Working Paper No. 227

# Agricultural Stagnation and Economic Growth in Kerala: An Exploratory Analysis

K.P. Kannan
K. Pushpangadan

We are grateful to V.M. Dandekar for his valuable suggestions on an earlier version of the paper. Thanks are also due to T.N. Krishnan and A. Vaidyanathan for their useful comments. The authors alone are responsible for any errors and omissions.

Centre for Development Studies
Trivandrum - 11

June 1988

# CONTENTS

# AGRICULTURAL STAGNATION AND ECONOMIC GROWTH IN KERALA

## An Exploratory Analysis

KP Kannan
K Pushpangadan

## Introduction

The experience of Kerala's economic development has attracted attention world-wide since the publication of the CDS study Poverty, Unemployment and Development Policy: A case study of selected issues with special reference to Kerala (United Nations: 1975). This is because Kerala presented an interesting contrast to the experience of all India as well as the historical experience of most developed countries. The important aspect of this development experience was the achievement of social (especially education and health) and demographic indicators comparable to the industrially advanced economies at relatively very low levels of per capita income. To an economic historian, its growth path is an exception to the historical patterns of present-day industrially advanced countries at a similar stage of development in terms of the shares of the three broad sectors - agriculture, industry and services - in both national income and distribution of workforce. While the industrial sector has shown some small increases in its share, agriculture has shown a decline and a corresponding increase in the service sector. As we shall see in section IV, per capita consumer expenditure in the recent past has shown an excess over per capita income indicating the influence of income transfer from outside the system (and not captured in the state income estimates).

While there has been a number of detailed studies on the growth and contribution of such sub-sectors of the service sector as health and education, and the interrelationship of these on demographic transition[1], no attempt has as yet been made to analyse the phenomenon of stagnation in agriculture and industry over a sufficiently long period of time. From the point of the overall economic performance of Kerala, this should be a matter of serious concern. This constitutes the point of departure of our study. Here we subject the performance of Kerala's agriculture over the last quarter of a century to a detailed analysis to identify the sources and causes of stagnation and then to view it in relation to the growth in income of other sectors as well as the economy as a whole.

The performance of Kerala's agriculture during the last quarter of a century has not been an impressive one, to say the least. The period under study, 1962-63 to 1985-86, seems to show that there have been two distinct phases in terms of agricultural growth. During the sixties and upto the mid-seventies, i.e. 1962-63 to 1974-75, there has been an overall increase in the rate of growth of area, production and yield for all the crops while in the following period 1975-76 to 1985-86 there has been a near stagnation in the growth rate of aggregate area, production and productivity. Despite the fact that the value of agricultural product per unit of land in Kerala is one of the highest in the country because of the diverse crop combination and the high value of many crops, the symptoms of stagnation during the past decade, if not reversed, are bound to cnstrain the growth of the overall economy of the state. There is hardly any scope for increasing the extensive margin in agriculture while the population density and the proportion of landless agricultural labourers to total agricultural workforce is one of the highest in India. Employment in agriculture has also been showing a declining trend. In such a background it is imperative that agricultural growth be accelerated by means of intensification of cultivation wherever feasible, but more importantly by a breakthrough in productivity.

The outline of this paper is as follows. In Section I, we start with an analysis of the pattern of land use and then examine the growth rates of output, yield and acreage for food and non-food grain crops. Based on the output performance of food and non-food grain crops the question of allocation of acreage between them is also examined. Further we look at the sources of productivity as the second source of output growth. In Section II, we develop a simple theoretical model for explaining the stagnation thesis. This model should not however be confused for a growth model since our intention is not to work out conditions of steady growth. The model is based on the empirical finding of the absence of any significant technical change in agriculture. The section also contains an empirical verification of the model. In Section III, we compare the role of price and non-price factors in increasing output and point out that it is the absence of the latter which has contributed to agricultural stagnation. Searching for causes, we identify two factors as responsible for stagnation. One is the absence of the provision of critical inputs as water and land development (including soil conservation), both considered as public goods, and the other the environmental degradation which have further affected water availability and soil quality adversely. In Section IV, we discuss the implications of our findings and assess the impact of agricultural stagnation in relation to the growth performance of other sectors as well as the overall economy for the period. The conclusion is that growth in aggregate income in the seventies has been largely contributed by tertiary sector and, given the poor performance of agriculture and industry, the impulse might have come from outside the economy (in the form of flow of remittances) which cannot continue for long. Hence the imperative to strengthen the productive base of the economy.

