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SUPPLY RESPONSE FUNCTION OF TEA FOR INDIA AND SRI LANKA A COMPARATIVE STUDY

R. Sudharshan Canagarajah*

Introduction,

Tea is a perennial crop widely cultivated in developing countries especially in South Asia and Africa. Although tea was not produced on a large scale until the 19th century, it had been in cultivation in China and Japan before the 17th century (Sarkar, 1972). Commercial cultivation of tea in large and intensive estates was started in Assam after 1852 and by Sri Lanka and Java after 1860 (Chung and Upkong, 1981). The main impetus to a tea industry came from Britain, which was the colonial power in these countries and the main world consumer of tea, The cultivation became popular in African countries, especially in Kenya, Tanzania and Nyasaland, only in the 1920s,

There are three main kinds of tea (a) Black Tea (b) Green Tea (c) Ooolong Tea. Commercially Black Tea is more important than other two types, and its major producers are India and Sri Lanka.

The developing countries, which produce about 88% of world tea, are to a large extent dependent on the commodity for their foreign exchange earnings. In 1984 the total value of world tea exports was $2860.1 million, of which $2530,6 million came from the developing countries of the world (FAO Trade Year book, 1986). However, it is important to note that tea constitutes only 1% by value of the primary commodities imported into the industrial countries. Although initially tea received high prices and constituted major part of exchange revenue for developing countries, today it has become one of the cheapest drinks in the world and has thus become by itself an inadequate source of foreign exchange revenue for developing countries.

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* I have enjoyed many helpful discussions about this paper with Dr. William Peterson and Mr, Andrew MacKay. Any remaining errors are of course my own responsibility.

Nevertheless, in India, Sri Lanka and China tea accounts for a high proportion of national income, employment and foreign exchange earnings. In Sri Lanka in mid 1970's tea contributed about 20% of national income and accounted for 65% of foreign exchange earnings, although it accounts today only for about 35% of foreign exchange earnings. Although in India tea is cultivated in only 0.5% of cultivation land, it accrues the largest source of export revenue among the crops accounting for about 10%.

In the world tea industry India and Sri Lanka are the two most important participants, as it can be observed from the summary of the latest tea statistics given in Table 1 with respect to these countries.

Table 1: Statistics of Tea Production in India and Sri Lanka, 1984.

	India	Sri Lanka
Export Volume (% of World Total)	20.06	18.9
Production (% of World Total)	29.4	9.5
Cultivated Area (% of World Total)	16.7	10.01
Yield (kg. / ha.)	157.3	84.9
Area Expansion between 1981 and 1985, percent	8.46	2.04

Source, Food and Agriculture Organisation Trade Yearbook, 1985
Food and Agriculture Organisation Production Yearbook, 1985.

In India and Sri Lanka, unlike Africa, tea is cultivated in large estates. The labour was recruited on contractual basis either from other parts of the country as in India or from neighbouring countries as was the case in Sri-Lanka, depending on relative labour costs. Although tea has generally been cultivated on a monoculture basis, recently in Sri Lanka they have started inter-plantation of rubber in tea estates.

In Sri Lanka more than 90% of the tea is sold at local auctions, whereas in India 53% is sold directly and 15% through local auctions, (Chung and Upkong, 1981). Thus London, which was originally the centre for tea auctions has diminished in importance. The increased importance of local auctions have limited the scope for re-exporting and blending which were carried out by the multinationals.

Another important development in the world tea industry has been the increasing importance of Kenyan tea and diminishing share of Indian and Sri Lankan tea. This has been mainly due to the extensive expansion of acreage in African countries which is not possible in the case of Sri Lanka or India. Thus earlier econometric studies show the significant area response functions for India and Sri Lanka, while those of African countries show the contrary.

These similarities and differences between India and Sri Lanka, along with the change in the relative position of both countries in terms of production trade and consumption makes it of interest to compare and analyse the nature and importance of the factors responsible for changes in the levels of supply.

Factors affecting the supply response of tea

The term supply 'response function' was used by W. W. Cochrane to denote changes in the long run supply caused by changes in all the relevant variables; thus it is differentiated from the 'supply function' which summarizes the changes in the limited number of factors in the short run. Supply response functions can be differentiated on the basis of the nature of changes in a limited number of factors in the short run. Supply response functions can be distinguished on the basis of the nature of the crop under cultivation. They are: (1) Annual crops – cultivated annually which yields without much delay, generally within that year and for that year only. (2) Perennial crops – yielding only after a lag which is called the gestation period of the crop during which time the crop matures. The latter group are thus characterised by an investment decision with yields only after a delay but continuously.

Tea falls into the second group as it is a perennial crop having long gestation periods and yields accruing over a long span of time. Hence like other perennial crops, supply of tea too, will rely on expectations of future prices and yield conditions; thus initial decisions are made on the basis of such expectations.

The tea age – yield profile gives an insight into the nature of the crop and expectation formations. Tea takes about three to eight years to mature and begins to produce a yield, in the period which we refer to as the gestation period. This period can and usually will, differ among regions of the same country or even between various countries. Tea tree reaches the peak yield between 13 to 15 years, and continues a high yield without much fluctuations for another 70 - 80 years, after which it starts declining steadily and slowly. During which time the producer may uproot and replant or accept the lower yields when prices are very high and profitable.

This age - yield profile plays an important role in understanding the age specificity that significantly affects the supply function. They are

1. Tea supply can be increased through the expansion of the area under cultivation, which is an investment decision and will cause changes in the levels of supply only in the long run.

2. Short run increases in the level of supply due to intensive plucking and fertiliser application resulting in increased yield.

Expansion of tea acreage depends crucially on the availability of land and availability of funds for investment both of which may possibly have high opportunity costs. This is so since tea is a perennial crop and since land could be also used in the production of other perennial export crops which may be profitable. Hence a long term of expansion of the area under cultivation depends on the relative profitability of tea with regard to other perennial crops such as coffee, rubber and cocoa all of which more or less compete for the same limited resources. Therefore the major way of dealing with the shortage of land and other factors is to carry out extensive and well planned replantation which again could be reduced to the minimum due to relative attractiveness of tea vis - a - vis other similar crops.

In the short run tea production can be increased mainly in two ways.

1. coarse plucking - 5 leaves and a bud are plucked instead of the usual 2 leaves and a bud. It should be, however, noted that tea quality decreases although yield and total supply increases.

