335	380	229	246	-	-	-
Coco shell powder	-	-	35	38	508	858	411	760
Coco shell charcoal powder	597	969	25	33	169	-	37	18
Activated carbon waste	-	13,739	-	-	-	-	-	-
Charcoal briquettes	13	-	-	-	-	-	-	-
Coconut shell.	14	86	-	213	21	39	16	20
Coconut seedlings	1,127	1,054	274	26	2	-	-	-
Coconut tree	60	-	-	-	-	-	-	-
Coco lumber/trunk4/	24	-	-	144	63	68	275 3/	31
Coco wooden pallet	-	-	-	-	-	13	62	-
Toilet/bath soap	351	686	73	116	-	132	760	427
	-	-	-	-	-	-	2820 5/	-
Laundry soap	-	3	50	-	-	-	12	254
Coco oil washing detergent	-	-	-	-	-	18	-	-
Shampoo	-	-	-	-	-	-	442	15
Paring oil	-	17	17	-	17	17	34	53

1/ Volume in copra terms
2/Volume in liters
3/Volume in pieces
4/Volume in board foot
5/ In cases
6/ In cartons
Source: Market Research and Promotion Division, Philippine Coconut Authority

Appendix Table 10. Value of exports of Philippine non-traditional coconut products/by products by commodity, 1990-1997.

COMMODITY	VALUE OF EXPORTS (FOB US$)							
	1990	1991	1992	1993	1994	1995	1996	1997
Coco chemicals1/	49,238,619	19,037,254	45,993,489	43,212,081	39,186,250	48,264,264	43,503,149	35,737,500
Crude glycerine	1,224,797	488,813	-	-	-	-	-	-
Refined glycerine	2,158,746	1,644,463	758,699	7,166,311	14,921,108	17,263,568	16,172,239	10,622,600
Coco acid oil	1,173,022	299,049	344,705	15,054	1,153,044	661,684	2,404,369	1,167,600
Alkanolamide	1,004,229	1,448,685	2,113,890	2,194,482	3,112,726	3,874,272	3,744,269	1,888,600
Fresh coconuts	1,749,061	1,388,697	1,537,349	1,439,919	1,049,663	1,384,472	1,868,616	1,595,570
Matured coconuts	350,240	281,974	775,730	124,244	251,313	-	-	-
Husk Nuts	6,300	18,112	14,901	17,762	236,039	-	-	-
Liquid coconut milk	181,641	851,787	1,094,703	1,652,401	1,280,020	1,350,579	1,247,450	1,257,170
Coco milk/cream powder	-	1,598,266	1,855,925	2,474,030	3,210,635	2,596,003	4,253,241	3,700,400
Special creamed coconut	-	-	-	-	-	13,416	-	118,040
Coconut chips	43,588	484,878	542,914	316,927	345,849	393,615	369,153	421,550
Toasted coconuts	112,654	-	-	-	-	-	-	-
Macapuno	-	983,768	1,163,061	1,079,973	1,492,537	1,546,039	2,535,063	1,853,060
Frozen coco meat	-	336,846	240,377	297,867	267,178	172,273	269,604	265,790
Bukayo	3,510	33,990	8,572	5,934	2,867	1,030	968	100
Coco candy	-	-	-	-	-	-	10	-
Coco jam	-	-	-	-	-	4,676	20,364	33,480
Nata de coco	335,301	561,793	1,056,505	26,057,544	22,439,322	7,562,764	7,389,509	6,076,420
Shortening	-	119,250	177,156	93,746	-	-	186,750	223,580
Margarine	-	-	-	-	-	-	793	1,210
Coco vinegar	160,952	200,546	291,392	333,610	398,438	264,654	274,194	208,190
Coco water concentrate2/	-	-	-	-	-	-	18,000	60
Coconut juice/water2/	-	254,000	471,533	1,140,371	2,714,014	1,581,378	1,568,824	1,421,250
Coco soy sauce	-	-	-	-	-	-	578	-
Ubod3/	900	-	1,000	258	346	-	-	1,920
Coco coir fiber	-	64,480	69,978	107,826	344,649	871,316	975,812	988,070
Coco coir fiber waste	82,443	-	79,596	82,140	23,547	43,408	256,804	190,850
Coco fiber dust	-	-	-	-	-	12,374	69,249	14,120
Coconut husk	10,158	27,338	15,288	150,619	249,381	264,238	231,178	178,660
Coco husk chips	2,400	10,690	15,850	88,383	51,817	144,978	66,782	73,460
Coco husk powder	-	-	-	-	-	2,081	11,375	2,710

Appendix Table 10. Value of exports of Philippine non-traditional coconut products/by products (Cont'd)

COMMODITY	VALUE OF EXPORTS (FOB US$)							
	1990	1991	1992	1993	1994	1995	1996	1997
Coco chips	43,588	484,878	542,914	316,927	345,849	393,615	369,153	421,550
Coco shell powder	-	-	2,819	9,064	58,841	177,206	85,961	83,590
Coco shell charcoal powder	45,242	135,203	3,336	3,193	36,455	-	5,676	2,550
Activated carbon waste	-	12,497,901	-	-	-	-	-	-
Charcoal briquettes	2,308	-	-	-	-	-	-	-
Coconut shell.	1,800	19,600	-	68,705	4,417	10,389	3,134	5,790
Coconut seedlings	321,809	227,236	57,304	8,022	1,279	-	-	-
Coconut tree	19,505	-	-	-	-	-	-	-
Coco lumber/trunk4/	-	-	-	149,710	7,224	23,050	47,648	47,340
Coco wooden pallet	-	-	-	-	-	3,029	15,600	-
Toilet/bath soap	423,954	875,539	111,082	173,881	-	224,493	1,608,406	857,430
Laundry soap	-	1,980	33,495	-	-	-	8,434	276,140
Coco oil washing detergent	-	-	-	-	-	8,664	-	-
Shampoo	-	-	-	-	-	-	1,124,171	46,270
Paring oil	-	10,911	19,057	-	19,051	20,593	51,084	78,270

1/ Volume in copra terms
2/Volume in liters
3/Volume in pieces
4/Volume in board foot
5/ In cases
6/ In cartons

Source: Market Research and Promotion Division, Philippine Coconut Authority

Appendix Table 11. PCARRD listing of priority commodities including their rank and percent share in the total research budget.

RANK/COMMODITY	SHARE OF FUNDING
Priority I	80%
1. Coconut and oil palm	
2. Corn and sorghum	
3. Fiber crops (includes cotton)	
4. Legumes (includes soybean)	
5. Plantation crops (includes coffee and cacao)	
6. Rootcrops (includes sweet potato)	
7. Sugarcane	
8. Vegetable crops (includes sweet tomato and garlic)	
9. Aquaculture (includes tilapia, milkfish and prawn)	
10. Marine fisheries (includes roundscad and tuna)	
11.Forage, pasture, and grasslands	
12. Carabeef	
13. Dipterocarp and lesser-used species	
14. Pines and other softwood species	
15. Mangrove and beach type forest	
16. Agroforestry anf forest plantation	
17. Bamboo, rattan, forest vines, and other medicinal plants	
18. Mineral resources: discovery to utilization	
19. Agricultural engineering	
Priority II	10%
1.Fruit crops (includes banana and pineapple)	
2. Rice, wheat, and other cereal grains	
3. Tobacco	
4. Beef/chevon	
5. Inland waters	
6. Molave type forest	
7. Farming systems	
8. Soil resources	
9. Water resources	
10. Mineral resources: management and economics	
Priority III	3%
1. Ornamental and medicinal plants	
2. Dairy	
3. Pork	
4. Poultry	
5. Parks, wildlife, and forest range	

Source: PCARRD

Appendix Table 12. Prioritization of commodities based on selected statistical parameters (developed by the Science and Technology Coordinating Council, STCC, 1989).

Commodity	Weighted Score 1[a]	Rank	Weighted Score 2[a]	Rank	Weighted Score 3[a]	Rank	Resulting Priority Levels and Rankings
A. Crops							Level 1 (A-E)
1. Sugarcane	4.3	1	4.25	1	4.6	1	1. Sugarcane
2. Corn	5.0	2	7.50	5	6.4	3	2. Cassava
3. Pineapple	5.0	2	4.50	2			3. Corn
4. Cassava	5.3	3	6.75	4	6.2	2	4. Coconut
5. Tobacco	6.3	4	6.25	3	7.0	5	5. Tobacco
6. Mango	6.6	5	6.75	4	7.8	6	6. Mango
7. Rice	8.3	6					7. Banana
8. Fiber Crops	9.0	7	12.00	9	11.4	8	8. Coffee
9. Coconut	10.0	8	7.75	6	6.8	4	9. Fiber Crops
10. Banana	10.0	8	8.00	7	8.0	7	10. Calamansi
11. Peanut	11.0	9	12.75	11			
12. Rubber	11.0	9	10.25	8			Level 2 (A-D)
13. Onion	11.6	10	12.25	10			1. Pineapple
14. Sweet Potato	14.0	11					2. Rubber
15. Garlic	14.0	11					3. Rice
16. Mungbean	14.0	11					4. Onion
17. Coffee	15.3	12	12.75	11	12.2	8	5. Peanut
18. Calamansi	15.6	13	15.75	12	14.8	9	
19. Tomato	16.6	14					Level 3 (A-C)
20. Cabbage	18.0	15					1. Sweet Potato
21. Eggplant	19.6	16					2. Garlic
							3. Mungbean
B. Livestock & Poultry							4. Tomato
1. Chicken, eggs	2.00	1		1. Chicken raisers (4)			5. Cabbage
2. Carabao	3.66	2		2. Hog raisers (4.75)			6. Eggplant
3. Chicken	4.00	3		3. Cattle raisers (7.4)			
4. Dairy	4.00	3					
5. Goat	5.30	4					
6. Duck Eggs	6.00	5					
7. Hogs	6.00	5					
8. Duck	6.66	6					
9. Cattle	7.33	7					

[a]Weighted score 1 is the average of the commodity's relative ranking for the following statistical parameters: change in production, value of production, and change in gross value added.

[b]Weighted score 2 is the average of the commodity's relative ranking for the following statistical parameters: change in production, value of production, change in gross value added, and value of exports.

[c]Weighted score 3 is the average of the commodity's relative ranking for the following statistical parameters: change in production, value of production, change in gross value added, value of exports, and number of beneficiaries.

Source: DOST

Appendix Table 13. Science and Technology Agenda for National Development (STAND) Priority Areas in Agriculture and Natural Resources.

I. Export Winners	II. Basic Domestic Needs
Marine Products	Food
Shrimp and Prawns	Rice
Seaweeds	Corn
Tuna	Rootcrop
Crabs	Vegetables
	Sugar
Fruits (Fresh and Processed)	Cattle
Mango	Swine-pork
Banana	Poultry
Pineapple	Fishes (small plegs, tilapia, milkfish)
Papaya	
Durian	II. Environment
	Rehabilitation of upland and agricultural lands
Ornamental Horticulture	Water management
Cutflowers	Protection, rehabilitation, and enhancement of coastal environment
Foliage and other plants	Development of pollution monitoring devices
Live plants	Urban and industrial waste management
Dried ornamentals	
III. Coconut Industry	

Source: DOST

Appendix Table 14. Ranking of commodities based on the National Agricultural Research and Extension Agenda (NAREA), 1988-1992.

RANK	LOWLAND RAINFED	LOWLAND IRRIGATED	HILLYLAND	UPLAND
1	Rice Corn Carabao	Rice Corn Carabao	Banana Pineapple Beef Cattle	Soybean Beef Cattle
2	Soybean Beef Cattle	Soybean Beef Cattle	Coffee Cacao Coconut Sugarcane Tobacco Cotton Carabao	Rice Corn Carabao
3	Tomato	Tomato	Tomato	Banana Pineapple
4	Garlic	Chicken Garlic	Rice Corn	Coffee Cacao Coconut Sugarcane Tobacco Cotton
5	Cassava Sweet Potato Swine	Cassava Sweet Potato Swine	Soybean Chicken	Tomato
6	Chicken		Cassava Sweet Potato Garlic Swine	Cassava Sweet Potato Chicken Garlic Swine

Ranking Based on technology generation component.
Source: Bureau of Agricultural Research

Appendix Table 15. Regional Priority Commodities under NAREA of BAR.

National Priority Commodities	Regional Priorities												
	1	2	3	4	5	6	7	8	9	10	11	12	CAR
I. Basic Commodities													
A. Crop Sector													
1. Cereals													
1.1 Rice	x	x	x	x	x	x	x	x	x	x	x	x	x
1.2 Corn	x	x	x	x	x	x	x	x	x	x	x	x	x
2. Fruit Crops													
2.1 Citrus	x	x	x	x	x	x		x		x	x	x	x
2.2 Watermelon	x	x	x	x								x	
3. Vegetables													
3.1 Tomato	x	x	x	x	x	x	x	x		x	x		x
4. Rootcrops													
4.1 Sweet Potato	x	x	x	x	x		x	x		x			x
4.2 Cassava	x	x	x	x	x		x	x		x			
5. Legumes													
5.1 Mungbean	x	x	x	x		x	x	x	x			x	x
5.2 Peanut	x	x	x	x		x	x	x	x				x
5.3 Soybean	x		x				x						x
5.4 Cowpea				x			x						x
6. Fiber Crops													
6.1 Cotton	x										x		
7. Multi-purpose Trees			x	x	x	x			x		x	x	
8. Garlic	x		x										
A. Animal Sector													
1. Livestock													
1.1 Cattle	x	x	x	x	x	x	x	x	x	x	x	x	x
1.2 Swine	x	x	x	x	x	x	x	x	x	x	x		x
1.3 Carabao	x	x	x	x	x	x	x	x	x	x	x		x
1.4 Goat	x	x	x	x	x	x	x	x	x	x	x	x	x
1.5 Sheep	x	x	x		x		x	x	x	x		x	x
2. Poultry													
2.1 Chicken	x	x	x	x	x	x	x	x	x	x	x	x	x
2.2 Duck		x			x	x	x				x		
I. Export Commodities													
A. Crop Sector													
1. Fruit Crops													
1.1 Mango	x	x	x	x	x	x	x		x	x	x	x	
1.2 Banana		x		x	x		x		x	x	x	x	x
1.3 Pineapple		x		x	x	x							
1.4 Papaya					x			x					
1.5 Durian										x	x	x	
1.6 Cashew	x		x		x	x				x	x	x	
1.7 Pili					x	x				x			
2. Plantation Crops													
2.1 Sugarcane			x		x	x				x			
2.2 Coconut		x		x	x			x		x	x		
2.3 Rubber									x		x	x	
2.4 Castorbean			x										
2.5 Coffee	x	x		x	x				x	x	x		x
2.6 Cacao	x	x			x					x	x		
2.7 Tobacco	x	x											
3. Rootcrops													
3.1 Yam	x	x	x										x
4. Ornamentals				x	x			x		x	x		x
5. Fiber Crops													
5.1 Abaca					x			x	x		x		
6. Bamboo				x	x	x			x		x		

Appendix Table 16. National Priority Commodities, Researchable Areas by Technology Level and Extension Areas (NAREA under BAR).

