

# **SUPPLY RESPONSE AND COST OF PRODUCTION OF NATURAL RUBBER - AN ECONOMETRIC STUDY**

**THESIS SUBMITTED TO THE DEPARTMENT OF APPLIED ECONOMICS  
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**BY**

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## CERTIFICATE

I certify that the work entitled 'Supply response and Cost of production of natural rubber- an econometric study' is a bonafide research done by Maya C. Pillai for the award of the degree of Doctor of Philosophy in the Department of Applied Economics under my guidance and supervision.

Kochi-22

03-03-2003



(Dr. D. Rajaseenan)

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## CHAPTER-I

### INTRODUCTION

Natural rubber has been used for various purposes over centuries. No one knows exactly when man first started using rubber. The earliest recorded mention of rubber in print was made in 1530 by PMd'Angliera as "gummi de opium". Earliest written references of rubber also include the writings of Spanish invaders of Aztec civilisation. Aztecs were reported to have made shoes, head gear, clothing and other water tight articles from latex. Various Aztec religious rites involving rubber were also described. Spanish writings also reveal a game at the court of Aztec emperor Montezuma II which involved using a rubber ball.

In 1735 the French excavator de la Condamine discovered natural rubber in South America. He referred to natural rubber by a French word "catouchouc" derived from the local Indians word meaning "weeping wood", The "Cataoutchouc" came from a tree called He've which grew in parts of both Peru and Brazil. The botanical name of commercial rubber "Hevea Brasiliensis" came from the two words He've and Brazil.

Discovery of solvents and the principles of compounding made the use of natural rubber wide spread in the subsequent years. In the late 1830s Charles Good Year made the crucial discovery of the vulcanization process which enabled the manufacture of elastic pliable and durable rubber products which were insoluble in common oils no longer sticky and unaffected by temperature. The final major invention of the nineteenth century was that of the pneumatic tyre in 1888 by John Boyd Dunlop. The first motor car to use pneumatic tyres took part in the Paris Bordcauk motor race of 1895.

All these factors led to the tremendous growth of natural rubber consumption. Due to the increased demand for rubber the need to supplement the production in its colonies was realised by the British as early as 1860. Sir Henry Wickam made several expeditions between 1866 and 1876. He succeeded in his expedition in the year 1876 and brought seeds capable of survival in the historic liner 'S.S. Amazonas'. Most of the rubber plants were sent to Srilanka wherefrom hevea plants were planted in the teak plantations of Nilambur in Kerala State in 1879.

The first commercial plantation of rubber, however, was started only by 1902 with the formation of Periyar Syndicate. Plantations were made on the banks of Periyar River and at Thattekad near Alwaye. Thus the foundation stone for rubber plantations were laid down by the British. Therefore rubber cultivation could be termed as a “colonial heritage”.

Though it is a colonial inheritance, the development of rubber plantations is the result of careful planning and hardwork of Indians. United planters Association of South India [UPASI] evinced keen interest on various aspects which helped in the rapid development of commercial plantations by the early years. The “Malayala Manorama”, a leading Malayalam Daily took up the crusade for natural rubber as early as 1905 giving assurance to the general public about the price stability and profitability of natural rubber. The first local joint stock company to plant rubber was floated in 1910 under the name of Malankara Rubber and Produce Company.

Historical evidence shows that globally institutional factors have been responsible for the growth of rubber cultivation. When it comes to active government intervention, both in the pre and post colonial era, India is not an exemption. The rubber (Production and Marketing) Act 1947 enacted by the Government of India was an important hall mark in the history of rubber production in India. It setup “The Indian Rubber Board” which became the “Rubber Board” by an amendment of the Act in 1954. It was mainly due to the efforts of the Rubber Board, that the total tappable area increased from 67181 hectares in 1955-56 to 569,000 hectares in 2000-01 India is now the fourth largest producer of natural rubber in the world having a share of 9.4 percent of the global output.

One interesting aspect in the rubber plantation development is that there is static geographical distribution of rubber area over the years. The Rubber belt comprising of the districts in Central Kerala was already formed in the colonial era and continued so even after independence. The area wise share of other states which was 5 percent in 1950-51 rose only to 16.4 percent by 2000-01. Thus for about 50 years Kerala has retained its dominant position in the rubber map of India.