(2) fertiliser application - It has been observed that through application of 1 kg. of Ammonium Sulphate yield can be increased varying by 5 to 8 kgs./ha. However the increasing cost of fertiliser makes it an unattractive way of increasing yield in developing countries. Fertiliser application also makes it possible to shorten the gestation period, (Chung and Upkong. 1981).

However it can be seen from the above reasoning that the limits of possible expansion of acreage to increase supply can be overcome by increasing the yield in the short run.

Climatic conditions and soil fertility are also relevant for better yield results, Tea crops need much rain and sunlight and should be grown in areas where there is no frost (G. K. Sarkar, 1972). The fertility consideration makes highlands of about 3000 – 5000 feet above sea level preferable to flat land. The difficulty in formulating a rational quantitative measure restricts the extensive analysis of weather conditions in the supply response functions. Although recently some studies have been including weather indices in supply response functions it has not resulted in any satisfactory or significant result.

Technological factors, too, play an important role in determining supply response of tea. The tea industry did not undergo much technological change after these countries gained independence from Britain partly due to fear of nationalisation of foreign investors and also due to scarcity of trained personnel. But very recently there has been much progress in the extensive research undertaken in tea industry which brought forth high yielding seeds thus providing a viable and efficient way of increasing yield. Also there has been substantial progress in areas of manuring, weed control, pruning, shade management, soil and moisture conservation, and control of pests and disease. All these factors gave higher yields than before. However, due to the variations over time and between countries in the use of such measures, and difficulties in obtaining an appropriate quantitative index, these factors are generally only captured by the introduction of the time trend as a dependent variable.

The most important factor that affects supply response function is the price factor, and in the case of perennial crops the expectation of price by producers is of particular importance, as the gestation period and other factors place restrictions in increasing supply in a short span of time. As mentioned above supply can be increased within a year or two by coarse plucking and fertiliser application. Maintaining the marginal land, the land which is declining in yield is also a possible way of increasing production. Although intuitively one would expect the long run price elasticity of supply to be higher than that at short period, it is lower in countries which have exploited existing cultivable land. Although land reforms and nationalisation were initially seen as positive ways of increasing supply through increased yield, it has resulted in adverse effects through reducing the attractiveness of tea industry investments. It can be observed that African countries attracted more investments due to absence of such fear which was an important inhibiting force in Asian countries.

The above analysis shows that supply response function is affected by both price and non-price factors and both are equally important. However due to measurement and quantifying difficulties and modelling constraints, non-price factors have been mostly assumed to be of not great significance.

A survey of supply response models

Supply response models have been formulated to study the responsiveness of supply to changes in prices and other factors. In the case of agricultural crops, unlike industrial production, supply response behaves in a peculiar manner due to the inherent constraints that limit supply response of crops. The models developed hitherto have been based on Marc Nerlove's partial adjustment model and deviate in some aspects of the specific consideration.

Askari and Cummings observe three basic areas in which the models of supply response have been different from Marc Nerlove's basic model (1958).

They are

(1) elementary modification of Nerlove or Nerlove - Addison model.

(2) certain modifications in the already existing variables and inclusion of variables related to the specific study concerned.

(3) modifications to deal with perennial crops and livestock which were not considered by Marc Nerlove.

The prototype Nerlove model is best suited and has been essentially applied to studies relating to annual crops, and as such the category of perennial crops fall outside the basic model. Also it is important to remember that Nerlove applied his original model to the study of supply response shown by farmeis in the U. S. for Maize, Cotton and Wheat (Nerlove: 1958). This fact clearly calls for modification and extension of Nerlove's model and, or, formulations of new models to the study of perennials and livestock. Therefore to understand the existing models of supply response it is essential that we begin with Nerlove's basic model.

The Nerlove "partial adjustment model" essentially has three equations. He explains changes in output as changes brought about mainly through price variations.

(1) An adaptive expectations price mechanism.

$$\left(P^e_t - P^e_{t-1}\right) = \beta\left(P_t - P^e_{t-1}\right) \quad (1.1)$$

(2) A partial adjustment process for output Q_t towards a desired output (Q_t^D)

$$Q_t - Q_{t-1} = Y(Q_t^D - Q_{t-1}) \qquad (1.2)$$

Where Q_t and Q_{t-1} refer to actual current and past output. (3) An equation relating desired output to expected price and other relevant exogeneous variables represented by Z_t.

$$Q_t^D = a_o + a_1 P_t^e + a_2 Z_t + u_t \qquad (1.3)$$

As the expected values cannot be formulated directly most of the subsequent work used the reduced form of the above model which can be stated as

$$Q_t = a_o \beta Y + a_1 \beta Y P_{t-1} +$$

$$[(1 - \beta) + (1 - Y)] Q_{t-1} - [(1 - \beta)(1 - Y)] Q_{t-2}$$

$$+ a_2 Y Z_t + a_2 (1 - \beta) Y Z_{t-1} + V_t \qquad (1.4)$$

where $V_t = Y(U_t - (1 - \beta) U_{t-1})$

The values of the parameters are obtained by either the maximum likelihood estimation or the least square estimation technique. It is important to note that Nerlove when applying his original model was unable to distinguish the coefficient of price expectation (β) from the coefficient of area adjustment (Y) as the identification problem in the output equation could not be overcome by inclusion of a suitable variable, as in the reduced form model (1.4) stated above (Askari and Cummings 1976).

Nerlove originally used the following three methods to formulate the price expectations in his model which is important in understanding the later developments of the model.

(a) $\beta = 1$. i.e. the crude cobweb expectation where last years actual price is considered to be the expected price of the present period $(P_t^e = P_{t-1})$

(b) calculations carried out without restrictions on β and mainly identifying the correct value through iterative procedure.

(c) P_t^e is a weighted average of past two years prices, using the form

$$P_t^e = \alpha P_{t-1} + (1-\alpha) P_{t-2}$$ (Askari and Cummings, 1976).

Nerlove along with Addison developed the method of identifying short run and long run elasticities through his original model, and also used a time trend (T) to capture changes in factors intangible and taking overtime (Nerlove and Addison, 1958)

Later studies have found the price formulation in the Nerlove model to be more general and have used specific and realistic price formulations by taking price received by farmers rather than the market price which was used by Nerlove; some have used consumer price index, price of inputs or price of other competitive crops to deflate the normal prices. However it should be stated that these later developments are also not free of criticism and further modifications.