Priority Commodities	Researchable Areas	Technology Level				Extension Areas
		TG	TA	TV	IG	
2.2 Coconut	1. Crop Improvement					* Production, multiplication and distribution of improved varieties and hybrids
	* Germplasm collection, evaluation and maintenance	x				
	* Adaptability trials	x	x			* Conduct of training for coconut growers on production/cultural management
	* Breeding					
	- hybridization for specific purposes:					
	a. copra	x				* Conduct of lecture-demo on the use of coconut products, and by-products
	b. oil and fatty acid content	x				
	c. pest resistance	x				
	d. protein content	x				
	e. biomass production	x				* Conduct of trainings, and dissemination of information on recent developoments in post-harvest technology and marketing aspects
	2. Cultural Management					
	* Fertilizer management		x	x		
	- chemical and organic fertilization for promising coconut hybrids under various agro-climatic zones					* Processing at the village-level
	* Pest and disease control					* Provision of assistance in the establishment of marketing linkages
	- biological control		x	x		
	- chemical control		x	x		
	- assessment of damage and economic threshold level		x	x		* Information dissemination on market requirements, prices and trade opportunities
	- development of IPM schemes for cadang-cadang and socorro wilt disease	x	x	x		

Appendix Table16. Continuation…

Priority Commodities	Researchable Areas	Technology Level				Extension Areas
		TG	TA	TV	IG	
	* Soil and water management					
	- soil classification/characterization		x	x		
	- water management for coconut-based farming system		x	x		
	3. Farming Systems					
	* Cropping systems					
	- cropping pattern improvement		x	x		
	- multi-cropping system		x	x		
	- cover cropping		x	x		
	* Crop-animal integration					
	- coconut-goat		x	x		
	- coconut-cattle		x	x		
	- coconut-carabao		x	x		
	4. Postproduction					
	* Product and by-product utilization					
	- development of industrial and wood products:					
	a. coconut chemicals	x	x	x		
	b. soap and detergents	x	x	x		
	c. coconut shell flour	x	x	x		
	d. coconut oil	x	x	x		
	e. coconut shell charcoal	x	x	x		
	f. glycerin	x	x	x		
	g. use of sawmill off-cuts, slabs, and sawdusts		x	x		
	- design and construction of house components		x	x		
	- preservation of coconut timber		x	x		

Appendix Table 16. Continuation…

Priority Commodities	Researchable Areas	Technology Level				Extension Areas
		TG	TA	TV	IG	
	* Processing techniques					
	- development of post-harvest technologies for copra cocowood		x	x		
	- control aflatoxin		x	x		
	- processing and preservation of various food products					
	- formulation of food product that are generally acceptable and of high nutritional value	x	x	x		
	5. Socioeconomics					
	* Market and marketing					
	- marketing of various coconut products					
	a. local market				x	
	b. foreign market				x	
	- economic feasibility studies of new technologies				x	
	* Policy analysis				x	
	6. Biotechnology					
	* Tissue culture	x	x			

Note: TG- Technolgy Generation
TA - Technology Assessment/Evaluation
TV- Technology Verification/Validation
IG- Information Generation

Appendix Table 17. Responsibilities of SCUs in Coconut R & D as part of the National Multi-Commodity Research and Development Centers (NMCRDCs).

A. Regional Responsibility

1. University of the Philippines Los Baños
   College, Laguna

2. Visayas State College of Agriculture
   Baybay, Leyte

B. Responsibility As Cooperating Agency

1. University of Southern Mindanao
   Kabacan, North Cotobato

2. Panay State Polytechnic College
   Mambusao, Capiz

3. University of Eastern Philippines
   Catarman, Samar

+Appendix Table 18. List of completed researches on coconut conducted by the PCA, 1988, 1998.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
I. Varietal Improvement			
A. Breeding & Genetics	1. Regional Testing of Promising Coconut Hybrids and Cultivars (Code: MULTILOC-ZRC)	G. Santos, G. Baylon, S. Rivera & R. Rivera	1985-1995
	2. Hybridization and Performance Evaluation of Coconut Populations of Various Local and Foreign Origin	G. Santos, R. Rivera, S. Rivera, G. Baylon, B. de la Cruz & E. Emmaunel	1976-1994
	3. Hybridization of Coconut Plantations of Various Local and Foreign Origin: Comparative Investment Analysis of Recommended Coconut Hybrids/ Cultivars for National Planting/Replanting Program	G. Santos, S. Rivera, R. Rivera, G. Baylon & B. de la Cruz	1979-1993
B. Tissue Culture	1. Effect of Table Grade Sugars on Growth and Development of Coconut Embryos In Vitro	Z. Bonaobra, E. Rillo & A. Ebert	1993-1995
	2. Effect of Lowering Sugar Concentration on Soil Establishment of In Vitro Cultured Coconut Seedlings	Z. Bonaobra, O. Orense, C. Cueto & E. Rillo	1993-1996
	3. Comparison of the In Vitro Growth Performance of Different Ages of Coconut Embryos	O. Orense, E. Rillo & A. Ebert	1994
II. Crop Production			
A. Sustainable Cropping Systems	1. Growth and Yield Performance of Four Coffee Varieties in Coconut-Based Cropping Systems in an Inland Upland Area of Davao	R. Margate, J. Maravilla & L. Canja	1987-1995
	2. Response of Coconut To Fertilizers Applied On Either Or Both Crops In An Intercropping System	R. Margate, J. Maravilla, R. Ebuna & M. Eroy	1985-1991
	3. Sequential Coconut Toddy (Sap) and Nut Production In Laguna Tall Variety and Hybrid Coconuts	J. Maravilla & S. Magat	1988-1991
	4. Corn and Peanut Intercropping Pattern Under Coconut in Davao	J. Maravilla & S. Magat & R. Margate	1987-1991
	5. Intercropping Under Modified Densities of Mature Coconuts at PCA-DRC	R. Margate, M. Eroy	1992-997
B. Integrated Soil Fertility Management	1. Response of Inland Coconut to Integrated Soil Fertility Management of Acidic Soils in Wet Growing Zones of Western Samar, Agusan del Sur and Camarines Sur	L. Canja, M. Eroy, G. Padrones, R. Margate, S. Magat, J. Cobacha, E. Perla, & M. Abargos	1987-1995

Appendix Table 18. Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	2. Response to ISFM of Inland Coconuts to Intermediate to Wet	M. Secretaria, R. Margate, J. Maravilla, R. Ebuna, J. Mantiquilla, & S. Magat	1986-1994
	3. Response of Hybrid Coconut to Organic and Inorganic Fertilizer Application in Four Agro-climatic Conditions of the Philippines: Inland Soil of South Cotobato; II. Coastal Upland Soil of Zamboanga City; III. Inland Soil of Tabaco, Albay; IV. Inland Soil of Solana, Cagayan	R. Margate, M. Secretaria, G. Padrones, J. Maravilla, E. Silva, R. Corsame, J. Borromeo & V. Rivera	1986-1994
	4.Generation of Trichoderma-activated Compost Fertilizers: Its Decomposition and Fertilizer Efficiency on Coconut Seedlings	R. Ebuña & R. Cagmat	1990-1991
	5. On-Farm Fertilizer Trials (OFFT) and Local and Hybrid Coconuts in Selected Areas in Luzon, Visayas and Mindanao	R. Margate, et. al.	1987-1998
C. Weed Control/ Management	1. Response of Coconut to Recycling of Coconut Crown Residues and Circle Weeding	G. Padrones, R. Margate, & J. Maravilla	1986-1994
	2. Evaluation of Mechanical Weed Control Practices in Corn Under Coconut	M. Eroy, R. Margate & N. San Juan	1991
D. Mineral Nutrition Management	1. Response of Hybrid Coconut to Increasing Sodium Chloride (Common Salt) Rates in Inland Tropudalf Soil in Davao	G. Padrones, R. Margate & R. Ebuna	1992 1989-1990
	2. Nutrient Depletion in Coconut Soils thru Harvest of Matured Nuts	M. Eroy, R. Margate & R. Ebuna	
	3. Chlorine Nutrition in Coconut from Nursery to Full Bearing Stage	S. Magat & R. Margate	1971-1988
E. Integrated Pest Control	1. Ecological Studies on the Rhinoceros Beetle: Attractability and Habitability of Varying Depths of Breeding Media for Coconut Rhinoceros Beetle (*Orycetes rhinoceros* L.)	E. Aterrado, R. Abad & R. Rodriguez	1994
	2. Population Development Study of the Rhinoceros Beetle (*Oryctes* rhinoceros L. var. Major) in a Changed Cropping Pattern from Coconut to Banana	E. Aterrado, R. Abad & R. Rodriguez	1992-1994
	3. The Use of Sawdust Trap Boxes As Lures for the Coconut Rhinoceros	E. Aterrado, R.	1994-1995

Appendix Table 18. Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	Beetle (*Oryctes rhinoceros* L.)	Madrazo, S. Kadil & R. Abad	
	4. Improved Technique for the Mass Production of *Metarhzium anisopliae* var. major, a Biological Control Agent Against the Rhinoceros Beetle, Oryctes rhinoceros L. (Coleoptera: Scarabaeidae)	E. Concibido, R. Abad & E. Geonzon	1990-1992
	5. Biological and Ecological Studies of the Greater Coconut Spike Moth (*Tirathaba rufivena* Walk.) and Its Natural Enemies	C. Gallego	1989
	6. Preliminary Studies on the Incidence, Biology and Control of the Greater Coconut Spike Moth, Tirathaba rufivena Walker (Lepidoptera: Pyralidae)	C. Gallego & R. Abad	1988
	7. Biology and Mass Rearing Studies of *Eocanthecona furcelatta* Wolf. Hemiptera: Pentatomidae) a Potential Polyphagous Predator of the White Slug Caterpillar, *Parasa lepida* in Cabadbaran, Agusan del Norte	V. Gallego, R. Escalona & J. Ferreira	1990-1991
	8. Insect Pests of Copra and Copra meal in the Philippines and Their Natural Enemies	M. Zipagan & E. Pacumbaba	1992-1995
	9. Pest Management in Coconut-based Farming System II. Resurgence of Rodent Infestation in Previously Rodenticide Treated Coconut Areas	V. Gallego, & R. Abad	1988-1991
F. Weed Management	1. A Hitherto Unreported Noxious Weed Species Encroaching on Coconut and crop Lands in Bago-Oshiro and Vicinities	E. Aterrado	1996
G. Disease Control	1. Studies on the Transmission of CCCVd to Bearing Palms	M.J.B. Rodriguez, G.G. Manalo, L.P. Estioko	1986-1998
	1.1 Transmission thru Harvesting Scythe	L.P. Estioko	1986-1998
	1.2 The Role of Pollen in CCCVd Transmission	L.P. Estioko, M.J.B. Rodriguez	1986-1997
	2. Screening of Progenies of Survivor Palms for Resistance to Cadang-cadang	M.J.B. Rodriguez, L.P. Estioko	1994-1998
	3.Host Range of the Coconut Cadang-cadang Viroid (CCCVd)	M.J.B. Rodriguez et.al.	1989-1998
	4. Isolation and Purification of the Coconut Cadang-Cadang - Cadang Viroid (CCCVd) for Analytical, Biological & Molecular Characterization	M. Rodriguez & M. Namia	1993

Appendix Table 18. Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	5. Infectivity Studies on the Commonly Detected Sequence Variants of the Coconut Cadang-Cadang Viroid (CCCVd) in Relation to Disease Spread	M. Rodriguez, L. Estioko & G. Manalo	1992
	6. Transmission of Cadang-cadang Disease by Insects and Mites	J. Orense, E. Pacumbaba and M. Zipagan	1990-1997
	7. Identification of Phytophthora Isolates Pathogenic to Coconut and Closely Related Species by Isozyme Analysis Through Starch Gel Electrophoresis	E. Manohar & E. Blala	1990-1991
	8. The Reaction of Coconut Cultivars in the Philippines to Phytophthora Diseases	E. Manohar & R. Abad	1990-1991
III. Coconut Processing			
A. Coconut Timber Utilization	1. Design, Fabrication and Evaluation of a Prototype Coconut Husk Decorticating Machine	R. Palomar, L. Penamora, A. Go, D. Fajardo, E. Ramos, J. Gross, E. Turco & Ilustrisimo	1994-1995
	2. Development of Integrated Charcoal Kiln and Hot Air Dryer	R. Palomar	1994
	3. Sawmilling of Coconut Trunks	R. Palomar & L. Penamora	1992
	4. Design and Construction of Cocowood Houses	R. Palomar	1978-1991
	5. The Efficacy of Various Wood Preservatives on Coconut Timber Exposed Under Three Locations	R. Palomar	1980-1990
	6. Utilization of Coconut Sawmill Offcuts and Slabs for Parquet Flooring	L. Penamora & R. Palomar	1991-1992
	7. The Response of Coconut Timber to Various Locally Available Wood Paints	R. Palomar	1986-1991
	8. Evaluation of Clear Finishes on Coconut Wood	L. Penamora & R. Palomar	1991-1992
	9. Control of Mould and Stain on Freshly-Sawn Coconut Lumber	R. Palomar	1987-1990
	10. Comprehensive Evaluation of the Gluability of Coconut Wood	N. Melencion and L. Peñamora	1992-1997
	11. Testing and Evaluation of Modified Furnace-Type Kiln Dryer	L. Peñamora and R. Palomar	1995-1997

Appendix Table 18. Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
B. Fresh-Dry Process	1. Fresh-Dry Process of Coconut Oil and By-Products Processing	PCA-ZRC	1994-1998
C. Copra Cake	1. RP- Reduction in Aflatoxin Contamination of Copra in the Philippines (to reduce the level of aflatoxin B, in the Philippine copra cake/meal export to 20 ppb and to establish a general copra quality improvement)		
D. Fuel/Energy and Oleochemicals	1. Feasibility Study for the Establishment fo Processing Plants for the Production of Methyl Ester (Diesel Fuel) and Base Chemicals (Medium Chain Fatty Esters) from Coconut Oil		1992-1995
IV. Marketing	1. Promotion and Marketing of Cocowood Products and Promotion Technology		1995-1997