Development of natural rubber cultivation has given a long awaited boost to the Indian Economy by setting up infrastructural facilities and by generating employment to the unemployed millions in Kerala. Rubber tree is considered as a “Kalpadhenu” as far as Kerala is concerned. It is said to yield milk, honey and oil. In



other words rubber tree yields latex rubber honey, rubber seed oil, biogas from rubber latex and also rubber wood. Above all it provides the principal raw material required for manufacturing over fifty thousand different products indispensable to modern life.

### **Section 1.1:-Why an analysis of rubber situation in India?**

Natural rubber is a raw material of considerable commercial importance in the world. India is the fourth largest producer of natural rubber in the world. India also ranks first in the case of productivity. In India, the traditional rubber growing regions comprises of Kerala, Kanyakumari district of Tamil Nadu and Coorg district of Karnataka. Non traditional rubber growing areas include Tripura, Assam, Meghalaya, Missoram, Nagaland, Goa and Andaman and Nicobar Islands. Rubber industry is primarily predominated by small growers. Hence, rubber cultivation has a great significance in income and employment generation. Rubber Board is increasing its area of production every year and hence it is fast achieving significance area wise.

Being a small grower sector, rubber industry is sensitive to market price of rubber. From a return of Rs.18/- per Kg. in 1989 – 90, the rubber price sky rocketed to Rs. 65/- per Kg. in 1996. This high level of returns generated great expectations and zest among planters. But this period was short lived. Price started to fall down to Rs. 45 /- per Kg. and by 1997 end it was as low as Rs. 26 /- per Kg.. In India demand for natural rubber and rubber products is ever on the rise. Supply is always short of demand and import has been accepted as a necessity. But even as NR prices were falling, NR stocks were accumulating. This inconsistent situation arose due to the liberalisation policies and the general industrial recession prevalent in the early nineties, which hit automobile industry in a big way. International price was also not supportive due to general growth sluggishness and later on due to South East Asian crisis. Domestically, liberalization can be pointed out as the cause for the sharp downfall of rubber prices from a very high level. Import of second hand rubber tyres was allowed and import of raw materials for making polyurethane beds, a major competitive to rubber was also allowed. Import of synthetic rubber, the prime substitute of NR was made easier. Due to lack of funds, co-operative societies failed to keep adequate buffer stocks of rubber. NABARD grants were found inadequate by Rubber Marketing Federation. The protest and propaganda against low prices assumed greater momentum when taken up by major political parties.

In this context an analysis of the macro economic environment of NR is thought to be of highly significant. It will throw light on the causative factors of the rubber price crash since 1997. The dilemma prompted the growers to revise the benchmark prices in the cause of their agitation against low prices. The business lobby in India continued its statement that the prices are too high and carried on their speculative stock policy to keep prices arranged desirable to them.

Tariff Commission studied the cost of production of NR and had notified the maximum and minimum price of rubber in the year 1951. Central Government's price ceiling limits depended on the subsequent revisions and recommendations of the Tariff Board. Recently, the Cost Accounts Branch of the Ministry of Finance conducted a study of cost of production of NR and the results of this study which is kept highly confidential, the central government notified the revised indicative price of Rs. 34.05 /- per Kg. of RSS 4 grade rubber.

Now the relevant question is, what is the fair amount of return that a grower especially small grower should get to make him satisfied enough to remain in business?. The Rubber Board, Tariff Commission, Finance Ministry all have their own methodology of calculating this amount of fair return and all of them are confidential. Rubber Board is accused of inflating cost figures to get grants for its own survival. The grower is alleged of including unnecessary elements in the cost calculations and ballooning up the figure.