Other than the modifications concerned with price factors, there have been other, more fundamental changes in the basic model. Some went on to use average ratio of the crop concerned to its substitute as a dependent variable in the output equation and some others (eg: Fisher, 1962) used changes in output in the expectation formation of prices, i.e.

$$P_t^e - P_{t-1}^e = \beta\left(P_{t-1} - P_{t-1}^e\right) + \delta\left(Q_t^e - Q_{t-1}\right) \quad (1.5)$$

where Q_t^e is expected output and Q_{t-1} is actual output.

Another important defect in Nerlove's model was exclusion of consideration of yield as an important variable. Thus some later studies included yield as a factor in all three of the basic equations where expected yield $\left(Y_t^e\right)$ was defined as

$$Y_t^e - Y_{t-1} = \beta\left(Y_{t-1}^e - Y_{t-1}\right) \quad (1.6)$$

(Askari and Cummings, 1976).

Some researchers went on to show that through use of pesticides and fertiliser supply may affect output through yield rather than acreage and thus reduce acreage elasticity. Thus we see that within three decades the modifications and extensions that have taken place in the basic Nerlovian model have changed in depth and focus of analysis of supply response functions.

With regard to the limitations in the structure of the models and availability of descriptive statistical information there has been an important area of concern in the perennial crops. The long gestation periods in the case of perennial crops lay much emphasis on the correct formation of future exceptations and thus makes the cultivation an investment decision on which returns can be expected only after the maturity. This is why the capital theory becomes of considerable relevance to perennial crops. Also the already existing stock of trees and their age profile will not only affect the total output but also future yields. Thus the supply response analysis has to consider the significance of past events cumulatively as they will continue to affect future cultivation plans, techniques and investment decisions of the producers. Another important difference with regard to the annual crops is that perennial crops have long gestation periods and thus one cannot assume that planted and harvested (mature) area to be identical.

Askari and Cummings have identified two specific problems with regard to the supply response analysis of perennials.

1. If a study has to be done over n years, one needs data for several years before the output data which is actually analysed;

2. The time length of the study: although it is preferable to study the response function over a long period of time in order to understand the features properly, the structural changes taking place over time will inhibit proper analysis of short period responses. For instance, it is doubtful that the expectation co-efficient remains constant as other factors change with time.

Merril Bateman (1968) dynamised the static Nerlovian model by including the expectation of streams of income spread over the life of the tree instead of price expectation of the crop in the supply response function. Thus he assumed that planters make their decisions in regard to maximisation of present discounted value of future streams of net return, defined as discounted gross net revenue minus discounted net costs, i. e. $(R_t - C_t)$. Bateman used multiplicative and additive formulation and found the latter to be more appropriate than the former to the study of supply response of cocoa. Behrman included the expected price of the crop and of its principal alternative in his model (1968). Kenneth, D. Fredrick has observed that despite falling prices acreage rose mainly due to non - price factors. (Askari and Cummings, 1976).

Wickens and Greenfield (1973) in a study with regard to coffee criticised the use of Nerlove model for the study of the perennial crops saying that the distinction between harvesting and investment decisions are blurred. They suggested 3 equations to overcome the difficulties with regard to the study of perennial crops. They are:

(1) Investment functions: $I_t = a_0 + a_1 I_{t-1} + a_2 P_t$

(2) Harvesting Function: $Q_t = b_0 + b_1 Q^p_t + \left[\sum_{1=0m}^{m} b_{i+z} P^2_{t-1} + b_{m+1} Q_{t-1}\right.$

(3) Vintage Production function : $Q^p_t = \left[\delta_i \,.\, I_{t-1}\right.$ where I represents investment, P the price, Q_t the actual output, Q^p_t the potential output, and elta the average yield of a tree of age i.

But due to data limitations the use of Wickens and Greenfield (W. G.) model has been not possible in many studies. French and Matthews (1971) model too has contributed much insight by taking into account the old plants and removals, a moving average price expectation and price to wage ratio as his dependent variables. Peter Ady used a capital stock adjustment model which gave better results than Bateman and Behrman's analysis.

Chung and Upkong (1981) use yield response and nature area response functions separately in the study of tea and also see whether it is possible to capture the significance of these variables when these functions are reduced to a single aggregate supply response analysis. Although this model seems simplistic, it generalizes the main aspects of the supply response models of perennial crops and as such defined as a pragmatic approach to supply response analysis.

Other than the above developments in the formal structure of the model there has been advancements in statistical data availability which has been and is still continuing to be an important area of deficiency in the empirical analysis of supply response functions.

Recently Hartley, Nerlove and Peters (1984) used data obtained by a survey conducted for the study concerned and attained a landmark in the study of supply response of perennials. They modified the W. G. model by including a replanting equation and forming a new planting equation which corresponds to the investment equation of the W. G. model. The age - yield data and age distribution of the total stock of trees allowed them to calculate potential output than using the reduced form as in earlier models.

The limitation of data and the non specificity of the supply response model to different crops in the econometric analysis of supply response functions of the perennial crops seem to be a drawback which has to be overcome to carry out more useful and insightful studies in this area.

The general model

As stated earlier the basis of supply response models of perennial crops has been Nerlove's partial adjustment model, in spite of the various limitations in using an annual crop model for the study of perennial crops. Thus I too formulate the general model for the present study on the same basis, but with various modifications to overcome major limitations, as follows.

(1) $A^{d}_{t-g\ t} = f\left(P^{e}_{t-g\ t}\right)$ defines the area desired at time as a function of expected prices at time t both decisions being made at time t - g, where g refers to the gestation period.

(2) $A_{t} - A_{t-1} = \lambda\left(A^{d}_{t-g\ t} - A_{t-1}\right) \quad O < \lambda < 1$ defines that the difference between the actual area cultivated in current and past year as a constant fraction amda of the difference between area desired at time t and area actually cultivated at time t - 1.

(3) $P^{e}_{t} - P^{e}_{t-1} = \delta\left(P_{t-1} - P^{e}_{t-1}\right) \quad O < \delta < 1$ i. e. the difference between current and last year's expected price is a constant fraction (δ) of the difference between actual and expected prices of last year. If $\delta = 1$ then this fraction reduces to a particularly naive adaptive expectations structure, as was used by Nerlove, where $P^{e}_{t} = P_{t-1}$. This is similar to the Cobweb Pheno-

mena which is quite popular in agricultural analysis, especially in the case of the annual crops.

