CHAPTER - I
INTRODUCTION

The Kerala model of development has attracted attention of both national and international scholars and development agencies in recent years. The basic characteristic of this model is the higher level of social development disproportionate to its level of economic development. In terms of indicators of physical quality of life like literacy, death-rate, life-expectancy and infant mortality, Kerala is way ahead of the rest of the states in the Indian union. Yet, per capita income in Kerala is only Rs. 9066 in current prices (Q, 1996-97) against national average of Rs. 10771 in current prices (Q, 1996-97).

One of the important features of development experience of Kerala is that the share of agricultural income in the state domestic product, had been decreasing over the years. Between 1960-61 to 1991-92 the share of agricultural income in SDP at constant prices decreased from 53.40 to 33.89 per cent. It has been stagnating around 34 per cent for over a decade (1980-90). Then from 1992-93 it continuously declined and touched the lowest level (27.58%) in 1995-96. At current prices the share of agriculture stood at 28.43 per cent in 1995-96. Between 1960-61 to 1991-92 the share of secondary sector in Kerala had increased from 21.11 to 23.83 per cent at constant prices. During 1995-96 the SDP share of secondary sector was 25.59 per cent at constant prices and 26.14 per cent at current prices. Performance of tertiary sector is more perceptible. Tertiary sector’s share to SDP had risen from 36.40 to 40.74 per cent at current prices and from 36.40 to 40.09 per cent at constant prices between 1980-81 to 1991-92.
Table 1.1

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<td>(30.52)</td>
<td>(29.72)</td>
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<td>92.98</td>
<td>92.91</td>
<td>92.78</td>
<td>86.27</td>
<td>87.83</td>
<td>87.79</td>
<td>56.66</td>
<td>85.44</td>
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<td>percentage of</td>
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<td>Tertiary sector</td>
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<td>495955</td>
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<td>(36.40)</td>
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<td>(39.74)</td>
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<td>(37.84)</td>
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<td>(40.58)</td>
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<td>Net SDP</td>
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<td>526234</td>
<td>536466</td>
<td>575161</td>
<td>638051</td>
<td>686882</td>
<td>729487</td>
<td>382273</td>
<td>1217349</td>
<td>1717520</td>
<td>2202433</td>
<td>2481949</td>
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<td>Per capita Income</td>
<td>1508</td>
<td>1815</td>
<td>1826</td>
<td>1932</td>
<td>2114</td>
<td>2246</td>
<td>2353</td>
<td>1508</td>
<td>4200</td>
<td>5768</td>
<td>7201</td>
<td>8007</td>
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</table>

Figures in brackets are percent to total SDP
In 1995-96, the tertiary sector contributed 44.69 per cent at constant prices and 40.58 per cent at current prices to SDP (see Table 1.1). Thus the economic structure is marked with higher contributions of about 44.69 percent from tertiary sector, 23.83 per cent from primary sector and 25.59 per cent from secondary sector. The contribution from primary sector is relatively low. An examination of sectoral contributions over the years shows that the shares of tertiary and secondary sectors are increasing. The only sector which showed declining share to SDP, was the primary sector. It is well known that economic development will be accompanied by decline in the share of primary sector. However, here, there has been hardly any economic development worth mentioning as can be inferred from the low per capita income. Yet the decline has been rather sharp partly because the absolute size of the primary sector which has been almost stagnant over the past several years. Since agriculture accounts more than 90 per cent of the primary sector of Kerala and as its contribution to SDP is declining over the years, this sector needs special attention. In this connection an overview of the agricultural situation in Kerala would be quite useful and relevant.

According to the survey conducted by the Directorate of Economics and Statistics, Thiruvananthapuram (1995) the land put to agriculture in Kerala had almost reached a saturation point. Together with forests, land devoted for agriculture stood at as high as 85.47 per cent of total geographical area which is perhaps the highest for any state in the country. The state is keen in making use of every bit of land which has potential for any kind of use as could be seen from the declining trend in the categories of lands coming under “cultivable wastes” and “barren and uncultivable land”. Another feature is that where population density is very high, agricultural land is getting diversified and put to
non-agricultural purposes. The very high cropping intensity of about 136 as early as in the seventies reveal inter crop adjustments1.