In reality supply response implies the violation of the traditional 'Ceteris paribus' assumption of assuming other influencing factors to be constant. In the case of supply, the non price factors are, the cost of input, technology, weather, socio-political conditions etc. Due to seven years gestation lag, past prices are equally important as present prices. When these supply shifters are allowed to interact, the growers react. Their reaction is reflected through the quantity offered for sale by them in the market. The grower response is manifested in two ways incorporating the time element. One is short run price output relationship and the other is long run planting price relationship. In the short run, the farmer adjusts output with the cyclicity of price when the price is high and is expected to rise further, farmer adopts the strategy of new planting, intensive tapping of existing trees and postponement of slaughtering process in a bid to maximize profits. Again, when the down trend starts, the farmer resorts to replanting and thus follows a policy of loss minimization. Since the

gestation lag is a necessary evil, the economic rationality of the growers makes him manipulate the timings of the lags to suite his end.

The grower's response to the current price situation was varied. Majority stayed on adopting short term supply reduction policies in the hope for the better turn of the cycle. Some people resorted to crop switching and inter cropping. A few people just quit by selling their plots. Decision to quit is always a difficult one in the case of NR as the high capital investment is required for the long run and the return involves seven year lag. In this context, it is highly relevant to explore, whether there is any empirical evidence of the behavioral response of the growers with respect to planting decisions in relation to price cyclicity. Supply response studies are of great importance for the success of Government programmes and policies launched with a view to mitigating poverty and upgrading the standard of living of the masses.

Improved technology in rubber cultivation has improved the potential for greater output and the prospects of sustained growth of the industry in the face of both fluctuating prices and increasing cost of inputs. It is therefore, highly significant to forecast the supply and demand for NR. Since majority of rubber suppliers are small holders and economically more backward than the rubber consumers, and therefore it is relevant to determine the potential so as to verify whether encouragement of productivity increase is a viable option or not.

### **Section 1.2:- Objectives of the Study**

1. To estimate the short term and long term supply response of NR in India.
2. To analyse the macro economic environment of NR industry and the causative factors of the rubber price crash.
3. To determine the minimum cost of production of NR.
4. To forecast the potential production of NR in India.

### **Section 1.3:- Database and Methodology**

Both primary and secondary data are used for the study. Secondary data are collected from various publications of the Rubber Board and International Rubber Study Group.

Supply response of NR in India is analysed using the Nerlovian Method and Fishers Model.

A SWOT Analysis of the macro economic environment of NR has also been worked out.

An all Kerala primary survey was conducted from November 1999 and April 2001. Random samples were chosen from North, Central and South Kerala based on their weightage in rubber production. Altogether 20 sample units were surveyed with a well formulated questionnaire. Sample units chosen from North Kerala are Horsdurg, Kasargod, Kanjangadu, Thalassery, Thaliparampa, Kozhikode, Manjeri, Sreekandapuram, Palakkad, Thrissur and from Central Kerala, Kothamangalam, Eranakulam, Muvattupuzha, Thodupuzha, Pala, Erattupetta, Kanjirapally, Kottayam, Changanacherry, Pathanamthitta and from South Kerala, Thiruvananthapuram and Nedumangad.

Supply and demand forecasts were made using time series method. Production forecasts were made using average yield profile method and also by using normal production method.

#### **Section 1.4:- Review of Literature**

Rubber Research Institute of Malaya (RRIM) in its Annual Report (1975) stated that tapping and collection cost continued to be the biggest item accounting for about 40 percent of the total matured area cost per kilogram of rubber production.

Unni and Jacob, (1969-70) found out that most of the small holders used ordinary planting materials. Inter planting of other crops was found to be crucial in determining the yield of Rubber. Majority of the small holders were found to practice the crude method of sun or kitchen smoking. Both manuring and plant protection measure were regularly done only in 37.7 percent of the total area surveyed. The survey revealed that the average yield per hectare in budded clonal and unselected area were 641, 565 and 388 kilogram respectively.

A Report, (1980) of study on the working of co-operative societies in Kerala dealing in Rubber stated that in the case of small holders it is possible only to process 80 percent of its produce which they collect as liquid latex and sell it at reasonable price. The 20 percent of their produce, which is in the form of scrap rubber whose composition and dry rubber content vary considerably depending upon certain factors.

They have to sell it to country dealers from whom it passes through a chain of middle men before it actually reaches the rubber consumers.