The aggregate supply function can be formulated as

$$(^1)\quad Q_t^s = f_1\left(a_{it}, y_{it}\right) = \sum_{i=o}^{m} \left[a_{it} \times y_{it} \right.$$

But due to data limitations the average yield $(\bar{y})$ is multiplied by the mature area. rather than yield of each age category being multiplied by the number of "bushes" in the particular age group.

On the basis of the age - yield profile of tea bushes and previous empirical investigations we see that yield and acreage cultivated depends on lagged values of the dependent variable and on the past prices. This can be stated in general terms as

$$\bar{y} = f_2\left(\phi_1 (L)\, P_{t-i}\right) \quad \text{and} \quad Q_t^s = f_3\left(A_t, \phi_2 (L)\, P_{t-i}\right)$$

On the basis of Chung and Upkong I too intend to estimate the mature area response, yield response and aggregate supply response functions separately for each country independently and then analyse the difference in the significance of these functions.

The three equations will be of the form:

$$A_t = f_4\left(A_{t-1}, P_t^e, T\right)$$

$$Y_t = f_5\left(Y_{t-1}, \phi_1 (L)\, P_{t-i}, CL_t, T\right)$$

$$Q_t^s = f_6\left(Q_{t-1}^s, \phi_2 (L)\, P_{t-i}, CL_t, T\right)$$

As the significance of these variables differ between countries the specifications finally used in the actual estimations differ from the general rules laid down above. The climatic factor (CL_t) denoted in the above functions could not be used due to absence of proper quantitative data on such measure. However it is observed that unless otherwise it is adverse to the extent of affecting tea supply climatic considerations are of minor importance to the study of tea supply response functions. Also it should be noted that any adverse climatic conditions would tend to affect the future levels of output and will be a persistent factor determining future levels of supply.

The price variables which are of major importance were also used on the basis of the different nature of price expectations formations that may prevail in each of these countries. Different techniques have been used to derive the expected prices which may differ in appropriateness between countries. Although initially naive adaptive expectations, other expectation mechanisms were tried due to their failure to capture the significance of the price factor. On the basis of French and Matthews (1971) I used a moving average price expectation formation defined over a period of three years, i. e.

$P^e_t = (1/m) \sum_{i=1}^{m} P_{t-i}$, where m = 3, I regressed the residual of the present period on lagged residual values to see whether it has a significant co-efficient in which case to conclude that there is an adaptive expectation structure. I intend to see whether the price formation satisfies one of Muth's rationality conditions of insignificant coefficient on lagged error in the price expectation.

Another more general mechanism used with regard to price expectations is based on Baritelle and Price (1974) defining the expected price to be the predicted value of price when present period price is regressed on past period prices. I used last three years, i.e.

$$\hat{P}_t = \hat{a}_O P_{t-1} + \hat{a}_1 p_{t-2} + \hat{a}_2 P_{t-3} + e_t$$

Again the error randomness test was carried out.

Also a variation of the above price mechanism was tried, The predicted price and the moving average price were regressed separately on lagged predicted price and the difference in the past actual and expected prices,

i. e.

$P^e_t = f\left(P_{t-1}, \left(P_{t-1} - P_{t-1}\right)\right.$ The prediction of this regression was used in line with the adaptive expectations defined in equation 3. The lagged predicted price and the difference in the past actual and expected price were included as two separate factors to see which of them had higher significance with respect to the function considered.

The time factor was included in the equations to capture the technological advancements and implications of research and innovation. Both linear and exponential time trends were investigated.

The model was applied under two different specifications.

(1) loglog specification (multiplicative model)

(2) linear specification (additive model)

The estimations were carried initially under OLS techniques. However, whenever necessity arose maximum likelihood method under Cochrane - Orcutt procedure was used. The significance of the above models was seen to differ between the countries concerned.

The data

The data for this study has been mainly obtained from publications of international organisations which provide statistics of both countries almost under similar definitions. Hence one of the important obstacles of carrying out a comparative study between countries with different measurements has been almost overcome. Whenever the data was not found or not given for a certain period under consideration the local country statistical sources were consulted.

Data was collected for the period 1947 - 1983 on acreage cultivated, production, money wages, money prices at local auctions, consumer price index, and real wage index. Data on acreage, production and local auction prices were obtained from Annual Bulletin of Statistics of International Tea Committee. Data on money wages, consumer price index and real wage index were obtained from Year Book of Labour Statistics and other local sources. The main local sources were Statistical Abstracts of India and Annual Reports and Reviews of the Economy of the Central Bank of Sri Lanka.

Due to the use of lagged variables the number of degrees of freedom was substantially reduced and on an acreage 30 observations were only considered. Figures 1 - 4 compare the acreage, production, yield and money prices of both these countries (See Appendix 3 - Figures)

In the case of India cost of living index of agricultural workers and real wage indices obtained from Year Book of Labour Statistics was used to deflate the average money price of tea observed at Calcutta auctions. To derive mature area, caltivated area was lagged 6 years and yield was calculated by dividing production by aforementioned lagged area. As it has been observed in earlier studies (P. Ramanujam, 1986) due to its shorter average gestation period, a lag of 5 years was used for Sri Lanka.

The fact that only 0 . 92% in India and 2% in Sri Lanka of tea trees are less than 9 years does not grossly misappropriate the definition of mature area used in this study. In the case of Sri Lanka a dummy variable was used for the year 1983 in order to capture any possible effect of communal riots: these were believed to have been detrimental to the whole economy and especially to the tea industry as the Indian Tamil population were severely affected. The dummy defined as DI was given a value of zero for the period 1947 – 1982 and 1 for 1983.

In the case of consumer price index and real wage index 1970 was used as base year for both countries in order to maintain regularity of the data to facilitate comparative study.

Appendices 1 and 2 contain the data used in this study.

Rational formulation of prices

As mentioned in section 4, different price expectation structures were used to capture the significance of the price factor in the above equations. Prices were either deflated by consumer price index or the real wage index. Initially the present price was regressed on past three period prices and the predicted value $(\hat{P})$ was used as the expected price. Then the current price residuals $(e_t = P_t - \hat{P}_t)$ was regressed on the lagged residuals $(e_{t-1} = P_{t-1} - \hat{P}_{t-1})$ in the following form:

$$e_t = P_1 + P_2 e_{t-1} + W_t$$

$H_O : P_2 = O$ was tested to see whether there is any basis to conclude that people make systematic errors. If $P_2 = O$ then it was inferred that present error is not related with past error and thus this formulation of prices was considered to fulfil Muth's rationality condition (see Muth, 1961; Ghosh et. al., 1982).

