A SUPPLY RESPONSE STUDY OF COCONUT IN THE PHILIPPINES

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by

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CHAPTER I

INTRODUCTION

The Coconut Industry in Perspective.

The coconut industry had taken a position of strategic importance in the Philippine economy even before the nineteenth century. Coconut planting on a large scale began with a 1642 decree issued by the Spanish Governor General in 1800 ordering all village chiefs to plant 200 trees to provide coir for rigging the Spanish galleons. This decree started the rapid expansion of agricultural land planted to coconuts. In 1977 it was reported that the coconut industry provides livelihood to 14 million Filipinos particularly the plantation owners, the tenants, the copra makers, laborers and employees of the various manufacturing establishments and their families.

At present, coconut palms occupy a vast area of agricultural land in the Philippines. Of the total land base which is 30 million hectares, 3.126 million hectares was reported to be planted to coconuts in 1980 giving a total production of 9,774 million nuts in the same year.

Exportation of coconut products such as copra, coconut oil, desiccated coconut and copra meal or cake represents a large share of the total foreign exchange receipts of the Philippines. Among the Philippine exports, coconut products account for 25 percent of the total foreign exchange receipts and rank as the number one major export of the Philippines in 1978. The 1978 figure for exporting various coconut products had reached $907 million, out of the total value of exports amounting to $3,424 million.

However, the present situation of the coconut industry is plagued with problems. First, the average coconut production of 30-35 nuts per tree per year is very low compared to the potential yield of 150 nuts per tree per year. The low productivity is due to the senescent stage of the coconut trees. Most coconut palms have reached the 60 years of economic life and production is starting to decline. Also many farmers have neglected their trees in terms of management and cultural practices such as fertilization, crop protection and the like.

Second, close substitutes for coconut oil like palm oil have been increasing. Countries with palm oil like Indonesia and Malaysia have reemerged as exporters of coconut oil since they can use palm oil domestically as a substitute for coconut oil. If coconut production continues to decline, prices will tend to increase unless demand also declines. This decline in production will hamper a great deal the exportation of coconut products.

In addition, the decreasing productivity of the coconut tree has led the different oil mills to operate at more or less half their capacity. According to the Philippine Coconut Oil Producers

Association seven of the fifty oil mills in the industry had shut down as of 1979.[1]

Statement of the Problem

The response of farmers to changes in economic variables in developing countries like the Philippines had been a topic of great importance and had been studied for years. The extensiveness of supply response for any relevant commodities being studied has a great impact on the whole economy. It will affect political issues and problems of public finance, prices and income stabilization. As an agricultural country, as the number one producer of coconut in the world and as a great contributor to total coconut exports in the world, the Philippine coconut industry needs to be studied intensively.

It is well known that relatively few studies have been made on the supply response of perennial crops such as the coconut. Bauer and Yamey[2] have noted the following as factors that have led to fewer studies on perennial crops.

"There are ... serious difficulties in measuring the degree of responsiveness of producers to price changes. There are familiar problems arising from the usual absence in the real world of anything resembling closely the _ceteris paribus_ of the theoretical formulations of functional relationships in economics. There are further difficulties created by the time lags between changes in agricultural capacity and

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[1]UNCTAD Meet Relevant to RP, Special Report, Bulletin Today, Philippines, May 20, 1979.

[2]P.T. Bauer and B.S. Yamey, "A Case Study of Response to Price in an Underdeveloped Country," _The Economic Journal_, 49(276), December 1959, p. 800.

changes in output; and also by the effects of uncertainty about the permanence of absolute and relative price changes. The problems of testing a hypothesis or of measuring the strength of functional relationships make it difficult to reach objective assessments, and rival hypotheses are likely to flourish side by side, often deriving from opposing policy preconceptions and sometimes giving rise to opposing policy prescriptions."

In addition, some historical relevant data for quantitative estimation of the parameters involved are still lacking. Specifically, data of ages of the coconut trees are unavailable to the researcher. However, for the development of the coconut industry and for it to maintain its status in the world careful attention and studies should be done on the supply response of coconuts in the Philippines. So far factors generating the wide annual variations in yield have not been determined. But perhaps prices and weather conditions may affect the estimate of production and yield.

Research Objectives

The specific objectives of this study are:

1. To analyze trends in area, yield and production of coconut domestically.
2. To analyze price trends of the different coconut products.
3. To statistically measure the response of supply to changes in the price of coconut products.

4. To find out what other factors will significantly affect the production and supply of coconuts.
5. To derive some policy implications of the results that will be obtained.

Methodology

Time series data on production, area, yield and prices of coconut and coconut products from 1959 to 1981 will be gathered from different publications of the Philippines and other publications that are available in the Kansas State University library.

Other relevant information necessary for modelling a perennial crop as coconut will be utilized to significantly relate these data to the supply response model of coconut. Computer runs will be done to estimate the coconut supply model.

In addition, tabular, graphical and descriptive analysis of the data will be used.

CHAPTER II

COCONUT AND COCONUT PRODUCTS
PRODUCTION, PRICES AND GOVERNMENT POLICIES

Coconut Products and Uses

The coconut tree is said to be a tree of life. There are about 360 uses of the coconut palm tree and its fruit which make coconut a very versatile plant.[3] The four main products widely exchanged in international trade are discussed at some length in this chapter.

Copra is the dried meat of the mature coconut. The moisture content has been largely reduced by sun-drying or by alternative methods of artificial drying, including smoke curing or drying over an open fire in direct driers or kilns, and indirect drying either on a heated platform or in an enclosed chamber by flues. Copra is not edible but is very useful mainly as a source of coconut oil and its by-products, copra meal and copra cake. During drying, the moisture content of the coconut meat must be lowered from about 50 per cent down to between 5 and 7 per cent, the moisture content producing the optimum amount of oil. The optimum oil content of copra is 65 to 70 per cent and the average number of nuts required to produce one metric ton of copra ranges from 3,5000 to 6,000 nuts, depending on the size of the nuts and the thickness of the meat.

Coconut oil may be produced from fresh, undried meal (via coconut milk), or from copra, either from pressing (with single or multiple

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[3] PCARR, The Phillipines Recommends for Coconut 1975, Los Baños, Laguna, Philippines, p. 27.

presses) or by solvent-extraction methods. The principal uses of coconut oil are for edible purposes (the manufacture of margarine, cooking oil and shortening) and for industrial usages (the manufacture of soap, fatty alcohols, plasticizers, detergents and explosives). Its value in these uses is chiefly due to its peculiar chemical properties which are quite distinct from those of other fats and oils; it has less tendency to become rancid than other oils; it has a high melting point (76°F) which makes it an oil (i.e, a liquid glyceride) in tropical climates but a solid in cool climates; it contains more than 40 percent solids at 50°F and, having a consistency similar to butter, is made into margarine and is useful in the manufacture of confectionery and bakery products. The specific gravity of coconut oil is 0.925 at 15°C. Its unusually high saponification value (250 to 260) and very low iodine number (8 to 10) result from its fatty acid composition, the principal acids present being the saturated ones of lower molecular weight (lauric acid and myristic acid). It is this composition of coconut oil, notably its lauric acid content, which confers good lathering properties in soap, shampoo and shaving cream, making it exceedingly useful in the soap industry. The ability of coconut oil to combine with alkalies or caustic soda even in ordinary weather make it most widely used oil for the manufacture of cold-process soap on a cottage-industry basis. Coconut oil also contains glycerine, a substance used in the manufacture of explosives.[4]

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[4]United Nations, The Coconut Industry of Asia, 1969, pp. 3-4 .

Copra meal and cake is the residue left after oil is extracted from copra. It is also known as coconut meal and is mainly used as a protein concentrate in livestock feeds. Copra cake is obtained as a by-product of coconut oil when mechanical extraction methods are used to extract oil while copra meal is the name given when solvent processes are used for coconut oil extraction. Copra cake has an oil content of 5 percent while copra meal generally does not exceed one per cent of oil content, since much of the oil has been removed by preliminary pressing. Commercial copra meals in general have a moisture content of 9-10 per cent. The crude protein content of copra meal (rarely exceeding 20 per cent) is distinctly lower than that of other oilseed cakes and meals like those of peanut, soybean and linseed. It has a high 12 per cent fiber content which limits its use for feeding poultry and pigs, but useful in feeds for ruminants. The higher oil content coconut meals can be used where high energy livestock diets are required. They are popular as components in compound animal feeds because of the property of absorbing half of their own weight of molasses.[5]

Desiccated coconut is manufactured by extracting the whole fresh kernel from the mature nut after removing the thick brown skin by paring. The pared nuts are placed in a tank and sliced into two to release any coconut water; the cut pieces are given two further washings followed by sterilizing in boiling water. The sterilized pieces are

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[5] D. Crabbe and S. Lawson, The World Food Book (Kogan Page, London/ Nichols Publishing Co., New York, 1981).

shredded in a disintegrator and the wet shredded material dried in a hot air oven at about 82°C, until the moisture content has been reduced to below about 2.5 per cent. Because of its pleasant taste and aroma, and nutrient content similar to that of copra it is widely accepted all over the world in making cakes, pastries, candies and other confectionery products. It is reported that desiccated coconut is marketed inthe United States under several names such as "maccaroon", "thread" and "ribbon".

In Sri Lanka and the Philippines, 1,000 nuts yield between 145 and 180 kilograms of desiccated coconut, depending on the district and variety.

Other products obtained from the coconut palm to mention a few are coir fiber for the manufacture of brooms, sacks, brushes, matresses and cushions, coconut shell for charcoal and fuel in native copra-drying kilns and products from the trunk such as rafters, posts and furniture.

Area, Yield and Production Trends

An important characteristic of Philippine agriculture is the dominance of small farms.[6] This is observable for coconut farms.

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[6]According to the census of agriculture, a farm consisted of one or more parcels of land, irrespective of ownership, which could be located in different barrios or even in different municipalities. The farms were enumerated in the districts where the farm operators resided. When a parcel of land with one owner was divided among and operated separately by several tenants, the land actually cultived by each tenant was enumerated as one farm. Separate farms operated by different members of a household were reported together as one farm. A crop farm was typed according to the crop occupying 50 percent or more of the cultivated area; between two temporary crops usually covering 50 percent or more of the tilled area, priority was given to the one that contributed most to total farm production and the value of output.

The 1960 census showed that the average coconut farm size was 4.4 hectares and had increased by almost 10 percent in 1971 (Table 1). Farms of less than 10 hectares in size were 62 percent of total coconut area in 1960 and had negligibly decreased to 58 percent in 1971. On the other hand, farms of 50 hectares and over in size were 8 percent and 10 percent of total coconut area in 1960 and 1971, respectively. According to the same census 20 percent of approximately 2.2 million total number of farms in 1960 and 18 percent of 2.35 million farms in 1971 were coconut farms.

The relative distribution of coconut area and production in the twelve administrative regions[7] of the Philippines are shown in Table 2 and Table 3. In 1954 and 1960 Southern Tagalog was the leading region in coconut area and production. Historically, commercial production had been concentrated in a narrow band originating in the provinces of Quezon and Laguna (two provinces in Southern Tagalog) and has gradually extended into Bicol region and Eastern Visayas. At present, expansion is occurring in Northern, Southern and Central Mindanao regions. In 1950 the combined area of Mindanao regions was 23 percent of the total area. By 1980 the relative share of the Mindanao regions increased to 40 and 50 percent, respectively while Southern Tagalog region's relative share declined to 17 percent in both years. In like manner the combined production of Mindanao regions was less than 32 percent of the total in 1950 but had reached 41 percent in 1980.

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[7]Data were not available for Central Visayas, Southern Mindanao and Central Mindanao since the Philippines was only divided into nine regions until 1971.

Coconut production has exhibited a moderate upward trend throughout the period 1950 to 1981 as can be observed from Figure 1. In 1950 the total number of nuts harvested was approximately 4 billion as compared to volume of production of about 10 billion nuts in 1981. The growth in total nut production during the study period can be attributed to the sharp expansion in area cultivated from approximately 985 thousand hectares in 1950 to 3,260 thousand hectares in 1981 (also in Figure 1).

For further trend analysis the 32-year period under study was broken down into decades of the fifties, the sixties and the seventies. In the fifties, the coconut hectarage exhibited a slight increase from 985 thousand hectares in 1950 to 1,006 thousand hectares in 1959. Over this period coconut production and yield per hectare in terms of number of nuts moved in almost the same manner. The peak in total nut output and the yield per hectare were recorded in 1959 to be 6,041 million nuts and 6,005 nuts per hectare, respectively. The low level of nut production and yield per hectare were registered in 1952 at 3,406 million nuts and 3,451 nuts per hectare, respectively. The rate of increase in total output and yield was strikingly greater, 34 and 32 percent, respectively as compared to the very slight expansion of area in the same years. Most of the increase in production was attributable to the favorable climatic condition of the country.

During the sixties, the trend of output in terms of number of nuts was erratic. Although there was an increase of almost 17 percent in nut production between 1960 and 1969, the growth rate was somewhat

Table 1. Characteristics of coconut farms, Philippines, 1960 and 1971.

Item	Year 1960	Year 1971
Number of farms (1000)	440.3	432.5
Area of farms (1000 has.)	1,938.6	2,152.8
Average size of farm (has.)	4.4	4.9
Percent of total area in		
Farms of 50 hectares and over	8	10
Farms between 10 and 49 hectares	30	32
Farms of less than 10 hectares	62	58

Source: Philippine Statistical Yearbook, NEDA, Philippines, 1979, p. 245.

Table 2. Relative distribution of coconut area by region, Philippines, 1954, 1960, 1970 and 1980.

Region	Year			
	1954	1960	1970	1980
	(percent)			
Ilocos	0.30	0.24	0.24	0.43
Cagayan Valley	0.44	0.32	0.57	0.21
Central Luzon	1.27	1.13	0.48	0.06
Southern Tagalog	25.87	24.78	17.52	17.55
Bicol	18.69	16.92	12.78	11.30
Western Visayas	9.83	10.10	7.60	3.02
Central Visayas	NA	NA	NA	5.16
Eastern Visayas	20.13	16.77	20.54	11.80
Western Mindanao	11.85	13.07	22.61	12.70
Northern Mindanao	11.62	16.67	17.66	11.78
Southern Mindanao	NA	NA	NA	17.82
Central Mindanao	NA	NA	NA	8.17
Total	100.00	100.00	100.00	100.00

NA - Not available

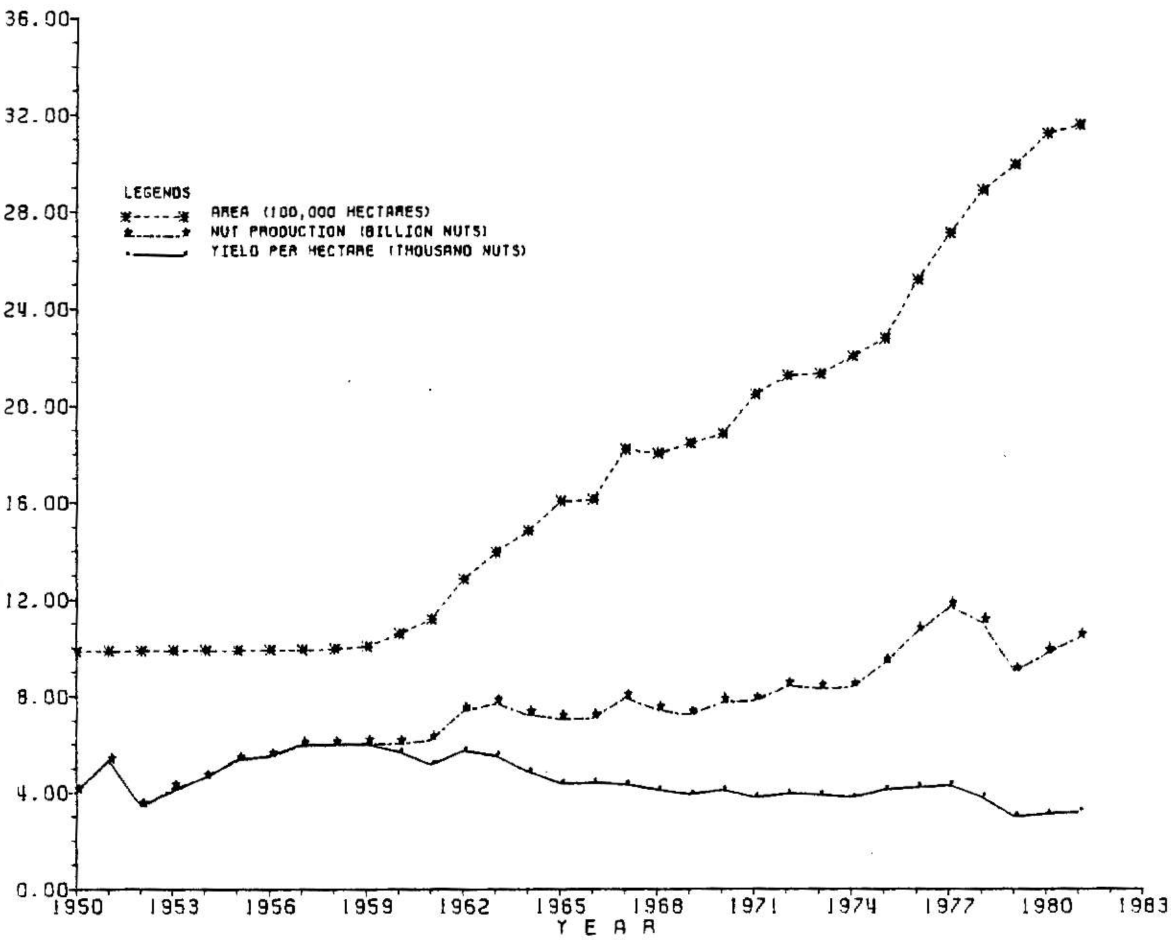
Table 3. Relative distribution of coconut production by region, Philippines, 1950, 1960, 1970, and 1980.