**Table 1.2**

**Gross Cropped Area and Area under Food and Non food Crops in Kerala.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Gross cropped area</th>
<th>Area under food crops</th>
<th>Area under Non food crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-71</td>
<td>2933</td>
<td>1844</td>
<td>1088</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(62.9)</td>
<td>(37.1)</td>
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<tr>
<td>1980-81</td>
<td>2885</td>
<td>1778</td>
<td>1107</td>
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<tr>
<td></td>
<td></td>
<td>(61.6)</td>
<td>(38.4)</td>
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<tr>
<td>1990-91</td>
<td>3043</td>
<td>1496</td>
<td>1524</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(49.2)</td>
<td>(50.1)</td>
</tr>
<tr>
<td>1995-96</td>
<td>3067</td>
<td>1441</td>
<td>1626</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(47.0)</td>
<td>(53.3)</td>
</tr>
</tbody>
</table>

Figures in brackets are percent to gross cropped area.

**Source:** Government of Kerala, Economic Review, State Planning Board, Thiruvananthapuram. (various years)

Table 1.2 shows that area under food crops in Kerala during the last three decades has decreased considerably. Area under food crops decreased from 1844 thousand hectares during 1970-71 to 1441 thousand hectares during 1995-96. But situation is just the reverse in the case of non-food crops, which went up from 1088 thousand hectares in 1970-71 to 1626 thousand hectares in 1995-96. Area under food crops were much higher in Kerala as compared to area under non-food crops, during seventies and

eighties. By 1990-91, the differences in area under food and non-food crops were only marginal. Since 1990-91 the area under food crops had again declined and became much less than that of non-food crops.

The index for overall agricultural production in Kerala which was 100.17 for the triennium ending 1978-79 has been steadily increasing from 132.67 in 1992-93 to 146.68 in 1995-96. The increase in production is largely contributed by increase in productivity of crops as evidenced by the sharp increase in productivity index from 98.71 during 1978-79 to 121.59 during 1995-96. There was only a marginal increase in area index during this period (i.e., from 101.48 to 106.59). The indices of area, production and productivity of major categories of crops are given in Table 1.3. The overall index for crop production in Kerala had shown signs of decline in the eighties when the farm front was undergoing structural changes. Now the situation is fast changing. Non food grains production on the whole increased from the triennial average of 100.52 for the period ending 1978-79 to 163.47 during 1995-96 whereas the index of food grains production fell sharply from 98.67 during 1978-79 to 74.25 during 1995-96. The fact that the increase in the area index in respect of non food crops is larger than the improvement in productivity is noteworthy. With regard to food crops, the area index has lost considerably and continuously from 102.55 during 1978-79 to 58.38 during 1995-96. This shows that the gain in productivity was not adequate enough to make good this short fall. Another feature to be noted among non food categories is the growth of area expansion index with respect to plantation crops. It went up from 95.04 during 1978-79 to 180.38 during 1995-96.\(^2\)

Food crops in general have been losing ground, with their area indices falling from 102.55 during 1978-79 to 58.38 during 1995-96. Change in productivity index of these crops even though maintaining a positive trend, the growth rate is only marginal and hence not adequate enough to compensate the loss due to fall in area. This means that, food grains production which has been short of demand since the reorganisation of the state continues to decline inspite of increasing demand, thus widening the demand-supply gap. As per the estimates of the Directorate of Economics and Statistics, Thiruvananthapuram, during 1993-94, there was 294 percentage increase in the import of food grains into the state. Hence the following negative features connected with agricultural Scenario of Kerala require closer examination.

(I) The productivity of crops remains low and this along with high pressure of population on land result in relatively very low percapita income.