Market study on Natural Rubber, (1982) stated that out of the total cost of production of raw rubber maintenance and upkeep account for 26 percent, tapping and collection 39 percent, general charge 6 percent, development or amortisation cost 8 percent and processing packing and forwarding cost account for 21 percent and 56 percent of the total cost of labour comprises of plantation labour.

George and Joseph, (1973) analysed the feasibility of investment in Rubber and examined the present value of future returns. They worked out the internal rate of return on capital for rubber as 10 percent. The benefit cost ratio was also worked out using constant discount rate which was found to be 1.2 for rubber. The pay back period of rubber was estimated as 14 years.

Thomas, (1979) estimated the cost of production of small holdings relative to estates. He found that the cost of production per 100 kg of rubber in estates had increased by 332.96 percent between 1950-51 and 1974-75, whereas corresponding increase in holdings was only 236.56 percent. But the actual cost of production of holdings remained higher than that of estates during the whole period of analysis. The increase in the yield was also higher in the estates (155.91 percent than that of holdings 139.77 percent). price had increased during the period by 103.9 percent. He estimated the break down point of Rubber cultivation and found that estates are in a more advantageous position than the small holdings both in physical and in its value terms.

Response of production or supply to the changes in prices has been studied intensively during the post-planning period. The studies range from investigation into association between changes in prices and changes in area under specific crops to formulation and testing of dynamic models of the supply function. Early in 1954, the study of relationship between production and prices was in the form of crude observations. Though most of the authors have observed a positive association between prices and acreage, a few of them observed absence of any relationship between the two or even a negative relationship.

Parthasarathy (1959) and John (1965) observed negative relationship in the case of sugar-cane versus paddy. Both of them observed that the changes in acreage are not induced by changes in prices but by changes in profitability. Sugarcane being

far more profitable than paddy, the area under sugarcane increased even during the period when the prices of sugarcane were on the decline. These studies have given simple correlation or simple regression with two variables and their conclusion vary. Though, most of the authors have observed a positive association between prices and acreage, a few of them observed absence of any relationship between the two or even a negative relationship.

Of all the studies which have investigated into simple association between changes in prices and area under different crops, DharmNarain's study (1950) has a significance of its own. His study is extensive and systematic and investigates into the price-acreage relationship for various crops in different parts of the country. His analysis brings into clear focus the positive relationship between acreages of competing crops and relative prices with the use of a simple device of tabular analysis and geometric charts. He has indicated the relationship of output and area with weather changes and prices. He has a wider compass which covers important food crops like rice and wheat and non-food crops like cotton, jute groundnut and sugarcane. The study covers the period from 1900 to 1939. Between food crops and non-food crops the production of the former is influenced to a great extent by weather, and that of the latter by prices. An element of subsistence economy is believed to be responsible for this differential behaviour.

The earlier studies of investigation into simple association between changes in prices and area under specific crops emphasised the need to investigate more closely into the supply relationship.

Rajkrishna, (1963), adopted a Nerlovian type distributed lag model and postulated that a farmer plans to achieve a certain level of production but the actual level of production achieved may be different. He formulated the model as under

$$X_t = a + b P_{t-1} + c Y_{t-1} + g Z_{t-1} + h W_t + U_t$$

$$X_t - X_{t-1} = B (X_t - X_{t-1})$$

The reduced form of equation being

$$x_t = a_0 + b_2 P_{t-1} + b_3 P_{t-1} + b_4 Z_{t-1} + b_5 W_t + b_6 X_{t-1} + V_t$$

where  $a_0 = aB$ ,  $b_2 = bB$ ,  $b_3 = cB$ ,  $b_4 = gB$ ,  $b_5 = hB$ ,  $b_6 = 1 - B$  and  $V_t = B U_t$

and  $X_t$  = Standard irrigated acreage

$x_t$  = Standard irrigated acreage planned by farmers

$x_t$  = Total irrigated acreage in all crops of the season

$w_t$  = Annual rainfall

$p_t$  = The relative price of the crop deflated by the prices of alternative crops.

$y_t$  = The relative yield of the crop deflated by the yields of the alternative crops.