Region	Year			
	1950	1960	1970	1980
	(percent)			
Ilocos	0.08	0.18	0.08	1.23
Cagayan Valley	0.11	0.29	0.16	1.01
Central Luzon	1.55	0.97	0.57	0.18
Southern Tagalog	30.24	40.01	10.72	29.84
Bicol	9.88	14.31	5.94	5.58
Western Visayas	8.90	7.04	7.66	4.33
Central Visayas	NA	NA	NA	10.75
Eastern Visayas	17.58	11.16	26.67	5.99
Western Mindanao	14.98	9.98	33.62	7.54
Northern Mindanao	16.68	16.06	14.58	9.34
Southern Mindanao	NA	NA	NA	16.29
Central Mindanao	NA	NA	NA	7.92
Total	100.00	100.00	100.00	100.00

NA - Not available.

FIGURE 1

TREND IN COCONUT AREA, PRODUCTION AND YIELD
PHILIPPINES, 1950-1981



lower than the previous decade. The hectarage planted in this decade showed a rapid acceleration of 42.6 percent as contrasted to the slowly increasing and fluctuating production of nuts. The peak in production was achieved in 1967 with approximately 7.9 billion nuts. In the early sixties (1960-1963), a 21.9 percent rise in output is explained mainly by the favorable weather condition in the major producing areas. The following years after 1963 showed a setback in nut production until 1966 due to the severe typhoon that hit the Philippines in November 1964 and to the reported spread of yellow mottle decline (cadang-cadang) disease that swept nearly all the coconut area in Bicol Region. Recovery occured in 1967. Production of nut was boosted by sufficient rainfall in earlier months of 1967 coupled with a substantial number of new trees reaching the producing stage due to the hectarage expansion which took place in the 1960's. Although another severe typhoon ocurred in November 1967, it caused a reduction in nut production in the following year since production is related to rainfall six to twelve months before harvest and to typhoon damage ten to twelve months before harvest. The nut output went down to 7.2 billion nuts in 1969 as compared to the peak in 1967. Southern and Central Luzon which normally produce 40 percent of the Philippine total nut output were heavily damaged by the said typhoon. National average yield per hectare drastically decreased by almost 45 percent from 5,684 in 1960 to 3,925 nuts per hectare in 1969.

The seventies almost depicted the same trend as the sixties with respect to the area, nut production and yield per hectare. The hectarage expanded sharply from 1.9 million hectares in 1970 to 3 million hectares in 1979, a growth of approximately 37 percent. This reflects the continuous expansion of area planted to coconuts in Mindanao for it is a frontier area with substantial land suitable for coconuts and in addition some abaca and corn had been replaced by coconuts. The nut production in this decade experienced a growth of 21 percent as contrasted to the negative growth rate of 36.6 percent in nut yield per hectare. The Philippines had been experiencing good weather conditions until 1977 when total output reached a high of 11.7 billion nuts. However, in 1978 lower rainfall in most of the coconut growing areas and destructive effects of typhoons that hit Bicol and Southern Luzon slowed down production to 9 billion nuts in 1979. The two years that followed were again characterized by increasing area and total nut production. However, yield continued to decrease.

Another factor explaining the moderate upward trend in nut production is the number of total trees planted to the continuous expanding area coupled with the rising number of bearing trees through time (Figure 2). Yield per bearing tree increased through 1959 by 21.3 percent but declined substantially in the next two decades by 21.6 and 28.6 percent in the sixties and the seventies, respectively. The declines reflect that many were reaching the age wherein the

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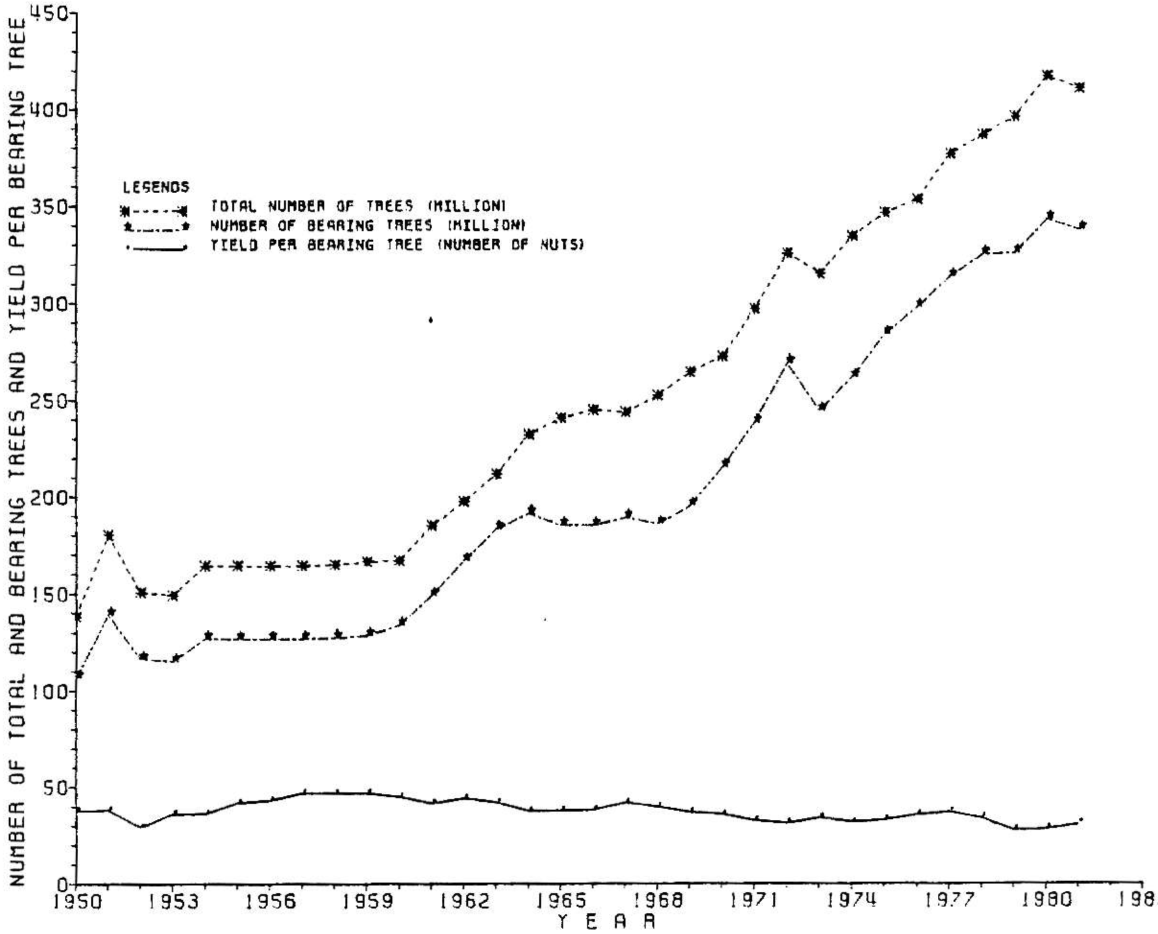
FIGURE 2

TOTAL AND BEARING TREES AND YIELD PER BEARING TREE
PHILIPPINES, 1950–1981



productivity was not as vigorous as before. Also, many farmers were neglecting their plantation as to fertilizer application, disease control and management. The total number of trees had expanded by 17, 37 and 31 percent in the 50's, 60's and 70's, respectively. Nearly the same growth rates were achieved in the total number of bearing trees -- 17, 31, and 34 percent, respectively.

Trends in Coconut Products Production

The volume of production of the different coconut products including copra, coconut oil, copra meal and desiccated coconut for the period 1950 to 1981 is plotted in Figure 3. The chart shows that the major coconut product, copra, and its by-products, coconut oil and copra meal, have continued to increase over the study period, while desiccated coconut has increased only slightly over the period.

Table 4 shows the growth rates of copra, coconut oil, copra meal and desiccated coconut in each decade since 1950, and for the years 1980-1981. In the fifties there were substantial increases in the output of copra, coconut oil and meal. However, desiccated coconut exhibited a sharp decline of about 31 percent from 73.33 thousand metric tons in copra equivalent to a low level of 56 thousand metric tons in 1959. The peak of copra and copra meal production was registered in 1957. The tremendous rise in output of copra and its by-products reflects the increasing number of nuts produced during that decade and the expanding market for copra products (and declining market for desiccated coconut) especially for export.

From 1960 to 1969, the growth rate of copra production was 32 percent, coconut oil 52 percent, copra meal 54 percent and desiccated coconut a low 5 percent. In the sixties, the considerable expansion in the Philippine exports of coconut oil to the United States led to high coconut oil production in the Philippines. Under the foreign exchange decontrol program it became possible for Philippine oil millers to offer attractive prices for copra for domestic milling in relation to the returns which traders could obtain by exporting copra[8]. As a consequence there was a marked jump in coconut oil production in copra equivalent of 758 thousand metric tons in 1962 as compared to 274 thousand metric tons in the previous year. Copra meal output also contined to rise dramatically as it is a by-product of coconut oil.

Between 1970 to 1979, copra output rose by almost 8 percent reaching a definite peak in 1977 and 1978 (Figure 3). The sudden soar of about 23 percent from 1976 to 1977 is partially explained by the total number of nuts produced which also peaked in 1977. Coconut exportation was continuing to shift from copra to coconut oil, with oil, production increasing a full 54 percent in this decase. Desiccated coconut output substantially rose by almost 40 percent as well.

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[8]FAO Coconut Situation, No. 9, May 1963, p.2.

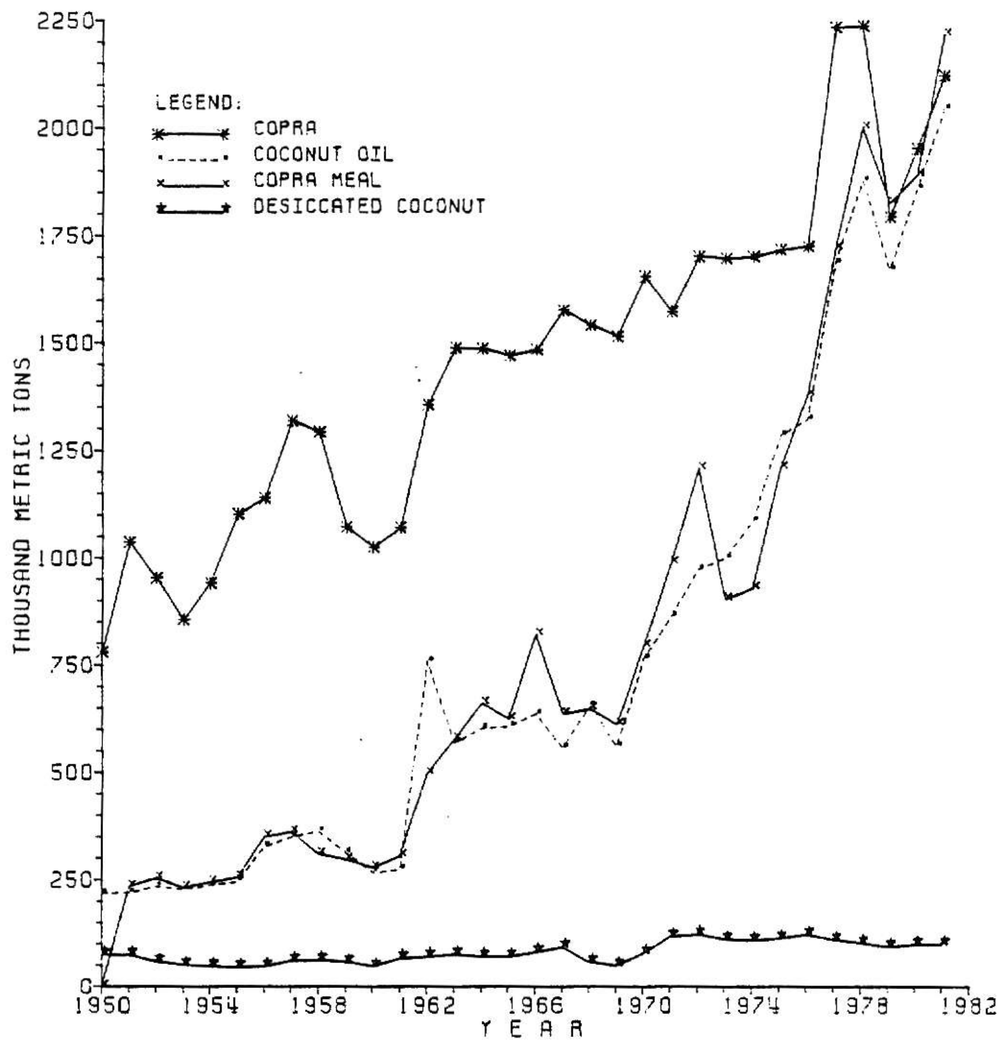
Table 4. Coconut products production growth rates, Philippines, 1950-1981.

Coconut Product	Year 1950-1959	1960-1969	1970-1979	1980-1981[b]
	(percent)			
Copra	27.24	32.37	7.73	7.93
Coconut oil	30.41	52.52	54.19	9.05
Copra meal	21.05[a]	54.50	56.47	14.69
Desiccated coconut	-30.97	4.99	39.71	-0.95

[a]1951-1959 growth rate

[b]Annual growth rate whereas previous columns represent a ten-year expansion.

FIGURE 3
VOLUME OF PRODUCTION OF COCONUT PRODUCTS
IN COPRA EQUIVALENT
PHILIPPINES, 1950-1981



Copra production between 1980 and 1981 increased by 168.4 thousand metric tons while that of desiccated coconut in copra equivalent decreased by 1.3 thousand metric tons. Coconut oil and copra meal growth rates were 9.05 and 14.69 per cent, respectively.

Domestic and Export Price of Coconut Products

Pricing Procedures

Domestic pricing of coconut products at a particular level usually depends upon the price at the next highest level. Most of the exporters and processors receive daily cables from the world copra markets in London and New York, informing them of the current price and the market situation or apparent trend. They then base their buying price on the potential selling price. The town buyer will base his buying price on the price he can obtain from the exporter.[9]

The price that the typical exporter pays on a given date for copra is not uniform for all suppliers. The quoted price is that which will be given to the town buyers. Large plantations which consistently sell to the exporter frequently get a price higher than the quotation. Conversely, a small farmer delivering less than a ton receives less than the quoted price. If a dealer had a considerable quantity to sell and the exporter needed it to complete shipment, the exporter would probably pay a premium above the quoted price.[10]

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[9] A.J. Nyberg, "The Philippine Coconut Industry in Economic Perspective," The Philippine Agriculturist", Vol. 52, 1968, p.22

[10] Ibid.