Source: PCA, PCARRD and PCIERD

Appendix Table 19. List of completed studies on coconut conducted by the Forest Products Research and Development Institute (FPRDI), DOST, 1988-1998.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
I. Technical Aspects of Cocowood Utilization			
A. Basic Properties	1. Properties of Green and Yellow Varieties of Coconut (*Cocos nucifera L.*)	Z. Espiloy, M. Maruzzo, and M. Dionglay	1990
B. Working Properties	1. Preservative Treatment of Coconut Wood Poles by HPSD Method	F. Siriban and C. Pabuayon	1990
C. Process of Product Development	1. Production and Properties of Plant-Materials Cement-Bonded Composites	D. Eusebio and M.Susuki	1990
	2. Cocowood Design Standards	A. Gesmudo and J. Siopongco	1990
	3. Development and Evaluation of Cocosoft Lumber Core (Blockboard) for Furniture	M. Laxamana and E. Bauza	1988
	4. Effects of Bleaches on the Finishing Quality of Coconut and Tangile for Furniture and Furniture Components	J. Palisoc, M. Laxamana, and N. Lamana	1991
	5. Coconut Wood for Power and Telecommunication Cross Arm	J. Parayno, F. Siriban, and C. Pabuayon	1988
	6. Lignin from Coconut Palm Wastes - Its Isolation, Characterization, and Evaluation as an Adhesive for Plywood	M. Romana, E. Salud, and F. Chan	1988
	7. Production of Cocowood Grocery Pallets	L. Villavalez and O. Enriquez	1994
	8. Manual on Cocowood Pallet Manufacture	L. Villavalez, T. Cuaresma, V. Eguia, E. Cortiguerra, and P. Cruz	1992

Appendix Table 19. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	9. Improvement of the Two-Man Rip Saw	P. Alcachupas and R. Natividad	1991
	10. Development of Compsing Jig for Lumber Core Production for Furniture Components	M. Laxmana and D.Hernandez	1989
	11. Utilization of Coconut Coir Dust for Water Treatment and Removing Heavy Metal Ions from Solutions	A. Manas, S.Romana and A. Torres	1992
II. Socio-economic Aspects of Cocowood Utilization Including Techno-Transfer	1. Feasibility Study on the Production of Cocowood Grocery Product Pallets	E. Cortiguerra	1990
	2. Availability and Distribution of Coconut Palms in the Philippines	C. Garcia	1990
	3. Feasibility Study on Coco Lumber Production (Chainsaw FPRDI Table Saw Tandem)	M. Matibag	1989
	4. Socio-cultural Dimensions of the Coconut Trunk Utilization Industry in Selected Areas in the Philippines	V. Revilleza	1988
	5. Situational Analysis of Jordan Guimaras for the Establishment of Charcoal Briquetting and Other Coconut-based Industries	L. Briones, H. Unciano, and C. Estudillo	1990
	6. Delivery of the Coconut Wood Lumbering Technology	Y. Robillos and R. Eala	1989
	7. Delivery of Wood Treatment Technology for Coconut Lumber and Bamboo Slats	Y. Robillos and R. Trinidad, F. Siriban, and C. Pabuayon	1988
	8. Pilot-seals Production of Cocowood Grocery Pallets	L. Villavalez and O. Enriquez	1990
	9. Delivery and Utilization of the HPSD Treatment Technology for Green Round Poles to Electric Cooperatives in Regions V to VII	R. Zamora, W. Tordilla, F. Siriban, and C. Pabuayon	1988
	10. Transfer of Some Technologies on Coconut Wood Utilization	F. Siriban and R. Eala	1991

Source: FPRDI

Appendix Table 20 . List of completed researches on coconut conducted by ITDI-DOST, 1988-1998.

RESEARCH AREA	STUDY TITLE	SOURCE OF FUND	DURATION
I. Coconut Processing			
A. Non-Food	1. Sythesis of Cocoamine Betaine	PCIERD	1998
	2. Scale-Up Production of Polyglycerol Esters	PCIERD	1998
	3. Production of Alkyl Polyglycosides	PCIERD	1994-1996
	4. Pilot Plant Production of Derived Oleochemicals for the Plastic Industry - for further evaluation	PCIERD	1994-1996
	5. Polyol Esters from Coco-based Chemicals (Scale-up Production and Application Testing)	PCIERD	1994-1995
	6. Surfactants from CNO	PCIERD	1 year
	7. Bench Scale Production of Amine Oxide from Coco-based Chemicals	PCIERD	1 year
	8. Pilot Plant Production and Application Testing and Alkyl Phosphates As Textile Auxiliary from Coco-Based Chemicals	PCIERD	1993-1994
	9. Scale-Up Production of Triacetin from Coconut Oil Derivative Glycerol	PCIERD	1993-1995
	10. Synthesis of Fourth Generation Biocides	PCIERD	1993-1995
	11. Application Testing of Medium Chain Triglycerides	PCIERD	1993-1995
	12. Lubricant Additives from Coco-based Chemicals	PCIERD	1993-1994
	13. R and D Program on Oleochemicals from Medium Chain Fatty Acids (C_6-C_{12}) of Coconot Oil	DOST	1995-1996

Source: PCIERD and PCARRD

Appendix Table 21 . List of completed researches on coconut conducted by FNRI, 1988-1998.

RESEARCH AREA	STUDY TITLE	DURATION
I. Coconut Processing		
A. Non-Food	1. A. "Lahar" Minicolumn Test Kit for Aflatoxin Screening of Copra Meal	1994
	2. Industrial Non-Food Applications of Nata de Coco	1994
B. Food	1. Micronutrient Fortification of Priority Foods: Vitamin A in Cooking Oil	1998
	2. Therapeutic Effects of MCT in the Management of Diarrhea	1997
	3. Reassessment of Nutrition Prevalence of Cardiovascular Diseases (CVD) in Four Provinces of the Bicol Region	1996-1997
	4. MCT Intake and Endurance Performance	1996-1997

Source: PCIERD

Appendix Table 22. List of completed researches on coconut conducted by UPLB, 1988-1998.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
I. Varietal Improvement	1. Cell and Protoplast Culture of High-Yielding Coconut Varieties. Study 1. Isolation and Culture of Protoplasts from the Mesophylls of the Young Leaf of Coconut	J. Sajise (BIOTECH)	PCARRD	1992-1995
	2. Cell and Protoplast Culture of High-Yielding Coconut Varieties. Study 2. Cytological Study of Three Cultivars of Coconut: Catigan, Laguna + Catigan x Laguna (Hybrid)	J. Sajise (BIOTECH)	PCARRD	1992-1995
	3. Cell and Protoplast Culture of High-Yielding Coconut Varieties. Study 3: DNA Isolation in Coconut	J. Sajise (BIOTECH)	PCARRD	1992-1995
	4. Tissue Culture of Coconut	J. Sajise (BIOTECH)	PCARRD	1984-1995
	5. Regional Testing of Promising Coconut Hybrids and Cultivars (Phases 2 and 3)	J. Sangalang (Horti-CA)	PCARRD & PCA	1983-1996
	6. Coconut Breeding Project	C. Baltazar (Entom)	NAST	1990-1991
	7. UPLB Coconut Breeding Project. Study 1: Field Performance of Selected Dwarf Populations	J. Sangalang (Horti-CA)	UP Basic/ Applied	1975-1995
	8. Upland Coconut Breeding Project. Study 2. Evaluation of Some Local Hybrids and Tall Coconut Populations	J. Sangalang (Horti-CA)	UP Basic/ Applied	1975-1995
	9. Mass Propagation of Makapuno through Embryo Culture Technique	A. del Rosario (Horti-CA)	UPLBFI	1978-1998
	10. Variations in the Nut Qualities (Physical and Chemical) of Different Cultivars and Hybrids of Coconuts and at Various Stages of Maturity	E. Bernardo (Entom)	PCARRD/ RRDP	1987-1991
	11. Tissue Culture of High-Yielding Coconut Varieties	R. Laude (Biosci)	DOST	1993
II. Crop Production				
A. Coconut-Based Farming Systems	1. Development of Computer Model on Light Availability and Annual Intercrop Suitability Under Coconut	S. Medina (FSSRI)	UP Basic/ Applied	1995-1997
	2. Sustainbility of Small Rumninants/Coconut System in the Philippines	C. Sevilla (Animal Sci)	PCARRD & IDRC	1993
	3. Increasing Production and Utilization of Feed Resources Under Coconut Plantation: Productivity of Naturalized Fodder Shrubs and	N. Velasco (DTRI)	PCARRD & IDRC	1990-1993

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	Grass-Legume Mixtures			
	4. Sustainable Small Ruminant Production Under Coconut Plantations: Sustainable Small Ruminant Production on Stargrass-based Pasture Under Coconuts	N. Velasco (DTRI)	PCARRD & IDRC	1991-1993
	5. Performance of Vegetable Legumes in a Coconut-based Cropping System	O. Emata (DTRI)		1992
	6. Production and Postproduction Systems: Coconut, Coffee, & Rubber	C. Baltazar (Entom)	IDRC	1989-1991
	7. Multi-storey Cropping Under Coconut in Tayabas, Quezon	L. Madamba (Chem)	IC	1991
	8. Case Studies of Successful Farmer-Managed Coconut-based Farming	N. Librojo	U.S.-Isarel-CDK-AID	1990-1991
	9. Integration of Small Ruminants with Coconut Production System	A. Barrion (BioSci)		1991
	10. National Coco-based Farming Systems Research and Documentation-Complementary Program	E. Aguilar (FSSRI)	PCARDD/ RHO	1990-1993
B. Cultural Management				
- Fertilizer	1. Ubod Production from Coconut Seedlings (Variety and Fertilizer Trials)	C. Protacio (Horti,CA)	DOST	1993-1996
- Pest and Diseaase Control/Management	1. Cadang-cadang As a Form of Environmental Stress	J. Velasco (BioSci)	-	1985-1994
	2. Development of Methods to Assess Rodent Damage in Coconut (Two Studies)*	M. Hoque & P. Ocampo	NCPC	1985-1993
	3. *Bacillus thuringiensis* Against Lepidopterous Pests of Coconut	L. Padua (BIOTECH)	DOST	1990-1993
III. Coconut Processing				
A. Non-Food	1. Bioconversion of Coconut Coir Dust Into Bio-Organic Fertilizers: Study 2: Testing of Coconut Coir Dust Fertilizer on Various Crops	E. Arreola (BIOTECH)	UCPB-CIIF	1996-1997
	2. Bioconversion of Coconut Coir Dust Into Bio-Organic Fertilizers: Study 3: Support Studies on Pilot Plant Production of Organic Fertilizers from Coconut Coir Dust	E. Arreola (BIOTECH)	UCPB-CIIF	1996-1997

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	3. Bioconversion of Coconut Coir Dust Into Bio-Organic Fertilizers: Study 1: Studies on Degradation of Coconut Coir Dust with Various Other Substrates with Various Other Substrates and Microbial Inoculants	B. Espiritu (BIOTECH)	UCPB-CIIF	1996-1997
	4. Characterization of the Components of the Growth Hormones Extracted from Waste Coconut Water. Study 2: Biological Effects of Growth Hormone Extract from Waste Coconut Water on Selected Plant Growth Parameters	A. Lopez (BIOTECH)	PCARRD	1994-1997
	5. Technology Refinement and Scale-Up Production of Growth Hormones Extracted from Wast Coconut Water. Project 1. Scale-Up Production of Growth Hormoned Extracted from Coconut Waters. Study 3: Formulation of Tissue Media Using Coconut Water Growth Hormone for Orchids and Ornamentals	A. Lopez (BIOTECH)	PCARRD	1994-1997
	6. Technology Refinement and Scale-Up Production of Growth Hormones Extracted from Wast Coconut Water. Project 2. Refinement of Coconut Water Growth Hormone Technology for Crop Production. Study 3: Coconut Water Growth Hormone Technology for Cutflowers	A. Lopez (BIOTECH)	PCARRD	1994-1997
	7. Characterization of the Components of the Growth Hormone Extracted from Coconut Water. Study 1: Physico-Chemical Characterization of Growth Hormone Extract from Waste Coconut Water	C. Mamaril (BIOTECH)	PCARRD	1994-1997
	8. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 1. Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Study 1: Production of Coconut Water Growth Hormone for Use in the Refinement of Coconut Water Growth Hormone Technology	J. Mamaril (BIOTECH)	PCARRD	1994-1997
	9. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 1. Scale-Up Production of Growth Hormones Extracted from Waste Coconut	E. Paner (BIOTECH)	PCARRD	1994-1997

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	Water. Study 2: Analysis and Quality of Coconut Water Growth Hormone			
	10. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 2. Refinement of Coconut Water Growth Hormone Technology for Crop Production. Study 2: Coconut Water Growth Hormone Technology for Root Crops	J. Simbahan (BIOTECH)	PCARRD	1994-1997
	11. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 2. Refinement of Coconut Water Growth Hormone Technology for Crop Production. Study 1: Coconut Water Growth Hormone Technology for Vegetables	J. Simbahan (BIOTECH)	PCARRD	1994-1997
	12. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 2. Refinement of Coconut Water Growth Hormone Technology for Crop Production. Study 4: Coconut Water Growth Hormone for Cotton	J. Simbahan (BIOTECH)	PCARRD	1994-1997
	13. Characterization of the Components of the Growth Hormone Extracts from Water Coconut Water. Study 1. Extraction and Physico-Chemical Characterization of Coconut Water Growth Hormone Extract	A. Lopez (BIOTECH)	PCASTRD	1993-1996
	14. Characterization of the Components of the Growth Hormone Extracts from Waste Coconut Water	J. Mamaril (BIOTECH)	PCASTRD	1993-1996
	15. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 1. Scale-up Production of Growth Hormones Extracted from Waste Coconut Water. Study 1: Qualitative and Quantitative Analysis of Growth Hormone	J. Mamaril (BIOTECH)	PCASTRD	1994-1997
	16. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 1. Scale-up Production of Growth Hormones Extracted from Waste Coconut Water. Study 2: Storage and Shelf Life of Extracted Coconut Water Growth Hormone	E. Paner (BIOTECH)	PCARRD	1994-1997

