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COMPARATIVE RESPONSE OF SRI LANKAN FARMERS BY SIZE OF HOLDING TO THE SUBSIDY FOR REMOVAL OF EXCESS COCONUT PALMS: MEASUREMENT AND POLICY IMPLICATIONS

BY

N. T. M. H. De SILVA

Deputy Director, Coconut Development Authority

and

C. A. TISDELL

Professor of Economics, University of New Castle, Australia.

ABSTRACT

Some relevant theory is developed to highlight factors that may influence decisions of coconut growers in removing excess palms. This theory provides a basis for analysing the comparative response of growers to the subsidy for the removal of excess palms and empirical data from the Matara district, Sri Lanka, are used to show that a strong positive relationship exists between the size of coconut holdings and the per acre removal of excess palms. Implications of this relationship for the optimal distribution of the subsidy for removal of excess palms are outlined. A differential subsidy favouring smaller holders may result in the greatest increase in coconut supplies in relation to the amount of government funds used to subsidise the removal of excess palms.

INTRODUCTION

A wide variety of agricultural practices require an investment and in some there is an immediate decline in production followed by enhanced productivity. This is the case for thinning of overcrowded perennial crops, for example coconuts, where the palms that are removed are bearing. If non-bearing palms only are removed, there is however, no initial decline in production but as in the previous case investment is required, mainly to meet the cost of removal of excess palms. In both situations a certain time period elapses before the remaining stand responds fully to less crowded conditions. In this paper we shall concentrate on the case where bearing coconut palms are removed.

Thinning of crop stands is not a routine cultivation practice. It is a practice usually adopted to upgrade productivity from existing crop stands, especially perennials which are debilitated due to overcrowding. Overcrowding is commonplace in small-holder dominant perennial crop-culture (Child, 1974 and Smith, 1971). In coconut cultivation, overcrowding frequently results from incorrect procedure adopted in replanting[1].

In early 1974, a subsidy scheme was launched in Sri Lanka to encourage coconut growers to rehabilitate densely planted coconut stands by adopting suitable thinning.

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1. Pethiyagoda (1978) notes two circumstances leading to overcrowding of coconut stands in Sri Lanka.
   (*a*) Underplanting of an established stand while the initial planting is still young.
   (*b*) Failure to remove older palms.

The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Coconut Development Authority.

The response of the growers to this scheme has not been encouraging (Perera and Ranbanda, 1981, 1982). A detailed study of the observed response should provide an insight into ways of rectifying the situation.

It seems likely that not all classes of growers have responded equally to the subsidy scheme and that the response functions of farmers with larger holdings differ from that of growers with holdings of smaller size. One of the purposes of this paper is to estimate and compare the response of growers with different sized holdings. A cross-sectional 'indirect' method is used to do this analysing data from the *Matara* District. First some necessary background theory of decision making by growers in the removal of palms is outlined. The theory is developed on the assumption that stands of palms are uniform, that bearing palms are under consideration for removal and that a lag is allowed between thinning and increased productivity of the stand. The theoretical impact of the subsidy is considered within this framework which provides a basis for using data from the *Matara* District to estimate subsidy response-functions for farmers with different sizes of holdings in the District. Possible, policy consequences of differences in the nature of the estimated subsidy response-functions are then considered, especially bearing in mind that the major aim of the Sri Lankan authorities is to adopt policies to raise the supply of coconut on the island.

RATE OF REMOVAL OF PALMS: SOME THEORY

Suppose that initial yield per acre is y when the existing density is x palms per acre. The density, x is assumed to be one above the recommended density for establishing a stand of coconut and one for which the yield of this stand can be improved by suitable thinning. Nevertheless (as assumed here) if productive palms are removed then, the *immediate* consequence of thinning is a decline in yield but in a longer period thinning enhances favourable conditions for crop growth and productivity in situations where interspecific competition has affected productivity.