Rajkrishnas pioneering work in this field revealed that the farmers of the Punjab adjusted acreage under competing crops like wheat and cotton in the same manner as farmers in USA. In other words, economic forces operate both in the under developed and highly developed countries in a similar manner. This finding ruled out the need for explaining the behaviour of the so called subsistence farmer in the developing economies in terms of non-economic factors.

Following Rajkrishna's approach Sethi (1966), used a non-linear- supply function. He postulated that due to the operation of the Law of Diminishing Marginal Product, linear model cannot be considered realistic. He therefore, tried several non linear functions of which he found the following one to be the best.

$$1 - Y_t / Z_t = \text{Exp} - [a_0 + a_1 P_{t-1} + a_2 X_{1t} + a_3 X_{2t} \dots \dots \dots + U_t]$$

Where  $x_1$   $x_2$  etc are other relevant variables such as yield, rainfall, etc., and

$Y$  = acreage of the relevant crop,

$Z$  = acreage of the competitive crop,

$P$  = relative price,

$U$  = random term.

He found not only the fit to be better in terms of higher value of  $R^2$ , but also the magnitudes of price elasticities to be larger in case of non-linear function than those found on the basis of the linear function. Sethi shows further that if the linear function is used, the price elasticities would be different for different sub-periods or long periods. Sethi calls the studies on the lines of Rajkrishnas'crop substitution functions' (CSF), they are not in a way true supply functions (TSF). Changes in acreages are used as proxies for changes in production the underlying assumption being that the farmer can control the use of acreages but cannot plan for production in view of uncertainty of weather. This will be true in so far as land is a major input and other inputs are closely associated with the use of land.

In a recent study relating to paddy in Kerala State, Pillai (1969) has extended the analysis of supply response a little further in addition to area. He has taken into account productivity and production for observing the impact of movement of prices. He has taken both the current and the lagged prices and has found that all the three variables, namely, production, productivity and area, are responsive to price changes. However, there was no systematic change in the value of  $R^2$  when current prices and lagged prices were used as independent variables.

Herdt (1964) has an important contribution relating to the supply responses. His study differs from that of others in that he has attempted to estimate the response of supply of aggregate agricultural output to changes in price of agricultural products. He has estimated, probably for the first time in the Indian context, the elasticity of the aggregate agricultural supply. His research relates to the Punjab region and covers two periods. 1) 1907-46 and 2) 1951-64. He has worked supply responses separately for 12 districts of the region. Along with the price he has considered other relevant variables such as weather, canal irrigation, new technology, etc. Weather has been represented by rainfall for different crucial months and technology by a trend variable. For the period 1907-46, the results show positive response of aggregate output to changes in prices (real) of agricultural products. During this period the contribution of weather- also has been found to be significant. For the latter period viz, 1951-64, the results are divided. Of the 12 districts studied, five shows negative aggregate supply elasticities and the remaining districts show positive elasticities.

Literature on crop supply response concentrated mainly on the annual crops and perennial crop received little attention till the 60s. The essence of previous econometric, studies of perennial crops supply response models are mainly related to the issues and problems of investment in perennial crops. Various supply response models throw light on various shift variables identified and relationships explained by different researches in the field.

Bateman (1965) estimated the supply functions for- Ghanaian cocoa, in 1965. His model related producers expectations about future demand and supply with actual new planting and replanting. He used Nerlove's adaptive expectations scheme to transform the expected price into determinants of planting. Actual planting is then related to observed prices and actual output becomes a function of actual planting price and natural factor namely rain, humidity etc.



The Bate Man, (1965), Model.

$$x_t = a_0 + a_1 P_t + a_2 C_t + U_t$$

where  $X_t$  = number of acres planted in year t.