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	17. Stereospecific Analysis and Interesterification of Local Seed Oils (Phase 2 - Lipase Catalyzed Production of Specialty Fats and Monoglyceride Laurates from Coconut Oil and Pili Nuts)	Li Pham (BIOTECH)	PCASTRD	1993-1996
	18. Technology Refinement of Scale-Up Production of Growth Hormones Extracted from Waste Coconut Water. Project 2. Refinement of Coconut Water Growth Hormone Technology for Crop Production. Study 2. Refinement of Coconut Water Growth Hormone Technology for Vegetable Production Under Field Conditions	J. Lales (Agronomy)	PCARRD	1994-1997
	19. Enzymatic Interesterification of Coconut Oil for the Production of Methyl and Ethyl Esters	W. Padolina (CHEM)	PCA	1991-1994
	20. Cross-Linked Beaded Cellulose from Nata de Coco as Matrix for Dye-Ligand Chromatography	D. Sabularse (CHEM)	IC	1989-1994
	21. Treatment and Disposal of Nata de Coco Waste Water	V. Luis, Jr. (CEAT)	-	1993-1994
		R. Amongo (CEAT)	-	1994-1995
	22. Charcoal and Activated Charcoal from Coconut Husks	E. Fernandez (Wood Sci & Tech)	DOST	1989-1991
	23. Preparation of Agricultural Chemicals from Coconut Fatty Acid Derivatives	E. Rasco Jr. (Horti)	USAID/ Israel	1991
	24. Production of Serum and Alternative Culture Media Using Coconut Water and Egg Yolk for Mamalian Cell Cultivation	C. Pham (BIOTECH)	-	1993-1996
	25. Studies on the Utilization of Coconut Shell in Hardwood Manufacture	W. Padolina (CHEM)	Papilon* (Private)	1991
	26. Production of Volatile Fatty Acids from Coconut Water	C. Barril (CHEM)	DOST	1990-1996
	27. Production of Agro-Industrial Chemicals. Study 1. Selective Hydrolysis of Coconut Oil by Microbial Lipase Excreted by *R. arrhizus* and *A. niger*	E. Castillo (CHEM)	IC	1986-1992
	28. Production of Agro-Industrial Chemicals. Study 2. Application of Fermentation and Membrane Filtration in the Production of Coconut	E.del Rosario (CHEM)	IC	1986-1992

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	Oil and Protein			
B. Human Food and Animal Diet	1. Effect on Nitrogen Level on the Shelf-Life of Buko Juice	L. Raymundo (IFST)	IFST	1997
	2. Assessment and Improvement of the Quality of Distilled Coconut Wine (Lambanog)	P. Sanchez (IFST)	IFST	1995-1996
	3. PAH in Copra and Derived Products	E. Lozada (CEAT)	AMDP	1994-1997
	4. The Los Baños Fresh-Dry Method of Cooking Oil Production	E. Lozada	AMDP	1993-1996
	5. Bioconversion of Copra Meal for Agricultural and Industrial Use. Study 2. Digestibility Studies of Enzyme-treated Copra Meal and Nutritional Value of Fermented Copra in Broiler Diets	A. Zamora (BioSci-CAS)	BIOTECH	1990-1995
	6. Production and Utilization of Nata. Project I. Isolation and Characterization of Nata Organisms. Study 2: Environmental Conditions	E. Carpio		1994-1995
	7. Functional Properties of Intact Coconut Meat. Study 1. Effect of Different Stages of Maturity of Coconut on Browning Characteristics of Dried Coconut	R. del Rosario (IFST)	U.P. Basic	1992-1995
	8. Functional Properties of Intact Coconut Meat. Study 2. Effect of Different Solutes on Absorption Characteristics of Dried Coconut Meat	R. del Rosario (IFST)	U.P. Basic	1992-1995
	9. Functional Properties of Intact Coconut Meat. Study 3. Effect of Different Stages of Maturity on Chemical Composition of Coconut Water	R. del Rosario (IFST)	U.P. Basic	1992-1995
	10. Functional Properties of Intact Coconut Meat. Study 4. Effect of Different Additives on Behavior of Processed Coconut Water	R. del Rosario (IFST)	U.P. Basic	1992-1995
	11. Production and Utilization of Nata. Project 2. By Product Utilization	R. del Rosario (IFST)	U.P. Basic	1994-1995
	12. Production and Utilization of Nata. Project 3. Development of New Production System	R. del Rosario (IFST)	-	1994-1995
	13. Production and Utilization of Nata. Project 1. Isolation and Characterization of Nata Organism. Study 1. Nutrient Requirement	V. Garcia and R. del Rosario (IFST)	-	1994-1995

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	14. Control of Mycotoxin-Forming Fungi Using Ammonia on Copra and Corn. Study 1. Determinin the Effect of Ammonia on the Growth, Sporulation and Spore Germination of Various Mycotoxin-Producing Isolates in Vitro	R. Garcia (IFST)	NAFC-DA	1992-1995
	15. Control of Mycotoxin-Forming Fungi Using Ammonia on Copra and Corn. Study 2. Evaluating the Efficacy of Ammonia on the Growth and Subsequent Mycotoxin Contamination in Copra and Cron During Storage	R. Garcia (IFST)	NAFC-DA	1992-1995
	16. Control of Mycotoxin-Forming Fungi Using Ammonia on Copra and Corn. Study 3. Determining What Concern and What Method of Application of Ammonia Is Most Effective in Controlling Mycotoxin-Producing Organism	R. Garcia (IFST)	NAFC-DA	1992-1995
	17. Control of Mycotoxin-Forming Fungi Using Ammonia on Copra and Corn. Study 4. Evaluating Whether Ammonia Afforded Adequate Protective and Therapeutic-Producing Copra and Corn Storage	R. Garcia (IFST)	NAFC-DA	1992-1995
	18. Pilot Plant Detoxification of Aflatoxin-Contaminated Copra Meal Using Methylamine	I. Dalmacio (BioSci)	DA-BAR	1993-1995
	19. Aflatoxin Detoxification of Copra Meal	I. Dalmacio (BioSci)	NAFC-DA	1990-1993
	20. Monoclonal Antibodies for Rapid Screening of Aflatoxin-Producing Organisms in Copra, Copra Meal Cake and Other Coconut Meat Products. Study 1. Immunization of Purified Aflatoxin-Producing Organisms to BALB/c Mice Production	T. Espino (BIOTECH)	PCA	1992-1994
	21. Monoclonal Antibodies for Rapid Screening of Aflatoxin-Producing Organisms in Copra, Copra Meal Cake and Other Coconut Meat Products. Study 2. Cloning, Multiplication and Preservation of Monoclonal Antibodies	T. Espino (BIOTECH)	PCA	1992-1994
	22. Monoclonal Antibodies for Rapid Screening of Aflatoxin-Producing Organisms in Copra, Copra Meal Cake and Other Coconut Meat Products. Study 3. Mass Production of Monoclonal Antibodies	T. Espino (BIOTECH)	PCA	1992-1994
	23. Monoclonal Antibodies for Rapid Screening of Aflatoxin-Producing	T. Espino	PCA	1992-1994

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	Organisms in Copra, Copra Meal Cake and Other Coconut Meat Products. Study 4. Purification and Characterization of Monoclonal Antibodies from Ascitic Fluid	(BIOTECH)		
	24. Monoclonal Antibodies for Rapid Screening of Aflatoxin-Producing Organisms in Copra, Copra Meal Cake and Other Coconut Meat Products. Study 5. Development of Diagnostic Kit Against APO	T. Espino (BIOTECH)	PCA	1992-1994
	25. Monoclonal Antibodies for Rapid Screening of Aflatoxin-Producing Organisms in Copra, Copra Meal Cake and Other Coconut Meat Products. Study 6. Evaluation of the Efficacy of the Diagnostic Kit in Detecting Aflatoxin and APO-Coconut Meat Product	T. Espino (BIOTECH)	PCA	1992-1994
	26. Copra Dryer	E. Lozada (CEAT)	-	1992-1994
	27. Lipases: Their Application on the Production of Novel Chemicals from Coconut Oil	T. Espino (BIOTECH)	PCA	1991-1995
	28. Bioconversion of Copra Meal for Agriculture and Industrial Use	A. Sapin (BIOTECH)		1993
	29. Functional Properties of Intact Coconut Meat (4 Studies) *	R. del Rosario (Food Sci)	U.P. Basic	1992-1993
	30. Utilization of Spent Liquor of Nata for Vinegar Production	R. del Rosario (Food Sci)	IFST	1993
	31. Effect on Processing 14C-chlorpyrifus Residues in Copra	A. Tejada (NCPC)	IAEA	1993
	32. Hydrolysis of Copra Meal for Agriculture and Industrial Use	A. Zamora (BioSci)	PCA & BIOTECH	1993
	33. Pilot Scale Production of Dextran by Local Strain of *Leuconostoc mesenteroides* Using Coconut Water by Direct Whole Cell Fermentation	G. Reyes (BIOTECH)	Private*	1992-1993
	34. Development of Food Products from Coconut and Coconut By-Products	R. del Rosario (FoodSci)	IFST	1985-1993
	35. Development of Instant Buko Juice Drink	L. Raymundo (FoodSci)	IFST	1992-1994

Appendix Table 22 .Continued.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
	36. Instant Coconut Milk Extract	L. Raymundo (FoodSci)	IFST	1992-1994
	37. Development of Beverage from Coconut Sap and Coconut Water (Two Studies)*	J. Sangalang (Horti)	U.P. Basic	1990-1991
	38. Synthesis of New Sucrose Esters from Coconut Fatty Acids	E. Rasco Jr. (Horti)	IPB/ PCARRD	1988-1991
	39. Microbial Detoxification of Aflatoxin-Contaminated Copra	R. del Rosario (FoodSci)	IFST	1989-1992
	40. Characterization and Utilization of the Gel and Gum-Forming Compounds in Coconut	M. Paje (Horti)	IPB	1991
	41. Chemical Characterization of Studies in the Endosperm of Makapuno and Non-Makapuno Coconuts with Special Reference to Cell Wall	M. Paje (Horti)	U.P. Basic	1991-1992
	42. Incidence of Other Mycotoxins in Copra	R. Garcia (NCPC)	U.P. Basic	1991
IV. Coconut Processing and Marketing	1. Documentation and Assessment of Successful Coconut Production, Processing and Martketing Strategies (Phase 1). Study 1.Case Studies of Successful Coco-based Processing Enterprises in Luzon; (Studies 2 and 3 are handled by personnel from PCA)	D. Manalo and S. Medina (FSSRI)	PCARRD	1994-1997
	2. Marketing of Coconut and Corn By Small Producer Groups in Southern Tagalog	CEM	PCARRD	1992-1995
	3. The World Market for Coconut Products: An Economic Analysis from the Perspective of the Philippines	CEM	ACIAR	1992-1995
V. Socio-economics and Marketing	1. Economics of Small Ruminants in Coconut Production Systems	R. Huelgas (CEM)	IDRC	1989-1991
	2. Market Study for the Cooking Oil Produced by the UPLB Integrated Coconut Processing Fresh-Dry Method	L. Divinagracia (CEM)	AMDP	1996-1997
VI. Nutrition	1. Nutritional Composition of Copra Cake and Copra Cake-Based Food Products	W. Hurtada (CHE)	U.P. Basic/ Applied	1996-1997

Source: UPLB, PCARRD, PCIERD, and PCRDF

Appendix Table 23. List of completed M.S. thesis on coconut conducted at UPLB, 1988-1998.

RESEARCH AREA	THESIS/DISSERTATION TITLE	GRADUATE STUDENT'S NAME	YEAR
I. Varietal Improvement			
A. Breeding & Genetics	1. Cytogenetics of Coconut (*Cocos nucifera* Linn.) Varieties Catigan Green Dwarf (CAT) and Laguna Tall (LAG) and Their F1 Hybrid	M. Tudor	1995
	2. Genetic Polumorphism of Coconut (*Cocos nucifera* L.) Varieties Catigan, Laguna and Their F1 Hybrid Based on Random Amplified Polymorphic DNA Markers	N. Bebino	1996
II. Crop Production			
A. Pest Control/Mgt. and Disease Control/ Aflatoxin Control	1. Biological and Ecological Studies on the Greater Coconut Spike Moth (*Tirathaba rufivena* walker) and Its Natural Enemies	M. Gallego	1989
	2. Distribution and Comparative Studies of Phytophthora Diseases of Coconut (*Cocos nucifera* L.) in the Philippines	E. Concibido	1990
	3. Detoxification of Aflatoxin-Contaminated Copra Meal by "*Flavobacterium aurantiacum*"	M. Tuason	1993
III. Coconut Processing, Coconut Utilization, Post production Practices			
A. Postproduction Practices	1. Effect of Drying and Storage Conditions on Aflatoxin Incidence in Copra	V. Villanueva	1989
	2. Operating Temperature for Copra Dryer Using Response Surface Analysis	M. Diokno	1989
B. Processing	1. Effect of Legume Flours (Soybean and Mungbean) on the Growth and Nata Production of *Acetobacter aceti subsp. Xylinum* on Coconut	Suranti	1989
	2. Influence of Other Micro-organisms on the Yield of Nata (Processed Food from Coconut Milk) by *Acetobacter aceti subsp. Xylinum* (Brown)	L. Collado	1988
	3. Preparation of Immobilized Invertase on 2 Dio Salt P. Aminobenzoyl-"Nata"	N. Parayno	1992
	4. Triacylglycerol Profile and Stereospecific Analysis of Coconut (*Cocos nucifera* L. var. Laguna) Oil	M. Gregorio	1995
	5. Enzymatic Intensification of Coconut-Corn Oil Mixtures	R. Javier	1997
	6. Beaded Cellulose Gel from Nata de Coco as Matrix for Dye Ligond Chromatography	A. Borja	1992
	7. Characterization of the Structured Lipids and Physical Blend Derived frrom Coconut & Corn Oils	J. Colis	1993

Appendix Table 23. Continued.

RESEARCH AREA	THESIS/DISSERTATION TITLE	GRADUATE STUDENT'S NAME	YEAR
IV. Socio-economics			
A. Sociological	1. Patterns of Farm Diversification Among Households in a Coconut-based Ecosystem	R. Fabro	1990
B. Economics/Policy	1. Effect of Government Policies on welfare Gains from Rice, Corn, and Coconut Research in the Philippines: An Ex-Ante Economic Analysis	N. Carambas	1993
V. Others			
A. Environmental	1. Treatment and Disposal of Nata de Coco Waste Water	R. Amongo	1995
	2. Impact of Coconut Oil Mill Pollution on Tigbao River in Tacloban City	N. Dayap	1998
B. Copra Meal As Feeds	1. Urea-Treated Rice Straw With Fish Meal or Copra meal in Concentrate Supplemented at Two Rates for Daily Replacement Heifers	T. Atega	1989
	2. Urea Mineral Molasses Block (UMMB) as a Supplement to Rice Straw and Gliricidia vs. Copra Meal + Rice Bran as Supplement to Urea-Treated Straw for Goats	F. Antonio	1989
	3. Fish Meal vs. Copra meal in Concentrate Supplemented at Two Rates of Urea-Treated Rice Straw for Cows in Late Lactation	E. Zanting	1988
	4. Comparison of Copra meal and Palm Kernel Expeller Supplementation on Growing Dairy Cattle Feed with Mix Roughage	S. Rano	1993

Appendix Table 24. List of completed Ph.D. thesis on coconut conducted at UPLB, 1988-1998.

