

Aggregate Demand¹ for Fertilizer in the Coconut Industry in Sri Lanka

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Abstract:

This study attempts to identify the major determinants of fertilizer consumption in the coconut industry in Sri Lanka. The author identifies two groups of cultivators; namely, small holders (those who own less than 20 acres) and estates (those who own 20 acres or more). It is argued that each group of cultivators pursues its own objectives with respect to input-use and production. Estates are expected to be mainly profit-oriented whereas small holders are mainly consumption-oriented.

The author constructs a simple model to explain fertilizer consumption of each group and estimates the parameters of the model, using time series data for the 1956-75 period. According to the results obtained, there is empirical evidence to support that each group reacts to bad weather spells, prices and level of produce in the same direction, but with different intensities. The author also finds that the price elasticities of demand for fertilizer are in the range of 0.4 to 0.7 and output elasticities with respect to fertilizer consumption in range of 0.8 to 0.9.

I. Introduction

This study aims at explaining the consumption of fertilizer in the coconut industry of Sri Lanka using aggregate time series data for the 1960-75 period. It attempts to explain changes in fertilizer consumption with the aid of a simple econometric model.

It is generally agreed that the main determinants of coconut yield are weather and fertilizer.² Other inputs such as seedlings, planting materials, labour etc. play a minor role in determining yield. Weather being an exogenous factor, we concentrate mainly on the effect of fertilizer input on coconut yield.

Table I shows the relationship between average fertilizer consumption and average coconut production for five-yearly intervals. Fertilizer prices, product prices and exports are also given in the table. It is quite clear from the table that falling consumption of fertilizer is largely responsible for the fall in production and exports since 1970. Falling production has pushed the average price of produce considerably. Sharp increases in the price of fertilizer seem to be the cause for falling fertilizer consumption.

According to the figures given in Table I, fertilizer consumption reached a peak in the 1966/70 period and since then, it has begun to deteriorate rapidly. There is evidence to support that the neglect of the practice of fertilizer application, coupled with the heavy demand for coconut lands for alternative uses such as housing, tourism etc. have affected coconut production considerably. It can be argued that one definite way of, at least, sustaining production at the present level is by increasing the application of fertilizer. Hence, one of the important objectives of this study is to evaluate the relative importance of the determinants of fertilizer consumption.

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1. Only the demand aspect is considered here since fertilizer requirements are met by fertilizer imports. Thus supply and price of fertilizer are treated as exogenous.
 2. See Administrative Reports of the Commissioner for Coconut Rehabilitation.

Another objective of the exercise is to measure the elasticity of demand for fertilizer with respect to its own price and elasticity of fertilizer consumption with respect to output. The formulated model will also be used to test whether cultivators respond to price changes.

Thirdly, it is expected that the constructed model would enable the policy-maker to forecast the total cost of the subsidy bill which was around Rs. 13 million annually, on average, over the 1971-75 period. A coconut fertilizer subsidy scheme was introduced in 1956 by the Department of Coconut and Cocoa Rehabilitation of Sri Lanka for the benefit of coconut cultivators. Under the scheme, fertilizer has been made available at subsidized prices. For the purpose of subsidy payments, coconut cultivators have been divided into two categories: small holders (those who own holdings of less than 20 acres) and estate owners (those who own 20 acres or more). Upto 1968 estate owners received a subsidy amounting to one third of the price of fertilizer

TABLE 1
Fertilizer Consumption, Coconut Production, Exports and Prices, 1956-79

<i>Period</i>	<i>Fertilizer Consumption (tons)</i>	<i>Coconut Production³ (in million nuts)</i>	<i>Exports</i>	<i>Price Index for Fertilizer (1960-100)</i>	<i>Colombo Market Price for 1000 nuts (Rupees)</i>
1956-60	36,700	2,300	1,100	105.6	151
1961-65	45,800	2,700	1,400	105.8	132
1966-70	58,300	2,500	1,000	133.0	179
1971-75	41,800	2,400	800	221.9	264
1976-79	34,100	2,100	500		666

Source : Coconut Statistics (Coconut Development Authority, 1974)
Administration Reports of the Commissioner of Coconut and Cocoa Rehabilitation, 1964-71.
Annual Reports of the Coconut Development Authority, 1972, 1973, 1974 and 1975.

whereas small holders received a subsidy equivalent to half the price of fertilizer. Since 1968, a common subsidy of 50 per cent of the price of fertilizer was in operation and in 1978 the common subsidy has been raised up to 75 per cent. Obviously, the increasing rate of subsidy as well as the abolition of discriminatory subsidies would have added extra expenditure to the existing subsidy bill. The model constructed here would enable the policy-maker to evaluate the effects of varying rates of subsidies on the aggregate level of fertilizer consumption.