Copra grade is also considered in pricing by exporters. Copra with a moisture content of 6 percent is the standard, and is called "copra resecada". In practice, however, buyers do not give farmers a premium price for good quality copra. Regardless of the quality (moisture content) of copra, there is an automatic shrinkage deduction ranging from 30 to 40 percent depending upon the buyers ocular or feel evaluation of the moisture content. Moisture meter requirements remained unenforced at the farm level.[11]

Contract for future delivery is also prevalent in the coconut market industry. Special pricing arrangements like contract pricing (15-30 days) and 15 days advanced payments schemes are entered into when processors and or exporters need to be assured of copra supply.[12] This holds for copra exporters, oil millers and desiccating firms. Those coconut producers with contract arrangements usually receive prices lower than they would if they didn't receive advance payment.

With all these pricing procedures there exist price leadership in the industry. The price leaders apparently are located where desiccators, oil mills and exporters who could give high prices are present.

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[11] N.R. Deomampo, "Domestic Coconut and Marketing in the Philippines- Its Structure, Conduct and Performance", Lecture Prepared for the Training Program on Agricultural Marketing held at CDEM, U.P. at Los Baños on April 14 - May 10, 1980, p. 13.

[12] Ibid. p. 23.

Price Trends

The growth rates in actual and real domestic and export prices of copra, coconut oil, copra meal and desiccated coconut are shown in Table 5. The percent changes are reported in selected periods of 10 years each from 1950 to 1981

The domestic and export prices of copra exhibited similar patterns from 1950 to 1981, as graphed in Figure 4. Between the years 1950 and 1959, deflated domestic price had gone up by almost 19 percent as opposed to the slight negative growth rate of 0.6 percent in the deflated export price of copra. The 1960-1969 period was characterized by a substantial increase of 15 and 27 percent for deflated domestic and export prices of copra, respectively. Prior to 1972, prices fluctuated mildly but in 1974 a sudden rise (of approximately 64 percent in the deflated domestic price and 57 percent in the deflated export price of copra) was experienced. A drastic drop reversed the situation of prices in the following year, as deflated domestic and export prices suddenly decreased by 157 and 122 percent, respectively. This is partially explained by the 1973 fuel crisis, causing serious dislocations in shipments and withholding products from the market to safeguard against contingencies.[13] The year 1974 again reflected a big leap to the actual price of coconut products due to the drought affecting foreign countries that produce competing oil products, coupled with the dollar devaluation which caused panic buying by foreign investors.

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[13]E. Lachica, "Supply and Demand Prospects For Philippine Coconut Oil and Implications on International Trade", MS Report 1978, p. 27.

It will be noted that not only the price of copra was affected, but also prices of coconut oil, copra meal and desiccated coconut followed similar patterns. The sudden drop in prices of coconut products after 1974 was associated with the issuance of Presidential Decree 527, granting authority to the National Economic and Development Authority (NEDA) to set minimum prices of coconut oil, copra and other products and by-products. With the implementation of this decree prices went back to normal and then increased gradually to lower peaks than the deflated domestic prices of 1974. By 1980 the deflated domestic price of copra had moved down to its lowest level (₱34.72 per hundred kilograms) in 32 years. Later reports indicate that prices have been continuously decreasing since 1980.

As mentioned earlier price movements of coconut products have been greatly affected by world market prices. It is known that there has been sharply increasing exportation of the close substitute, palm oil, whose price is lower than the price of coconut oil. To compete in the international market, the prices of copra and its products has to be decreased.

The price pattern for coconut oil is very similar to that for copra as can be seen in Figure 5. The deflated domestic and export prices of coconut oil also peaked in 1974, when prices were ₱336 and ₱323 per hundred kilograms, respectively. Before 1974 both export and domestic prices fluctuated widely for short intervals, Actual prices soared up in 1974 and again 1979 as a result of devaluations of the peso.

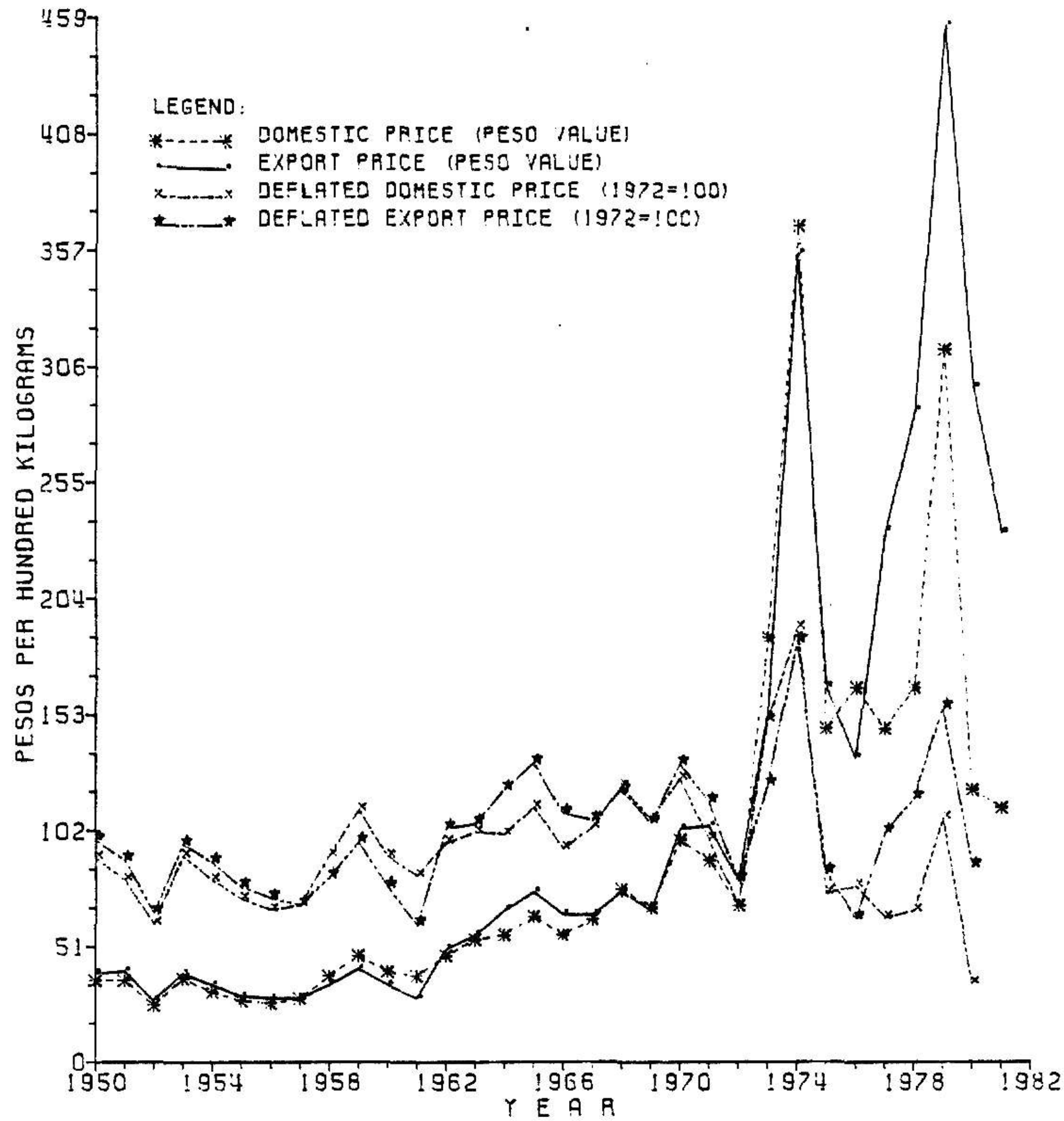
Table 5. Coconut products price growth rates, Philippines, 1950-1981.

Coconut Product	Year 1950-1959	1960-1969	1970-1979	1980-1981[a]
Copra		(percent)		
Domestic Price	23.40	41.18	68.79	-7.14
Export Price	4.88	49.25	77.41	-27.47
Deflated Domestic Price	18.94	15.23	-16.15	-
Deflated Export Price	-0.66	26.87	15.94	-
Coconut Oil				
Domestic Price	15.00	38.05	73.79	-3.77
Export Price	48.57	46.39	76.12	-20.23
Deflated Domestic Price	10.05	10.72	2.45	-
Deflated Export Price	45.57	22.75	11.07	-
Copra Meal				
Domestic Price	26.67	46.43	67.21	-5.00
Export Price	7.69	42.86	67.56	-10.89
Deflated Domestic Price	22.39	22.79	-22.04	-
Deflated Export Price	2.31	17.66	-20.54	-
Desiccated Coconut				
Domestic Price	9.59	52.71	86.24	-7.31
Export Price	9.59	44.83	81.59	-13.84
Deflated Domestic Price	4.32	31.85	48.78	-
Deflated Export Price	4.32	20.49	31.46	.

\- No available wholesale price index for 1981

[a]Annual growth rate whereas previous colummns represent a ten-year expansion.

FIGURE 4
DOMESTIC AND EXPORT PRICE OF COPRA
PHILIPPINES, 1950-1981



The growth rate of copra meal prices is also reported in Table 5 and presented graphically in Figure 6. From 1950 to 1981 the actual domestic and export prices of copra meal are generally increased. Little fluctuation was observed between 1950 and 1961, in either actual or real domestic and export prices. However, from 1960 to 1969 there were substantial increases (approximately 46 and 43 percent, respectively) in the actual domestic and export price of copra meal. This can be attributed to the start of monetary devaluation. After 1973, the actual prices rose sharply as devaluation of the peso and dollar continued. Actual domestic and export prices rose by some 67 percent as, compared to the drops in the deflated domestic and export prices of about 22 and 21 percent, respectively, between the periods 1970 and 1979.

With respect to actual domestic and export prices of desiccated coconut, Figure 7 indicates a very similar pattern as observed for coconut oil and copra prices. The actual domestic price was highest in 1979 and the actual export price was highest in 1980. In 1974 the price soared (₱438 and ₱641 per hundred kilograms for actual domestic and export price, respectively), but then suddenly dropped the following year to ₱206 and ₱335 for actual domestic and export price, respectively. This pattern also reflects the fuel crisis and the price control for coconut products in 1974.