Table 2: Rational formulation of prices

	Intercept	e_{t-1}	$\bar{R}^2$	DW
SRI LANKA				
CPI	0.00013	0.332	0.0338	1.62
	(0.047)	(1.43)		
RW	-0.00046	-0.0069	-0.0326	1.39
	(-0.11)	(-0.22)		
INDIA				
CPI	-0.0014	0.326	0.0806	2.06
	(-0.50)	(1.88)		
RW	-0.0004	0.0067	-0.0357	1.70
	(-0.103)	(0.0029)		

Dependent Var able = e_t

CPI = Consumer Price Index

RW = Real Wage Index

As can be observed from table 2 when prices were deflated by the cost of living index p was significantly different from zero for both India and Sri Lanka, possibly indicating the presence of a naive adaptive price mechanism. However, when prices were deflated by the real wage index not only did p_2 become insignificant, the constant too became insignificant. This indicated the latter price formation to be more rational than the former one.

Further, the moving average structure did not show any indication of rational price formulation. Here both e_{t-1} and intercept had significant coefficients. Thus the regressed price deflated by the real wage index (ECW) was finally used in the present study.

Adaptive expectation of prices

Here I used the price predicted from the regression to formulate an adaptive structure which has been used extensively in earlier studies of agricultural crops. As table 3 shows I used a real wage deflated price in a linear specification and a consumer price index deflated price in log specification. The results derived were interesting with respect to the relationship they displayed. In the case of Sri Lanka the linear specification showed same coefficient for P^e_{t-1} and $\left(P_{t-1} - P^e_{t-1}\right)$ namely 1.22. The coefficient of these two variables were very significant indicating the existence of an adaptive structure within the price system. The adaptive expectation coefficient was 1.22 for Sri Lanka and .953 for India. In the case of India also the function displayed similar characteristics. Both equations passed the Durbin's h test indicating the absence of autocorrelation.

The log specification too showed similar characteristics. Of course the $\bar{R}^2$ value was high in the linear specification. The appropriateness of adaptive structure was seen by the adaptive expectation coefficient value of .6518 for Sri Lanka and .607 for India.

Thus the price predicted through this two stage prediction was used along with the single stage predicted price $\left(P_t^e\right)$ discussed earlier. Mostly the real wage deflated two stage predicted price (ECW) was used due to the validity of its use.

Yield response functions

I used an equation $Y_t = f\left(Y_{t-1}, P_t, T\right)$ in both log and linear specification with variations on the price factor. As table 4 shows initially I used ECW_t as the price factor along with a linear time trend. In the case of India all the factors were of significance in the logarithmic specification, especially showing t ratio of 1.83 for the price factor, whereas for Sri Lanka the same function could not capture the main effects and was not significant even at .10 level. Also in the case of Sri Lanka the linear time trend showed a

Table 3: Adaptive Expectations of prices

	Intercept	P_{t-1}^e	$\left(P_{t-1} - P_{t-1}^e\right)$	$\bar{R}^2$	SEE	LLF	Durbin
INDIA							
Log. CPI	0.046 (34.4)	0.480 (31.1)	0.607 (33.9)	0.9835	0.0019	180.8	-2.19
lin. RW	0.0019 (2.33)	1.06 (125)	0.953 (3.42)	0.9977	0.0027	167.7	-1.48
SRI LANKA							
log CPI	0.0296 (23.3)	0.580 (29.4)	0.652 (28.9)	0.9764	0.0016	185.4	0.29
lin. RW	-0.0051 (-10.3)	1.22 (147)	1.22 (95.1)	0.9984	0.0012	197.2	0.05

Dependent Variable = P_t^e

log. = Log Specification
lin. = Linear Specification
SEE = Standard Error of the Estimate
LLF = Log of the Likelihood Function
Durbin h = Durbin's Statistic

Negative and significant coefficient which may be possibly due to the effects it purports to capture a time trend which is non - linear in reality. The highly significant time trend in the case of India capture the higher applications of fertiliser and other mechanisation techniques which were introduced to boost production levels, as the acreage expansion was ruled out in the case of India. Both in the case of India and Sri Lanka the single stage price expectation $\left(P_t\right)$ was used and found to be significant. For instance in the case of India it was as shown below.

	Intercept	Y_{t-1}	ECW_t	T	DI	$\bar{R}^2$	SEE	LLF	Durbin h	Stability Test F
INDIA										
log.	-0.140	0.479	0.0712	0.123	—	0.9644	0.03239	55.42	2.04	3.80
	(-1.16)	(2.36)	(1.83)	(2.33)						
lin.	0.574	0.212	0.785	0.0145	—	0.9725	0.03559	59.64	2.00	1.14
	(4.03	(1.06)	(2.50)	(3.75)						
SRI LANKA										
log	0.1917	0.969	0.0283	-0.0367	-0.126	0.8751	0.0289	70,41	0.24	6.26
	(2.01)	(18.8)	(1.07)	(-4.05)	(-3.99)					
lin.	0.065	0.961	0.222	-0.0018	-0.10	0.8658	0.0247	70.17	0.22	7.61
	(1.39)	(17.1)	(1,06)	(-2.99)	(-3.59)					

Dependent Variable $= Y_t$

Stability Test F = Chow's Test Statistic - F (4, 22) under Null Hypothesis for India; F (5, 20) for Sri Lanka.

Table 4 : Yield response functions

$$\ln Y_t = -0.141 + 0.459 \ln Y_{t-1} + 0.075 \ln P^e_t + 0.127 \ln T$$
$$(-1.19) \qquad (2.32) \qquad (2.02) \qquad (2.43)$$

$\bar{R}^2 = 0.9653$ SEE $= 0.032$ LLF $= 56.78$ Chow Test F $= 3.41$

In the Sri Lankan case none of the yield equations passed Chow's stability test, in contrast to the case of India where most of the equations could be considered stable. However the ratio of the price difference captured the price significance of .10 level as shown below although it did not pass the stability test.

$$\ln Y_t = -0.115 + 0.9704 \ln Y_{t-1} + 0.032\left(\ln P_{t-1} - \ln P^{e}_{t-1}\right) - 0.037 \ln T - 0.013\, DI$$

(-3.41) (19.7) (1.27) (-4.15) (-3.91)

$\bar{R}^2 = 0.8769$ SEE $= 0.028$ LLF $= 70.66 =$ Durbin h 0.344 Chow Test $F = 6.5$

In general the low significance of the price factor in Sri Lanka could be attributed to the intensive export diversification measures adopted recently.