The yield response of a palm-stand after thinning is gradual and in coconut it may take two years or more before the full response is achieved. This lag will be assumed for the purpose of this paper to be a fixed one of L-periods with production first falling in proportion to the number of bearing palms removed and by the amount of their nut production. Production is assumed to recover and reach its new potential in the L-th period after removal of palms. The effective cost of thinning (w) per acre is given by

$$w = \left(\sum_{t=1}^{L-1} \hat{p}_t \, y_o / x_o \right) T + C_R T \qquad (1)$$

where T is the number of palms removed per acre, L is the length of the adjustment lag, $\hat{p}_t$ is the discounted price received for coconut in the period, Y_o is the yield per acre when the initial density is x_o and C_R is the cost of removing a palm, It is assumed that palms in the holding are of uniform bearing status. The first term on the R.H.S. of equation (1) represents the present discounted value of coconut production initially foregone as a result of thinning. Given that C_R is constant the marginal cost of thinning palms is, when expressed as a negative number,

$$-\frac{dw}{dT} = \frac{dw}{dx} = - \left(\sum_{t=1}^{L-1} p_t \, y_o / x_o + C_R \right) \qquad (2)$$

The profit-maximising density of coconuts per acre can be found (see Tisdell and de Silva, 1983) by maximising

$$v = \sum_{t=L}^{n} \hat{p}_t f(x) + \left(\sum_{t=1}^{L-1} p_t y_o / x_o + C_R \right) x \qquad (3)$$

where f (x) is the steady-state production function, y = f (x), for coconuts as function of their density, n is the length of life of the current stand of palms (or the length of the planning period) and the coefficients of x in the last term corresponding to those in (1). Suppose that x_u maximises (3) and that the corresponding steady-state yield is y_u. Then if the existing density of palms is x_o, it is optimal to remove $T = (x_o - x_u)$, palms and to increase the steady-state yield from y_o to y_u per acre. The present discounted profit of the coconut grower will then be maximized and amounts to

$$\bar{\pi} = \sum_{t=L}^{n} p_t y_u - w \qquad (4)$$

$$= \sum_{t=L}^{n} \hat{p}_t f(x_u) - \left(\sum_{t=1}^{L-1} \hat{p}_t y_o / x_o + C_R \right) (x_o \; x_u) \qquad (5)$$

Note that (3) is not present discounted profit but provides a simple means for determining the optimal density and hence optimal levels of removal of palms.

The optimisation problem is illustrated in Figure 1, assuming that it takes three years for palms to adjust fully to thinning. Curve ABC represents the present discounted value of the marginal product (in a steady-state) of the density of palms. Line GHJ represents the present discounted marginal cost of removing a palm (C_R