3. Total production = Domestic Consumption + exports. *Domestic consumption figures are obtained by multiplying per capita consumption of coconut and coconut products by mid-year population. This method of computation is rather unsatisfactory because per capita figures which come from Consumer Finances Surveys are not responsive to continuous price changes.

An attempt is also made to study the effect of weather on fertilizer consumption with the aid of the model.

Two Groups of Cultivators:

In this study, coconut cultivators are divided into two categories on the basis of holdings size; namely, estate-owners and small-holders. Cultivators who own 20 acres or more are classified as estate-owners while those who own less than 20 acres are classified as small-holders. It is known that cultural and management practices of cultivators differ widely between these two groups. According to the findings of the Survey of Coconut Lands in the Kurunegala District (1977), the majority of small-holders treat coconut cultivation as a mere secondary occupation compared to paddy cultivation, whereas estate-owners run their estates as business enterprises.

As shown earlier, these two groups are distinguished for the purpose of subsidy payments. Similar distinction is also made with regard to the distribution of fertilizer. Small-holders have been allowed to order their fertilizer requirements either directly or through co-operatives while estates have to obtain their requirements directly from the central stores in Colombo. Even with the establishment of fertilizer stores at regional level, priority has been given to the small-holders.

A distinction can also be made on the type of labour used by each category. Most of the small-holders do not hire labour for cultivation purposes because of the abundance of family labour, while for the estate sector the main source would have been hired labour. Since coconut is not a short-term crop, it is possible for small-holders to devote their family labour leisurely during slack periods when there is less demand from other crops, especially paddy. As a result of these considerations, an attempt is made to develop models for these two groups separately.

Hypothesis Concerning Fertilizer Consumption

In this study, we formulate the hypothesis that estate owners and small holders take decisions concerning fertilizer consumption to achieve different goals. Since estates are mainly private enterprises, they attempt to maximize their profits. On the other hand, small holders use family labour for cultivation, consume a certain portion of their produce and try to maintain a certain level of income to meet the family's consumption requirements.

II. Specifying a Reduced Form Model for Fertilizer Consumption:

In this study, it is assumed that the major determinants of fertilizer consumption (C_F), are the subsidized price of fertilizer (P_F), output (X), weather (W) and the availability of fertilizer in the near vicinity (D). Thus the model is expected to be in the following form:

$$C_F = f(P_F, W, X, D) \quad \dots\dots\dots(1)$$

In model (1), it is assumed that the subsidized price of fertilizer will reflect the actual price of fertilizer to the cultivator, since the government subsidy is an outright grant which will effectively reduce the price. In the model, weather⁴ is approximated by the average rainfall (\bar{R}) and the relative dispersion of rainfall (S_R).

Assuming that C_F is related to the variables given in (1), in linear form, equation (1) can be written as

$$C_F = b_0 + b_1 P_F + b_2 \bar{R} + b_3 S_R + b_4 X_{t-1} + b_5 D + u \quad (2)$$

where X_{t-1} — one year lagged output

u — the disturbance term.

III. Data, Variables and Expected Signs:

It is expected that large price increases will have a discouraging effect on fertilizer consumption and hence the subsidized price of fertilizer is expected to have a negative sign. It is assumed that fertilizer consumption is sensitive to the length of drought periods and hence the level and relative dispersion of rainfall are included in the model to take account of the influence of weather. During long spells of drought, the cultivator will be reluctant to apply fertilizer and hence the mean rainfall is expected to have a positive relationship with fertilizer consumption.

It is expected that one-year lagged output is positively related to fertilizer usage. Since there is no reliable data available on actual production, one-year lagged exports are used as a proxy for output. Exports being a residual component of production, it is assumed that the higher the level of production, the greater the amount available for exports. However, it is important to note that the government has actually intervened in the market by controlling the amount that can be exported in some years (1973 and 1977). One-year lagged period was selected because of our belief that small holders as well as some estates will have a short planning period with regard to fertilizer applications.

It is also assumed that the availability of fertilizer in the locality would have had a significant effect on the small holder's decision concerning fertilizer use. Thus, a variable indicating the role of co-operatives in the distribution of fertilizer to small holders is included in the model. This variable is expected to have a positive sign in the model.

The data on fertilizer requirements of both sectors and fertilizer prices including subsidies can be obtained from the annual reports of the Commissioner for Coconut and Cocoa Rehabilitation for the period 1964-71 and those of the Coconut Development Authority for the 1972-75 period. Varia-

4. Weather, W , is represented by \bar{R} the average monthly rainfall and S_R relative dispersion of rainfall for the Kurunegala district. S_R is equal to the ratio of standard deviation rainfall to \bar{R} . Only one rainfall station was selected because of the difficulty in selecting weights for a weighted average rainfall, covering all rainfall stations in the coconut growing areas.

bles on fertilizer consumption and prices are expressed in the form of index numbers with 1960 as base. The fertilizer price index is obtained by combining the prices of CRI 'A', CRI 'B', CRI 'C' and CRI 'Y.P.M.' mixtures of fertilizers.