(II) Food crops nurtured and developed by huge investments in irrigation, extension support and other infrastructural facilities are becoming increasingly difficult to sustain.

(III) There is a shift in cropping pattern and the shift is largely from low value and high labour intensive crops (like paddy and tapioca) to high value and low labour intensive crops (like coconut and rubber).
Table 1.3

Index of Area, Yield and Production of Food and Nonfood crops in Kerala: (Base year - Average of Triennium ending 1979-80)

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area</th>
<th></th>
<th>Yield</th>
<th></th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>All crops</td>
<td>101.48</td>
<td>103.73</td>
<td>104.09</td>
<td>106.59</td>
<td>98.71</td>
</tr>
<tr>
<td>Food grains</td>
<td>102.55</td>
<td>63.18</td>
<td>62.55</td>
<td>58.38</td>
<td>96.22</td>
</tr>
<tr>
<td>Non food grains</td>
<td>101.00</td>
<td>123.38</td>
<td>123.21</td>
<td>128.77</td>
<td>99.52</td>
</tr>
</tbody>
</table>

The cropping pattern changes that had occurred are mainly based upon the farmers' decisions in Kerala. Based upon the agro-climatic conditions, soil fertility, labour availability, cost of cultivation, irrigation facilities, mechanisation, price levels, profitability etc., farmers decide whether to allocate their land for agricultural purposes viz., which of the crops to cultivate, how much area to allocate, etc., or for nonagricultural purposes. To understand the above issues one must know the decision behaviour of primary producers, and to analyse the decision behaviour, agricultural economists usually prefer supply response studies.

Supply response functions provide useful information regarding farmer's decision behaviour in response to changes in price and other economic factors. They help one to find out how the farmers react to movements in the price of the crop that they produce. They also help one to ascertain how farmers reallocate resources among various crops in response to changes in relative price levels. Three types of responsiveness are generally exhibited. They are;

a. Response of acreage under a crop to prices and other factors.
b. Response of yield of a crop to prices and other factors, and
c. Relationship between average production and supply determining factors.

In 1994-95 food grains occupied only 20 percent of total cropped area of 30.42 lakh ha. This was largely because of the fact that by mid-seventies a larger proportion of paddy cultivating areas were converted into coconut gardens or rubber plantations. The statistical profile of Kerala agriculture since 1960, clearly established that the cropping pattern in Kerala made a significant shift from the traditional food crop, paddy to
cash/plantation crops. This shift is very significant since 1980. Naturally there must be certain determinants which motivated the farmers to make a shift in the cropping pattern. Hence it is felt that an analytical study on farmer’s decision behaviour with regard to important crops in Kerala in response to changes in different factors will be useful for policy formulation. The present study is an attempt in that direction.

**Objectives of the study**

The major objectives of the present study are:

a. To examine the response of supply of major agricultural commodities in Kerala, viz., paddy, coconut and rubber.
b. To understand farmer’s decision behaviour in response to changes in price and other non-price factors based on supply responses.

**Scope of the study**

The agricultural sector of Kerala is dominated by paddy, coconut, rubber, tapioca, banana, pepper, arecanut, cashewnut, cardamom, tea, coffee etc. But paddy, coconut and rubber alone contribute 62 per cent of the total cropped area. Hence the scope of the study is limited only to these three crops. Similarly the supply response is analysed considering the state-level data.

**Limitations of the study**

Supply response models require a big basket of variables which include price of the crop and competing crops in the current period, area under crop and yield of the crop in the current period, cost of cultivation,
returns, irrigation facilities, application of fertilizers and pesticides, level of technology, weather, past years area, yield and prices, expected area, yield and prices, humidity, regional variations, etc. But inclusion of all the above mentioned variables will create data problems and estimation problems. For instance, the crop-wise use of fertilizers, pesticides etc. are not readily available. Even if the values are appropriated, it may not yield reasonable and statistically valid results. Further, inclusion of many variables will lead to serious statistical and econometric problems. Hence the researcher was compelled to restrict the analysis to limited number of variables. A related data problem was also observed in the case of paddy. Though paddy is a seasonal crop, season-wise information for all the relevant variables were not available and thus the analysis was performed using annual data available from Kerala Government publications. The above mentioned limitations are unavoidable in econometric exercise.