RESEARCH AREA	THESIS/DISSERTATION TITLE	GRADUATE STUDENT'S NAME	YEAR
I. Crop Production			
A. Coconut Production/ Farming Systems	1. Productivity and Nutritional Status of Coconut Under Different Production Schemes	F. Togavio	1993
	2. Sustainability of Small Ruminant-Coconut Production System in the Philippines	E. Villar	1993
B.Coconut Disease	1. Etiology and Dynamics of the Stem Bleeding Disease of Coconut (*Cocos nucifera* L.) in the Philippines	N. San Juan	1997
II. Coconut Processing	1. MCFA Enrichment of Coconut (Cocos nucifera L.) Oil by Low-Temperature Fractionation	P. Katisak	1997
	2. Characterization of the Lipid and Protein Membrane Components of the Natural Emulsifier of Coconut (*Cocos nucifera* L.) Milk	P. Punsri	1997
III. Others			
A. Copra Meal as Feed	1. Effect of Formaldelhyde-Treated Copra meal Supplementation on the Growth and Milk Production of Buffalos	D. Aquino	1992
	2. Feeding Value of Refined, Crude and Acidulated Coconut Oil in Broiler and Layer Diets	M. Sapkota	1992
B. Chemical	1. Biochemical and Ultrastructural Studies on the Walls of Normal and Makapuno Coconut Endosperms	M. Flavier	1994

Appendix Table 25 . List of completed researches on coconut conducted by U.P. Diliman, 1988-1998.

RESEARCH AREA	STUDY TITLE	DURATION
I. Coconut Processing		
A. Coconut Meat Food	1. Development/Standardization and Sensory Evaluation of Recipes: New Products from Nata de Coco	1994
	2. Physico-chemical Characterization of Coconut Flour Produced Through The Aqueous Process	1990-1991
	3. Piloting Studies of New Products for Nata de Coco	1994
B. Non-Food	1. Oleochemicals from Coconut Oil	1995-1988
	2. Synthesis of Oleochemicals from Coconut Oil Using Fungal Lipases	1995-1988
	3. Antigenotoxicity of Coconut Oil	1990-1991
	4. Determination of the Structure of New Glycerides from Coconut Oil	1990-1992
	5. Polyurethane Plastics from Coconut Oil	1992-1993
	6. Heterogeneous Photocatalytic Synthesis of Fuel Alkanes from Cocounut Oil Fatty Acids Using Solar Energy	1995-1996
II. Marketing	1. Production, Marketing, and Utilization of Coconut Flour and Other Non-Traditional Exportable Coconut Items[1]	1993
	2. Survey and Development of Coconut Food With Export Potentials in the Philippines (Phase I)	1990-1991

[1]Conducted in collaboration with PCA.

Source: PCIERD

Appendix Table 26. List of completed coconut researches conducted by VISCA, 1988-1998.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
I. Varietal Improvement	1. Breeding fro Improved Varieties of Coconut: Utilization of Heterosis	T. Nuñez and M. Baliad	1976-1996
	2. Collection and Characterization of Loal and Introduced Coconut Cultivars/Hybrids: Study 1	T. Nuñez and M. Baliad	1983-1998
	3. Collection and Characterization of Loal and Introduced Coconut Cultivars/Hybrids: Study 2	T. Nuñez and E. Malasaga	1983-1998
	4. A Study on the Alternate Bearing Phenomenon in Dwarf Coconut Cultivars	T. Nuñez and D. Molato	1983-1998
	5. Development of Self-Pollinating and Precocious Makapuno-Bearing Palms Using Highly Selfed Dwarf Coconut Cultivars	T. Nuñez, V. de la Paz and D. Lina	1987-1998
	6. Rapid Propagation of Hybrid Makapuno	T. Nuñez	1995-1996
	7. Regional Testing of Promising Coconut Hybrids/Cultivars (MULTILOC-ZRC)	A. Dingal	1984-1998
II. Crop Production	1. On-Farm Trials of Promising Coconut-based Cropping Systems in Established Coconut Plantations	N. Pascual and M. Baliad	1993-1997
	2. Utilization of Organic Sources of Fertilizer for Banana Grown Under Coconut	A. Dingal and R. Cortez	1995-1998

Source: PCARRD

Appendix Table 27. List of completed researches on coconut conducted by UCAP, 1987-1997.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED
I. Coconut Processing	1. Production of Structured Lipids 2. Production and Testing of Structured Lipids 3. Synthesis/Production and Testing of Monoacy/glycerides 4. Application Research of Monoacy/glycerides and Structured Lipids on Certain Consumer Products	Mr. Elias Canapi
II. Nutrition	1. Nutrition Studies	Dr. Corazon Intengan
III. Medicine	1. Clinical Studies: Stressed Human Studies 2. Stressed Animal Studies	Dr. Conrado Dayrit Dr. Manuel Macapinlac
IV. Socio-economic and Marketing	1. Pre-Feasibility Study on the Production and Market Potential of Strucutured Lipids and Monoacy/glycerides	

Source: UCAP

Appendix Table 28. List of on-going researches on coconut conducted by PCRDF as of 1999.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
I. Varietal Improvement	1. Coconut Makapuno Embryo Culture	Basic/Applied Research	1995-Present
II. Crop Production	1. Field Planting Establishment of Embryo Cultured Makapuno in Brgy. Del Rosario, Pilar, Sorsogon	Applied Research	1995-Present
	2. Lakatan-Makapuno Intercropping in Brgy. Del Rosario, Pilar, Sorsogon	Applied Research	1996-Present
III. Coconut Processing	1. State of the Art on the Production of Coconut Vinegar from Coconut Sap	Experimental Development	On-going

Source: PCRDF

Appendix Table 29. List of completed coconut researches conducted by other SCUs, governemnt agencies and private institutions, 1988-1998.

AGENCY OR INSTITUTION/ RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
A. Government Agencies and SCUs			
DA-R4			
A. Crop Production: Coconut-based Farming Systems	1. Crop-Livestock Coco-based Farming Systems:Coco-based Cattle Production With Improved Pasture	R. Cuasay and E. Lalas	1993-1998
	2. Coco-based Cropping Pattern: Coconut + Rambutan, Tayabas, Quezon	L. Marquez and E. Lalas	1993-1997
	3. Coco-based Cropping Pattern: Coconut + Rambutan + Banana + Lanzones + Coffee + Cacao (Multi-Storey Cropping Under Coconut) on Station	L. Marquez and M. de Luna	1994-1997
DA-R5			
A. Crop Production: Coconut-based Farming Systems	1. Development of Evaluation of Sustainable Production Management Technologies Applied to Major Soils in the Bicol Region. Study 2: Evaluation of Low-Cost Production Management Systems for Pumice Soils Under Coconut-Pili Nut	R. Cabangbang	1994-1997
DA-R6			
A. Crop Production: Coconut-based Farming Systems	1. Coconut-based Farming Systems	N. Verdeflor	1992-1997
DA-R8			
A. Crop Production: Coconut-based Farming Systems	1. Farm Resource Systems: Study 1: Intercropping Studies on Coffee Under Coconut	B. Mascelino and G. Pernito	1993-1997
DA-QAES			
A. Crop Production: Coconut-based Farming Systems	1. Intercropping Under Modified Densities of Young Coconut Trees in Tiaong, Quezon	L. Sajise	1996

Appendix Table 29 continued…

AGENCY OR INSTITUTION/ RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	2. Intercropping Under Double Row Triangular Pattern for Mature Coconut Trees in Tiaong, Quezon	G. Peñaflorida	1996
DA-BPI **A. Coconut Processing**	1. Accelerated Fermentation in the Preparation of Coco Vinegar	E. Ramos	1994-1997
USM **A. Crop Production: Coconut-based Farming Systems**	1. Intercropping Under Modified Densities of Mature Coconuts in Kabakan, South Cotabato	R. Cabangbang	1996
DSAC **A. Varietal Improvement**	1. In-Vitro Culture of Makapuno Embryo	R. Sangalang, A. Sanchez, R. Nosa and R. Margue	1996-1997
B. Private Sector			
1. RISE and WIST **A. Coconut Processing**	1. Fresh Coconut Meat Processing (FCMP) System		1995-1996
2. ASCOT, PG Aurora **A. Crop Production, Processing and Marketing**	1. Aurora Coconut Agro-Industrial Research and Development Program		June 1988-1999

Source: PCARRD

Appendix Table 30. List of on-going coconut researches conducted by PCA as of 1999.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
I. Varietal improvement			
A. Breeding and Genetics	1. Collection and Evaluation of Coconut Cultivars and Conservation of Genetic Resources		
	1.1 PCA-ZRC, San Ramon, Zamboanga City	G.A. Santos, R.L. Rivera, S.M. Rivera, E.E. Emmanuel	1972-2000
	1.2 PCA-ARC, Banao, Guinobatan, Albay	B.V. Dela Cruz	1996-2001
	1.3 PCA-PSPC Coconut Breeding Trials Unit	R.C. Dizon	1993-Onward
	2. Hybridization of Coconut Populations of Various Local and Foreign Origin	G.A. Santos, R.L. Rivera, S.M. Rivera, E.E. Emmanuel	1973-2000
	3. Coconut Genotype Evaluation in Cadang-cadang Affected Area and Breeding for Disease Resistance	G.A. Santos, M.J.B. Rodriguez, R.L. Rivera, S.M. Rivera, B.V. dela Cruz	1977-1999
	4. Development of Synthetic Variety of Coconut: PCA SYNVAR 001 (PHSV 001)	G.A. Santos, R.L. Rivera, S.M. Rivera, G.B. Baylon, E.M. Salamanca	1988-2020
	5. Production and Utilization of Selected Planting/Replanting Materials in the Philippines (Code:HSP) Pollen Production	G.A. Santos, E.E. Emmanuel, R.L. Rivera	1990-1999
	6. Establishment of Mini-Seedgarden for the Mass Production of Hybrid Coconut Seednuts for the Replanting Component of Small Coconut Farms Development Project	G.A. Santos, R.L. Rivera, J.A. delos Santos, S.M. Rivera, E.E. Emmanuel, G.B. Baylon	1995-2020

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	7. Determination of Fatty Acid, Protein Profile and Triglyceride Composition of Promising Coconut Hybrids and Cultivars[1/]	G.A. Santos, E.M. Mendoza, J.B. Sangalang, O.A. Magyani	1995-2000
	8. Action Program on Adoption of Suitable Technologies With Emphasis on Coconut Varieties and Hybrids from the Multiloc Project (MULTILOC ACTPRO)	S.S. Magat, G.A. Santos	1996-2006
	9. PCA-PKI Joint Project: Coconut Multilocation Test		
	9.1 PCA-ZRC, San Ramon, Zamboanga City	G.A. Santos, R.L. Rivera, S.M. Rivera	1995-2000
	9.2 PCA-ARC, Banao, Guinobatan, Albay	B.V. dela Cruz, G.A. Santos	1995-2000
	9.3 PCA-DRC, Bago-Oshiro, Davao City	R.C. Blancaver	
	10. Coconut Seed Production Center, Aroman, Carmen, North Cotabato	P. Garcia	1990-Onward
	11. Farmer Participatory Research to Identify Multipurpose Uses of Coconut & Suitable Varieties; and Ex-situ Coconut Genetic Resources Conservation, Evaluation and Use in Localized Conditions through the Coconut-based Farming System Approach	G.A. Santos, R.L. Rivera, E.E. Emmanuel, J.S. Cruz, E. Balbarino, L. Astete, J. Rodriguez	1998-2000
B. Tissue Culture	1. Studies on the Embryo Culture of Coconut	M.B.B. Ubaldo, Z.S. Bonaobra III, C.A. Cueto, O.D. Orense, E.P. Rillo	1989-1999
	1.1 The Growth and Development of Coconut Embryos In-vitro (89/02.2)		
	1.1.1 Phloroglucinol (PG) as Auxin Synergist: Improvement of Root Growth of In Vitro Cultured Coconut Seedlings		

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	2. Clonal Propagation of Coconut Using Various Explants		1989-1998 1999-
	2.1 Clonal Propagation of Coconut Using Leaf Explants (89/01.1)	M.B.B. Ubaldo, Z.S. Bonaobra III, E.P. Rillo	
	2.2 Response of Coconut Cultivars to Callus Initiation, Multiplication, Embryogenesis, and Organogenesis Using Inflorescence as Explants (90/01.1)	C.A. Cueto, M.B.B. Ubaldo, Z.S. Bonaobra III, E.P. Rillo	
	2.3 Clonal Propagation of Coconut using Plumular (Epicotyl) Tissues (96/01.1)	E.P. Rillo, C.A. Cueto	
	2.4 Isolation of Protoplast & Cell Culture (98/01.1)	O.D. Orense	
	3. Makapuno Mass Production	E.P. Rillo, C.A. Cueto, M.D. Alcos	1992-2000
	4. Commercial Production of Makapuno Seedlings		
	4.1 Establishment of Four Satellite Makapuno Culture Laboratories and Demonstration Farms in Selected Sites and Mass Production of Makapuno Seedlings		1999-2004
	4.1.1 PCA-ARC, Banao, Guinobatan, Albay	E.P. Rillo, C.A. Cueto	
	4.1.2 PCA-ZRC, San Ramon, Zamboanga City	R.M. Madrazo, R.A. Blancaver	
	4.1.3 PCA-DRC, Bago-Oshiro, Davao City	R.A. Blancaver, E.S. Poliquit	
	4.1.4 Don Severino Agricultural College	A.C. Sanchez	
	4.1.5 PCA-Pangasinan	J. Aquino	