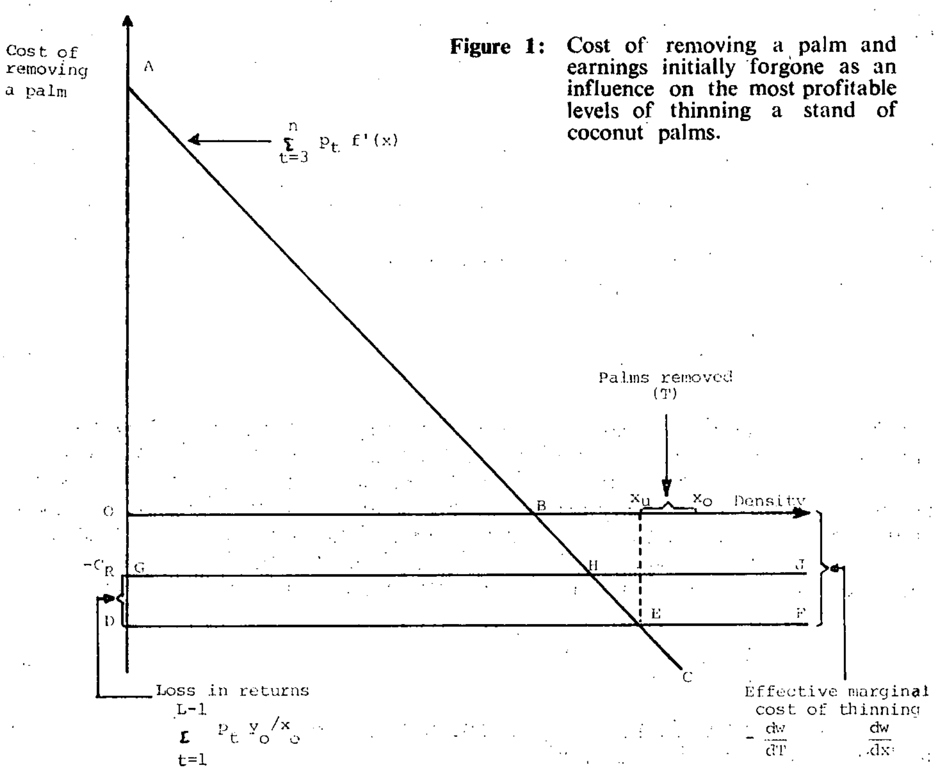


Figure 1: Cost of removing a palm and earnings initially forgone as an influence on the most profitable levels of thinning a stand of coconut palms.

expressed as a negative number). If these were the only costs, the optimal density of palms would correspond to H. However, where bearing palms are removed there is an initial loss in returns because of an immediate decline in yield per acre. This marginal cost is shown (expressed negatively) in Figure 1 by the distance GD and amounts to $-\sum_{t=1}^{2} p_t y_o / x_o$. The total marginal cost of palms removed is shown by line DEF. The optimal density of palms corresponds to point E [the intersection of the steady-state marginal value product curve (discounted) with the marginal discounted cost curve of palms removed when presented in the way indicated] and it is optimal to remove $x_o - x_u$ palms in order to maximize profit.

In terms of the above theory, a subsidy on the removal of palms reduces the effective cost of removal as far as growers are concerned. It pushes the overall effective marginal cost curve DEF in Figure 1 towards the X-axis. If a grower is maximising present discounted profit, his response to the subsidy depends in part on the shape of the discounted value of the marginal product curve ABC – the steeper this curve the less his response to the subsidy for removal of excess palms. If the effective subsidy for removal of excess palms is the same for all, growers, then if all have the same *linear* marginal product curve per acre and are profit-maximizers, *all should respond equally on a per-acre basis to the subsidy.* This is because the derivative of the marginal product functions of coconuts (as a function of density of palms) may be similar on different sizes of holdings. If this is so, we need to look for an explanation of differences in responses by different growers to the subsidy for thinning excess palms not in terms of differences in their productivity functions but in terms of such factors as differences between the apparent and real effective subsidy paid to growers, variations in attitudes of growers to profit maximization, differences between growers in the discounting of flows of costs and returns over time and variations between growers in their attitudes to risk and uncertainty or in level of risks faced by them. Uncertainty and those other factors have not been allowed for in the above model which nevertheless can be regarded as a useful one because it provides a standard for comparison.

As pointed out, the discussion so far assumes certainty about yield and revenue improvement due to thinning. However, (i) the yield improvement may not be as large as expected, (ii) it may take longer than anticipated and (iii) the market price of the crop may decline during the planning period. Such events are a source of uncertainty among growers. As observed by Perera and Ranbanda (1982), some growers even lack the initial capital requirements to commence any thinning and capital markets in a country such as Sri Lanka are very imperfect. Some growers may be more averse to thinning palms because they may have a higher preference than others for present income over future income or desire to have a stable and regular income from their holding. All these factors influence decisions of growers to thin stands of coconut and may need to be taken into account in considering the response of growers to the subsidy to thin excess palms. This is indicated by much of the existing literature on decision making in developing agriculture (for example see Dillon and Anderson, 1971 and Herath, 1980). Once the empirical evidence on the comparative response of growers to the subsidy for rehabilitation of coconut stands in Sri Lanka is considered we shall return to these issues.

SPECIFYING A RESPONSE FUNCTION FOR THINNING OF COCONUT STANDS

Research workers have used a number of methods to study decision making and responses by agricultural producers. For example, direct elicitation of utility functions, experimental methods and inferred behaviour from observations about input demand and output supply (Young, 1979). An indirect approach of the latter type is adopted here.