**Scheme of study**

The study is divided into eight chapters including the introductory chapter I.

Second chapter presents information regarding the important previous studies relevant to the study.

Different theoretical models on supply responses are discussed in the third chapter. The model used for the study is also specified in this chapter.
The agricultural situation of Kerala in general, the cropping pattern and the significance of paddy and coconut are discussed in the fourth chapter.

The results emerging from the study with reference to paddy are discussed in the fifth chapter that of coconut in the sixth chapter and that of rubber in the seventh chapter.

Summary and conclusions of the study are given in the last chapter VIII.

METHODOLOGY OF THE STUDY

The methodology adopted in the present study is presented under three main sections. A general discussion on the analysis of agricultural supply and sources of data for the present study are presented in section 1. The methodology adopted for analysing trends in area, yield and production of the crops is presented in Section 2. Section 3 presents analysis of time series data with reference to supply of paddy, coconut and rubber.

SECTION -1
Analysis of Agricultural Supply

The underlying aim of all supply response studies is to find out how farmers react to movements in the price of the crop that they cultivate. When more than one crop is being cultivated, the aim is to find out how the farmer intends to reallocate his resources among the various crops in response to changes in the relative price levels.
Theoretical discussion and past empirical work on agricultural supply distinguish two different approaches viz., (I) normative methods and (II) econometric methods. Normative methods are constructive methods which involve derivation of supply functions from data and information relating to production functions and individual behaviour. Econometric method is a positive approach which attempts to study what farmers as a whole will do in response to expected changes in economic variables based on what they had done in the past under dynamic situations.

There are however, serious difficulties in measuring the degree of responsiveness of producers to price changes. They arise mainly from the difficulties in approximating theoretical formulations of functional relationships to observed real world situations. These difficulties are further compounded because of the time lag between changes in production capacity and changes in output. Problems in adequate representation of risk, producer expectations, changing technologies and government policies thus assume importance.

Due to time lag between changes in agricultural production capacity and changes in output, any attempt to measure the price responsiveness should try to work out the functional relationship between planned output and expected prices. However, the possible discrepancy between planned and realised output and non-availability of any kind of reliable data about planned output except acreage under the particular crop have forced the researchers in the field of supply response to treat acreage as a proxy for planned output (In most agricultural activities actual output is not a good proxy for intended output. Most farmers have little control over the elements and therefore, over yield and total output. As land is the major input in agricultural
production and since the farmer has considerably greater control over this variable, the acreage planted would give a better indication of the farmer's intentions).

Price elasticity of acreage planted can be used as a reliable proxy for the price elasticity of planned output only if two conditions are satisfied. These are (I) inputs other than land can be varied in proportion to acreage and (II) returns to scale are not diminishing (If inputs other than land cannot be changed in proportion to acreage then this places physical constraint on production. At the same time if there are decreasing returns to scale the acreage planted will not be able to reflect the farmer's intentions). These two conditions are however, largely met in most underdeveloped regions where disguised and seasonal unemployment prevail and where the cost of capital service per unit of land at the existing level of technique is small. Most studies on supply responses in underdeveloped agriculture have therefore, used acreage planted as the dependent variable.

The necessity of using expected prices in supply response studies has given rise to many postulates about the ways in which farmers formulate their expectations about future prices. By now, Nerlove's reformation of Cagan's adaptive price expectation model has become a standard tool for estimation of supply functions. As is well known the adaptive expectation hypothesis implies that expected price at time is the geometrically declining weighted average of all past price changes. However, simpler price formulations like lagged prices and

\[ 3 \text{Marc Nerlove, Dynamics of Supply : Estimation of Farmer's Response to Price, p.64} \]
moving average prices have also been used extensively in supply response studies with Nerlove's area adjustment model.