$p_t$  = average expected future real producer price of cocoa

$c_t$  = average expected future real producers price of the competing crop viz coffee.

$$p_t = \frac{\sum_{i=0} P^*_{t+i}}{[1+r]^i / n+1}$$

$$C_t = \frac{\sum_{i=0} c^*_{t+i}}{[1+r]^i / n+1}$$

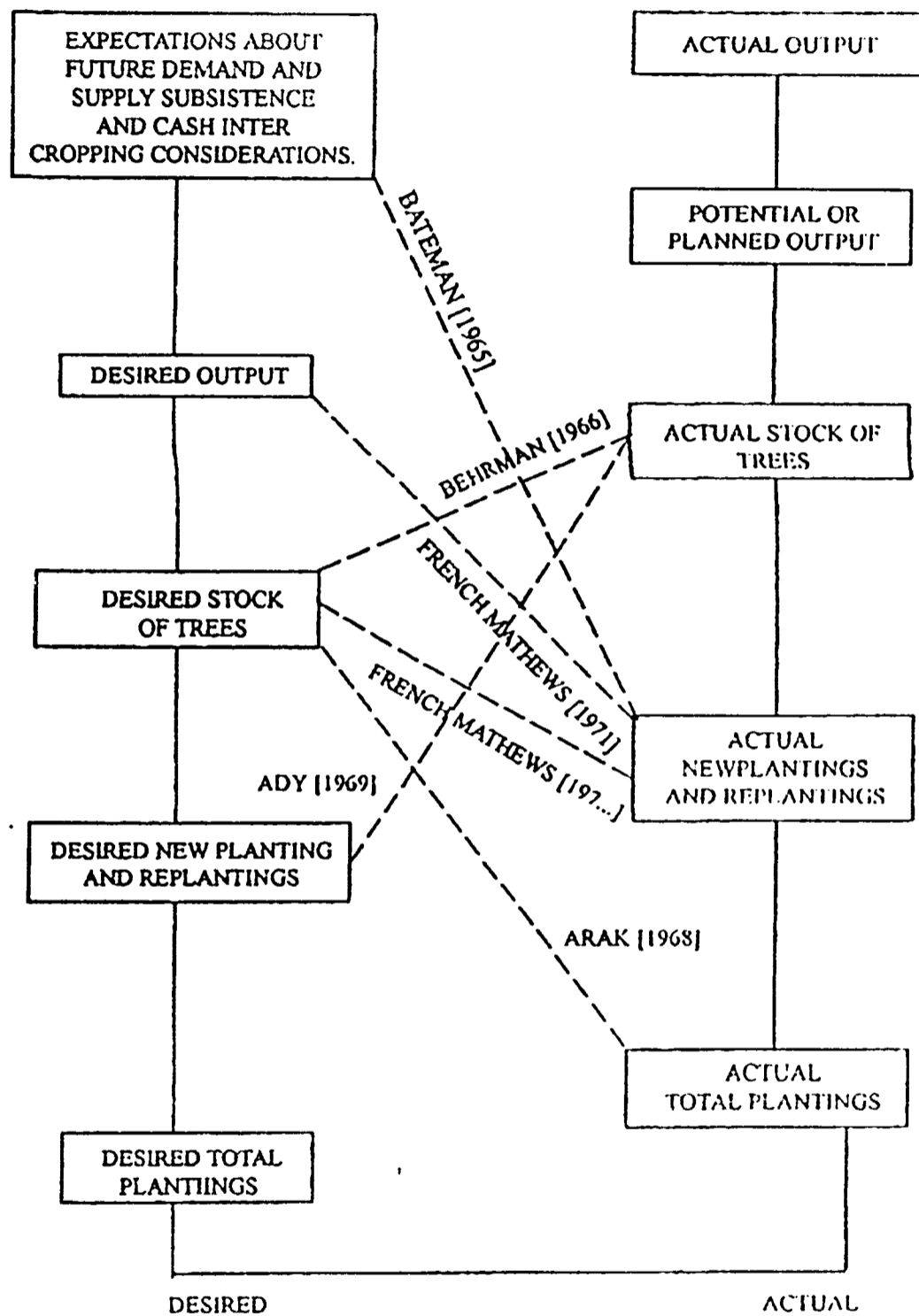
$P^*_{t+1}$  = Expected real producers price of cocoa in year t + 1

$C^*_{t+1}$  = Expected real producers price of coffee in year t

$r$  = farmers subjective rate of discount.