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	4.1.6 PCA-Tacloban	E. Nierva	
	5. Field Evaluation of In Vitro Cultured Makapuno Palms Under Fertilized Conditions (92/01.1)	E.P. Rillo, C.A. Cueto, R.Z. Margate	1992-2007
	6. Development of an Improved Embryo Culture Protocol	E.P. Rillo, C.A. Cueto	May 1998-Feb. 2000
	7. Coconut Tissue Culture: Optimization of Protocols Toward Increased Production of Clones		1999-2000
	7.1 Development of Clonal Propagation Procedure Using Inflorescence Tissues from PCA Recommended Hybrid, Tall & Dwarf Coconut Cultivars	C.A. Cueto, E.P. Rillo	
	7.2 Optimization of Micropropagation Techniques for Coconut Using Immature Embryo as Explants	O.D. Orense, E.P. Rillo	
	7.3 Development of a Micropropagation Protocol for Coconut (*Cocos nucifera L.*) using Epicotyl Tissues	M.B.B. Areza-Ubaldo, E.P. Rillo	
	8. Collection, Mass Propagation and Conservation of 'Lono' Type of Coconut in the Bicol Region (99/01.1)	E.P. Rillo, N.M. Navarro	
C. Biotechnology	1. Improvement of Coconut by Biotechnology: Application of DNA Marker Technology to Germplasm Characterization and Breeding Study 1. Analysis of PCA-ZRC Germplasm Collection 1.1 Interpopulation Genetic Diversity Analysis by RAPD 1.2 Infraspecific Genetic Diversity Analysis of Coconut Germplasm Study 2. Coconut Genome Mapping 2.1 Establishment of Mapping Populations with MYD and LAG as Parents	M.J.B. Rodriguez, G.G. Manalo, L.P. Estioko, M.T.I. Namia, S.D. Relova, J.A. Soniega	Oct. 1997-Sept. 2000

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	2.2 Indentification of DNA Markers for the Mapping Population		
	Study 3. Genetic Diversity Analysis of the Bicol Germplasm		
	Study 4. Identification of DNA Markers for the Makapuno Phenotype		
II. Crop Production, Agronomy, Cultural Mgt., Nutrition and Farming Systems			
A. Mineral Nutrition Management (MNM)	1. Growth and Yield of Young Palms as Affected by Annual and Intermittent Fertilizer Application	R.Z. Margate, M.N. Eroy, J.N. Maravilla	1990-2000
	2. Production of Bearing Palms as Affected by Annual and Intermittent Fertilizer Application	M.N. Eroy, R.Z. Margate, J.N. Maravilla	1995-2005
B. Integrated Soil Fertility Management (ISFM)	1. ISFM in Coconut-Based Farming System I. Perennial Crop-Lanzones	S.S. Magat, J.A. Mantiquilla, R.Z. Margate	1993-2003
	2. ISFM on Local Coconut Hybrid with Annual Intercrop at Farmers Level	M.I. Secretaria, R.Z. Margate	1993-1999
	3. ISFM in Coconut-Based Farming System II. Perennial Crop-Banana	J.N. Maravilla, G.D. Padrones	1995-1998 up to 2000
	4. Field Studies on the Effect of Coconut Coir Dust (cocopeat) on the Yield, Nutrient, Status, and Some Soil Properties of a Coastal Area of Western Mindanao	R.M. Ebuña, S.S. Magat, M.I. Secretaria, L.J. Peñamora, G.B. Baylon	1996-2004
	5. Integrated Soil Fertility and Nutrition Management (ISFNM) in Coconut and Durian Cropping System	R.Z. Margate et.al.	1999-2007
	6. Utilization of Leguminous Plants as Fertilizer for Coconut	G.D. Padrones, R.Z. Margate, R.M. Ebuña	1994-1999

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	6.1 ISFM in Coconut and Durian Cropping System w/ Emphasis on Biological Nitrogen-Fixation	R.Z. Margate, L.H. Canja	1999-2007
	6.2 Field Response to Nitrogen, Potassium & Zinc Fertilizer Combination in Coconut-Based Durian Cropping System	L.H. Canja, R.Z. Margate, S.S. Magat	1999-2004
	6.3 Economic Implications of Coconut and Durian Production Either Planted Singly or in a Mixed Cropping Combination	R.Z. Margate, L.H. Canja	2001-2007
	7. Response of Coconut to Varying Proportions of Inorganic and Organic Fertilizers in Three Agro-Climatic Sites	M.N. Eroy, R.Z. Margate, R.M. Ebuña, M.I. Secretaria	1997-2001
C. Sustainable Cropping System (SCS) / Coconut-based Farming Systems	1. The Residual Effect of Planting Grain Legumes on the Succeeding Crop under Coconut	J.A. Mantiquilla, R.Z. Margate	1994-1999 1998-1999
	2. Development of Coconut Leaf Pruning Techniques in Bearing Palms to Increase Sunlight Transmission and Productivity of Coconut-Based Farming System		
	2.1 Coffee	S.S. Magat, L.H. Canja, R.Z. Margate	1995-1999
	2.2 Annuals-Peanut, corn, sweet potato	S.S. Magat, L.H. Canja, R.Z. Margate	1996-1999 2000
	2.3 Gmelina Arborea	M.I. Secretaria, G.D. Padrones, S.S. Magat	1993-2003
	2.4 Varietal Response of Coconut to Leaf Pruning		
	2.4.1 Varietal Response of Local Coconut Population with Durian Intercrop to Leaf Pruning under DRC Condition	M.N. Eroy, R.Z. Margate, J.A. Mantiquilla, S.S. Magat, G.A. Santos	1995-2005

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	2.4.2 Varietal Response of Foreign Hybrids and Tagnanan Tall to CLP under DRC	M.N Eroy, R.Z. Margate, S.S. Magat	1996-2001
	2.4.3 Response of Local Populations to CLP under ZRC Condition	M.N. Eroy, R.M. Ebuña, G.B. Baylon, R.Z. Margate, S.S. Magat, G.A. Santos, R.R. Rivera	1996-2001
	2.4.4 Response of Exotic Hybrid and Local Talls to CLP under ZRC Condition	M.N. Eroy, R.M. Ebuña, G.B. Baylon, R.Z. Margate, S.S. Magat, G.A. Santos, R.R. Rivera	1996-1999
	2.4.5 Response of Various Coconut Population to CLP	M.N. Eroy, R.M. Ebuña, R.Z. Margate, S.S. Magat, G.A. Santos, R.R. Rivera	1998-2005
	3. Sequential Coconut Toddy and Nut Production (SCTNP) in Coconut Cultivars and Hybrids	M.I. Secretaria, R.M. Ebuña, J.N. Maravilla, S.S. Magat, R.M. Madrazo, G.A. Santos, G.B. Baylon	1998-2000
	4. Evaluation of Nitrogen Fixing Trees as Living Poles for Blackpepper under Coconut	J.N. Maravilla, R.Z. Margate, M.I. Secretaria, M.N. Eroy	1995-2005 1998-2005
	5. Growth and Yield Modeling of Coconut at PCA-DRC	M.N. Eroy, L.H. Canja, R.Z. Margate, J. Dauzat, S. Braconnier	1997-2000 May 1998-May 1999

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	6. Architectural Modeling and Radiative Climate Simulations for Predicting Productivity of CBFS Involving Selected Coconut Varieties and Hybrids in Different Agro-Ecological Conditions in the Philippines	R.Z. Margate, S.S. Magat, M.M. Eroy, M.I. Secretaria, R.M. Ebuña, L.H. Canja, R.B. Rivera, E. Aguilar (FSSRI), Medina (FSSRI), CIRAD researchers	1998-2000
D. Integrated Crop-Livestock	1. Integration of Forages for Cattle Production into Small Scale Coconut Farms	J.A. Mantiquilla, R.Z. Margate, S.S. Magat	1996-1999
	1.1 Evaluation of Forage Technologies for Grazing under Coconut 1.2 Evaluation of Legumes for Use as Cover Crops in Coconut Plantations 1.3 Demonstration and Multiplication of Grasses for Use in Cut-And-Carry Feeding Systems in Older Coconut Plantations 1.4 Evaluation of Multi-purpose Trees and Shrubs (MPTS) for Use in Cut-And-Carry Feeding Systems under Coconuts		
	2. Participatory Research with Smallholder Farmers	W.W. Stur, F. Gabunada, E. Magboo, R. Buac, R. Laguardia Jr., C. Albacite, J.A. Mantiquilla	1997-1999
E. Combined Irrigation and Fertilization of Young Palms & Existing Stands w/ CBFS under Different Climatic Conditions in Mindanao		L.H. Canja, S.S. Magat, R.Z. Margate, R.M. Ebuña, M.I. Secretaria, G.D. Padrones	1999-2003
	Sub-study 1. Effect of Increasing Levels of Irrigation in Polybagged Coconut Seedlings	L.H. Canja, R.Z. Margate, S.S. Magat	1999-2000

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	Sub-study 2. Effect of Combined Irrigation & Fertilization on Young Laguna Tall Palms Planted in the Intermediate & Dry Growing Zones in Zamboanga & Sarangani Provinces	L.H. Canja, R.Z. Margate, S.S. Magat, R.M. Ebuña	1999-2003
	Sub-study 3. Response of Bearing Laguna Tall Palms w/ CBFS under Different Soil Types & Climatic Conditions in Luzon, Visayas & Mindanao	L.H. Canja, M.I. Secretaria, G.D. Padrones, M.N. Eroy, S.S. Magat	1999-2003
F. Integrated Crop Protection			
F.1 Integrated Control of Major Coconut Pests	1. Rhinocero Beetle		
	1.1 Bio-ecological and Damage Assessment Studies on Rhinoceros Beetle under Field Condition	R.G. Abad, E.D. Atterado	1998-2005
	1.1.1 Collection of Geographical Isolates of the Green Muscardine Fungus (GMF), Cultural Requirement Studies, Characterization and Bioassay	E.D. Atterado, N.S. Bachiller	1993-2000
	1.1.2 Search for Cheaper Substrates for the Mass Production of the Green Muscardine Fungus (GMF)	E.D. Atterado, N.S. Bachiller	1995-2000
	1.2 New Technology of Pest Management against Pests of Coconut: Research and Development on Selective Trapping using Synthetic Attractants	AR.R. Alfiler	1999-2000
	1.3 Pathogenecity Trials of GMF on Silkworm, *Bombyx mori L.*	E.D. Atterado	1998-1999
	2. Limacodids		
	2.1 Use of Crude Extracts of Diseased Limacodid Larvae against Slug Caterpillars	R.T. Escalona, N.S.J. Bachiller	1991-2000
	2.2 Screening of Coconut Cultivars/Hybrids for Rresistance/Tolerance to Slug Caterpillars	V.C. Gallego	1997-2000

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	3. Use of Botanicals Biocides for the Control of Major Pests of Coconut and Intercops (99/01)		
	3.1 Extraction and Biological Evaluation of Selected Botanical Biocides	J.C. Orense, E.P. Pacumbaba	1999-2003
	3.2 Integration of Botanical Biocides to Pest Management Schemes in Coconut-Based Farming System	M.L. Imperial, E.P. Pacumbaba	1999-2003
F.2 Integrated Control of Major Coconut Diseases	1. Phytopthora Disease		
	1.1 Survey & Collection of Phytopthora Isolates (Study)	E.S. Poliquit, R.G. Abad, E.C. Manohar	1988-2000
	1.2 Further Studies on the Effect of Light, pH, Temperature and Relative Humidity on Growth and Sporulation of P. Palmovira Disease of Coconut	N.S.J. Bachiller	1998-1999
	1.3 Morpho-chemical Characterization Studies of *Phytophtora*	N.S.J. Bachiller	April 1999
	1.4 Exploratory Trial on the Effect of Inorganic Phosphorus Fertilizer on the Incidence on Phytopthora Disease of Coconut under Field Conditions (Study)	E.S. Poliquit, R.G. Abad	1995-2000
	1.5 Bio-ecology of Phytopthora in DRC	E.S. Poliquit, R.G. Abad, N.S.J. Bachiller	
	2. Cadang-cadang		
	2.1 CCVd Inoculation of Progenies of Palms Found Resistant to Cadang-cadang	M. Orolfo and M. Rodriguez	1994-2000
	2.2 Epidemiology of Cadang-cadang Disease of Coconut:	E.P. Pacumbaba, M.L.R. Imperial	1987-2000
	2.2.1 The Nature of Spread of Cadang-cadang Viroid in the Field		
	2.2.2 Confirmatory Survey of Cadang-cadang Distribution in the Philippines		1999 (Dec)

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	2.2.3 Biennial Survey (Assay of Remaining Test Palms and Consolidation of Data)		
	2.3 Seed Transmission of Cadang-cadang to F1 Progenies of Infected Palms	J.C. Orense, E.P. Pacumbaba	1990-2000
	2.4 Survey & Pathogenecity Testing of Viroid-like RNAs in Coconuts within the Philippines	J.A. Soniega, M.J.B. Rodriguez	1995-1999
	2.4.1 Detection and Isolation of Viroid-like RNAs (VLR) 2.4.2 Transmission of Coconut Cadang-cadang Viroid to *Maranta arundanicea*		
	2.5 Effect of Removing Cadang-cadang Infected Palms on the Spread of the Disease	R. Alfiler and E. Pacumbaba	1990-2000
G. Weed Management in Coconut	1. Biological Control of Chromolaena Odorata in the Philippines	E.D. Atterado, R.G. Abad	1999-2002
	2. Bioecological Studies on "Yellow Asters" Heliantus Circumerifolices Torn & Gray	E.D. Atterado	1998-2003
H. Pest Management in Coconut Based-Farming System (CBFS)	1. Biology and Control Studies of Rarosiella Cocosae Rimando, Afalse Spider Mite Severely Infesting Coconut Palms in Northern Mindanao	C.E. Gallego, R.G. Abad	1997-2001
	2. Mites 2.1 Mites - biological and morphological study 2.2 Mites - host range studies	C.E. Gallego	
	3. Biology and Biological Control of the Coconut Mealybug in S. Mindanao	V.C. Gallego	1998-1999
	4. Pest Management in Coconut-Based Farming System (CBFS) - Reg. XI	N.S.J. Bachiller, R.G. Abad, et.al.	cont.
	5. Development of an Integrated Pest Management in CBFS in Region V.	E.P. Pacumbaba, et.al.	cont.