In addition to acreage expansions, response to economic stimuli can also take the form of adoption of yield increasing measures. However, yield is prone to much more variation than area since yield can be influenced significantly not only by man-made factors but by natural factors as well. Timely application of adequate amounts of manures and fertilizers, availability of water at critical periods of plant growth and adoption of plant protection measures and other cultural practices can substantially increase productivity. However, the prevailing weather condition can also have an important bearing on crop yield. So, theoretically at least, yield response functions should incorporate such important variables as irrigated area, fertilizer price, trend etc., as explanatory variables in addition to the economic incentive in the form of the expected price and uncertainty elements in the form of measures of expected risk and proxies of weather parameters. However, continuous time series data on such factors are not always available. Nevertheless, as and when data availability permit, it would be profitable to consider them also in the yield response functions.

Estimates of supply elasticities at the macro level implicitly assumes that the various regions/subregions producing the commodity or commodities posses homogenous characteristics and that the level of supply and the nature of the producer's response everywhere would be the same. However, since there are inter-regional differences in resources endowments including agroclimatic conditions and managerial skills, the macro supply response relationship may not provide a true picture of resource allocative
decision of the farmers. Thus one has to strike a balance between the homogeneity of the region and the level of aggregation to be achieved.

Supply studies, like most other econometric studies with time series data, suffer from problems of multicollinearity and auto correlated disturbances. The problem of multicollinearity prevents the inclusion of all the relevant explanatory variables in the final estimating equation while the deletion of an important explanatory variable causes autocorrelated disturbances.

In the present study the response of paddy, coconut and rubber producers to changing variables have been analysed.

An estimate of the total output response is obtained by measuring its components, viz., area response and yield response. Supply response of the crops paddy (seasonal crop), coconut (perennial cash crop) and rubber (plantation crop) in Kerala take area and yield as proxies. The required time series data on price, average output, irrigated area, weather, etc. over the years from 1960-61 to 1995-96 were collected from the publications of Directorate of Economics and Statistics, Government of Kerala, Thiruvananthapuram, and various other secondary sources. Annual details were collected for the purpose since seasonal data from secondary sources are discontinuous. In the absence of continuous series of prices and to get the actual prices received by farmers farm prices were used in the study. The period of the study ranges from 1960-61 to 1995-96. Midseventies is a dividing line in the agricultural economy of Kerala because the Green Revolution of 1960's had its impact on crop production only after midseventies. Therefore the entire period of study from 1960-61 to 1995-96 is divided into two sub periods as given below.
SECTION - 2

1. Selection of Crops

Kerala farmers are shifting area under paddy to coconut and rubber while the state is 50 per cent short of paddy production. These three crops constitute 62 per cent of the gross cropped area. Therefore paddy, coconut and rubber have been selected as important crops for the study. In order to understand the reasons for these shifts over the years, farmer’s decision behaviour in area, yield and output adjustments is to be known, where supply response studies are quite helpful.

2. Trend Analysis

For measuring the year to year movements of area, yield and production simple indices were computed.

2.1 Decomposition

For separating the contribution of area and productivity towards the changes in production, the method of decomposition analysis (Narula and Vidyasagar, 1973) given in equation 1 was employed.

\[ P_n - P_o = (Y_n - Y_o)\ A_w + (A_n - A_o)\ Y_w \quad \ldots \ldots \ldots (1.1) \]

\[ A_w = \frac{A_n + A_o}{2} \quad \text{and} \quad Y_w = \frac{Y_n + Y_o}{2} \]
Where

\[ P_n = \text{Production in the } n^{\text{th}} \text{ period} \]
\[ Y_n = \text{Yield in the } n^{\text{th}} \text{ period} \]
\[ A_n = \text{Area in the } n^{\text{th}} \text{ period} \]
\[ P_0 = \text{Production in the base period} \]
\[ Y_0 = \text{Yield in the base period} \]
\[ A_0 = \text{Area in the base period} \]

To avoid the influence of extreme values the base period was fixed as the first triennium of the time series.