FIGURE 5
DOMESTIC AND EXPORT PRICE OF COCONUT OIL
PHILIPPINES, 1950-1981

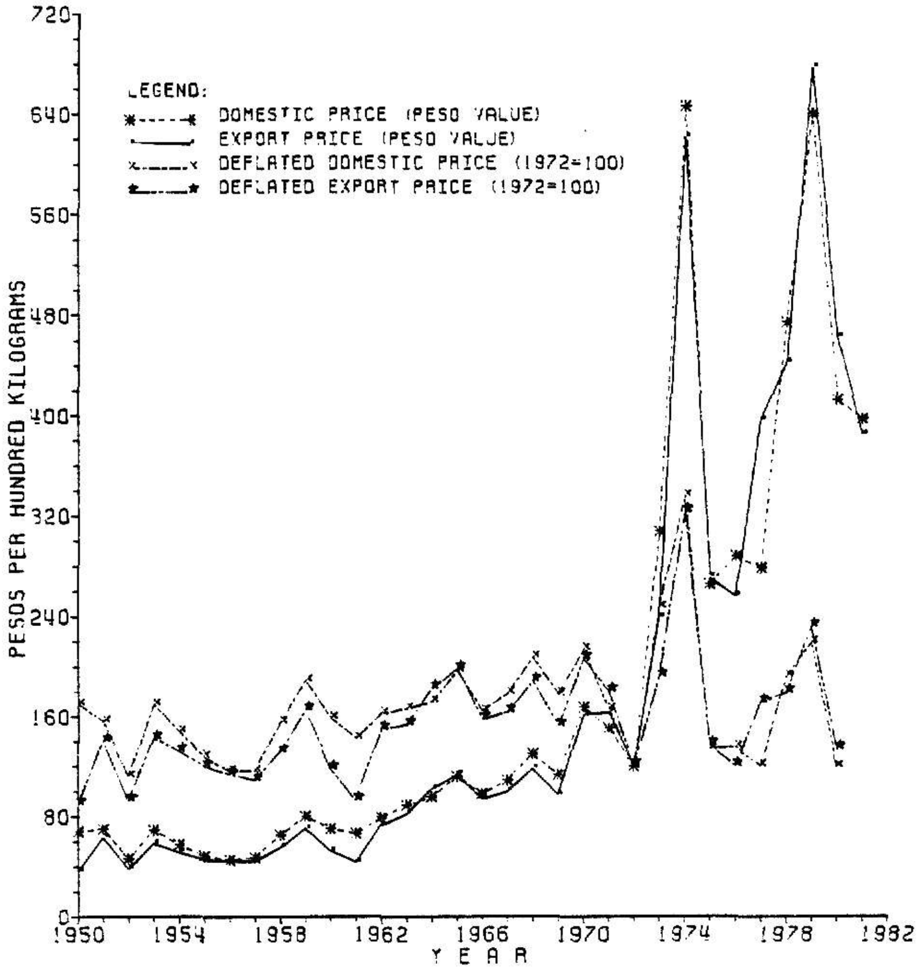


FIGURE 6
DOMESTIC AND EXPORT PRICE OF COPRA MEAL
PHILIPPINES, 1950-1981

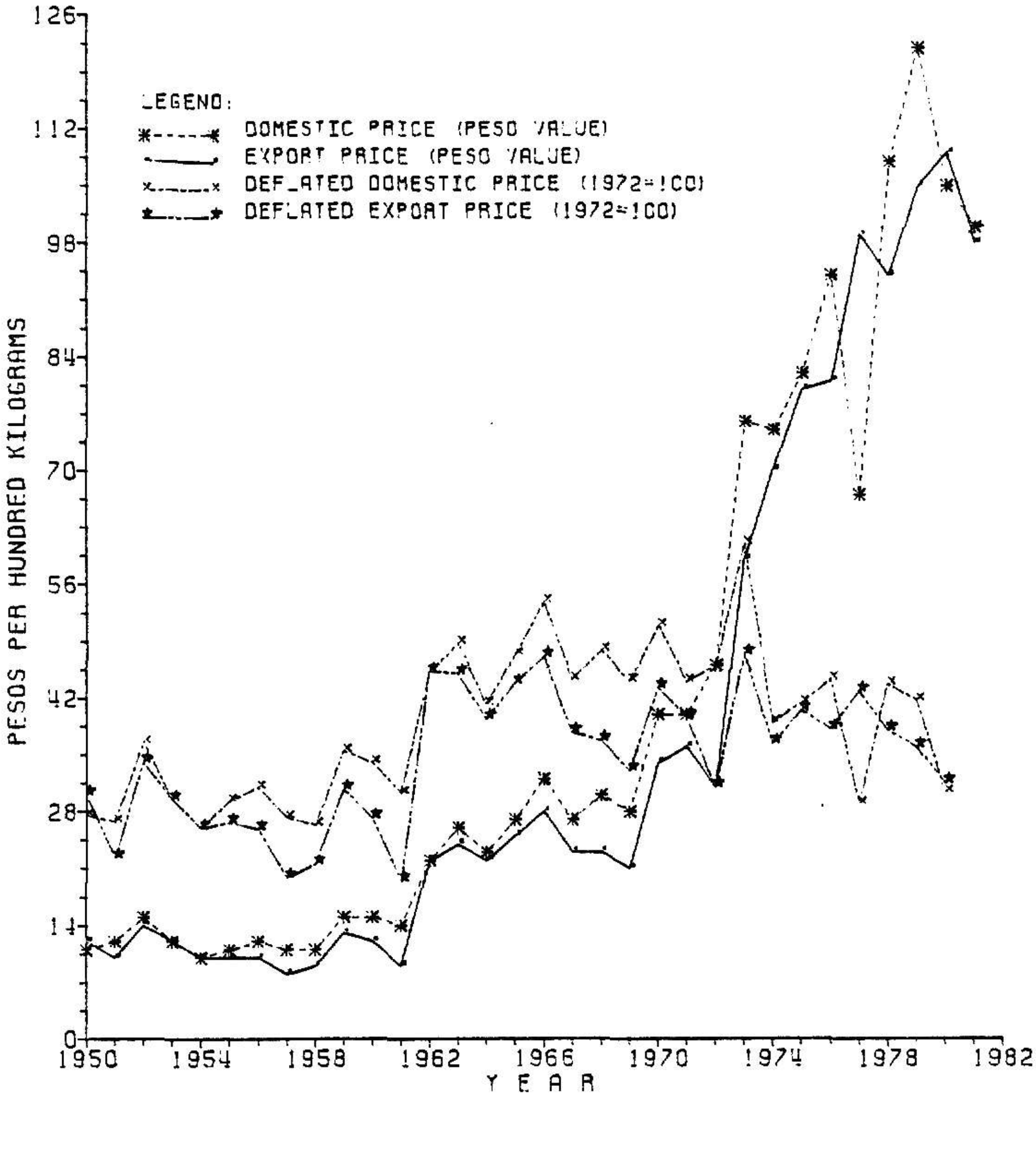
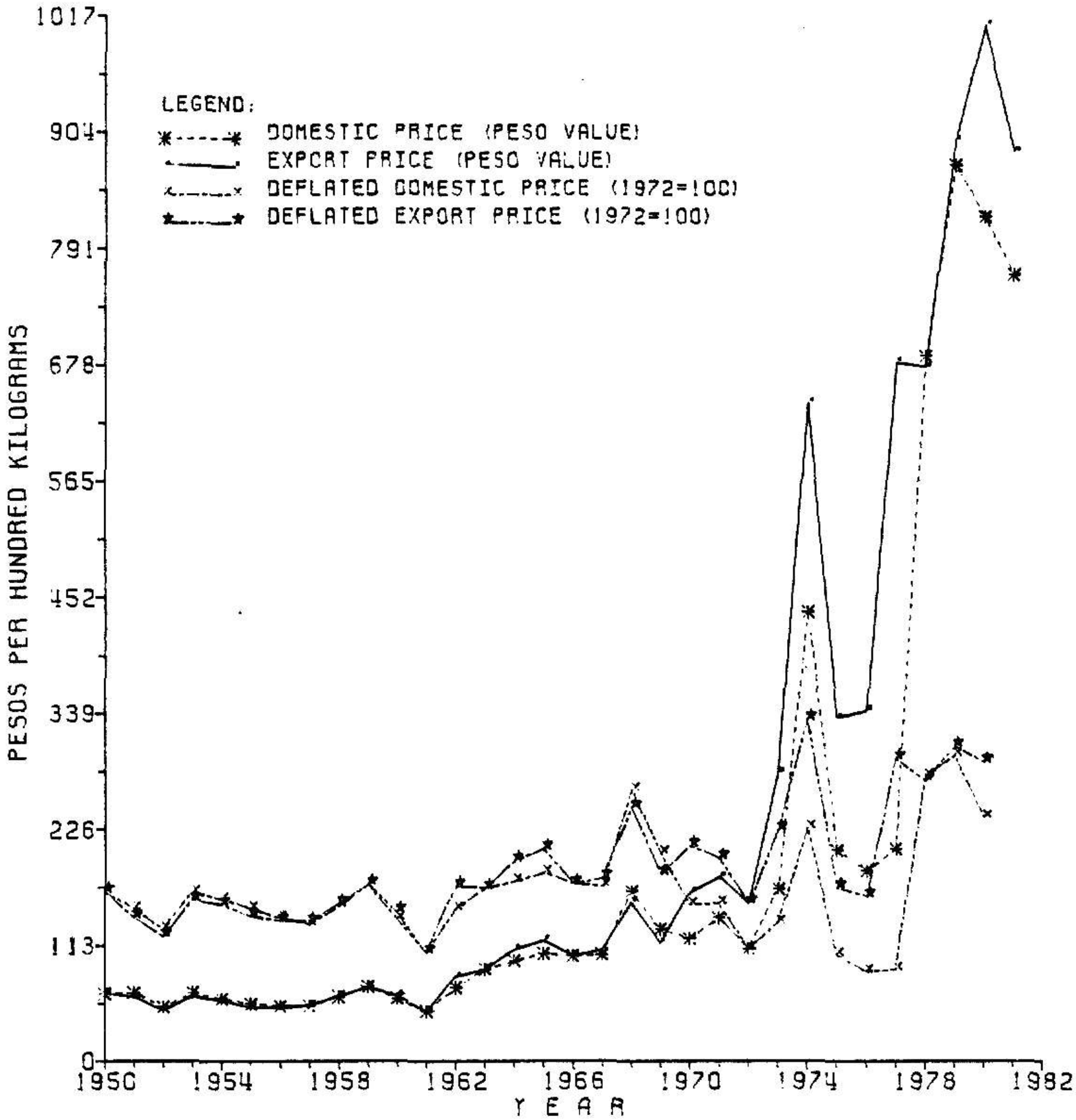


FIGURE 7
DOMESTIC AND EXPORT PRICE
OF DESICCATED COCONUT
PHILIPPINES, 1950-1981



Government Programs Affecting Domestic Production

The Philippine government through its policies and various development programs has been showing great interest and attention to the problems relating to production and marketing of coconut products.

The first government corporation established to promote the growth and development of the industry was the National Coconut Corporation (NACOCO). Created by the virtue of Commonwealth Act No. 578 in May 1940, it was designed to "...establish, keep, maintain, and operate drying plants, copra driers, or coconut centrals ... and to provide facilities for better curing of copra."

After World War II the Philippine Coconut Administration (PHILCOA) was established in June 1954 under Republic Act 1145. One of its noble contributions to the industry was the passage of the Moisture Meter Law under Republic Act 1365 in 1955, requiring buyers of copra to use moisture meters for determining the percentage of moisture content. With this law it was hoped that the quality of copra entering trade would be improved. The incentive was price premiums or discounts depending upon the moisture content of copra.

One of the most original and potentially effective measures, which is worthy of emulation in other copra producing countries, was the PHILCOA decision to set up copra bonded terminals (COBONTER), at strategic ports with subsidiary collecting centers spread all over the producing areas, with objectives as follows:

(a) To reduce cost of copra storage, handling and loading through centralization and mechanization, by constructing a loading terminal and warehouse complexes where mechanized handling operations would reduce the cost of handling and loading copra;

(b) To establish a more effective system of copra grading and inspection including laboratory examination of copra samples at the terminal sites;

(c) To provide centers of trade and information.[14]

Republic Act 1369, also passed on June 18, 1955, appropriated 30 million pesos from the sale of bonds to be used for industrialization. These funds were to finance the manufacture of coconut products, by-products, and tree by-products under the auspices of PHILCOA.[15] By June 1966, less than 2 million pesos had been loaned under provisions of this Act.[16]

In June 1959, under Republic Act 2282, another 30 million pesos was appropriated to cocnut producers and coconut cooperatives through the loaning operation of the Development Bank of the Philippines (DBP) with a low interest rate of 2 percent. The intent of the loan was to provide for the cost of acquiring machinery and facilities to provide initial working capital for procurement of raw material supplies

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[14] Op. cit United Nations, The Coconut Industry of Asia, p. 80.
[15] Op. cit. A.J. Nyberg, p.32.
[16] PHILCOA Annual Report, 1965-66.

and other operating expenses.

The DBP has recorded that only 5 million of these funds were loaned.[17] The reason for the lack of interest in the loans under these two finance programs is unknown. It could stem from rigid loan administration, or lack of borrowing initiatives.

To intensify research activities relating to coconut production, the Philippine Coconut Research Institute (PHILCORIN) was created under Republic Act 4059 in June 1964.

In June 1965, Republic Act 4403 was passed by the government to encourage farmer cooperatives in the coconut area producing provinces to help the coconut farmers control the marketing system. Such legislation also intended that greater financial assistance would be provided to the farmers. With the cooperative functions it was envisioned that coconut producers would receive a greater share of final prices as there would be a reduction of middlemen transactions from the farmer procuder to the ultimate buyer of coconut and coconut products.

Through Executive Order No. 344 the Coconut Coordinating Council (CCC) was formed in August 1971 to coordinate and evaluate the implementation of the different coconut programs.

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[17] Ibid.

Republic Act 6260, known as the COCOFUND Law, was created in 1972 with the sole aim of raising ₱100 million in 10 years through collection of 55 centavos per hundred kilograms of copra. This calls for the establishment of the Coconut Investment Co. (CIC) which would manage the ₱100 million COCOFUND levy.

On June 30, 1973, the functions of PHILCOA, PHILCORIN and CCC were integrated into one government agency, the Philippine Coconut Authority (PCA) by the virtue of Presidential Decree 232. PCA has undertaken and until now undertaking giant steps for the development of the coconut industry in terms of agricultural, industrial and marketing research and development.

Agricultural Research and Development[18]

Research on coconut was intensified and broadened to include several disciplines such as management, soils and fertilizers, crop improvement and crop protection. Studies were conducted on general yellowing of some coconut groves, coconut intercropping systems, effects of NPK, and other fertilizer on coconuts, hybridization, collection and evaluation of coconut cultivars, as well as biological and chemical control of the major coconut pests. On primary processing, studies of various methods of copra making and the development of alternate techniques were conducted. Studies on the utilization of coconut husks were also undertaken.

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[18] E. Yambot (ed.) Philippine Agriculture - Fact Book and Buyer's Guide. (Philippine Almanac Printers, Inc., 1979), p. 185.

In the Bicol region, research conducted involved the entomology-epidemiology of cadang-cadang, including studies on insect transmission of the disease and the occurence of cadang-cadang.

On agricultural development, intensive extension services were extended to the coconut farmers in forms of consultation and forum/symposium. Technical assistance on clearing, intercropping, covercropping and fertilization were likewise extended to them.

Module farms and demonstration farms are being maintained and managed. The module farm is a consolidation of small or sub-marginal coconut farms into an economically manageable plantation where research findings on cultural management, multi-culture and/or live-stock raising are applied. The demonstration farm concept is very similar except that the coverage is a small parcel of land, the average of which usually ranges between 2 and 4 hectares.

Coconut Industry Training Centers (CITC) were established to promote the maximum usage of coconut by-products like fiber, shell and leaves thereby minimizing wastage. As of the end of 1977 there were 12 training centers established and 464 persons trained. The Authority as part of its cottage industry promotion development also participated in agricultural, industrial and commercial expositions, trade fairs and displays.

Industrial Research

Industrial research has been concentrated mainly on food research and development, on coconut trunk utilization and on the improvement of present coconut processes. Research on coconut food products includes the possible incorporation of coco-flour in popular breads, cakes, coco chips, coco jam, coco cream (mayonnaise), coco cheese and the utilization of coco protein in sausages.

Research is underway on preservation techniques of coconut poles and posts for use in building and housing constructions. The aim of the research is to determine the life span of the coconut trunk when treated with preservatives so that it would be economical to use timber. Preservation techniques are being tested in Davao Research Center and Davao Wood Compund in Davao City.

Recent industrial studies that are being developed involve coconut-based fuel substitute such a coir dust for boiler fuel, charcoal from shell, coco-gas mixture, extruder, coir dust and coir processing wastes.

Market Research and Development

The Philippine Coconut Authority has organized coconut marketing associations which will become cooperative in due time, to provide enhanced bargaining powers for the farmers in marketing their produce. By the end of 1977 there were seven coconut marketing associations and two cottage industry producer's associations.

On the export side, the PCA is also regulating the export quality of the coconut products and by-products being exported. Export clearances are issued before any exporter can market his coconut products. Samples of the coconut products are taken and analyzed in the Tissue Analysis Laboratory of PCA.

PCA is also involved in the preparation of daily lauric market reports, weekly analysis and monthly market reports. Prices and production data of the different fats and oils are monitored daily and transformed into charts or graphs for public use.

Other important activities of the PCA revolve around the subsidies and levies on coconut products. Presidential Decree 276 was passed establishing a coconut consumers stabilization fund (CCSF). This CCSF levy is intended to subsidize coconut based products like soap, milk and cooking oil. The decree states that "... A levy, initially, of ₱15.00 per 100 kilograms of copra resecada or its equivalent in other coconut products shall be imposed on every first sale, in accordance with the mechanics established under R.A. 6260, effective at the start of business hours on August 10, 1973.

The proceeds from the levy shall be deposited with the Philippine National Bank or any other government bank to the account of the CCSF, as a separate trust fund which shall not form part of the general fund of the government."

By 1977 the CCSF levy had increased to ₱60 per 100 kilos of copra or its equivalent. The levy of ₱60 per 100 kilos was retained until 1981 and was allocated as follows:

Coconut Industry Development Fund (CDIF) ...	₱20.00
Research and Development Fund	2.00
COCOFED (Scholarship, etc.)	3.00
Subsidy	12.00
Coconut Industry Investment Fund	8.00
Refund to Farmers	15.00

Through the collections of the CCSF levy, PCA was able to establish the United Coconut Planters Bank where coconut farmers are the stockholders; was able to establish a hybrid nursery in Bugsuk, Palawan wherein the seedlings will be provided free to the farmers; was able to provide funds for its programs as well as the program of the Philippine Coconut Producers Federation (PCPF); was able to integrate production, processing and trading wherein the farmers are the ones controlling it and provided scholars from the coconut farmers' children.

Another important undertaking of PCA was the launching of the national coconut replanting program in 1980 in compliance with Presidential Decree 582. It calls for replacing gradually all unproductive stands with a high precocious yielding variety which is expected to bear as much as 500 percent of the production derived from the local varieties.

A section of Presidential Decree 582 created the Coconut Industry Development Fund (CIDF) to finance the replanting program. The fund is deposited with and administered and utilized by the Philippine National Bank through its subsidiary, the National Investment and Development Corporation (NIDC) for the following purposes: "to finance the establishment, operation and maintenance of a hybrid coconut seednut farm under such terms and conditions that maybe negotiated by the NIDC with any private person, corporation, firm or entity as would insure that the country shall have, at the earliest possible time, a proper, adequate and continuous supply of high yielding hybrid seednuts". This seedbank is operated by a private company, the Agricultural Investors Inc. in Bugsuk Island on the southern tip of Palawan. The coconut hybrid being used is a cross between the Malayan Yellow Dwarf and the West African Tall. It has been reported that a performance test in Davao del Norte showed that the hybrid is producing 1.7 tons of copra per hectare per year within 3 years and 9 months after transplanting.

With CIDF funds, PCA purchases the seednuts from the Agricultural Investors, Inc., to be distributed free to the farmers giving priority to those who are paying the levy.

The area to be replanted is programmed as follows: 8,883 hectares in 1981; 29,607 in 1982; 51,572 in 1983 and 60,000 per year for the period from 1984 to 1989.

CHAPTER III

REVIEW OF SUPPLY RESPONSE STUDIES FOR COCONUT AND OTHER TREE CROPS

In as much as there is very limited research on the supply response of coconuts, some perennial crops that have been widely investigated were also reviewed in this study. Coconut is a perennial crop and the production of any perennial crop involves planting, removal, yield and time dimensions not similarly encountered in annual crops.

Nyberg (1968) undertook regional as well as national supply analysis of coconut in the Philippines using data from 1954 to 1966 to determine the factors influencing production and the degree of influence. He used trees rather than hectares as the production unit since the former was assumed to be more accurate in as much as most coconuts are grown on small holdings and it is probable that tree numbers are more accurately known than hectarage.

He used a distributed lag model to describe and analyze the relationship between the explanatory variables and tree numbers. Tree numbers at time t were taken as a function of the expected copra price (which was assumed to be the average price of the two previous years) and of the trees in the previous time period. The supply elasticity coefficient he obtained on the national level was about 0.3 percent. On the regional level the differences between the effects of price change on new plantings is particularly interesting. The supply price elasticities indicated that whereas new plantings in the Eastern Visayas and Southern and Western Mindanao regions (0.618 and 0.621, respectively) were quite responsive to price, farmers in the Western Visayas and Northern and Eastern Mindanao regions responded only slightly (0.288 and 0.263, respectively). In Southern Tagalog and Bicol regions, equations that were obtained were poor in the sense that the multiple coefficients of determination (0.45 and 0.43, respectively) were low.