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
	6. Biology and Biological Control of the Coconut Mealybug in Palawan	J.C. Orense, E.P. Pacumbaba	1996-1999
III. Coconut Processing/ Postharvest			
A. Coconut Timber Coir, Fiber and Other Cellulosic Material Utilization/ Postharvest	1. Manufacture of Woodwool-Cement Boards from Logging Residues Sawmilling Wates and Husks 1.1 Piloting and Commercialization of the Prototype Coconut Husk Decorticating Machine 1.2 Design and Fabrication of Baling Press Machine and CWB Trimmer 1.3 Production of Coir-wood-cement Boards Decorticating Machine	R.J. Palomar, L.J. Peñamora	1991-2000
	2. Anatomical Variations, Chemical, Physical and Mechanical Properties of Cadang-cadang Infected Cocowood	L.J. Peñamora, R.N. Palomar, E.P. Pacumbaba, N.J. Melencion	1994-1999
	3. Fabrication & Commercialization of Coconut Husk Decorticating Machine	R.N. Palomar, D.G. Fajardo, E.V. Ramos	1998-2000
	4. Design & Fabrication of Coconut Coir Twinning Machine	N.J. Melencion, R.N. Palomar, L.J. Peñamora	1999-2000
	5. Agro-industrial Utilization of Coconut Coir Dust	L.J. Peñamora, R.N. Palomar, N.J. Melencion	1999-2000
B. Modernization of Coconut Production and Facilities for High-Value Products and By-Products	1. Fresh-Dry Production of Coconut Oil and By-Products Processing		On-going
C. Coir Dust Processing, Utilization, and Commercialization	1. Coir Decortication and Wallboard Manufacturing in Davao Oriental (Development Studies and Technology Transfer)		On-going

Appendix Table 30. Continued

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
D. Energy Security Program	1. Waste Heat Utilization		On-going
	2. Pilot-testing and and Cruzesterification Process in the Production of Biodiesel		1996-Onwards
E. Dry Process	1. Assessment and Improvement of Existing Dryer Designs		On-going
F. Alcoholic Beverage	1. Development Studies on Alcoholic Beverages (Wine and Champagne Type) from Coconut Water [1/]		On-going

[1/] In collaboration with UPLB

Source: PCA, PCARRD and PCIERD

Appendix Table 31 . List of on-going researches on coconut being conducted by ITDI-DOST as of 1999.

RESEARCH AREA	STUDY TITLE	SOURCE OF FUND	DURATION
I. Coconut Processing			
A. Non-Food/Oleochemicals	1. Pilot Plant Production of Monolaurin from Coco C_{12} Fatty Acid	PCIERD	1994 to Present
	2. Alkyl Phosphate (Pilot Production)	PCIERD	On-going
	3. Laboratory Synthesis of Di-Alkyl Sulfo Succinic Acid Ester from Coco-Based Chemicals	PCIERD	On-going
	4. Stearates (For Piloting)	PCIERD	On-going
	5. Polyamide Derivatives and Silicon-based Fatty Acid Ester for the Textile Industry	PCIERD	On-going
	6. Di-Functional Amides: Di-Ethelene Bistearamide (Scale-Up Production)	ITDI	On-going
	7. Mono-Laurin (Scale-up Production and Application Testing)	ITDI	On-going
	8. TMP and PEE (Scale-up Production)	ITDI	On-going
	9. Enzymatic Extraction of Monoglyceride	ITDI	On-going
	10. Imidazoline Derivative	ITDI	On-going
	11. Alkyl Glucoside	ITDI	On-going
	12. Coco-Amine Betaine	ITDI	On-going
B. Health Food and Medicinal Products	1. MCT (Production and Utilization)	UPLB-CIIF	On-going
C. Coconut Water Processing, Utilization, and Commercialization	1. Accelerated Vinegar Production	ITDI	On-going
	2. Coco Beverage Powder	ITDI	On-going
	3. Coco Water Concentrate	UNDP	On-going
D. Modernization of Coconut Production Processes and Facilities for High-Value Products and By-Products	1. Fast Drying of Coconut Meat	ITDI	On-going
	2. Integrated Coconut Processing (Wet Process/Wet-Dry Process)	ITDI	On-going

Source: PCIERD and PCARRD

Appendix Table 32. List of completed researches on coconut conducted by FNRI as of 1999.

RESEARCH AREA	STUDY TITLE	COOPERATING AGENCIES	DURATION
I. Coconut Processing and Product Development			
A. Nutrition and Health	1. Production and Utilization of Raw-Fat Coconut Flour As Functional Foods 1.1 Production of Quality Coconut Flour/Flakes Using a Rapid Drying Method 1.2 Characterization of the Dietary Fiber Content and Studies on the Nutritional Benefits of Coconut Flakes 1.3 Food Safety Aspects (e.g., Microbiological and Toxilogical Tests) of Coconut Flakes 1.4 Development of Functional Foods Utilizing Coconut Flakes	PCA, ITDI, College of Home Economics, U.P. Diliman	On-going (3 years)
	2. Nutritional and Health Benefits of Coconut Fiber, Legumes, Dilseeds, Rootcrops, and Beans		1998-2001

Source: PCIERD

Appendix Table 33. List of ongoing researches on coconut being conducted by UPLB as of 1999.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	SOURCE OF FUND	DURATION
I. Varietal Improvement	1. Improvement of Coconut Embryo Culture Efficiency for Germplasm Collection and Conservation	A. del Rosario (CA-Horti)	IPGRI (CA-Horti)	1998-2000
	2. Identification and Selection of Outstanding Tall Coconut Plantations and Mother Palms as Future Sources of Planting Materials	J. Sangalang (CA-Horti)	J. Sangalang (CA-Horti)	1996-06/ 1999
	3. Development of Genome Maps and Genetic Markers for Coconut and Mango using Molecular Marker Technologies	D. Hautea (IPB)	PCASTRD/ PCARRD	1996-05/ 1999
	4. Crops R&D Biotechnology Program: Project I. Development of Gene Constructs and Appropriate Transformation Systems for the Fatty Acid Modification of Coconut Oil	E. Mendoza (IPB)	DOST/ PCARRD	1999-2000
	5. Genetic Diversity Analysis of Coconut Talls Using Molecular Markets	C. Reano (IPB)	UPLB Basic	1997-01/ 1999
	6. Determination of Fatty Acid, Protein Profile and Triacylglyceride Composition of Promising Coconut Hybrids and Cultivars: Project II	E. Mendoza (IPB)	DOST/ PCARRD	1996-05/ 1999
	7. Identification and Genetic Variability Characterization of Causal Organisms of Bud and Fruit Rots in Coconut	G. Molina (IPB)	UPLB	1996-08/ 1999
II. Coconut Processing and Product Development	1. Preparation of Ultrafiltration and Reverse Osmosis Memebranes from Nata de Coco and their Use in Mango Processing	E. del Rosario (CHEM)	PCASTRD	1996-08/ 1999
	2. Enzymatic Intensification of Coconut and Non-Lauric Oils for the Production of Specialty Oils	L. Pham (BIOTECH)	UPLB- BIOTECH	1997-2002
	3. Studies on the Application of Biotechnology-Produced Lipases on Enzyme Catalyzed Syntheis of Flavor Esters of Coconut-Oil Based Products	T. Espino (BIOTECH)	PCASTRRD	1997-2000

Source:UPLB

Appendix Table 34. List of on-going researches on coconut conducted by VISCA as of 1999.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
I. Varietal Improvement and Genetic Conservation	1. Screening of Typhoon-Tolerant Coconut Cultivars and Hybrids	T. Nuñez and J. Vestra	1993-1999
	2. Mass Production of Self-Pollinating Makapuno Hybrids through Embryo Culture	T. Nuñez and V. De Paz	1995-2000
	3. Establishment and Maintenance of Coconut Genebank in VISCA	VISCA-RCRC Researchers	1983-Continuing
	4. Characterization of Local and Introduced Coconut Cultivars/Hybrids	VISCA-RCRC Researchers	1983-Continuing
	5. Assessment of the Potential of Coconut-based Intercropping System As A Tool for Coconut Genetic Resources Conservation	VISCA-RCRC Researchers	1999-2000
II. Crop Production			
A. Cultural Management Practices	1. Effects of Planting Depth on the Growth and Yield of Coconut Cultivars Grown in Hilly Areas in Eastern Visayas	VISCA-RCRC Researchers	1984-2000
	2. Improvement of Abaca Grown Under Coconut with the Use of Creeping Legumes		

Source: VISCA-RCRC

Appendix Table 35. List of on-going researches on coconut conducted by PCRDF as of 1999.

RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
I. Varietal Improvement	1. Coconut Makapuno Embryo Culture	Basic/Applied Research	1995-Present
II. Crop Production	1. Field Planting Establishment of Embryo Cultured Makapuno in Brgy. Del Rosario, Pilar, Sorsogon	Applied Research	1995-Present
	2. Lakatan-Makapuno Intercropping in Brgy. Del Rosario, Pilar, Sorsogon	Applied Research	1996-Present
III. Coconut Processing and Product Development A. Food Use	1. State of the Art on the Production of Coconut Vinegar from Coconut Sap	Experimental Development	On-going
	2. Production of Coconut Sap into Sugar: Pilot Testing		1995-present
	3. Young Coconut Water Development studies		On-going
	4. Product Development for the Use of Macapuno		On-going
B. Industrial Use	1. Enzyme Applications for Oleochemicals and Coconut Studies		On-going
C. Energy	1. Performance Study on the Use of Methyl Ester as 100% Substitute for Diesel		1991-present
	2. Coconut Methyl Ester as Fuel Using variuos Cuts/Fractions		On-going
	3. C6-C8-C10 for Soild Fuels		On-going
D. Nutrition, Health, and Medical Applications	1. Acceptability Test for Structured Lipids		
	2. MCT and Structured Lipids for Filipino Athletes		
	3. Antimicrobial and Anti-Viral Studies Using Monoglycerides (MAGS) - in collaboration with UNILAB		1995-present
	4. Feeding Program for malnourished Children Using Structured Lipids and Monoglycerides		

Source: PCRDF

Appendix Table 36. List of completed coconut researches conducted by other SCUs, governemnt agencies and private institutions as of 1999.

AGENCY OR INSTITUTION/ RESEARCH AREA	STUDY TITLE	RESEARCHERS INVOLVED	DURATION
A. Government Agencies and SCUs			
DA-R4			
A. Crop Production: Coconut-based Farming Systems	1. Coco-based Cropping Pattern: On Station Demo Trial of Rambutan and Lanzones under Coconut (Two Studies)	L. Marquez, E. Caringal and C. Amat	1996-2001
	2. Cattle Production Under Coconut in Poverty Stricken Areas in Bondoc Peninsula	DA-R-4	1998-2000
DA-BAI			
A. Crop Production: Coconut-based Farming Systems	1. Demonstration Trials Under Coconut and Setting Up of Community-based Fodder Development Project	F. Moog, A. Castillo H. Diesta & A. Deocareza	1995-2000
B. Private Sector			
UCPB-CIIF			
I. Coconut Processing: Health and Medical Applications	1. Anti-Microbial, Anti-Viral and Anti-Protozoal Monoglycerides		Ongoing
	2. Anti-Cancer Property Evaluation		
Energy	1. Coconut oil and Derivatives as Fuel Substitutes		Ongoing

Note: UCPB-CIIF is also into commercial production of coco-vinegar and composting of coir dust
Sources: PCCARD and DA-BAR

Appendix Table 37. List of ARDB matured technologies applicable for the Maunlad Na Niyugan Tugon Sa Kahirapan program.

TITLE OF THE TECHNOLOGY	DESCRIPTION/APPLICATION/ADVANTAGES
1. SALT (sodium chloride) as an effective and cheap fertilizer for high coconut productivity Technology Primer No. 1	The use of sodium chloride (NaCl) or common salt as fertilizer is a practical means of increasing coconut production. Advantages of applying NaCl as fertilizer for coconut are the following: (1) accelerates crop growth and development; (2) increases copra weight and number of nuts; (3) minimizes leaf spot damage; (4) increases tolerance to drought (El Niño damage); and (5) is environment-friendly under judicious practice. The use of salt as fertilizer at a rate of 1-2 kg salt/tree is estimated to give the benefit-cost ratio of 7.3-9.5 which is comparable to a net Return of P18,000-P29,000. Salt fertilizer costs only P580/ha per year compared to commercial KCl fertilizer which is P1,280/ha per year thus a total savings of P7800/ha per year or a cost reduction of at least P 700,00 for every 1,000 has. of fertilized coconut lands.
2. Makapuno embryo culture technology Technology Primer No. 2	Embryo cultured makapuno palms can produce up to 100% makapuno coconuts, if properly isolated compared to the traditional makapuno bearing palms grown from non-makapuno nuts which can give only up to 25% yield. Adoption of the technology can assure the coconut industry a reliable supply of makapuno.
3. Excelsa coffee under coconut Techno Guide Sheet No. 2: Plant Excelsa coffee under coconut and double or triple your income	Excelsa coffee can yield twice or thrice as much as that of Robusta or Arabica. It can increase income even if it demands a little lower price (by about P 5.00/kg) in the local market Regarding net income from coconut alone per hectare, it increased from P 10,136 in year 1 to P 16,213 in year 10. In coffee alone per hectare, a net loss of P22,463 in year 1 will be obtained while a net benefit of P 83,234 will be reaped in year 10. For coconut + coffee per hectare, the net loss will be P 12,327 in year 1 and the net benefits will be P 99,447 in year 10. The payback period is four years and three months.
4. The light levels under coconut canopy and their practical applications in intercropping. Techno Guide Sheet No. 4 Series of 1998	Knowing the amount of sunlight transmitted at varying coconut stands (different distances, ages and planting design) would be very helpful in maximizing intercropping activities. Since the level of light transmitted under different coconut stands is already determined and light requirement of some crops had been established, two most important applications are possible: (1) on existing palms, the farmers can be guided in choosing the appropriate intercrop to plant under their coconut palms, and (2) for new coconut plantings, the farmers can be guided in choosing the distance of coconut planting that they should adopt to provide the required level of light needed by the intercrop that they have in mind.

Appendix Table 37. Continued.

TITLE OF THE TECHNOLOGY	DESCRIPTION/APPLICATION/ADVANTAGES
5. Coconut Husk Decorticating Machine Information Bulletin No. 1 Series of 1997	The PCA coconut husk decorticating machine is of the village type machine designed for small-scale operations. It is affordable and socially adaptable. The main features of the machine are: 1/4 cubic meter-capacity cylindrical case that houses the 20-blade rotary assembly to decorticate the husk. It consists of two hoppers that serve as separate passages of coir fiber and dust. It is run by a 3-phase 20-hp electric motor. The machine has a rated capacity of 3 tons of coconut husk per day by operation. It can be fabricated at an estimated cost of P 170,000. The projected annual net profit is P 594,047.
6. Coconut Coir-Wood-Cement Boards Information Bulletin No. 2 Series of 1997	Coir-wood-cement board (CWCB) is a composite product of coir fiber, wood fiber and cement. It is a 3-ply assembly in which the coconut coir fiber is embedded in between layers of wood fibers. It is produced by mixing the fibers with cement at a predetermined ratio of 70% cement and 30% fiber. The mixture is pressed to the desired thickness and then cured. The boards are suitable for a wide range of uses from building construction materials for furniture parts. Annual net profit of CFCB production is P 3,335,700.
7. Sequential Coconut Toddy-Nut Production (SCTNP) Scheme Information Bulletin No. 3 Series of 1997	To get the most from the coconut palm coherent with the country's economic interest, the sequential production of two products: toddy and nuts from the same spathe of palms could be explored. The advantages of the technology are the following: (1) is simple, practical, feasible and economically viable; (2) provides additional income from toddy and its by-products (frozen fresh drink, syrup/crude sugar, vinegar and wine); (3) copra or oil can still be produced for local needs and for export; (4) ensures year-round supply of both coconut toddy for beverage and as raw material for vinegar, as well as fresh nuts for buko or copra; (5) increases farm productivity and sustainability; and (6) produces a satisfactory yield of toddy and nut/copra, giving an annual average net returns of P 71,000/hectare.
8. PCA recommended coconut hybrids and cultivar	After 15 years of study, nine (9) locally developed coconut hybrids and one (1) local tall were selected from the pool of 67 hybrids and cultivars established in 11 genetic trials at the PCA-ZRC genebank The coconut hybrids generally flower earlier (3-4 years from field planting) and produce nuts one to two years earlier than the local cultivars. Under moderate condition, e.i., 4 to 5 dry months per year, these hybrids have a potential yield of 5 tons copra per hectare.