Percentage share of area = \( \frac{(A_n - A_o) Y_n}{(P_n - P_o)} \times 100 \) and

\( \frac{(Y_n - Y_o) A_n}{(P_n - P_o)} \times 100 \)

2.2 Growth Rates

For measuring the rate of growth, the exponential functional form \( Y = a \cdot b^t \) is fitted to the time series data.

2.3 Fluctuations in Area, Yield and Production.

Fluctuations were measured by the coefficient of variation.
3. Supply Response

Supply response is measured by using Nerlove's supply response model.

The basic Nerlovian model is a three equation model. The equations are

\[ A_t = a_0 + a_1 P_t + u_t \] ..........(1.2)

\[ P_t - P_{t-1} = B (P_{t-1} - P_{t-1}) \] ..........(1.3)

\[ A_t - A_{t-1} = r (A_t' - A_{t-1}) \] ..........(1.4)

Where \( P_t \) is the expected price in the year "t", \( A_t \) is the desired planted area in the year t and \( A_t \) and \( P_t \) are the actual planted area in the year t and the actual price in the year t respectively, 'i' is the gestation period of the crop.

Equation 1.2 relates the desired planted area to the expected future price through a simple linear formulation. It represents a behavioural relationship.

Equation 1.3 implies that expectations are adaptive i.e., current expectations are formed by modifying (adapting) previous expectations in the light of the actual achievements. \( B \) is the coefficient of expectations and its value lies between 0 and 1.

The adjustment lag hypothesis implied in equation 1.4 reflects technological and/or institutional constraints which permit only a fraction of
the intended level to be realised during a short period, \( r \) is the Nerlovian coefficient of adjustment \( 0 < r < 1 \).

Though this model of supply response is more realistic than the one which allows either only the expectational or the adjustment element, simultaneous consideration of both types of lags present serious problems for econometric estimation. Consequently, the commonly used model in supply response analysis based on time series data is the Nerlovian adjustment lag model.

The lagged adjustment model is said to present a more realistic picture by incorporating distributed lags and thereby introducing a realistic assumption about the farmer's adjustment behaviour. The other advantage of this model compared to the traditional models is that it explains the data better by yielding coefficients more reasonable in sign and magnitude thereby providing better estimates of supply elasticities. Further, it eliminates or reduces the incidence of serial correlation in the residuals (Nerlove, 1958).

The present study also employs the Nerlovian adjustment lag model with necessary modifications because instead of annual crops seasonal and perennial crops were considered. In its simplest form it is based on the relation.

\[
A_t^* = A + bp_{t-1} + u_t \quad \ldots \ldots (1.5)
\]

\[
A_t - A_{t-1} = B \left( A_t^* - A_{t-1} \right) ; 0 < B < 1 \quad \ldots \ldots (1.6)
\]

considering 'i' as the gestation period of the crop.

For estimation it is necessary to eliminate the unobservable variable \( A_t^* \). This is done first by expressing \( A_t^* \) as a function of \( A_t \) and \( A_{t-1} \). Based
on equation 1.3 and then substituting this value of \( A_t \) into the equation to get the reduced form of estimating equation as given in relation.

\[
A_t = a_0 + b_0 P_{t-i} + C_0 A_{t-i} + r_t \quad \ldots \ldots (1.7)
\]

Where

\[
a_0 = aB, \quad b_0 = bB, \quad C_0 = 1 - B \quad \text{and} \quad r_t = Bu_t
\]

Additional variables like lagged yield, rainfall, irrigation etc. can be very easily incorporated into the structural equation.

**Area and Yield Responses**

The output response function is measured in terms of area and yield, since farmers respond to economic stimuli initially by altering the productivity by intensifying the cultivation practice and thereafter area under the crop. Since planned output is the product of intended cultivated area and planned yield, the elasticity of output can be easily determined once the area and yield models are separately developed on the basis of Nerlovian lagged adjustment model.