The coefficients for coconut trees at time t-1 revealed less variation, ranging from 0.43 for Western Visayas region to 0.78 for Northern and Eastern Mindanao region excluding the region of Southern Tagalog with a -0.90 tree coefficient.

He also found out that the short run supply price elasticity, long run supply price elasticity and elasticity of adjustment for the entire Philippines were 0.30, 0.66 and 0.45, respectively.

Nyberg derived a yield function for coconut using nuts per bearing tree as a function of dry season rainfall in the previous crop year and of typhoons during the current crop year. The typhoon coefficient of 0.833 for the Philippines was found to be significant at the 5-percent probability level while the rainfall coefficient of 0.033 was not significantly different from zero.

Tree crops receiving more attention by economic researchers since 1949 include cocoa, rubber, lemon and coffee.

Supply price elasticity of cocoa was studied by Bauer and Yamey in 1959, Bateman in 1965 and Behrman in 1966. Bauer, 1954, argued persuasively that producer prices influence incentives and the level of production. Although Bauer did not attempt to measure elasticities, he and Yamey's case study of 1959 presented statistical information which leaves little doubt as to the responsiveness of Nigerian cocoa and palm oil producers in the short run. They observed that in 1950 Nigerian produce-marketing boards widened the price differentials between various grades of the two products, farmers' short run response resulted in a significant increase in the proportion of top-grade produce submitted for purchase and the virtual elimination of the inferior grades. They reported that the proportion of Grade I (best quality) cocoa in the purchases of the Cocoa Marketing Board increased from 47 percent in 1947-48 to 98 percent in 1953-54, Grade II cocoa decreased from 24.7 percent in 1947-48 to 1.8 percent in 1953-54 and Grades III and IV cocoa were no longer purchased after 1951. The price differential between the Grade I price (£62.5 per ton) and the prices of the two lowest grades (Grade III and Grade IV) were £5.50 per ton and £15.00 per ton in 1947-48, respectively. In 1949-50 the price differential between Grade I price (£100 per ton) and Grade III price was £25 per ton and the composition of purchases of the Cocoa Marketing Board was 89.4 percent, 10.5 percent and 0.1 percent for Grades I, II and III of cocoa, respectively. Grade IV cocoa was no longer purchased this year and after.

In the case of oil palm, the Oil Palm Produce Marketing Board widened the differences in prices paid for the five different grades of palm oil. In 1948, the prices paid by the West African Produce Control Board to the producers ranged from £32.25 per ton for Grade I to £26.25 for Grade V. A marked increase of oil was bought by the Board at a special premium price of £71.00 per ton while Grade I and Grade IV were bought for £55 and £35 per ton, respectively. Grade V oil was no longer purchased this year and after. In 1954 it was reported that the Board purchased 60.8, 29.9, 4.4 and 4.9 percent of Special Grade, Grade I, Grade II and Grade III palm oil, respectively.

In 1965, Bateman developed a supply model with the interest of finding out what forces will motivate the farmers to plant perennial crops. He estimated the supply model of cocoa for various regions of Ghana. In his model he used cocoa prices, coffee prices, rainfall, humidity and lagged changes in output as explanatory variables and change in cocoa harvested from year to year as his dependent variable. The cocoa price elasticities of supply obtained ranged from 0.32 to 0.87 with the size of the elasticities varying inversely with the age of cocoa trees of the region. The region (Eastern region) that was first planted had the lowest response as compared to the newest region (Sunyani) planted which exhibited the highest response. The coffee price responses varied from -0.37 to -1.53 for Eastern and Sunyani regions and were both significant at 5-percent probability level. The rainfall and humidity coefficient for Eastern region were 0.923 (significant at 1-percent level) and -0.99 (significant at 5-percent level) while that of Sunyani were 1.618 and -4.305 (both significant at 5-percent level). R-square values computed were 0.85 and 0.78 for Eastern region and Sunyani, respectively. The coefficient for the one-year lagged dependent variable obtained was not statistically significant in the long run, leading the author to conclude that the farmers expected mean price in the future is equal to the current price.

Behrman (1966) utilized a model estimating cocoa-producer responses in countries of Ghana, Nigeria, Ivory Coast, Cameroun Republic, Brazil, Ecuador, Dominican Republic, and Venezuela. He used the desired stock of trees as a function of prices using the period 1947 to 1964. The long run supply elasticities obtained are shown in the following table and are significant at the 10 percent probability level.

Ghana	0.71
Nigeria	0.45
Ivory Coast	0.80
Cameroun Republic	1.81
Brazil	0.95
Ecuador	0.95
Dominican Republic	0.15
Venezuela	0.38

Behrman's aggregate supply function did not include age of trees and influence of weather. One interesting conclusion that he obtained was the relative low elasticities for Ecuador, the Dominican Republic and Venezuela. These countries are the oldest producing cocoa areas in the world.

Chan (1962) estimated the shortrun supply price elasticity of Malayan rubber using monthly and annual data. His model generally aimed at obtaining parameters which apply to the harvest or tapping response to price changes. He related output in a period to the producer price of rubber in the period, the composition of the tree stand, mature acreage, and a trend variable. The price coefficients using annual data for the estates were statistically insignificant while in the smallholders wherein the supply price elasticity is 0.12, it was statistically significant at the 10-percent level. The same kinds of results were obtained using monthly data for estates and smallholders.

Stern (1965) also estimated the shortrun supply price elasticity of Malayan rubber using quarterly data for the period 1953-1960 for estate and smallholder production. His explanatory variables for estate were current price deflated by estate wages for tappers and field workers, a ratio of beginning-of-quarter estate sales in the preceding quarter, and a time trend. The smallholder equation related output to deflated current price of rice, and a trend variable. Trend coefficients were highly significant in both. Current price was significant in smallholder equations only, with a shortrun supply price elasticity of approximately 0.20 being significant at the 1-percent level.

French and Bressler (1962) analyzed California lemons covering 1947-1960 period using least squares. The supply equation involved "an equation that explains the acreage of trees planted each year, and consequently the additions to production some five years later, and an equation that accounts for the acreage of trees removed from production each year . The change in bearing acreage is then given by the difference between the acreage coming into bearing and the acreage removed. Multiplying by average yields converts the acreage changes to changes in total output." They assumed that the rate of planting in any year is a linear function of expected long run profitability of growing lemons and the age distribution of the tree stock. The expected long run profitability is a five year average of past net returns per acre (total returns less cost) while the age composition is represented by age of trees over 25 years of age since the average life of a lemon tree is commonly stated to be approximately 30 years. The result was that the age variable was not significant and was dropped from the equation. The profit variable was highly correlated with the rate of new plantings. The correlation coefficient is r = .93 and the regression coefficient of the five-year average of net returns per acre is .02 with a t-ratio of 8.77. The Durbin-Watson test did not reject the hypothesis of zero first order autocorrelation among the residuals at the 5 percent level of significance.

In addition to the planting model, French and Bressler also attempted to estimate the parameters of a removal equation which was similar to the planting equation. They also assumed that the rate of removal was linearly related to profits and age. Using least squares, again, the variable age (bearing age over 25 years of age in t) proved to be nonsignificant due to its small variation during the period for which observations could be obtained. Expected current profitability was represented by both actual current net returns and five-year averages, but neither gave significant statistical results. The intercept obtained which represented the average proportion of trees removed because of disease and similar factors was estimated to be .045 which means that 4.5 percent of bearing trees were removed each year. The standard error of the mean was .0038.

Arak (1967) formulated an economic model of coffee supply in the Brazilian state of Saõ Paolo for the period 1930-1955. She used two models. The first model utilized new acres planted in year t as a function of the farmer's price expectations in that year, the availability of the coffee land and the age distribution of the tree stock. The expected price is represented as average (2-year) real earnings per bag of coffee produced. Another model utilized new acres as a proportion of the total stock of trees as a function of the same set of variables. The elasticity of annual plantings with respect to coffee prices was 2.02 and 2.28 in the first and second model, respectively. The values obtained were statistically significant at the 10-percent level. This showed that the short run responsiveness of farmers to a change in expected coffee prices was relatively high.

CHAPTER IV

A THEORETICAL FRAMEWORK FOR ANALYSIS OF COCONUT SUPPLY RESPONSE

An econometric model is needed for estimating the supply function of coconut in the Philippines. According to French and Matthews[19] the production of a perennial crop like coconut is "distinguished from the production of annual crops by (1) the long gestation period between initial input and first output, (2) an extended period of output flowing from the initial production or investment decision, and (3) eventually a gradual deterioration (usually of the productive capacity) of the plants. Thus, a perennial crop model must explain not only the planting process but the removal and replacement of plants and must explicitly consider the lags between input and output and the effects of populations of bearing plants on production." The unavailability of some of the data mentioned like removal and replacements of plants makes it necessary to modify the supply model that will be used specifically in this study.

In this model the supply equation will be separated into two components, (1) the number of bearing trees, and (2) yield per bearing tree. The response of each supply component to a set of explanatory (independent) variables based on total national annual data of the

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[19] B.C. French and J.L Matthews, "A Response Model for Perennial Crops," American Journal of Ag. Economics, Vol. 53, 1971, p.478.

Philippines will be measured statistically.

To start with, the basic market supply function is

$$Q_c = f\ (P_c)$$

where Q_c is the quantity of coconuts measured in copra terms with units of kilograms and P_c is the price per hundred kilograms of copra.

Given that functional form the following implied assumptions are included:

(1) The actual market for coconuts is represented by that for copra.

(2) The changes in the price of copra will be in real terms and assuming that all other prices are held constant.

(3) The price of copra relates to the time period(s) for which response in Q_c will be effective, i.e., if decisions at time t affect Q_c for t + 5, the price of copra represents the price expectation for t + 5.

(4) A proxy for price expectation, usually market prices with a system of distributed lags, will be used since they are the observable variables.

(5) The supply functions are for the whole market of all suppliers in which case the model is aggregative. If the function is to be continuous and smooth over the relevant range, additional implied assumptions includes (1) the market of coconuts is in the form of pure competition as there are many suppliers and the suppliers have perfect knowledge of the prevailing product and factor prices, (b) there are constant returns to scale or at least uniform returns to scale over the whole range, and

(c) all suppliers face similar production functions and transformation functions because technology is assumed to be given and constant.

Each of the implied assumptions has its own implications for the coconut supply function.

(1) Coconuts are produced per bearing tree and usually processed into copra prior to trading in the market so using conversion factors, coconut will be converted in copra terms.

(2) Prices of copra are reported in monetary terms and using wholesale price index as deflator prices can be converted to real terms. Also the ceteris paribus condition in the real world is absent so we have to look possibly at some representative input prices as fertilizer and other output prices as rice that will affect functional relationship.

(3) Distributed lag (or 2-year average) prices of copra will be used as proxy for price expectations as they are observable variables.

(4) Assumptions of pure competition are realistic for coconut producers in the Philippines. Technology is not constant, but new technology is not a major factor, as the use of new varieties is not reflected in the time series data used. The replanting program which uses high yielding precocious varieties started in 1980. However, the time trend variable could pick-up the effect of any other technological improvement.

Relationship between Trees and Yield

The quantity of coconuts produced in any one year can be expressed in the following simple equation:

$$Q_t = BT_t \times Y_t$$

where

Q_t = total quantity of coconuts (copra equivalent) expressed in kilograms at time t.

BT_t = total number of bearing trees at time t.

Y_t = yield per bearing tree expressed in kilograms at time t.

An indirect way of computing supply response was followed because of the lagged nature of production after planting. Thus, the two components of supply, BT_t and Y_t, are estimated separately. Multiplying the two equational components results in a supply function for Q_t as indicated by the above question.

Bearing Tree Equation

Instead of using hectarage as the production unit, tree numbers were used since coconuts are grown in small land holdings and the latter is more accurately known. In addition the coconut densities vary from region to region through time as new plantings and removals take place. Old coconut plantations especially in Southern Tagalog region were haphazardly planted and trees were planted more closely than the newly planted plantations in Mindanao which are systematically planted. In order for the tree to increase its yield the recommended density for planting is 9 x 9 meters triangular or 143 plants per hectare if in a triangular arrangement to 8.5 x 8.5 meters triangular or 160 plants per hectare.[20]

Since the number of bearing trees is readily available from statistical publications its use was selected as the dependent variable for bearing tree equation. In this case it is assumed that the producer knows the gestation period of the coconut tree he is to plant at time t-k (k is the number of years from planting to bearing) so that at time t the coconut tree starts bearing. Variety of the coconut used may affect the time of bearing. Varietal differences could be used as a dummy variable but the unavailability of varietal data prohibited this variable from inclusion in the equation.

It is assumed that the producer objective is to maximize the expected present discounted value of the future stream of net returns from his investment in coconuts versus some alternative land uses.

The major explanatory variables used to determine the number of bearing trees in any one year are the farmers' expectations with regard to the pattern of future prices of copra and rice. Rice is chosen as an alternative crop because it is one of the common catchcrops in coconut plantations in the Philippines. As the staple food of the Filipinos, farmers would easily get a market for this crop.

The bearing tree equation is as follows:

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[20] The Philippines Recommends for Coconut, 1975, p.9.

$$BT_t = a_0 + a_1F\bar{P}C_t + a_2F\bar{P}R_t + a_3BT_{t-1} + e_t$$

where:

BT_t = total number of bearing trees in year t

$F\bar{P}C_t$ = expected real farm price of copra in year t

$F\bar{P}R_t$ = expected real farm price of rice in year t

The expected deflated farm price of copra was proxied by the average farm price of the two previous years.

$$F\bar{P}C_t = (FPC_{t-1} + FPC_{t-2})/2$$

In like manner, the expected real farm price of rice was assumed to be the average price of the two previous years.

$$F\bar{P}R_t = (FPR_{t-1} + FPR_{t-2})/2$$

The number of bearing trees in the previous year was assumed to affect the present number of bearing trees. The sign of a_3 is expected to be positive since the number of bearing trees in year t would increase if there is an increase in the number in the previous year.

Yield Function

The second component of the supply function is the yield per bearing tree. According to French and Matthews[21] "*the per acre yield* of a perennial crop varies with the age of the bearing plants, with technology (cultural techniques, varieties, etc.) and weather and biological factors." The yield equation is as follows

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[21] Op. cit., B.C. French and J.L. Matthews, p. 485.

$$Y_t = b_0 + b_1 DPFERTA + b_2 CRED_{t-1} + b_3 RAIN_{t-1} + b_4 DUMMY + b_5 TIME + v_t$$

where:

Y_t = copra yield per bearing tree in kilograms

DPFERTA = average deflated fertilizer price in t-1 and t-2 in pesos per kilogram

$CRED_{t-1}$ = deflated interest rate for agricultural loan in t-1

$RAIN_{t-1}$ = monthly dry season rainfall from November to April in millimeters

DUMMY = 0 when no typhoon occurs during the year and 1 when typhoon occurs during the year.

TIME = a trend variable

v_t = error term

Data on the age grouping of the trees are not available so it is assumed that bearing trees should be planted in t-5. French and Matthews had mentioned that where data pertaining to age distribution are not available there is little that the researcher can do other than measure yields as some function of time, taking care that variations due to an age cycle are not projected as trends.

The price of fertilizer as an explanatory variable is assumed to affect yield of the tree. An application of fertilizer would increase yield (taking into consideration the law of diminishing returns). As a price incentive we would expect that as the price of the fertilizer decreases the farmers will use it in the production of coconut and hence increases yield.

The price of agricultural credit is assumed to affect yield also. We would expect that as the interest rate of agricultural loans decreases farmers are encouraged to borrow money from the banks as long as the interest rate they will pay is lower than the opportunity cost of investment.

Climatic factors that influence yield are rainfall and temperature. Rainfall during the dry season months is expected to affect yield of the tree. According to Menon and Pandalai[22] "of all the climatic factors affecting the coconut, rainfall and temperature appear to be the more important ones. The coconut palm can grow and bear fruits with a well distributed rainfall of 100 centimeters per annum but for profitable cultivation 100 to 225 centimeters per annum evenly distributed throughout the year appear necessary." The temperature of the Philippines is very suited to coconut production (See Appendix 7 for temperature ranges in the Philippines). The optimum mean annual temperature for best growth and maximum yields is stated to be 27°C with a diurnal variation of 6°C to 7°C. High temperatures might cause the young developing inflorescenses to dry up, and limit production to those months in the year when the temperature remains at a satisfactory level.