$n$  = life of the perennial crop.

**Fig : 1.1 - Flow chart of major perennial crop supply studies**



The estimating equation is attained

$$X_t = a_0 B + a_1 B P_t + a_2 B C_t + [1 - B] Y_t - a V_t$$

$$\text{Where } V_t = v_t - [1 - B] V_{t-1}$$

Then

n

$$\frac{\sum_0 P^*_{t-1}}{[1+r]^i} - \frac{[1+B] \sum_0 P^*_{t-1+1}}{[1+i]^i} = [n+1] B P_t$$

After some algebraic manipulation we get

$$P^*_{t+n} = \frac{[1+r][n+1] B P_t + [1-B] P^*_{t-1} - (r+B) n \sum_0 P_t + n-1}{[1+r] \quad [1+i]}$$

This is the price expectations formation equation implicit in Bateman's model.

J.R. Behrman' estimated the pricing response for cocoa in 1968. His model is based on a planting equation relating actual to the desired stock of trees. As the flow chart indicates this is complemented by an equation relating the desired stock of trees to the expected prices.

The Behrman,(1968), Model.

$$X_t = a_0 + a_{11} P^*_t + a_{12} C^*_t + U_{1t}$$

Where  $X_t^*$  = desired acreage in cocoa in the year t

$P^*_t$  = expected price of cocoa and coffee respectively in year t

$$X_t - X_{t-1} = a_{20} + 2[X^*_{t-1} - P_{t-1}] + U_{2t}$$

$$P^*_t - P^*_{t-1} = a_{30} + B[P^*_{t-1} - p_{t-1}] + U_{3t}$$

$$C^*_t - C^*_{t-1} = a_{40} + P_{t-1} C^*_{t-1} - C_{t-1} + U_{4t}$$

Estimating equation is

$$X_t = b_0 + b_1 X^*_{t-1} - b_2 X_{t-2} - b_3 P_{t-1} - b_4 C_{t-1} + V_0$$

where  $a_0 = a_{10} B + a_{11} a_{30} + a_{12} a_{40}$

$$b_1 = [2 - 2 + B]$$

$$b_2 = a_{11} - 2B$$

$$\begin{aligned}
b_3 &= a_{12} - 2B \\
v_0 &= 2V_0 + U_{2,t-1} - [1+B] - U_{2,t} \\
u_0 &= U_{1,t} - [1+B] - U_{1,t-1} + a_{11} U_{3,t} + a_{12} U_{4,t}
\end{aligned}$$

The Behrman model is expectation adjustment model and it was used to estimate supply response for annual crops and it is the most satisfactory of all models available.

Another economist named Ady,(1968),in his "supply function in Tropical Agriculture" formulated capital stock model based on the assumption that the existing or surviving stock of trees is an important determinant of further planting i.e. the actual tree stock influences desired new plantings. This basic relationship is complemented by equations relating actual to potential output and hence potential output to existing tree stock.

The Ady model:-

$$X_t = a_0 + a_1 P^*_t - a_2 A_{t-1} \dots \dots \dots (1) \text{ where,}$$

$P^*_t$  = expected price of Cocoa in year t

$A_{t-1}$  = acreage under Cocoa in year t-1

$X_t$  = difference between  $A_t$  and  $A_{t-1}$

$$P^*_t = P_{t-1} + B [W_{t-1} - P_{t-1}]$$

$$0 < B < 1$$

Estimating equation is obtained as

$$X_t = a_0 + a_1 [1 - B] P_{t-1} + a_1 B W_{t-1} - a_2 A_{t-1} + U_t$$

Arak,(1968),focused her interest on the determination of changes in the tree stock. It is basically a stock adjustment model, relating the actual new plantings to the desired stock of trees. The remaining equations in the model completing the adjusting mechanism are,

- a) An equation relating the rate of new planting and replanting to the proportion of old to young trees and expectations about the labour cost due to near monopsonistic market for labour in the Sao Paulo coffee sector which she was studying.
- b) An equation accounting for the cost of tree removals.
- c) An equation accounting for tree abandonment.





















































































































































































































































































































































































































