**Choice of Variables**

Supply decisions in agriculture are expected to be made on the knowledge relating to technical coefficients, prices of inputs and prices of products. All these three components needed for decision making are not known with certainty. Variations in such exogenous variables like weather, technology, government policies etc. also influence supply. Therefore the chosen model should explain important expectations influencing the decision
making process regarding the area allocation and adoption of yield increasing techniques.

The most important variables were selected on the basis of apriori reasoning. The models chosen were as follows:

\[ A_t = f(A_{t-i}, P_t^e, I_{t-i}, N-W_{pt}, PR_t^e, YR_t^e, Y_{t-i}, T) \]
\[ Y_t = f(Y_{t-i}, P_t^e, I_t, N-W_t, PR_t^e, YR_t^e, T) \]

for paddy (seasonal crop)

\[ A_t = f(A_{t-i}, P_{t-e}, Y_{t-i}, PR_t^e, YR_t^e, T) \]
\[ Y_t = f(Y_{t-i}, P_t^e, PR_t^e, YR_t^e, T) \]

for coconut (perennial crop) and

\[ Y_t = f(P_t, T, W_t) \text{ in the short-run} \]
\[ Y_t = f(Y_{t-1}, P_{t-e}, P_{t-e}^c, PR_t^e) \text{ in the long-run} \]

and

\[ PA_t = f(P_{t-e}, P_{t-e}^c, Y_t^e, TA_t, PR_t^e) \]

for rubber (plantation perennial crop)

where

\[ A_t = \text{Area under the crop in the current year} \]
\[ Y_t = \text{Yield per hectare of the crop in the current year} \]
\[ P_t = \text{Price of the crop in the current year} \]
\[ P_t^e = \text{Expected price of the crop} \]
\[ P_{t-e}^c = \text{Expected price of the competing crop} \]
\[ A_{t-i} = \text{Area under the crop lagged by } i \text{ years} \]
\[ Y_{t-i} = \text{Yield of the crop lagged by } i \text{ years} \]
\[ Y_t^e = \text{Expected yield of the crop} \]
\[ N-W_{pt} = \text{Difference between normal rainfall and total rainfall in the presowing months in mm.} \]
\[ N - W_t = \text{Difference between normal rainfall and total rainfall in mm during the crop yield} \]

\[ W_t = \text{Average annual rainfall in mm.} \]

\[ PR_t = \text{Expected price risk in the current year} \]

\[ Y_t = \text{Expected yield risk in the current year} \]

\[ I_t = \text{Irrigated area in the current year} \]

\[ I_{t-i} = \text{Irrigated area lagged by 'i' years} \]

\[ T = \text{Trend variable} \]

\[ PA_t = \text{Planted area under the crop in the current year} \]

\[ TA_t = \text{Tappable area in the current year} \]

**Price Expectation**

The price which farmers take into account for their decision making process is called the expected value. The price expectation implied in the Nerlovian adjustment lag model is the previous years price. The prices prevailing in the recent past influence farmer's expectations as to future prices, so that farmers are likely to be influenced significantly by the prices prevailing during the farm harvest period of the preceding year. Therefore the price variable introduced in the study must be one entering the producers expectations most vitally in influencing their resource allocative decisions. The average of prices prevailing in the preceding three years was tried in the response functions for coconut while the average prices in the preceding year was considered for response functions of paddy.
Preceeding years Yield of the Crop

Farmers, in their resource allocating decisions regarding a particular crop can be expected to be influenced by the post yield levels of the crop. So the lagged yield of the crop was included in the area response model as an independent variable.

Rainfall

Rainfall is a crucial factor determining the area under paddy as well as its yield. However, while the average allocation decisions are more influenced by the rainfall in the progressing months, yield mostly depends upon the rainfall during the crop yield. Hence in the area response functions total rainfall in the presowing months was considered. There are three crops for paddy viz., Virippu (autumn crop) Mundakan (Winter crop) and Punja (Summer crop). For paddy, March and April for autumn, July and August for winter and October and November for summer are the presowing months. In the yield response functions, the total rainfall during the crop period was taken as a proxy for the influence of weather. For coconut and rubber mean annual rainfall had been taken.