In formulating a model to measure the response of different growers to the subsidy for removing excess coconut palms, we assume that their decisions reflect to *some* extent the degree to which subsidy reduces the effective cost given in (1). In addition the size of holding in acres (z) may also influence the decisions of growers to remove palms and we shall test empirically for this as an influence[2]. Perera and Ranbanda (1981, 1982) have observed a close correlation between size of coconut holdings and mangement standards, and a number of authors suggest that in peasant agriculture socio-economic characteristics vary systematically with size of holdings (see Moscardi and de Janvry, 1977). The age (A) of palms in a holding may also influence the rate at which they are removed and we shall also include this in the explanatory variables and test for its econometric significance.

If the absolute subsidy paid per palm removed is k, the percentage reduction in the effective cost (S) of removal per acre is:

$$S = \frac{kT \cdot 100}{\left[\sum_{t=1}^{L-1} \hat{p}_t \, y_o / x_o\right] T + C_R T} \qquad (6)$$

Since T cancels out in (6), the percentage reduction in cost of palm removed per acre is same as percentage reduction in cost per palm removed.

Thus it is intended to use Sri Lankan data to consider whether the removal of excess palms by individual growers depends on the following relationship and if so approximate it and estimate appropriate parameters for it:

$$V = h\,(S, z, A) \qquad (7)$$

where V is the total number of palms removed on a holding. It may for example be possible to approximate equation (7) by the linear equation

$$V = a + b_1 S + b_2 z + b_3 A \qquad (8)$$

and estimate the parameters of this (where b_i are coefficients of independent variables). Using these relationships it will be possible to estimate the response functions for the removal of palms per acre, that is the response curve for T.

EMPIRICAL FINDINGS BASED ON DATA FROM THE DISTRICT OF *MATARA*

The data used for the empirical analysis (the determination of relationship 8) was obtained from a sample survey of 59 holdings selected randomly from a population of 970 coconut holdings (eligible for rehabilitation subsidy) in the district of *Matara*. The survey was conducted in September 1981. It provided the following information for each holding: (a) area planted with coconut; (b) the number of coconut palms; (c) the average age of the palms; (d) number of nuts harvested in the last six pickings; (e) the advice given by extension officers (Coconut Development Officers) on removal of excess palms in the holdings and (f) the action taken

2. Jayasuriya *et al.* (1981) pointed out that by providing subsidies large enough to (i) offset the cost of replanting and (ii) the foregone earnings during the gestation period, poorer farmers can be induced to undertake high cash investments needed in replanting rubber in Sri Lanka. Thus they employ the two main assumptions made in our response model.

by growers in response to the advice. This information enables y_O / x_O to be estimated for each holding on the basis of actual data, k is known and suitable estimates of p_t and C_R can be made so enabling S as set out in (6), to be calculated from actual data. Information on z and A is available from the survey and so relationship (8) can be estimated using regression analysis.

For purpose of specifying S, effective cost of thinning was estimated using representative coconut prices and cost of removal figures prevalent in the period 1979–1982, (details, given below). A discount rate of 20 per cent is assumed and an adjustment period (for palms) of three years is supposed because palms usually take about three years to adjust to changes in microclimatic conditions such as that due to thinning. However there is a need for the exact pattern of adjustment to be studied by field experiments.

Relationship (8) was fitted to the data by means of stepwise regression. Although the sign of the coefficient of age variable, A, accorded with what was expected a priori, it was not statistically significant. Its inclusion improved the fit only marginally (by .03%) and hence it was deleted as an explanatory variable. Consequently, the estimated response function depends only on z and S. It is

$$V = 31.0186 + \underset{(10.032)^{**}}{7.9507z} + \underset{(1.825)^{*}}{0.7201S} \qquad R^2 = .8348 \tag{9}$$

** significant at 1 percent level, * significant at 5 percent level.

It can be seen from (9) that the size of holding has a positive significant effect on the *total* response of growers in removing excess palms. Furthermore level of the subsidy also has a positive impact. But a more important consideration is the response in removal of palms on a per acre basis. This can be found by dividing (9) by z and gives the relationship.