As can be seen from the table both for india and Sri Lanka the linear specification showed significant coefficients. Especially in the case of India price factor has become significant at .05 level.

Area response functions

This function was defined as $A_t = f\left(A_{t-1}, P_{t-7}, T\right)$ and was applied under log and linear specifications with variations on the price factor. In the case of India two stage predicted price (ECW), and for Sri Lanka single stage predicted price $\left(P_t\right)$ were used respectively. The price factor was lagged seven years in the case of India and six years in the case of Sri Lanka to take into account the delay in production due to the gestation period. As shown in the table the price factor was not significant even at .25 level as one would expect in Sri Lanka and India where there is not much possibility of acreage expansion. Here too as in the yield response function the price factor gained higher significance when estimated under the linear specification. The time trend was not significant in the case of Sri Lanka under both specifications, although in the Indian case it was significant at .05 level in the linear specification. For both countries this function passed the stability tests under both specifications, except in Sri Lankan case where the matrix conversion of the second subset failed under log specification. Also the lagged dependent variable had a high level of significance for both countries mostly not less than .05.

Interestingly in the case of Sri Lanka when a exponential time trend was used under log specification the results was as shown below,

Table 5 area response functions

$$\ln A_t = 2.43 + 0.805 \ln A_{t-1} + 0.0045 \ln P^e_{t-6} + 0.00031\, T - 0.0042\, DI$$

(1.46) (6.01) (0.744) (1.00) (−0.59)

$\bar{R}^2 = 0.9005$ SEE = 0.0060 LLF = −266.7 Durbin h = 0.385 Chow Test F = 1.44

	Intercept	A_{t-1}	ECW_{t-7}	T	DI	$\bar{R}^2$	SEE	LLF	Durbin	Stability
INDIA										
log.	−0.352	1.02	0.00072	−0.0013	—	0.9933	0.00509	−265.2	−0.76	2.56
	(−0.41)	(14.5)	(0.67)	(−0.13)						
lin.	91177	0.693	47637	688.6	—	0.9940	1702	−263.6	−0.87	1.12
	(2.04)	(4.60)	(2.40)	(2.09)						
SRI LANKA										
log.	4.31	0.648	0.0014	0.0122	−0.0036	0.9087	0.0052	−265.4	1.95	n. a.
	(1.42)	(2.61)	(0.24)	(1.22)	(−0.61)					
lin.	0.448	0.798	32194	80.83	1207	0.9032	1407	−295.9	0.42	1.23
	(1.47)	(5.97)	(1.00)	(1.11)	(0.70)					

Dependent Variable = A_t

Chow statiitic distributed as F (4, 22) under Null Hypothesis for India; F (5, 20) for Sri Lanka.

The price factor becoming significant at least at .25 level is a remakable result. Also the dummy variable being not significant as in the case of yield and aggregate supply functions indicates its irrelevance to the area functions and suggests that the effect of communal riots on output has been mainly through yield.

Aggregate supply response

This function as noted earlier is basically a combination of the area response and yield response functions. Also the fact that area expansion is scarcely feasible makes the yield function the important component of the aggregate supply equation. Thus the current period price expectation becomes important than higher order lagged prices which were used in the area response function.

Although the table displays $Q^s_t = f\left(Q^s_{t-1}, P_t, T\right)$, If also tried

$Q^s_t = f\left(Y_{t-1}, A_{t-1}, P_t, T\right)$ to see which of the lagged factor causes the significant changes in the supply equation. Yield was found to have high and significant coefficient as can be seen in the following equation for Sri Lanka.

$$\ln Q^{s}_{t} = 10.01 + 0.833 \ln Y_{t-1} + 0.188 \ln A_{t-1} + 0.077 \ln P^{e}_{t} 0.0076 \ln T - 0.051\ D1$$

(0.746) (7.86) (0.17) (1.82) (0.17) (-1.05)

$\bar{R}^2 = 0.8019$ SEE = .0439 LLF = -322.2 Durbin h = - 4.3

As shown in the table the lagged dependent variable was mostly significant at .05 level even when tried with different price formulations.

Table 6: Aggregate supply response functions

	Intercept	Q^{s}_{t-1}	P_t	T	D1	$\bar{R}^2$	SEE	LLF	Durbin	Stability
INDIA										
log.	2.24	0.815	0.0643	0.103	—	0.9767	0.0343	-327.3	-1.57	3.67
	(1.57)	(6.92)	(0.731)	(1.37)						
lin.	114160	0.421	24840	4934	—	0.9813	13130	-324.9	2.00	1.37
	(3.23)	(2.26)	(2.03)	(3.13)						
SRI LANKA										
log.	0.527	0.974	0.0026	-0.040	-0.119	0.9154	0.0262	-310.3	0.55	6.92
	(0,988)	(19.8)	(1.08)	(-3.91)	(4.15)					
lin.	13630	0.975	56081	-471.3	-25913	0.9095	5253	-310.3	0.03	3.94
	(1.37)	(18.5)	(1.18)	(-2.97)	(-3.97)					

Dependant Variable = Q_t

Chow Statistic distributed F (4, 22) under Null Hypothesis for India; F (5, 20) for Sri Lanka.

Another fact that is evident from the table is the increased significance of the price factor under linear specification both for India and Sri Lanka. The time trend too is positive and significant at least at .10 level in the case of India denoting rhe importance of technological developments and fertiliser application in the aggregate supply functions, as one would expect the production to increase through higher productivity per acreage given that area expansion is very much limited. However, the fact that Sri Lanka having significant, negative time trend may possibly indicate misspecification of trend factor. However, as the following equation shows

$$\ln Q^{s}_{t} = 12.46 + 0.80 \ln Y_{t-1} + 0.0476 \ln P_{t-6} + 0.0012\ T - 0.064\ DI$$
$$(90.1) \quad (7.20) \quad (0.89) \quad (0.97) \quad (-1.16)$$

$\bar{R}^2 = 0.7997$ SEE — 0.0442 LLF = −322.98

an exponential time trend shows a positive coefficent with only .25 level of significance, although it failed the stability test.