# I

# Performance of Kerala's Agriculture: An Empirical Investigation

## 1.1 Data Base and Selection of Crops

Ideally it would have been worth while to examine the performance of Kerala's agriculture since its formation in 1956. However, the organisation of the collection of statistics was firmly established only from 1960. Even then there was hardly any scientific basis for the measurement of such important parameters as productivity. It was in 1961-62 that crop-cutting surveys were carried out under an ICAR scheme estimating productivity of important crops. But this was not carried out for all crops. However land utilisation surveys were conducted annually from 1960-61. We have therefore decided, in the interest of minimising problems relating to the use of time-series data for various crops, to start from 1962-63. Over the last ten years, the data collection system has been further improved with the introduction of Timely Reporting Surveys under the Establishment of an Agency for Reporting Crop Statistics (EARCS). This scheme, started in 1975-76, envisaged complete enumeration of all the villages in the state over a period of six years which has since been achieved[2].

The performance of Kerala's agriculture during the period 1962-63 to 1985-86 can be divided into two phases; first, 1962-63 to 1974-75 (Period I) and the second, 1975-76 to 1985-86 (Period II). The beginning of the second period also marks the beginning of a change in the methodology of data collection but that cannot explain the behaviour over the second period as a whole.

We have observed that Period I is marked by a relatively better performance in terms of an increase in area as well as production and productivity. However, Period II has registered a decline in the aggregate performance. It is this phenomenon which leads one to characterise Kerala's agriculture as stagnating since the mid-seventies. To account for this, we shall first examine the decline in net area sown (NAS) followed by the decline in the growth rates of aggregate production and productivity.

To understand what has happened to the NAS it is necessary to look at the pattern of land use (see Table 1). In the early sixties NAS accounted for a little over 52

% of the total geographical area. This has increased to 57% by the mid-seventies. It would appear that this increase has largely been attained by a reduction in the land under miscellaneous crops and total fallow. However, during the second period, the NAS has registered a marginal decline to around 56%. But this marginal decline conceals a much greater increase in total fallow which is compensated by a decrease in land under miscellaneous crops.

Table 1: Land Use in Kerala, for selected periods

(Average for the triennium)

| | Area uder each use as a % of TGA | | |
|---|---|---|---|
| Category | 1962-65 | 1972-75 | 1983-86 |
| Forests | 27.33 | 27.28 | 27.84 |
| Land put to non-agr.use | 5.65 | 7.41 | 7.18 |
| Barren & uncult.land | 3.06 | 1.71 | 2.20 |
| Permanent pastures & other grazing lands | 0.89 | 0.73 | 0.12 |
| Land under misc.crops not included under net area sown | 5.40 | 2.69 | 1.34 |
| Cultivable waste | 3.20 | 1.90 | 3.30 |
| Fallow other than current fallow | 1.03 | 0.58 | 0.74 |
| Current fallow | 1.01 | 0.67 | 1.10 |
| Net area sown | 52.43 | 57.08 | 56.23 |
| Total geographical area (TGA) | 100 | 100 | 100 |

Source: GOK, Statistics for Planning (various issues).

## 1.2 Decline in Output

Kerala's agriculture is characterised by a diversity of crops in which many are garden crops grown as inter-crops in a given area. While most of the crops are grown all over the state regional specialisation also exists in terms of dominant crops. For analysing the growth in aggregate output we have taken, as mentioned earlier, all the major crops. Of these, paddy accounts for 90 percent of the area under foodgrains and coconut, tapioca, rubber, cashew, pepper, banana, coffee, tea, arecanut, cardamon and seasamum account for 82-84 percent of the area under non-foodgrain crops.