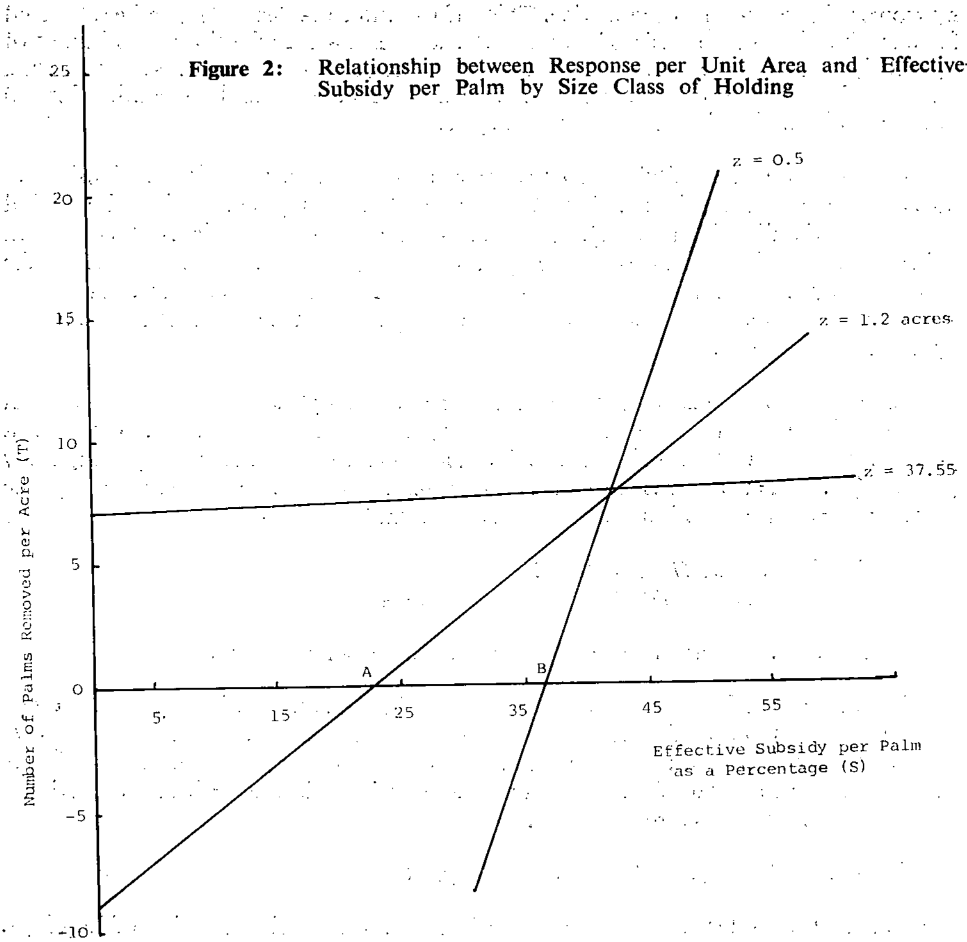
$$T = V/z = -31.0186/z + 7.9507 + (0.7201/z)\ S \tag{10}$$

We can now consider how this response function varies with the size of holdings.

Figure 2 shows the relationship between the response of growers per acre (T) and the percentage reduction in the effective cost of thinning per palm(S) based on the premise that other things remain unchanged. For illustrative purposes, only three holding categories have been selected and are depicted using the mid points of the respective category.

It is evident from Figure 2, that a change in response to a change in the reduction in effective cost ($\partial T/\partial S$) is greater for smaller holdings than for larger holdings once the former are within a response range. Point B in Figure 2 represents the lower bound of the response range for the holding category 0.0 to 1.0 acres and A is the corresponding point for the holding category 1.1 to 2.5. The relative positions of the lower bounds show that as the size of the holding gets smaller, greater subsidy (hence effective cost reduction) will be the required to elicit any response. As for the holdings in the size category 25.1 to 50.0 acres, the increase in the subsidy for the removal of excess palms virtually has no effect on the number of palms removed. On such holdings, a large number of excess palms are removed even in the absence of any subsidy for their removal.

Figure 2: Relationship between Response per Unit Area and Effective Subsidy per Palm by Size Class of Holding



POLICY IMPLICATIONS AND OTHER CONSEQUENCES

The preceding empirical analysis indicates that a strong relationship exists between the size of coconut holdings and decisions of growers to remove excess palms. The response relationship established in (10) can be used to derive various policy implications.