Appendix Table 37. Continued.

TITLE OF THE TECHNOLOGY	DESCRIPTION/APPLICATION/ADVANTAGES
9. Integrated Pest Management for Rhinoceros Beetle CPD Technoguide No. 1 Series of 1998	The rhinoceros beetle are the most injurious pest of coconut. The beetle bores its way into the soft tissues in the bud. As the leaf emerges, it exhibits symmetric cuts and in many instances, the spathe is missing on the axil. Depending on the level of population, the leaf may show varied forms of damage ranging from single cuts, double or multiple cuts. Leaves with cut at the base usually break off as it emerges. Causes of beetle outbreaks are the following: (1) abundant breeding sites alike rotting trunks; (2) stumps; (3) heaps of sawdust; (4) corn cobs; (5) rubber tree; (6) heaps of rice straws; (7) sugarcane bagasse; and (8) animal manure. The most practical approach in beetle control is preventing the flight of the adult to cause damage. The control methods are the following: (1) mechanical (use of trap box egg laying site); (2) cultural (intercropping, sanitation, covercropping); (3) biological (green muscardin fungus, baculo virus); and (4) chemical.
10. Rodent control methods in coconut production. CPD Technoguide No. 2 Series of 1998: Control rodents in coconut to increase production.	Estimate of rat damage to coconut ranges from 2-23%. Signs of damage on seedlings are gnawed holes made on the base of seedlings. These holes predispose the seedlings to disease infection while on seednuts are irregular gnawed holes on perianth lobe of immature nuts. Five-month old nuts are most often damaged although 3-8-month old nuts are susceptible . The damaged nuts prematurely fall. Methods of controlling rats in coconut plantations which have been proven to be successful are the following; (1) cultural control (ring weeding, clean culture and cultural practices; (2) baiting (crown baiting and ground baiting); and (3) banding.
11. Method of controlling coconut bud and nut rots CPD Technoguide No. 3 Series of 1998: Control of coconut bud and nut rots	Coconut bud and nut rots are caused by the soil-borne fungus *Phytophthora*. For bud rot, the initial symptom is the wilting and bending of the spear leaf. Eventually this will droop and dry. If the bud is dissected, rotten tissues exuding foul odor is manifested. At this stage, the palm could no longer recover. Death of palm takes 3 to 9 months after onset of infection. Initial symptom of nut rot is the appearance of dark brown sunken irregular patches with water-soaked borders on the equatorial portion on the surface of the nuts. The infected nuts will no longer reach maturity since it falls-off prematurely. When the nuts are split, rotten meat is observed. Farm sanitation is the control measure used.

Appendix Table 37. Continued.

TITLE OF THE TECHNOLOGY	DESCRIPTION/APPLICATION/ADVANTAGES
12. Use of the Green Muscardine Fungus (GMF) to control the coconut Rhinoceros beetle CPD Technoguide No. 4 Series of 1998: Control the coconut Rhinoceros beetle using the Green Muscardine Fungus (GMF)	The Green Muscardine Fungus (GMF) infects the larva, pupa and adult of the beetle. The white mass of the fungus can first be seen on the surface on the mummified body of the beetle, which turns green after 3 to 5 days. The methods of GMF application are the following: (1) mixing the GMF powder in the breeding media where active beetle breeding is taking place; (2) using a locally-made injector; and (3) controlling with GMF-infected larva. The cost of trap box installation + GMF per hectare is P1,770. Equivalent income of P6,287.50/ha (443.60 kg copra x P14.50/kg) is achieved if Rhinoceros beetle will be controlled using GMF. Hence this will give an ROI of 377.6% (6,287.50/1770 x 100).
13. Coconut husk decorticating machine Technology Primer No. 4: Commercialization of coconut husk decorticating machine	The specifications of the coconut husk decorticating machine are as follows: (1) the cylinder which houses the rotary assembly measures 80 cm in diameter and 120 cm in length and made of flat iron sheet 9.5 mm in thickness; (2) the rotary assembly has a total of 24 blades; (3) a trough which receives the husks before feeding them inside the cylinder; (4) two hoppers installed below the machine; and (5) a 20-Hp, 3- phase electric motor which serves as the power unit. The plant capacity is expected to produce 352 tons or coir fiber and 2.4 tons of coir dust per day in an 8-hour operation. Based on the grading standard of coir fibers, the fibers produced by the machine are mixture of long (12.7 cm or more) and short (6.35 cm to < 12.7 cm) fibers including fibers less than 6.35 cm. The operation of the machine and its accessory equipment requires a total land area of 1,000 square meters. The plant employs one plant manager and 8 production staff. The basis for establishing a market for coir fibers and dusts are the following: (1) market outlets; (2) promotions; and (3) selling price wherein the coir fiber is sold at PhP 6.50 per kilogram while the dust at PhP 2.50. The financial aspect of establishing a coconut husk processing plant are as follows: The total investment amounts to PhP 1,602,000, annual production cost at PhP 2,304,000 annual sales of PhP 3,608,000, annual gross profit of PhP 1,304,000 and net profit of PhP 882,740. Financial analysis in the production of coir fiber and dust show that the project is profitable, indicating a benefit-cost ratio (BCR) of 1.17 and an internal rate of return (IRR) of 25.83%. The investment cost can be recovered in 1.23 years of operation assuming that all the coir fibers and dusts produced are absorbed in the market.

Source: PCA

Appendix Table 38. Other coconut technologies developed by PCA.

COCONUT TECHNOLOGY	STATUS
1. Improved Kukum Dryer - Designed-improved the existing kukum dryer. The performance of the expeller and neutralization equipment were optimized and appropriate procedures producing good quality copra was determined.	For commercialization
2. Utilization of Fiber Pads for Construction and Civil Works	For technology dissemination; PCA to propose to DPWH for field testing
3. Coco Wine and Champagne from Coconut Water	For piloting
4. Coconut Leaf Pruning	For commercialization
5. Average Fertilizer Combination (Ammonium Sulfate Plus KCl) to Correct N, S, K, & Cl Deficiency	For information dissemination

Source: PCIERD and PCA

Appendix Table 39. Coconut wood utilization technologies developed by FPRDI-DOST.

COCONUT TECHNOLOGY	STATUS
1. High Pressure Sap Displacement Treatment of Coconut Trunk Utility Poles	Already commercialized Adopted by Agri-Aquatic Resources and Meralco
2. Chainsaw Table Saw Lumbering System	Already commercialized Adopted by Quezon Lumber Co., Daraga Business Venture, Rances Construction Enterprises, MCB Construction & General Services, and Alwyn Enterprises
3. Cocowood Grocery Pallets	Already commercialized Adopted by CFB Inc., Pasajol Wood-Craft, and Philippine Pallet Resources
4. Cocowood-based Wares and Cocowoodcraft	Already commercialized Adopted by The Davao Ethnokraft Design
5. Charcoal Briquetting from Coconut Shells and Husks Using the FPRDI Mechanical Briquettor	Already commercialized Adopted by Ausur Manufacturing Inc.
6. Composing Jig for the Production of Cocopanels for Furniture	Already commercialized Adopted by Jermond International, Inc.
7. Coco Veneer Laminated Panels	Already commercialized Adopted by Fancy Panels, Inc.
8. Coir Dust Resin	Piloted in the Constant Manufacturing Co.; for commercialization

Source:FPRDI

Appendix Table 40. Coconut technologies developed by ITDI-DOST.

COCONUT TECHNOLOGY	STATUS
1. Synthesis of Cocoamine betaine - Developed the laboratory scale synthesis of amino betaine C_8-C_{14} from fatty amines and also developed a new product based on coco-based chemicals such as amphoteric surfactants up to the bench scale level	Evaluate for commercial potential
2. Scale-up Production of Polyglycerol Esters - Developed a process for the production of polyglycerol esters from the laboratory to the scale-up level. Reaction parameters were optimized to effect the maximum yield of good quality product.	Evaluate for commercial potential
3. Production of Alkyl Polyglycosides From Fatty Alcohols and Glucose	For economic evaluation
4. Polyol Esters from Coco-based Chemicals (Scale-up Production Application Testing) - Developed a process for the production of poly esters, namely pentaerythritol ester in a scale up level. It involved the reaction of coconut fatty acids with pentaerythritol in the presence of PbO	For economic evaluation
5. Surfactants from Crude Coconut Oil (CNO) - Developed intermediaries for detergents and shampoos and industrial surface active agents through sulfation and phosphorylation reaction of coco fatty alcohols	For economic evaluation
6. Production of Amine Oxide from Coco-Based Chemicals - Produced amine oxide on bench-scale from coco-based chemicals in a 5-liter reactor. A sample was submitted to a private company for application testing of the oxide as textile softener and as a secondary surfactant for detergent and shampoo.	For economic evaluation
7. Plant Production and Application Testing of Alkyl Phosphate as Textile Auxiliary from Coco-Based Chemicals - Developed a technology for the production of selected textile auxiliaries from coconut oil-based chemicals, lauryl alcohol, for commercial production	For economic evaluation
8. Production of Triacetin from Coconut Oil Derivative Glycerol - Developed local technology of producing triacetin from glycerol which is available from the hydrolysis or splitting of coconut oil and acetic acid or acetic anhydride.	For economic evaluation
9. Synthesis of Fourth Generation Biocides Using Coconut Fraction	For economic evaluation
10. Application Testing of Medium Chain Triglycerides (MCTs) for Food Application and Purification of Strucutured Fats	For economic evaluation
11. Lubricant Additives from Coco-based Chemicals	For economic evaluation
12. Cold Process of Soap Making	Commercialized
13.Technology for processing nata de coco into biopolymer	For possible commercialization

Source: PCIERD

Appendix Table 41. Coconut technologies developed by FNRI.

COCONUT TECHNOLOGY	STATUS
1. "Lahar" Minicolumn Test Kit for Aflatoxin Screening of Copra Meal	For commercialization
2. Micronutrient Fortification of Priority Foods; Vitamin A in Cooking Oil - Developed the local fortification of Vitamin A in cooking oil wherein the process is being done in a closed system with very minimal presence of oxygen to miminize the degradation of Vitamin A - Established the adequate fortification level of crude coconut oil (CNO), temperature of CNO as well as the storage of production wherein the fortification is added	Technology already commericialized - the technology was successfully transferred to the San Pablo Manufacturing Corp. The latter is already selling "Minola" Edible Oil which is fortified with Vitamin A in the local market.

Appendix Table 42. Coconut technologies developed by UPLB researchers.

COCONUT TECHNOLOGY	STATUS	UNIT
1. Integrated Coconut Processing: Los Baños Fresh-Dry Methods	Commercialization	CEAT-AGPET
2. Application of Beta-Monoglyceride (Produced from Lipase Catalysis) As An Anti-Microbial Agent in Soap	Pliot testing	BIOTECH
3. Instant Buko Juice	Laboratory stage	CA-IFST
4. Centennial Wine	Pilot testing	CA-IFST
5. Mannanase-Treated Copra Meal	Commercialization	BIOTECH
6. Cocogro	Commercialization	BIOTECH
7. Fractionation Column for the Production of Cocodiesel and Methyl Esters	Fabrication	CEAT-CHEMENG
8. Technique for Oil Extraction from Nata de Coco Scrappings	Laboratory stage	CA-IFST
9. Coco Water Beverage	Laboratory stage	CA-IFST
10. Coconut Sap Syrup	Laboratory stage	CA-IFST
11. Copra Meal	Laboratory stage	CA-IFST
12. Nutri-Beverage from Coconut Skim Milk	Pilot testing	CA-IFST
13. Syrup for Bottled Buko	Pilot testing	CA-IFST
14. Dehydrated Edible Coconut Meat (DECM)	Commercialization	CA-IFST
15. Coconut Milk Yoghurt	Commercialization	CA-IFST
16. Coconut Filled White Soft Cheese	Commercialization	CA-IFST
17. Coconut Water Vinegar Production	Commercialization	CA-IFST
18. Nata de Coco	Commercialization	CA-IFST
19. Tissue Culture of Makapuno	Commercialization	CA-IFST
20. Embryo Culture of Makapuno	Commercialization	CA-IFST
21. Use of Expeller for Extracting Oil from Sapal	Commercialization	CA-IFST
22. Control of Rancidity in Coconut Oil from Wet Processing	Commercialization	CA-IFST

Souce: UPLB

Appendix Table 43 . Coconut technologies developed by U.P. Diliman.

COCONUT TECHNOLOGY	STATUS
1. New Food Products from Nata de Coco	For dissemination
2. Synthesis of Oleochemicals from Coconut Oil Using Four Fungal Lipases	For economic evaluation
3. Antigenotoxicity of Coconut Oil	For economic evaluation
4. Determination of the Structure of New Glycerides from Coconut Oil	For economic evaluation
5. Polyurethane Plastics from Coconut Oil	For economic evaluation
6. Heterogeneous Photocatalytic Synthesis of Fuel Alkanes from Coconut Oil Fatty Acids Using Solar Energy	For economic evaluation
7. Coconut Flour and Other Non-Traditional Exportable Coconut Items	For technology adaptation at the farm level

Source: PCIERD

Appendix Table 44. Coconut technologies developed by VISCA-RCRC.

COCONUT TECHNOLOGY	STATUS
1. Nine Coconut Hybrids	Commercialized
2. Four Makapuno Genotypes	Commercialized
3. Technique to Double Seedling Production from Makapuno Embryos	Commercialized
4. Appropriate Techniques to Sustain Soil Fertility Using Cheap and Indigenous Organic Materials	Commercialized
5. Suitable and Promising Annual and Perennial Crops As Intercrops	Commercialized
6. Tools and Equipment for Coconut Processing	Commercialized
7. Low-Cost and Efficient Technique In Copra Processing Such as the VISCA Dryer for Direct Fire Drying of Copra	Commercialized

Source: PCARRD and VISCA