Risk Factor

The risk factors in the model were represented by price variability and yield variability. The price risk in period ‘t’ was represented by the standard deviation of price in the past three years from period ‘t’.
## Time Trend

In addition to the factors mentioned above, production decisions are also influenced by some other factors like technological innovations, changes in supporting infrastructure, etc. Hence time trend (T) was included in the models as a 'catch-all' variable.

Introducing all the chosen variables into the Nerlovian lagged adjustment model, the final estimating area response and yield response equations respectively obtained were as follows:

\[
A_t = a_0 + a_1 A_{t-1} + a_2 P_t \epsilon + a_3 (N - W_{pt}) + a_4 Y_{t-1} + a_5 YR_t \epsilon \\
+ a_6 PR_t \epsilon + a_7 I_{t-1} + a_8 T + V_t \ldots \ldots \ldots (1.8)
\]

\[
Y_t = b_0 + b_1 Y_{t-1} + b_2 P_t \epsilon + b_3 (N - W_t) + b_4 YR_t \epsilon + b_5 PR_t \epsilon + b_6 I_t + b_7 T \\
+ u_t \ldots \ldots \ldots (1.9)
\]

Instead of considering the variable \( N - W_t \) and \( N - W_{pt} \) for coconut and rubber \( W_t \) was considered. The functions were estimated both in linear and in double log linear form by the method of OLS. The regression coefficients were tested for their significance using \( t \)-test. Since double log forms were found to be good fit, only those functions were considered for the present study.

## Price Elasticity

In the case of double log functions regression coefficient of price itself represent the short run price elasticity. Longrun elasticity was obtained
by dividing the short run elasticity with the coefficient of adjustment of area/yield.

**Speed of Adjustment**

Speed of adjustment was estimated using the relation

\[(1 - P)^N = 0.05\]

Where

\(P\) = coefficient of area/yield adjustment

\(N\) = number of years required to realise 95 per cent of the price effect.

**Statistical Problems in Estimation**

Two major estimation problems arising out of the use of time series data are multicollinearity and auto correlation.

a. **Multicollinearity**

When the determinants in a relation are closely correlated it becomes difficult to isolate their separate influences and obtain a reasonably precise estimate of their relative effects (Koutsoyiannis, 1973). The independent variables were tested for multicollinearity by computing the zero order correlation matrix. Whenever significant multicollinearity was observed appropriate modifications were made in the model.
Auto-correlation

Serial correlation of the random term ‘u’ violates the assumption of the method of ordinary least squares. Though unbiased estimates of parameters can be obtained, their sampling variances will be unduly large and further, there will be serious under-estimation of the variances (Johnston, 1972).

Durbin and Watson d statistic is commonly employed for testing the incidence of auto correlation.

\[
d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\Sigma_{t=1}^{n} e_t^2}
\]

Where \(e_t\) and \(e_{t-1}\) are residual terms of current and lagged dependent variables respectively.

However, the d-statistic is not an appropriate measure of auto correlation if among the explanatory variables there are lagged values of the endogenous variable. For such cases Durbin suggested the h-statistic. Despite the limitations of small sample, the h-statistic was employed in the present study (Lal and Singh, 1981: Kapila, 1982).

\[
h = (1 - d) \left[ \frac{n}{2} \right] \frac{1}{1-n V(b_1)}
\]

Where

\(V(b_1) = \text{estimate of the sampling variance of } b_1\) sample size.

\(d = \text{computed Durbin Watson d-statistic.}\)
However, the test involving h statistic breaks down than when $V(b) \geq 1$. For such cases, the d statistic was employed to check the incidence of serial correlation.
REVIEW OF LITERATURE