In the case of India under linear specification the consumer price index deflated two stage predicted price (APC) showed higher level of significance of lagged supply as shown below.

$$Q^{s}_{t} = 16437 + 0.4261\ Q^{s}_{t-1} + 804500\ APC_{t} + 0.7167\ T$$
$$(0.544) \quad (2.44) \quad (2.24) \quad (3.09)$$

$\bar{R}^2 = 0.9819$ SEE = 1244 LLF = −324.4 Durbin h = −1.01 Chow Test F = 2.28

This function also has a higher, likelihood function which probably indicates it to be a better specification, although not a substantial improvement.

Also the fact that all equations in the case of Sri Lanka yield a negative and significant dummy variable justifies the hypotheses that tea production probably were affected by the communal riots in 1983. Also the linear specification passed the stability which again is a substantial improvement with regard to the Sri Lankan case. In the case of Sri Lanka the lagged and current dependent variable are very highly correlated unlike in India.

Dummy variables – multiplicative and additive

It is believed that the intermittant political disturbances and communal riots in Sri Lanka since 1977 have had an important effect on the economy and especially in the tea industry as most of the plantation workers are almost always affected. Although a multiplicative dummy was introduced to the period 1977 – 83 for the lagged dependent variable, except for the aggregate supply function in all the other equations it was not significant, thus rejecting the hypothesis, that civil disturbances gave rise to a change in the significance of of the coefficients. The dummy variable was significant only at .25 level as can be seen in the equation below.

$$\ln Q^{s}_{t} = 12.38 + 0.921 \ln Y_{t-1} + 0.0143 \ln \left(Y D 1_{t-1}\right) + 0.024\ ECP_{t} + 0.0199 \ln T$$
$$(107.0) \quad (15.0) \quad (1.37) \quad (0.60) \quad (1.31)$$

$\bar{R}^2 = 0.8848$ SEE = 0.0306 LLF = -314.7 Durbin h = 0.937

Thus as shown in the previous tables additive dummy was used for the year 1983 and was found to be highly significant variable as expected.

Tests of stability

The sample of 30 observations was subdivided into two to carry out the Chow Test for the stability of coefficients in the equations. The functions for India almost always passed the test for stability, unlike in Sri Lanka where it frequently failed. The absence of serious disruptions in the tea production of India seem to account for more stable results, than in the case of Sri Lanka where the relationships seem to be disrupted by communal disharmony and change in focus of economic policies.

However, as was observed earlier the nature of data along with the specification seem to give more stable results for India, unlike Sri Lanka where except for area response functions almost all the other functions showed signs of instability.

Test of specification

The RESET test for misspecification of the functional form was carried out on the equations which displayed a high level of significance and passed the stability tests in the previous sections. It is also claimed that tests of this nature should also identify omited variables to the extent that these are correlated with the additional variables. It is, however, vary important to note that it is not totally correct to conclude that nonlinearity or misspecification are absent on the basis of the RESET test alone (Spanos, 1986)

Table 7 RESET test results for India

Dependent Variables	Independent Variables	t values y_t^2	t values y_t^3	F test	Wald Test X^2
(log specification)					
Y_t	Y_{t-1}, ECW_t, T	3.5	-2.6	6.90	13.8
A_t	A_{t-1}, ECW_{t-7}, T	0.67	-0.66	1.88	3.77
Q^s_t	Q^s_{t-1}, ECW_t, T	3.74	-3.72	9.17	18.35
Q^s_t	Q^s_{t-1}, P_t, T	3.69	-3.67	8.78	17.57
A_t	A_{t-1}, P_t, T	0.916	-0.910	2.60	5.20

(Linear Specification)

Y_t	Y_{t-1}, P_t, T	2.576	-2.57	3.35	6.70
Y_t	Y_{t-1}, ECW_t, T	2.82	-2.84	4.05	8.10
A_t	A_{t-1}, ECW_{t-7}, T	1.28	-1.26	1.80	3.61
A_t	A_{t-1}, P_t, T	2.10	-1.16	4.00	8.00

F Statistic distributed as $F(2, 24)$

Wald statistic distributed as chi-squared with 2 degrees of freedom

The log specification was initially tested using wage index deflated prices. As initially prescribed by Ramsey (1969), higher order values of the predicted value of the dependent variable $\left(y^2 \text{ and } y^3 \text{ say}\right)$ were included in the equation and the significance of the new coefficients was jointly tested using an F test. Other, more specific tests of nonlinearity using cross products and higher order values of the independent variables were not carried out.

Table 8 RESET Results for Sri Lanka

Dependent Variable	Independent Variables	t values y_t^2	t values y_t^3	F test	Wald Test X^2
(log specification)					
Y_t	$Y_{t-1}, ECW_t, T, D1$	0.65	0.70	0.295	0.591
A_t	$A_{t-1}, ECW_{t-6}, T, D1$	0.41	-0.41	3.41	6.82
A_t	$A_{t-1}, P_t, T, D1$	0.54	-0.54	0.696	1.39
Q^s_t	$Q^s_{t-1}, ECW_t, T, D1$	0.086	-0.038	0.55	1.09
Q^s_t	$Q^s_{t-1}, P_t, T, D1$	0.138	-0.141	0.497	0.995
Q^s_t	$Y_{t-1}, A_{t-1}, P_t, T, D1$	-0.439	0.431	2.07	4.14

As the table indicates almost all the variations of the three response functions did not have significant coefficients for either y^2 or y^3. These equations also passed the Wald test at the 0.05 level of significance. Although these equations did not pass the stability test as observed earlier, it is interesting to note that they appear to be adequately specified; it is possible that the relations are inherently unstable.

In the case of India, except for the area response functions, the functions neither passed the F test nor the Wald test. When the additive model was tried the yield and area response functions passed both the F and Wald tests at the 0.05 level.

Conclusion

The advancement in modelling perennial crops in econometric analysis along with increased availability of reliable and appropriate data with respect to many crops from most of the international organisations and local statistical sources has brought in a renewed interest in the field of supply response functions of perennial crops. The fact that most of the developing countries rely very largely on primary commodities or perennial crops and the inelastic nature of the demand and supply functions has made it of interest to investigate both types of functions to study the means of optimally exploiting the benefits that could be derived in order to meet the growing need for scarce foreign exchange resources. This issue is particularly pressing as both countries have suffered from the reduced world demand for tea due to the introduction of many artificial beverages. In the present study I have tried to analyse the difference in the structure of tea production and other supply considerations in two of the most important tea producers of the world.