In order to overcome problems of different units of physical output, index numbers were constructed for each crop with 1962/63 as the base. A measure of aggegate output was obtained by weighting crop index numbers by the proportion of their area in the gross cropped area. These weights can be either for base year or current year or changing weights. We have used the base year weights. Apart from the aggregate output index we have also constructed index numbers for food grains (i.e. paddy) and non-food grain crops separately in order to examine the growth pattern as between tho broad groups of crops.

The overall performance of the agricultural sector can be measured by the growth rate of output and its components, viz., area and yield. Two methods are available for the purpose. The first method is the Decomposition Method pioneered by Minhas and Vaidyanathan (1965) and its variants (Alauddin,M. and Tisdell,C. 1986). The second method is the statistical estimation using different functional forms. Since the Minhas-Vaidyanathan method depends crucially on end points, and the reliability of estimates are not known unlike the regression method, we have used the second method. Although general functional forms such as linear, semi-log, Gompertz, logistic, etc. are available for the purpose (Chattopadhyay,M. and Bhattacharya, G.1987) we have used a second degree exponential function due to the following reasons. This function can be interpreted as a varying parameter growth rate function as explained in Technical Note 1. Further, it can be used to test the hypothesis of acceleration/deceleration of growth (Reddy,V.N.1978). The usual method for the estimation of period-wise growth rate is to estimate separate regressions for each period. But the pitfalls of such an exercise have been demonstrated recently by Boyce (1986). He further suggests that the period-wise growth rates become more reliable if it can be estimated through kinked exponential function which impose a continuity restriction at the break-points between sub-periods. The methodology is given in Technical Note 2. The period-wise growth rates based on kinked exponential function and the findings based on polynomial exponential function for Kerala and all-India respectively are given in Table 2.

Table 2: Trend and Period-wise Growth Rates in Agriculture (1962-63 to 1985-86)

| Crop | Trend in growth rates |  | Growth rates(Kerala) |  |
|---|---|---|---|---|
|  | Kerala | India | Period I | Period II |
| All crops |  |  |  |  |
| Area | D (80-81)[a] | C (0.53)[b] | 1.8 | -1.0 |
| Output | D (77-78) | C (2.75) | 3.6 | -0.8 |
| Yield | D (75-76)[d] | C (2.22) | 1.7 | 0.2 |
| Food grains |  |  |  |  |
| Area | D (76-77) | C (0.45) | 0.8 | -2.1 |
| Output | D (80-81) | C (2.90) | 1.8 | -0.8 |
| Yield | NS | C (2.45) | 1.0 | 1.2 |
| Non-food grains |  |  |  |  |
| Area | D (83-84) | C (0.70) | 2.4 | NS |
| Output | D (81-82) | C (2.40) | 4.4 | NS |
| Yield | D (78-79) | C (1.70) | 2.0 | NS |

Source: Tables A1 to A5 in Appendix.

**Notes:** Period I = 1962-63 to 1974-75.
Period II = 1975-76 to 1985-86.
D = deceleration; C = constant,i.e, no trend.

[a] The numbers in brackets refer to the year of maximum growth rate derived from the estimated polynomial functions given in the Appendix.

[b] The numbers in brackets refer to the constant growth rate for the period 1962-63 to 1985-86.

[d] To be consistent the year of growth rate reaching maximum derived from the yield equation for all crops should be the same as that derived for non-food grains since the growth rate in yield for food grains is not significant. The obsereved descrepency could be due to the effect of aggregatin the two equations.

NS The growth rate is not significant.

The agricultural sector in Kerala showed a declining trend in production, acreage and yield during the period 1962-63 to 1985-86. The growth rate started with slowing down of yield followed by output and area. In other words, the stagnation began with a decline in productivity in the agricultural sector. At the disaggregate level, the behaviour of food grains (i.e. paddy) is different but a similar pattern emerges for non-food grain crops. In the case of food grains, the decline in the growth of output is mainly due to a decline in the area since the yield has remained more or less constant during the period. At the all-India level, the growth rate in food grains has remained constant. In order to compare the growth rates and its components between Kerala and all-India, the period-wise growth rates are estimated using kinked exponential curve. In the case of Kerala, it is widely believed that the growth rate has changed around the mid-seventies. Therefore, the entire period is broken into two periods. Period I, from 1962-63 to 1974-75, and Period II, from 1975-76 to 1985-86. The period-wise growth rates for Kerala are shown separately in Table 2. The growth rates for all India are given in brackets for the entire period in Table 2. The statistical test using polynomial exponential function does not reject the hypothesis of constant growth rate. This is in contrast to the results of a recent study on growth rates of Indian agriculture (Chattopadhyay, M. and Bhattacharya, G. 1987) where the authors show a trend in growth rates. This, we believe, could be due to the change in the period of study and the use of different functional forms.