The time trend variable measures the effect of technological changes which have taken place through time, including biological

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[22] K. Menon and K. Pandalai, The Coconut Palm, 1958, p.111.

growth of the coconut trees.

Statistical Procedure

Ordinary least squares linear multiple regression is the estimation procedure used in this empirical analysis. Regression equations were estimated using the secondary aggregate time series data from 1957 to 1980. The appendix tables present the data that were utilized.

The following test statistics were computed.

1. Coefficient of Determination(R^2)

One criterion in choosing a model is to look at the value of the coefficient of determination or R^2. The coefficient of determination measures the extent of variability in the dependent variable as explained by the independent variables. The unexplained portion of variation in the dependent variable, on the other hand, can be attributed to some noise or disturbances which are called residuals.

The coefficient of determination is computed as:

$$R^2 = 1 - \frac{\sum(Y_i - \hat{Y}_i)^2}{\sum(Y_i - \bar{Y})^2} \qquad \text{or}$$

$$R^2 = 1 - \frac{SSE}{SST} \qquad \text{or}$$

$$R^2 = \frac{SSR}{SST} \qquad \text{since } SSR + SSE = SST$$

where:

SSE = sum of square residuals or the variation in the dependent variable unexplained by the model

SSR = sum of square regression or the variation in the dependent variable explained by the model

SST = sum of square total or the total variation of the dependent variable.

The possible values of R^2 range from 0 to 1 . The closer the value of R^2 to 1 the more the independent variables affect the dependent variable. If it is closer to zero then the independent variables weakly explain the dependent variable. A zero R^2 means that there is no independent variable in the equation as formulated that explain the dependent variable.

The significance of R^2 is further tested using the F-test. It tests R^2 not to be different from 0 or that the dependent variable is not explained by the explanatory (independent) variable in the equation. The null hypothesis sets all beta coefficients to zero. The following is the formula used.

$$F = \frac{SSR/(k-1)}{SSE/(n-k)}$$

where

F has (k-1, n-k) degrees of freedom

k = number of variables in the model

n = number of observations

The high value of F means rejection of the null hypothesis. Thus, if the SSR is high relative to SSE, rejection of null hypothesis occurs and R^2 is statistically significant.

2. T-statistic

In estimating the regression model, the regression coefficients of the explanatory variables are computed. If each of the independent variables shows significance, the t-ratio tells at what level could the independent variable be significant. We usually accept significance at 10-percent probability level and less.

The common approach in testing a regression coefficient is to assume that b = 0. This implies that a variable with zero coefficient in an equation carries no weight in explaining the variation of the dependent variable; therefore it may as well have been omitted. The approach in testing the regression coefficient is to set

$$t = \frac{\hat{b}}{S_{\hat{b}}}$$

where:

t = t-ratio

$\hat{b}$ = estimated regression coefficient

$S_{\hat{b}}$ = standard error of the estimated coefficient.

3. Durbin-Watson Statistic

The Durbin-Watson statistic is a technique used to determine or detect autocorrelation or serial correlation among the error terms in the first order condition. In other words ρ is equal to 0 in the following equation.

$$U_t = \rho U_{t-1} + e_t$$

where:

ρ = autocorrelation coefficient and $-1 < \rho < 1$

U_t = error term in time t

e_t = another error term; $E(e_t) = 0$

$$DW = \frac{\sum_{t=2}^{n} (\hat{e}_t - \hat{e}_{t-1})^2}{\sum_{t=1}^{n} \hat{e}_t^2}$$

where:

$\hat{e}_t$ = estimated error term in time t

Durbin and Watson have provided tables for testing the serial correlation. In this test they have set the lower and upper critical values d_L and d_U for various values of independent variables K' and sample size n. If $DW < d_L$, we reject the null hypothesis of positive autocorrelation $\rho > 0$. If $DW > d_U$, we do not reject the null hypothesis. If $d_L < DW < d_U$, the test is inconclusive. On the other hand, if $DW > 4 - d_L$, we reject the null hypothesis and accept the hypothesis of negative correlation $\rho < 0$. If $DW < 4 - d_U$, we do not reject the null hypothesis. If $4 - d_U < DW < 4 - d_L$, the test is inconclusive.[23]

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[23] T. Hu, Econometrics: An Introductory Analysis (University Park Press, 1973), 0. 94.

CHAPTER V

EMPIRICAL ANALYSIS OF COCONUT SUPPLY RESPONSE

Bearing Tree Equation

The estimates of the bearing tree equational component of the supply function for coconut in the Philippines is shown in Table 6. It is expected that the anticipated production of coconut will be reflected by the number of bearing trees already existing. The model that is used assumes that the number of bearing trees in year t (BT_t) is dependent on the producers' expected deflated price of copra in year t ($F\bar{P}C_t$), the producers' expected deflated price of rice in year t ($F\bar{P}R_t$), and the number of bearing trees in year t-1 (BT_{t-1}).

Producers' expected deflated price of copra ($F\bar{P}C_t$)

The producers' expected deflated price of copra in year t is represented by the average price of the two previous years. It was found that the producers' pattern of price expectations relevant for the bearing tree equation is shaped largely by the prices of copra in the two previous years; hence the two-year average price is used as proxy for producers' price expectations in the model. The deflated price of copra lagged beyond two years shows negative signs as opposed to the expectations.

The resulting positive sign of the producers' expected deflated price of copra is consistent with the expectation. The estimated regression coefficient of 0.3695 is large relative to its standard error and significant at the 10-percent probability level. As price of copra increases one would expect farmers to react positively, that is to increase the quantity of nuts produced through increasing the number of bearing trees, holding other things constant.

The supply price elasticity of copra (see Table 9) indicates that a one-percent increase in the expected deflated price of copra will result in approximately 0.12 percent increase in the number of bearing trees in the following period or about 425,940 trees. This low result is comparable to those obtained by Nyberg in Southern Tagalog and Bicol regions, (0.150 and 0.152, respectively), for the old coconut producing areas in the Philippines. In the same way, Behrman also got the same result in estimating the supply price elasticity of cocoa (0.15) in the Dominican Republic, one of the oldest cocoa producing areas in the world.

Producers' expected deflated price of rice ($FP\bar{R}_t$)

The producers' expected deflated price of rice in year t is represented by the average price of the two previous years. As expected a negative sign for the regression coefficient of $F\bar{P}R_t$ was obtained. The value of the coefficient (1.6713) is significant at the 10-percent level. One would expect farmers to increase the production of copra or nuts through increasing the number of bearing trees as the price of alternative crop decreases ceteris paribus. The supply cross-price elasticity of rice (see Table 8) indicates that a one percent increase in the expected deflated price of rice will decrease the number of bearing trees by 0.164 percent or approximately 563,340 trees.

Bearing trees in the previous year (BT_{t-1})

The coefficient of bearing trees at time t-1 (1.0074) is highly significant at one-percent probability level. In the same manner, holding all other variables constant, a one percent increase in the number of bearing trees in period t-1 will result in a 0.96 percent increase in the number of bearing trees (about 3.3 million trees) in period t.

Summary Statistics

The coefficient of determination or R^2 (0.97, Table 6) reflects statistically good fit. Ninety-seven percent of the variability in the number of bearing trees is explained by the variations in the explanatory variables in this equation -- the prices of copra and rice in real terms, and the number of bearing trees in the previous year.

The Durbin-Watson statistic (1.976) indicates that the auto-correlation coefficient of 0.003 in the first order condition is not significantly different from zero and hence no autocorrelation exists

Table 6. Bearing tree regression for coconut, Philippines (1957-1980)

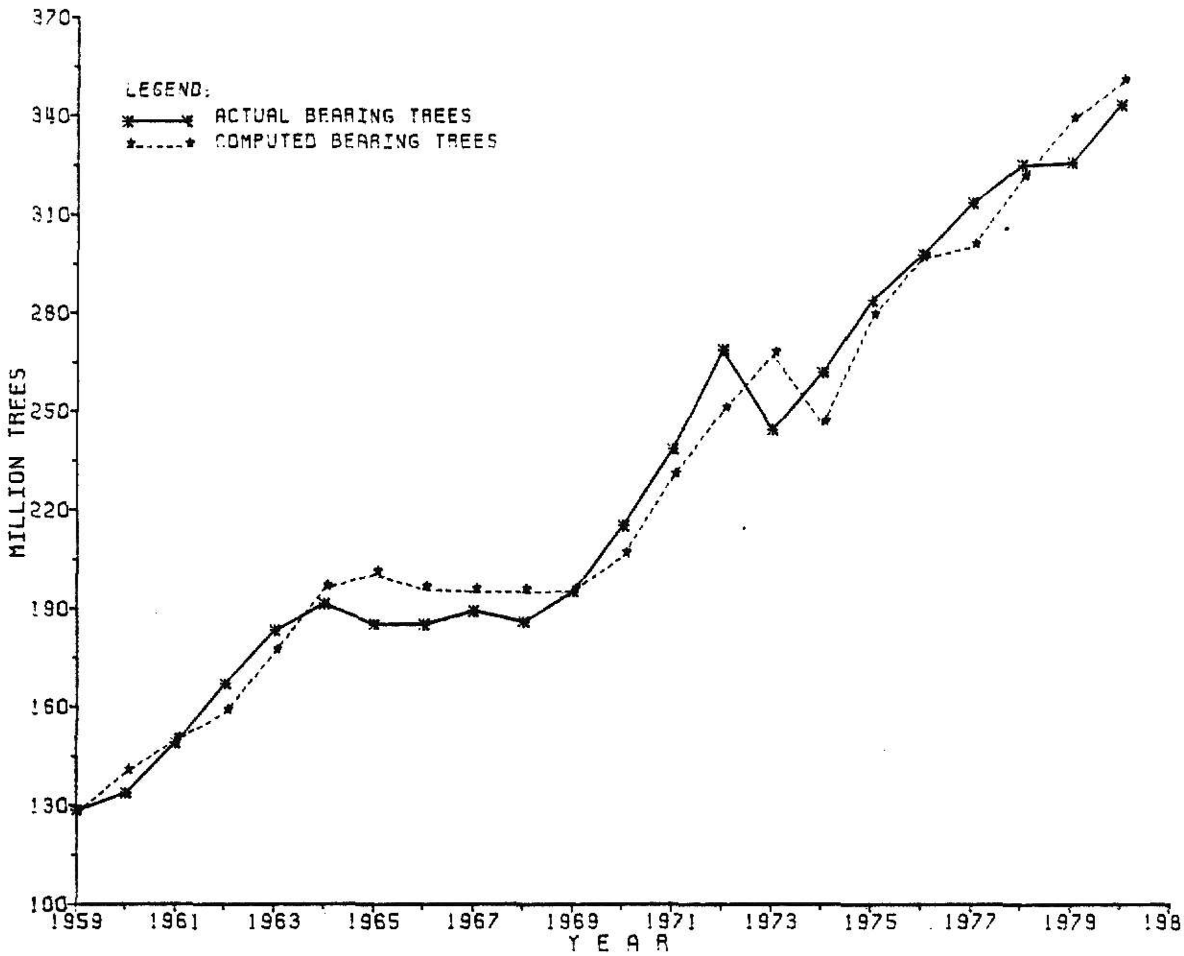
Explanatory Variables	Dependent Variable BT_t	T for H_0:Parameter = 0
Constant	17.2578	0.648
	(26.6368)[a]	
$F\bar{P}C_t$	0.3695[+]	1.921
	(0.1923)	
$F\bar{P}R_t$	-1.6713[+]	-1.747
	(0.9569)	
BT_{t-1}	1.0074**	25.057
	(0.0402)	
Summary Statistics		
R^2	0.9743	
Root MSE ($\hat{\sigma}$)	11.4025	
F-value	227.481	
Prob > F	0.0001	
DF	21	
Durbin-Watson	1.976	
1st order autocorrelation	0.003	

** Significant at 1 percent level

[+] Significant at 10 percent level

[a] Standard errors are in parenthesis

FIGURE 8
ACTUAL AND COMPUTED NUMBER OF BEARING TREES
PHILIPPINES, 1959-1980



among the error terms.

The graph of the actual and computed number of bearing trees from 1950 to 1980 is shown in Figure 8. The estimated values (computed) and the actual line do not coincide on all points but they exhibit almost the same trend. Discrepancies are observed for the 1964 to 1968 period as the estimated number of bearing trees are higher than the actual number of bearing trees. During this period copra prices were high due to the effect of foreign exchange decontrol program of the sixties. Producers wanted to produce more copra and hence the estimated number of trees was greater. On the other hand, between 1970 and 1972 the estimated number of bearing trees was lower than the actual number as the expansion of area planted to coconuts occurred in the early sixties. The "Typica" varieties of coconuts which were commonly used were tall and late maturing (6-7 years from planting when properly managed). In 1973, the gap of 23 million trees between the estimated and actual number of bearing trees is probably due to the tropical cyclone in the previous year. The same is observed between 1979 and 1980 as another typhoon had occurred in 1978. In addition, there were 325 hectares of demonstration farms for the replanting program beginning in 1976 and some trees were already bearing fruit as early as 3 years from planting time.

Yield per Bearing Tree Equation

The yield function is the second component of the supply analysis in this study. Several factors were assumed to affect the yield per bearing tree. However, one important variable that is expected to affect the yield a great deal, age distribution of bearing trees was not available. The data obtained for deflated interest rate on the agricultural credit variable were for a 15-year period only (1966 to 1980) and appeared insignificant in all models that were tried. The lagged rainfall and the dummy variable (0 when a typhoon does not occur during the year and 1 when a typhoon occurs during the year) also proved insignificant.

For comparison the different yield functions with insignificant variables for rainfall and typhoons included are presented on Table 7. The model ultimately selected based on a higher coefficient of determination, least standard deviation and lowest value of the first order autocorrelation is that for Y_1 (Table 7), with yield per bearing tree as a function of the fertilizer price and copra price ratio (FERCOP), expected price of copra ($F\bar{P}C_t$), average deflated price of fertilizer (DPFERTA), FERTIME (a cross-product term between the deflated price of fertilizer and time trend variable), time (TIME) and lagged rainfall ($RAIN_{t-1}$). The resulting yield equation is

$$Y_t = \underset{(3.1101)}{9.0923} + \underset{(2.3405)}{5.108}\ FERCOP + \underset{(2.3201)}{4.0261}\ F\bar{P}C_t - \underset{(3.5742)}{8.4968}\ DPFERTA$$

$$+ \underset{(0.3241)}{0.5027}\ FERTIME - \underset{(0.1613)}{0.4449}\ TIME - \underset{(0.0029)}{0.0042}\ RAIN_{t-1}$$

Table 7. Coconut yield per bearing tree equation, Philippines (1957 - 1980).