Figures on coconut exports are obtained from the annual reports of the Central Bank of Sri Lanka and a composite index of exports was constructed with 1960 as base. The monthly rainfall figures are obtained from the reports of the Department of Meteorology.

IV. Empirical Results:

Equation (2) was fitted for the period 1960-75 and the following estimates of the coefficients were obtained by using the ordinary least squares method.

TABLE 2
Determinants of Fertilizer Consumption

Variable	SECTOR	
	Small Holders	Estates
Price of Fertilizer ..	-0.32* (3.85)	-0.51* (3.55)
Mean rainfall (\bar{R}) ..	-0.67 (0.22)	8.71 (1.67)
Dispersion of rainfall (S_R) ..	0.33 (1.22)	0.68 (1.46)
One-year lagged output (E_{t-1}) ..	-0.74* (2.22)	-0.89* (2.09)
Mode of transport (D) ..	1.73 (1.44)	
Intercept term ..	126.76	130.39
R^2 ..	0.72	0.67

*Significant at the 5 per cent level
(t-ratios are in parenthesis)

As expected, the estimated coefficient of the price of fertilizer has the correct sign and is significant at the 5 per cent level for both sectors. It is quite obvious from the results that small holders do not run down fertilizer applications as much as the profit-oriented estate sector, when price increases take place. The rate of decrease in the estate sector is more than 1½ times that of the small holdings sector. This difference can be attributed to differing objectives of these two sectors. From the results, it is also clear that the estimated coefficient of lagged exports is highly significant and has the correct sign for each sector. The estate sector responds more to a falling output than the other sector, thus showing their different objectives. Falling output (and falling exports) does alarm producers and hence, they will take measures

to increase output through the intensive application of fertilizer, in the short-run. In order to achieve this objective, estates react faster than small holders even though the response rate is not very different.

The estimated coefficient of rainfall is significant at 10 per cent level and has the expected sign only for the estate sector. The other variables included in the model are not highly significant though they have the correct signs. However, the overall fit of the model is rather high. The coefficient of determination varies around 0.7 for both sectors.

Elasticities:

One of the objectives of this study is to compute own-price elasticity and output elasticity with respect to fertilizer. The results obtained from this exercise are given in Table 3.

TABLE 3

Price and Output Elasticities with Respect to Fertilizer

<i>Sector</i>	<i>Price</i>	<i>Output (Exports)</i>
Small-holders	-0.41	-0.76
Estates	-0.67	-0.93

Price Elasticity:

Figures given on price elasticities in table 3 indicate that estates are more inresponsive to increasing prices than the small holder. A 10 per cent increase in the subsidized price of fertilizer reduces consumption by nearly 7 per cent in the estate sector whereas the corresponding reduction in the small holdings sector is 4 per cent. The prices used here have been heavily subsidized (around 75 percent) towards the end of the sample period under consideration. Even with a large subsidy, increasing prices have discouraged the consumption in both sectors. One can safely infer that any attempt to abolish the fertilizer subsidy scheme will hurt the industry. The abolition will shoot up prices so drastically that cultivators will abandon the use of fertilizer almost completely. Hence any attempt to introduce free market price has to be done gradually by lowering the subsidy at various stages. Different sizes of price elasticity confirm our hypothesis that each sector pursues its own goals.

Output Elasticity:

According to the results obtained, a 1 per cent fall in production in the preceding year is associated with a 0.8 per cent increase in fertilizer consumption in the current year in the small holdings sector whereas 0.9 per cent in the estate sector. This result, once again, confirms our hypothesis with regard to the attitude of the organized sector. The estate sector tends to react more by increasing fertilizer usage whenever they are faced with a fall in output as compared with the small holdings sector.

V. Policy Implications:

In summarizing, one can conclude that there is evidence to support that the habit of fertilizer use in coconut plantations differs between the organized and unorganized sectors. As a profit-maximising enterprise, the estate sector reacts to changes in prices and output, more in comparison with the small holdings sector whose aim is to produce for its own-consumption. As a result, the estate sector tends to run down fertilizer consumption faster than small holders, whenever price increases take place. With falling production, however, estates increase fertilizer applications faster than small holders thus supporting our view that each sector pursues its own goals. It can be concluded that the small holder's reaction to price and output changes is slow when compared to that of the estate sector.

One can also argue that the subsidy itself, whatever the level, will not encourage the producer even though the abolition of it will raise the price of fertilizer and hence will reduce consumption drastically. Because of the dominance of small holders in the coconut industry, any scheme of fertilizer subsidies, operating in isolation, will not encourage the application of fertilizer extensively over a wide area though it will increase the intensive application of fertilizer per palm. What is urgently needed is the introduction of a comprehensive package, embracing various aspects of coconut production coupled with an efficient system of extension and advisory services, aiming at the widespread use of fertilizer among cultivators.

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