The functional form used in this supply response study is very general and not specific to the countries concerned in most respects. The unavailability of model-specific data with respect to these countries has greatly limited the specificity of the model to the countries concerned. In instances where data was unobtainable it was necessary to estimate the values of the appropriate variables, validity.

The model used in this study differs in some specific characteristics from earlier studies. The real wage indices have been used to deflate the prices instead of cost of living index or prices of substitutes which have been used in earlier studies. Also a specific kind of two stage expected price has been used as the price factor which proves to be significant as observed in the equations.

Also both log and linear specifications have been applied to the same data with identical equations to consider the merits of each specification.

All the tests to see the robustness of the model were not carried out which makes the comparisons made of lesser usefulness. This could, however, be done in an extensive study. The data limitation could be overcome by using a model - specific survey to obtain the data to carry out a more robust study as undertaken by, for example, Hortly, Nerlove and Peters (1984).

On the whole the analysis presented here has raised some interesting issues with respect to the price expectations mechanism, the appropriate deflator and the comparative features of the study, despite the limitations of the model. More advanced research needs to be carried out to analyse further the various interesting aspects observed in the comparative study carried out in this paper.

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Appendix I Data or India

Year	Area	Production	Price	CPI	Real Wage Index
1947	312126.3	254268.4	3.17	33.00	101.50
1948	312515.6	257779.6	3.46	36.10	102.90
1949	315645.8	265154.1	3.70	37.20	85.00
1950	316868.0	278212.6	3.90	37.70	104.30
1951	317914.5	285398.9	3.37	38.90	101.00
1952	318641.0	278670.7	3.04	38.50	99.90
1953	319476.0	278776.9	4.19	39.70	98.70
1954	320236.0	295505.3	6.13	37.70	103.50
1955	320586.0	307703.8	4.50	35.70	105.00
1956	323283.0	308719.4	5.00	39.30	81.70
1957	325355.0	310802.7	4.43	41.20	80.90
1958	326495.0	325225.6	4.61	43.20	82.10
1959	330828.0	325955.4	4.87	45.20	73.40
1960	331280.0	321077.5	5.27	46.00	81.30
1961	332525.0	354397.0	4.76	47.60	84.20
1962	334036.0	346736.0	5.08	52.80	88.90
1963	337814.0	346413.0	4.98	54.30	91.20
1964	341762.0	372486.0	4.82	61.50	81.20
1965	345256.0	366374.0	5.27	67.40	89.80
1966	347653.0	375983.0	5.50	74.60	93.60
1967	351065.0	384759.0	5.52	84.50	87.50
1968	353359.0	402489.0	5.30	87.00	83.30
1969	354133.0	393588.0	5.56	95.10	95.50
1970	356516.0	418517.0	6.86	100.00	100.00
1971	358675.0	433322.0	7.25	103.30	103.00
1972	360126.0	455996.0	6.99	109.80	97.50
1973	361663.0	471952.0	7.05	128.30	87.50
1974	363303.0	489475.0	10.24	165.20	78.00
1975	364275.0	487137.0	11.35	174.50	66.00
1976	366276.0	511817.0	12.08	160.90	79.40
1977	369184.0	556267.0	16.77	173.90	85.00
1978	373747.0	563846.0	14.02	178.80	82.20
1979	378447.0	543776.0	14.69	190.20	89.10
1980	381891.0	569550.0	15.08	212.00	95.30
1981	384292.0	559583.0	15.25	239.70	85.80
1982	394999.0	560732.0	16.82	258.20	86.90
1983	397123.0	581484.0	26.15	289.20	96.80

Sources:

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Area = Area Cultivated with Tea, ha.
Production = Output of tea, tonnes.
Price = Average price of tea at Calcutta Auctions, average for the year, Indian Rs, / kg.
CPI = Consumer Price Index, 1970 = 100.
Real Wage Index, 1970 = 100.

Appendix 2 Data for Sri Lanka

Year	Area	Production	Price	CPI	Real Wage Index
1947	224224.9	135409.5	3.52	61.00	60.40
1948	224634.1	136890.0	3.42	66.30	59.40
1949	227901.9	140413.5	4.25	67.30	54.20
1950	229640.4	143432.6	4.55	69.30	63.20
1951	230983.6	147997.6	4.19	72.40	95.80
1952	231961.0	143717.1	3.81	71.70	96.20
1953	232877.0	155597.6	4.21	73.20	97.70
1954	233562.0	166349.5	5.64	73.20	99.70
1955	229192.0	172370.9	4;93	72.50	105.70
1956	230452.0	170359.2	4.76	72.30	103.50
1957	230903.0	180427.6	4.10	74,20	106.70
1958	231766.0	187403.9	3.81	75.80	101.10
1959	234577.0	187392.6	4.30	76.00	100.40
1960	235455.0	197180.6	4.43	74.80	104.40
1961	237713.0	206488.3	4.25	75.70	104.10
1962	239217.0	211849.7	4.10	76.80	106.00
1963	237702.0	219797.6	3.88	78.70	109.00
1964	239569.0	218513.1	3.90	81.20	104.30
1965	240508.0	328235.8	4.03	81.40	105.80
1966	241373.0	222312,3	3.62	81.30	104.10
1967	242331.0	220741.6	3.48	83.10	105.80
1968	241769.0	224802.6	4.03	87.90	113.40
1969	241401.0	219639.0	3.55	94.40	106.40
1970	241799.0	212210.0	3.73	100.00	100.00
1971	241667.0	217773.0	4.14	102.70	120.10
1972	241858.0	213475.0	4.39	109.20	100.30
1973	242302.0	211271.0	4.34	119.70	109.20
1974	242191.0	204038.0	6.64	134.40	103.20
1975	241877.0	213679.0	6.84	143.50	120.00
1976	240578.0	196666.0	9.21	145.20	131.50
1977	242012.0	208572.0	16.05	147.00	148.50
1978	242903.0	198981.0	14.09	164 80	168.50
1979	244099.0	206417 0	12.19	182 60	192.90
1980	244715.0	191375.0	18.33	230.20	202.00
1981	244919.0	210148.0	18.10	871.60	172.10
1982	242141.0	186631.0	23.43	301.10	185.60
1983	242130.0	179960.0	43.24	343.10	177.40

Sources;

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Area = Area Cultivated with Tea, ha.

Production = Output of Tea, tonnes.

Price = Average price of tea at Colombo Auctions, average for year, Sri Lankan Rs. /kg.

CPI = Consumer Price Index, 1970 = 100.

Real Wage Index, 1970 = 100.