Explanatory Variables	Dependent Variables		
	Y_1	Y_2	Y_3
Constant	9.0923	4.9860	9.1043
	(3.1011)[a]	(1.6837)	(3.2104)
FERCOP	5.1080*	7.2583**	5.1428^{+}
	(2.3405)	(1.9667)	(2.4419)
$F\bar{P}C_t$	4.0261^{++}	5.2397*	4.0929^{++}
	(2.3201)	(2.2785)	(2.4756)
DPFERTA	-8.4968*	-5.1750^{++}	-8.6390*
	(3.5742)	(2.9842)	(3.9091)
FERTIME	0.5027^{++}		0.5120^{ns}
	(0.3241)		(0.3459)
TIME	-0.4449*	-0.1960**	-0.4499*
	(0.1613)	(0.0177)	(0.1731)
$RAIN_{t-1}$	-0.0042^{ns}	-0.0028^{ns}	-0.0043^{ns}
	(0.0029)	(0.0029)	(0.0032)
DUMMY			0.0316^{ns}
			(0.2857)
		Summary Statistics	
R^2	0.9139	0.9001	0.9140
Root MSE ($\hat{\sigma}$)	0.4017	0.4189	0.4156
Prob > F	0.0001	0.0001	0.0001
F-value	26.55	28.846	21.261
DF	21	21	21
Durbin-Watson	1.691	1.667	1.7
1st order autocorrelation	0.127	0.148	0.122

[a]Standard errors are in parenthesis **Significant at 1 percent level

*Significant at 5 percent level $^{+}$Significant at 10 percent level

$^{++}$Significant at 15 percent level ^{ns}Not significant

Fertilizer price and copra price ratio (FERCOP)

The input-output relationship of a production function describes the rate at which resources are transformed into products. The importance of fertilizer price in coconut production suggests that this measure may be highly correlated with grower cost and profit expectations. The sign one normally expects for the coefficient is negative since an increase in the fertilizer price relative to copra price will discourage producers to use fertilizer. However, in the equation used the effect of copra and fertilizer prices were separately considered and with time the deflated price of copra generally increased slightly until 1974 and then gradually decreased after that year. On the other hand, the deflated price of fertilizer did not exhibit a definite pattern. In this case, the positive sign obtained for the fertilizer-copra price ratio is not unreasonable. The coefficient (5.108) is significant at 5-percent probability level. A one-percent increase in the fertilizer-copra ratio results in a 0.44 percent increase in copra yield or approximately 0.028 kilograms of copra per tree.

Producers' expected deflated price of copra ($F\bar{P}C_t$)

The positive sign of the regression coefficient (4.0261) is as expected. The supply price elasticity in the yield component of supply is 0.3749. The result is significant at 15-percent probability level. One would expect that as the price of copra increases farmers will be encouraged to produce more and hence yield increases. Holding other things constant, a one percent increase in the expected price of copra will result to a 0.37 percent increase in copra yield equivalent to 0.023 kilograms.

Average deflated price of fertilizer (DPFERTA)

The average deflated price of fertilizer was computed from the two previous years. The regression coefficient of -8.4968 is significant at 5-percent probability level and the negative sign is consistent with the expectation. Decrease in the price of fertilizer provides incentive for farmers to use it to increase the yield per bearing tree. A one-percent decrease in the price of fertilizer results in a 0.54 increase in copra yield or 0.034 kilograms of copra per tree (Table 8).

Cross-product of deflated price of fertilizer and time (FERTIME)

An interaction term (FERTIME) between the price of fertilizer and time is included in the equation. This term (holding other variables constant) indicates that the change in Y due to a change in time is not only a function of time but also a function of the deflated price of fertilizer (that is the change in Y due to time will also depend on the fertilizer price). A one-percent increase in the FERTIME variable is associated with yield increase of 0.46 percent or 0.029 kilogram of copra per tree. Time measures technological changes and since most coconut trees are being intercropped, fertilization of the intercrops indirectly affects the coconut trees, so that the positive sign on the cross-product variable FERTIME is not unreasonable. The regression coefficient of 0.5027 is statistically significant at the 15-percent level.

Time trend variable (TIME)

The regression coefficient (-0.4449) for the time trend variable is significant at the 5-percent level. The negative sign showing a negative association with the coconut yield is partially explained by the old coconut trees that have been giving low yield coupled with the young bearing trees which have not yet reached the peak of production.

Lagged rainfall ($RAIN_{t-1}$)

The dry season rainfall data from November to April and in regions (excluding Central Luzon and Ilocos region in this case) where coconut trees are predominantly planted was considered. The regression coefficient of -0.0042 is of the expected sign but not significant. The coconut regions in the Philippines have a well distributed rainfall throughout the year. The data gathered show that annual rainfall ranges from 172 to 295 centimeters as compared to the required rainfall in the ranges of 100 to 225 centimeters per annum.

Summary Statistics

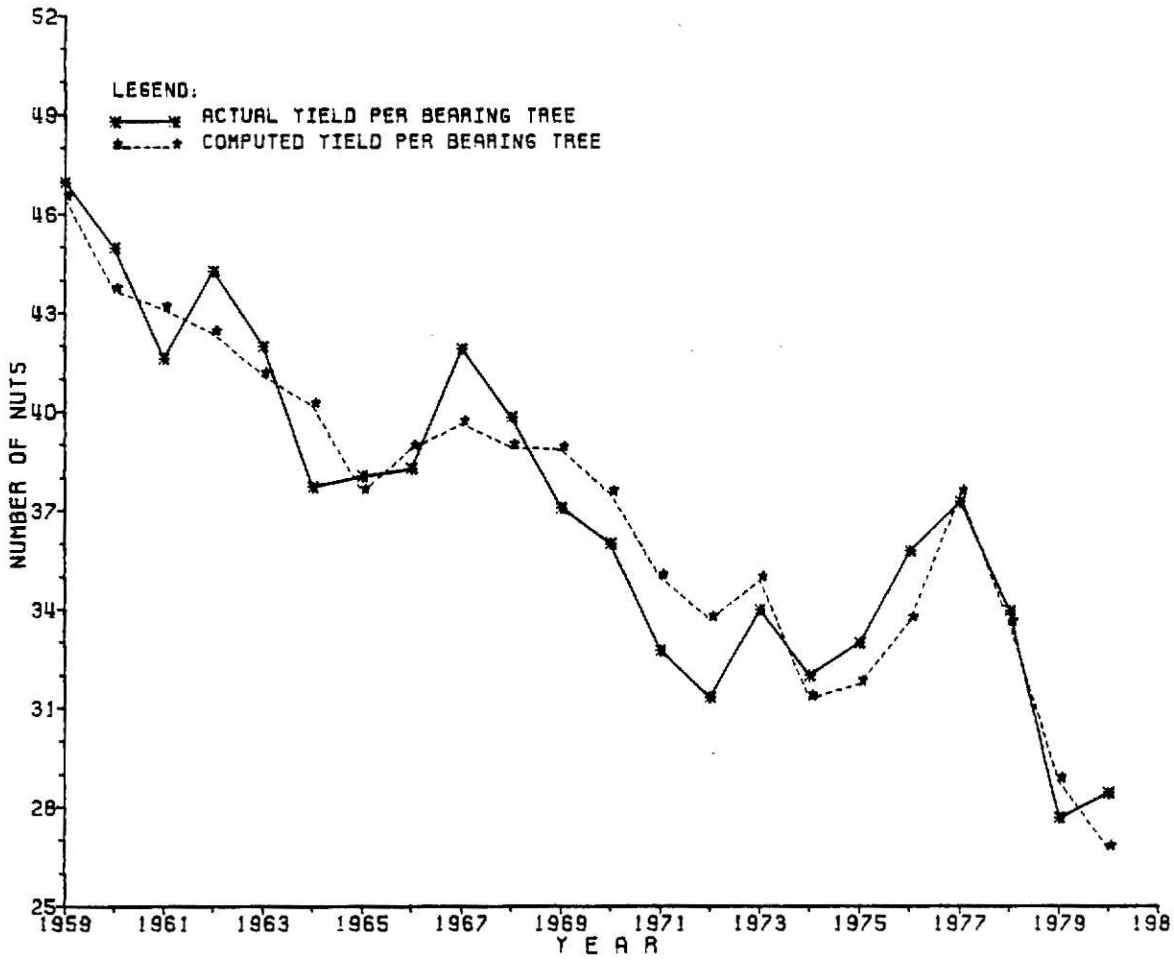
The value of R^2 for the yield model chosen is 0.91 (Table 7). It shows that ninety one percent of the variation in the yield per bearing tree is attributable to the variability in the fertilizer-copra

Table 8. Elasticity coefficients for Philippine coconut supply function (1957-1980).

Bearing Tree Function		Yield Per Bearing Tree Function	
Variables	Elasticity	Variables	Elasticity
$F\bar{P}C_t$	0.1243	DPFERTA	-0.5392
$F\bar{P}R_t$	-0.1640	TIME	-0.7296
BT_{t-1}	0.9640	FERTIME	0.4564
		$RAIN_{t-1}$	-0.0895
		FERCOP	0.4390
		$F\bar{P}C_t$	0.3749

[1]The elasticities are computed at the sample means.

FIGURE 9
ACTUAL AND COMPUTED YIELD PER BEARING TREE
PHILIPPINES, 1959-1980



price ratio, expected copra price, price of fertilizer, time trend, rainfall and fertilizer-time cross product term. The first order autocorrelation of 0.127 is inconclusive at the 5-percent level.

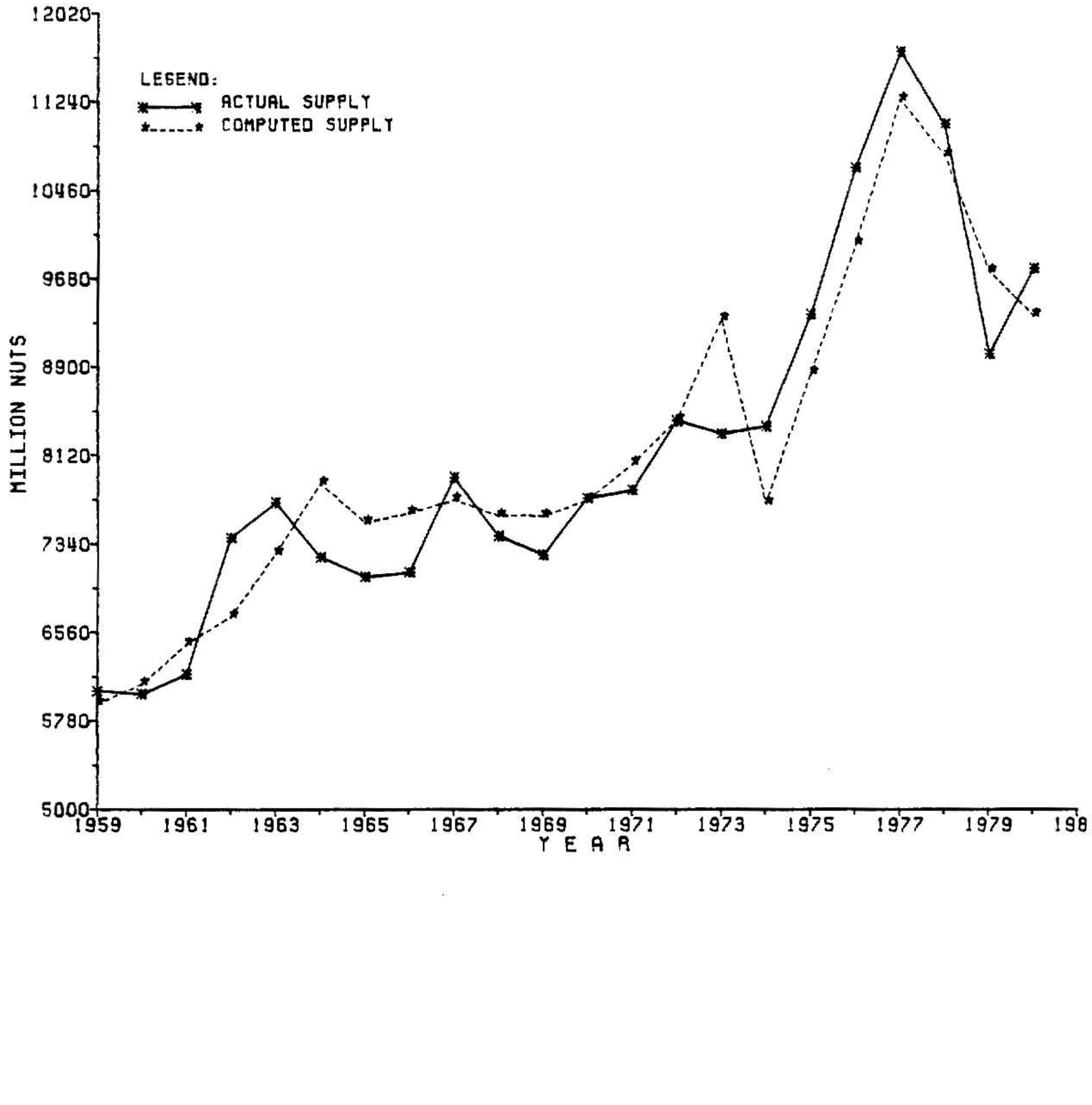
A graph of the actual and computed yield per bearing tree from 1959 to 1980 is shown in Figure 9. The two lines show the same trend although not all points coincide. The variations between the actual and computed lines is caused by unexplained variation included in the error term.

In 1962 and 1967 yield per bearing tree was greater by 2.5 and 2 nuts per bearing tree than the estimated yield of 42 and 40 nuts per bearing tree, respectively. Favorable weather conditions in the years 1961 and 1966 had increased the actual yield of nuts per bearing tree. However, between the years 1969 and 1973, the estimated yield line and actual yield line differences could be attributed to the various ages of the trees that had been bearing already as a result of the plantings in the early sixties but was not included in the equation. Another discrepancy occurred between 1974 and 1976 when the actual yield line is greater than the estimated line. In the same manner, the coconut trees planted in the sixties were reaching the production peak and hence the actual number of nuts produced are increasing. In 1980, there were increases in the actual yield as compared to the estimated point as the demonstration farms for replanting program were showing potential increases in the yield per bearing tree.

Actual Supply and Computed Supply of Coconuts

The estimated (computed) Philippine coconut supply for the range of the period under study was obtained by multiplying the computed values of the bearing tree equation and the yield per bearing tree equation. Figure 10 shows the actual coconut production trend from 1959 to 1980 as compared to the computed coconut production trend in the same years. The discrepancies in the estimated and actual lines of the yield and bearing tree equations are depicted in the gaps occuring between the actual and estimated coconut supply trend lines. In 1962 and 1963 the actual supply of coconuts was greater than estimated as a result of the increasing initiative of the farmers to produce more because of high copra prices. Between 1964 and 1969 the estimated coconut supply was greater than the observed except in 1967; the gap is even more distinct in 1973. In 1973 the oil embargo caused an increase in prices of coconut products and farmers wanted to produce more. However, with the government decree subsidizing the coco-based products (1973 CCSF levy) coupled with rapidly increasing market prices, government promotional programs (giving free seedlings to the replanting operation if farmers pay levy and giving scholarship grants to children of coconut farmers) the estimated increase in supply in Figure 10 from 1974 to 1978 lagged behind the actual increases in supply of coconuts.

FIGURE 10
ACTUAL AND COMPUTED SUPPLY OF COCONUTS
PHILIPPINES, 1959-1980



CHAPTER VI

SUMMARY AND CONCLUSIONS

The coconut industry plays a very important role in the Philippine economy, but recent statistical data revealed that the industry is plagued with problems of low productivity and price instability.

This study aimed (1) to analyze the trends in area, yield and production of coconut on the national level; (2) to analyze price trends of the different major coconut products; (3) to statistically measure the response of supply to changes in the price of copra; (4) to find out what other factors significantly affect the production and supply of coconut; (5) to derive some policy implications of the results obtained.

In order to accomplish the above objectives, time series secondary data on production, area, yield, prices of coconut products, prices of fertilizer, rainfall and interest rates for agricultural credit from 1950 to 1981 were gathered from different Philippine statistical publications.

Regression analysis using the Statistical Analysis System (SAS) was utilized to build the supply model for coconut in the Philippines.

As of 1971 there were 432,500 coconut farms with an average size of 4.9 hectares. In the same year, farms of 50 hectares and over in size represented 10 percent of the total coconut area of 2.15 million hectares. Southern Tagalog and Southern Mindanao regions lead in terms of area planted to coconut in the Philippines as 34 percent of the total area in 1980 is equally shared by the two regions.

However, Southern Tagalog had a larger production share (13.5 percent more) than Southern Mindanao since the former has old as well as new palms while the latter has dominantly young coconut groves which have not yet reached the peak of production.

Both coconut production and area planted to coconut generally show increasing trends as contrasted to the generally slight decreasing trend in yield of coconuts per bearing tree per hectare. The average yield of coconut from 1950 to 1981 was 37 nuts per bearing tree. The average number of coconut trees per hectare was 135 with an average number of 107 bearing trees. Decreasing nut yield is attributed to the lagging nature of coconut production, the existence of old coconut plantations and to the reluctance of farmers to allow practices of modern technology such as fertilization and management.