The response of growers (measured by T) in the absence of a subsidy can be estimated by setting S in the response relationship (10) equal to zero. For T to be positive when there is no subsidy provision (i.e., S=0), it is necessary for the size of a holding, z, in (10) to be greater than 3.9 acres. Accordingly if no subsidy is available, only those growers with holdings greater than 3.9 acres in size would remove excess palms. A grower having a holding of 3.9 acres would require a subsidy lowering the effective cost of removing a palm by at least 6 percent in order to show any response in removing excess palms. Under a uniform subsidy scheme it is therefore evident that the larger grower who already finds it profitable to remove a certain amount of excess palms even in the absence of a subsidy would now be able to claim at least 6 percent of the cost incurred in removing palms which he would have removed in any case. Holdings which are smaller than 3.9 acres require a reduction in the effective cost of palm removal by a higher amount than 6 percent to initiate at least a minimum response. It is important to note that as the subsidy is increased to offset the 'inertial cost' (Leibenstein, 1977) (inertia) of the small-holders in removing excess palms the income gains to the larger growers from the subsidy rises and they may obtain a larger subsidy for the removal of palms which they would have removed even in the absence of the subsidy.

By providing subsidies for removal of excess palms that would have been removed anyway, the government is not maximizing the removal of excess palms for the aggregate amounts of funds it spends on the subsidisation, and is not maximizing the increase in coconut supply that can be obtained by the wise distribution of these funds. A more effective policy in this regard would be to only provide a subsidy to owners of larger coconut holdings for the removal of palms *in excess of a specified* number. The appropriate number can be predicted from an analysis of the above type. Furthermore, and this is a separate matter, by subsidizing palm removal at a uniform rate and by paying the subsidy on all excess palms removed, larger growers are liable to obtain the greatest comparative increase in income from the subsidy and to have their competitive position strengthened relative to small holders.

The discussion points to the need for replacement of the current subsidy scheme for excess palm removal by a differential subsidy which discriminates in favour of small holders. Considering the greater prevalence of crowded stands on smaller sized holdings (Census and Statistics, 1970), a policy such as this may be more effective in increasing coconut supplies than the current scheme. Discrimination may result in a greater number of palms being removed for the aggregate outlay on the subsidy, and promote removal of palms on small holdings where stands are very crowded and a substantial improvement in yields can be expected from thinning palms. Furthermore, such a discriminatory policy would lessen 'unfavourable' distributional consequences. In this respect similar policy instruments for 'reverse' discrimination have been suggested by others (see Mohan *et. al.*, 1982 and Sambrani, 1982).[3] The long run consequences of 'unfavourable' distributional effects can be cumulative. It may result in the take-over of small production units by larger owners (Tisdell 1982) and while this may lead to greater economic efficiency it has an income distribution outcome that is not favoured by the Sri Lankan government. This problem occurs not only in developing countries but as noted by Clairmonte (1980) in developed countries as well.

A differential subsidy on an input designed to expand the supply of a particular commodity, such as coconuts, can give rise to administrative difficulties in cases where (a) the subsidized input can be resold to those not obtaining the most beneficial rate of subsidy (of Barker and Hayami, 1976) or (b) be diverted to increase the production of a commodity other than that intended to be increased in supply. The differential subsidy that used to be paid on fertilizer intended for application to coconut palms by holders of small plantations involved such difficulties in Sri Lanka. Much of this subsidized fertilizer was diverted to other crops such as rice and some was resold to individuals owning larger acreages of land. In the case of subsidies for the removal of excess coconut palms neither of these difficulties arise. Subsidy administration by size of holding is administratively possible in this case, as in the case of senile palms. Furthermore, given the above analyses, a differential subsidy may be desirable in principle.

3. Mohan *et al.* (1982) found that growers with larger holdings gain more benefits from subsidies than small growers irrespective of the form of the subsidy. They compared three types of subsidies viz., cost subsidies, output subsidies and concessionl interest rates.

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