Among coconut products coconut oil is becoming the most important since it gives more income to the farmers and traders. Early in 1950 copra production was 563 thousand metric tons more than the production of coconut oil while in 1981 the difference was only 77 thousand metric tons. Coconut meal and desiccated coconut also show increasing volume of production.

The recent price trend in real terms of the different coconut products has been downward. Between 1980 and 1981 real domestic prices of copra, coconut oil, copra mean and desiccated coconut went down by 7, 4, 5, and 7 percent, respectively. These decreases are due to the increasing supply of competing fats and oils and synthetics.

The Philippine government shows interest and concern in the coconut industry through its various agricultural, industrial and marketing development and research programs. For the industry to have a bright future, the objectives of the different government programs and implementation of the different presidential decrees must be met.

Statistical supply response models for coconut in the Philippines were estimated in the study. The results show that the farmers respond only moderately in plantings to price changes, as a one percent increase in the price of copra results in an estimated 0.12 percent increase, and a one percent increase in the price of rice results in an estimated 0.16 percent decrease in the number of bearing trees. The bearing tree response function explained 97 percent of total variation over the 1959-1980 period, but the real copra price and real price of rice variables were significant only at the 10 percent probability level.

The deflated price of fertilizer, fertilizer-copra price ratio, and the time trend variables were the only factors found to statistically affect the coconut yield per bearing tree at the 5-percent level. The expected copra price and the fertilizer price-time cross product term were significant in the yield response function at the 15-percent probability level. The rainfall variable was not significant. The estimated supply price elasticities in the yield function are 0.37 for copra price, -0.54 for fertilizer price, 0.44 for the fertilizer-copra price ratio and 0.46 for the fertilizer price-time cross product. An

R-square value of 0.91 was obtained for the selected coconut yield response function.

Appendix 1. Area, production and yield per hectare of coconuts, Philippines, 1950-1981.

Year	Area (thousand hectares)	Production (million nuts)	Yield per hectare (nuts)
1950	985.00	3,997.49	4,058
1951	987.00	5,279.64	5,349
1952	987.80	3,406.19	3,451
1953	989.97	4,182.00	4,045
1954	990.00	4,602.95	4,650
1955	990.00	5,321.46	5,376
1956	992.00	5,504.07	5,549
1957	992.00	5,951.00	5,999
1958	995.61	5,973.60	6,000
1959	1,006.10	6,041.36	6,005
1960	1,059.40	6,015.93	5,684
1961	1.119.88	6,189.70	5,163
1962	1,283.74	7,395.57	5,761
1963	1,394.31	7,704.41	5,533
1964	1,482.89	7,222.16	4,870
1965	1,604.74	7,051.86	4,394
1966	1,610.92	7,089.85	4,401
1967	1,820.15	7,925.21	4,354
1968	1,800.41	7,412.46	4,117
1969	1,845.48	7,244.06	3,925
1970	1,883.92	7,745.21	4,111
1971	2,048.49	7,813.95	3,814
1972	2,125.53	8,424.41	3,963
1973	2,133.30	8,310.91	3,896
1974	2,206.01	8,376.32	3,797
1975	2,279.50	9,368.02	4,110
1976	2,521.19	10,662.39	4,229
1977	2,713.80	11,686.40	4,306
1978	2,890.00	11,045.00	3,822
1979	2,995.00	9,018.00	3,011
1980	3,125.92	9,774.00	3,127
1981	3,162.25	10,412.00	3,194

Source of Data:

1950-1977, P.A. Alcaide, et. al., Compendium of Agricultural Statistics in the Philippines, CPDS, UP at Los Banos, Philippines, Vol 1, 1979.

1978-1981, Bureau of Agricultural Economics, Philippines.

Appendix 2. Number of total and bearing trees and nut yield per bearing tree, Philippines, 1950-1981.

Year	Number of Trees Total (million)	Bearing (million)	Yield Per Bearing Tree (nuts)
1950	138.1	106.6	37
1951	180.2	139.0	38
1952	150.7	116.3	29
1953	149.3	115.2	36
1954	164.3	126.8	36
1955	164.4	126.8	42
1956	164.4	126.8	43
1957	164.4	126.8	47
1958	165.0	127.4	47
1959	166.6	128.6	47
1960	167.1	133.8	45
1961	185.1	149.0	41
1962	197.6	167.1	44
1963	211.7	183.4	42
1964	232.1	191.4	37
1965	240.9	185.3	38
1966	244.8	185.2	38
1967	243.7	189.2	42
1968	252.7	186.0	40
1969	264.5	195.2	37
1970	272.4	215.2	36
1971	297.0	238.4	33
1972	325.5	268.7	31
1973	315.2	244.4	34
1974	334.5	261.8	32
1975	346.6	283.9	33
1976	353.5	297.8	36
1977	376.9	313.6	37
1978	387.0	325.2	34
1979	396.4	325.9	28
1980	417.4	343.5	28
1981	411.2	338.0	30

Source of Data:

1950-1965, A.J. Nyberg, Growth in the Coconut Industry (1901-1966). Growth of Output in the Philippines. (Papers presented at a conference at the International Rice Research Institute, Los Banos, Laguna, Dec. 9-10, 1966).

1966-1981, Bureau of Agricultural Economics, Philippines.

Appendix 3. Volume of production of coconut products in copra equivalent, Philippines, 1950-1981.

Year	Copra	Coconut Oil	Copra Meal	Desiccated Coconut
		(thousand metric tons)		
1950	780.00	217.74	n.a.	73.33
1951	1,037.00	219.35	234.37	73.33
1952	954.00	233.87	253.12	57.77
1953	856.00	227.41	231.25	50.00
1954	942.00	237.09	243.75	47.22
1955	1,103.00	245.16	256.25	44.44
1956	1,140.00	327.41	350.00	46.66
1957	1,319.00	349.99	362.50	59.99
1958	1,293.00	362.90	309.37	62.22
1959	1,072.00	312.90	296.87	55.99
1960	1,025.00	266.12	278.12	46.66
1961	1,071.00	274.19	306.25	65.88
1962	1,356.00	758.06	496.87	69.99
1963	1,488.60	568.38	577.81	74.44
1964	1,487.20	602.90	661.87	69.99
1965	1,470.90	606.77	624.06	69.55
1966	1,484.70	636.12	821.87	80.33
1967	1,576.80	557.25	636.25	92.44
1968	1,541.80	655.96	648.12	56.66
1969	1,515.50	560.48	611.25	49.11
1970	1,656.20	765.96	795.31	77.77
1971	1,574.10	864.51	990.00	116.66
1972	1,703.00	974.83	1,208.75	122.66
1973	1,698.40	1,000.32	904.68	109.77
1974	1,702.70	1,086.61	930.62	107.77
1975	1,718.50	1,285.80	1,210.31	112.55
1976	1,726.60	1,323.54	1,380.62	122.22
1977	2,235.10	1,688.55	1,721.88	152.40
1978	2,238.00	1,878.06	2,000.94	141.40
1979	1,795.00	1,671.94	1,826.88	129.00
1980	1,954.00	1,860.32	1,892.19	137.90
1981	2,122.40	2,045.32	2,218.13	136.60

n.a. - no data available

Note: Data were converted to copra equivalent using conversion factors in Appendix 6.

Source of Data:

1950-1977, Crop and Livestock Survey, Bureau of Agricultural Economics and Central Bank Statistical Bulletin, Philippines (various issues).

1978-1981, IAPMP,"Coconut Industry Profile, Situation and Policy," Memorandum 82-4-4, April 29, 1982.

Appendix 4. Domestic prices of coconut products, Philippines, 1950-1981.

Year	CURRENT PRICES				DEFLATED PRICES (1972=100)			
	Copra	Coconut Oil	Copra Meal	Desiccated Coconut	Copra	Coconut Oil	Copra Meal	Desiccated Coconut
				₱/100 kilograms				
1950	36	68	11	66	90.07	170.13	27.52	165.12
1951	36	70	12	67	80.23	156.01	26.74	149.32
1952	25	46	15	53	60.90	112.06	36.54	129.11
1953	37	69	12	67	91.02	99.03	29.23	163.22
1954	31	57	10	61	80.44	147.90	25.95	158.28
1955	27	48	11	56	71.98	127.97	29.33	149.29
1956	26	45	12	54	67.17	116.25	31.00	139.50
1957	28	47	11	54	69.38	116.45	27.25	133.80
1958	38	65	11	63	91.06	155.76	26.36	150.97
1959	47	80	15	73	111.11	189.13	35.46	172.58
1960	40	70	15	61	90.76	158.84	34.04	138.42
1961	38	66	14	49	82.18	142.73	30.28	105.97
1962	47	79	22	72	96.77	162.65	45.30	148.24
1963	54	89	26	90	101.29	166.95	48.77	168.82
1964	56	96	23	98	100.43	172.17	41.25	175.75
1965	64	112	27	105	112.26	196.46	47.36	184.18
1966	56	98	32	103	94.18	164.82	53.82	173.23
1967	63	109	27	104	103.28	178.69	44.26	170.49
1968	76	130	30	166	121.29	207.47	47.88	264.92
1969	68	113	23	129	107.07	177.92	44.09	203.12
1970	98	168	40	120	124.82	213.99	50.95	152.85
1971	89	151	40	140	98.00	166.26	44.04	154.15
1972	69	120	46	110	69.00	120.00	46.00	110.00
1973	187	308	76	168	150.18	247.35	61.03	134.92
1974	368	647	75	438	191.25	336.24	38.98	227.63
1975	147	266	82	206	74.26	134.38	41.42	104.07
1976	165	288	94	186	77.72	135.65	44.27	87.61
1977	147	279	67	207	63.64	120.78	29.00	89.61
1978	165	475	108	687	66.80	192.31	43.72	278.14
1979	314	641	122	872	107.46	219.37	41.75	298.43
1980	120	413	105	822	34.72	119.50	30.38	237.85
1981	112	398	100	766	-	-	-	-

Source of Data:

1950-1977, Central Bank Statistical Bulletin, Philippines (various issues).

1978-1981, IAPMP, "Coconut Industry Profile, Situation and Policy," Memorandum 82-4-4, April 29, 1982.

Appendix 5. Export prices of coconut products, Philippines, 1950-1981.

Year	CURRENT PRICES				DEFLATED PRICES (1972=100)			
	Copra	Coconut Oil	Copra Meal	Desiccated Coconut	Copra	Coconut Oil	Copra Meal	Desiccated Coconut
	₱/100 kilograms							
1950	39	36	12	66	97.57	90.07	30.02	165.12
1951	40	63	10	63	89.15	140.41	22.29	140.41
1952	27	38	14	50	65.77	92.57	34.10	121.80
1953	39	58	12	64	95.01	141.29	29.23	155.91
1954	34	51	10	59	88.22	132.33	25.95	153.09
1955	29	45	10	53	77.31	119.97	26.66	141.30
1956	28	44	10	53	72.33	113.67	25.83	136.92
1957	28	44	8	55	69.38	109.02	19.82	136.27
1958	34	55	9	64	81.48	131.80	21.57	153.37
1959	41	70	13	73	96.93	165.48	30.73	172.58
1960	34	52	12	64	77.15	117.99	27.23	145.22
1961	28	43	9	49	60.55	92.99	19.46	105.97
1962	50	73	22	83	102.94	150.30	45.30	170.89
1963	56	82	24	90	105.05	153.82	45.02	168.82
1964	67	102	22	109	120.16	182.93	39.45	195.48
1965	75	113	25	118	131.56	198.21	43.85	206.98
1966	65	94	28	103	109.32	158.09	47.09	173.23
1967	65	100	23	109	106.56	163.93	37.70	178.69
1968	75	118	23	155	119.69	188.32	36.71	247.37
1969	67	97	21	116	105.50	152.73	33.07	182.65
1970	103	162	34	165	131.19	206.34	43.31	210.16
1971	104	164	36	180	114.51	180.58	39.64	198.19
1972	80	121	31	154	80.00	121.00	31.00	154.00
1973	152	239	59	281	122.07	191.94	47.38	225.67
1974	356	622	70	641	185.01	323.25	36.38	333.13
1975	165	271	80	335	83.35	136.90	40.41	169.23
1976	134	256	81	342	63.12	120.58	38.15	161.09
1977	234	397	99	681	101.30	171.86	42.86	294.81
1978	287	443	94	676	116.19	179.35	38.06	273.68
1979	456	678	105	896	156.06	232.03	35.93	306.64
1980	297	463	109	1,008	85.94	133.97	31.54	291.67
1981	233	385	98	885	-	-	-	-

Source of Data:

1950-1977, Foreign Trade Statistics of the Philippines, National Census and Statistical Office, Manila, Philippines (various issues).

1978-1981, FAO Trade Yearbook, 1978-1982.

Appendix 6. Coconut Conversion Table

1 kilogram copra = 4.5 nuts

1 kilogram copra = 0.62 kilogram oil

1 kilogram copra = 0.32 kilogram copra meal

1 kilogram copra = 0.90 kilogram desiccated coconut

Source: The Philippines Recommends for Coconut 1975

Appendix 7. Normal maximum and minimum temperature, by month and by principal island (In Centigrade)

Month[1]	Philippines		Luzon		Visayas		Mindanao	
	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum	Maxi-mum	Mini-mum
Annual	31.1	22.8	30.9	22.7	31.0	23.7	31.4	22.1
January	29.5	21.7	28.7	20.7	29.6	22.9	30.2	21.5
February	31.0	21.7	29.5	20.8	30.0	22.8	33.5	21.6
March	31.1	22.3	30.9	21.8	31.0	23.3	31.3	21.7
April	32.1	23.2	32.3	23.1	32.1	24.2	32.0	22.2
May	32.5	23.7	33.0	23.9	32.5	24.6	31.9	22.7
June	32.1	23.5	32.8	23.9	32.5	24.2	31.4	22.4
July	31.4	23.3	31.6	24.0	31.5	23.8	31.0	22.2
August	31.3	23.3	31.2	23.6	31.5	24.0	31.1	22.4
September	31.3	23.2	31.1	23.4	31.6	23.9	31.3	22.3
October	31.2	22.9	30.9	22.9	31.3	23.7	31.5	22.1
November	29.9	22.7	30.0	22.4	28.5	23.6	31.1	22.0
December	30.0	22.3	29.1	21.6	30.1	23.4	30.8	21.9

[1]Based on a 20-year observation, 1951-70.

Source: National Census and Statistics Office, *Philippine Yearbook, 1977.*

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A SUPPLY RESPONSE STUDY OF COCONUT
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AN ABSTRACT OF A MASTER'S REPORT

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ABSTRACT

The study was undertaken to analyze descriptively and measure statistically the different factors that significantly affect the supply of coconuts in the Philippines with the end view of providing additional information to policy-makers for government programs relating to the development of the coconut industry.

The supply response models for coconut in the Philippines were estimated using the Statistical Analysis System (SAS).

The lagged nature of production after planting was reflected by separating the estimated coconut production in any one year into two equational components - a bearing tree equation and a yield per bearing tree equation. The postulated hypothesis is that the number of bearing trees is a function of the producers' expected deflated price of copra, the producers' expected price of an alternative crop (rice), and the number of bearing trees in the previous year. The postulated relationship for the yield equation is that yield per bearing tree is a function of the deflated price of fertilizer, the producers' expected deflated price of copra, the amount of rainfall, occurence of a typhoon and a time trend variable.

The results indicate that the farmers respond only moderately in plantings to price changes, as a one percent increase in the price of copra results in an estimated 0.12 percent increase, and a one percent increase in the price of rice results in an estimated 0.16 percent decrease in the number of bearing trees. An R-square of 97 percent was obtained, but the real price of copra and the real price of rice variables were significant only at the 10-percent level while the number of trees in the previous year

The deflated price of fertilizer, fertilizer-copra price ratio, and the time trend variables were the only factors found to statistically affect the coconut yield per bearing tree at the 5-percent level. The producers' expected deflated copra price and the fertilizer price-time cross product term were significant in the yield response function at the 15-percent probabilit level. The typhoon and rainfall variables were not statistically significan The estimated supply price elasticities in the yield function were 0.37 for copra price, -0.54 for fertilizer price, 0.44 for the fertilizer-copra price ratio and 0.46 for the fertilizer price-time cross product. An R-square value of 0.91 was obtained for the selected coconut yield function.