While the main source of growth at the all-India level is yield, both yield and area contributed more or less equally to the growth of output in Kerala during Period I. At the disaggregate level, yield contributed more to the growth of output of food grains for Kerala and for non-food grain crops, the area contributed more to the growth rate. For Period II, there is a negative growth rate for all crops because of a decline in growth rate of area and an insignificant increase in growth rate of yield. Looking at the disaggregate level, the yield increase is outweighed by a negative growth rate of area resulting in negative growth rate of output for food grains. However, no such pattern exists for non-food grains for the second period, although there is deceleration in the growth of output and its various components for the entire period.

### 1.3 Allocation of NAS Among Crops

We have seen that paddy has experienced a decline in area in Period II which needs to be explained. In the conventional framework this could be explained by the movement of prices of food grains relative to the price of other crops competing for the area which are tapioca and coconut in Kerala. However, tapioca is an inferior substitute for rice and is mainly cultivated in marginal lands not suitable for paddy. Therefore, it is reasonable to assume that tapioca does not compete for the area under paddy.

This limits the choice of substitutes to mainly coconut. Therefore the change in area under paddy should be explained by the change in the price of paddy relative to that of coconut. At the risk of oversimplification, one may say that the allocation decision is based on observed current prices which are assumed to be equal to the expected prices. However, the allocation decision here is one of conversion of land under a seasonal crop to a perennial crop which have long-term implications on the income of the farmer. These long term implications are: (i) that there is the need for additional investment for planting coconut in paddy land, (ii) there is a loss of income for a period of 7 to 10 years because of the gestation period for yielding, (iii) the expected future income should compensate the loss of income in the gestation period, and (iv) reverting to paddy cultivation is not easy and entails additional costs. From a theoretical point, it can be argued that such allocation decisions are in the nature of ex-ante evaluations of alternative uses of land involving discounting of expected future incomes with an implicit rate of discount. In the absence of such detailed data for empirical verification, we examine this allocation decision through an econometric analysis of the role of past prices on expected prices (see Technical Note 3). In this case, we have developed three models; one based on the assumption of perfect foresight and the other two based on Nerlovian expectation. Model 1 postulates that the allocation decision is based on expected prices which are related to current observed prices only assuming perfect foresight. Model 2 and 3 hypothesise that the current expected prices are formed on the basis of previous year's expected price and actual price following Nerlovian tradition. Since model 3 assumes that the current expected price is a weighted average of past prices and model 2 considers only the previous year price, model 2 is only a special case of model 3. The models estimated econometrically are given in Table 3.1 (Technical Note 3).

The results show that there is no evidence to believe that the assumption of perfect foresight is valid in acreage allocation decision (as per Model 1). Both versions of the Nerlovian model (Models 2 and 3) support the view that acreage allocation decision depends on the weighted average of past prices. In terms of elasticity, it varies from 0.05 (model 2) to 0.20 (model 3). Since long run elasticity is higher than short run elasticity, model 3 refers to the long run acreage allocation function of the farmers. This is quite consistent with our earlier observation that a shift from annual to perennial crop involves long term considerations. This phenomenon would then account for the increase in total fallow which implies that the farmers take time to make up their mind as to what new use the land should be put. There is also an additional factor in the form of an Act, The Kerala Land Utilization Act, which prohibits the conversion of land under paddy to other crops. While one cannot credit this particular act with any greater degree of effectiveness than similar acts it could often be a snag in the farmer's decision on conversion.

## 1.4 Sources of Productivity

The second independent source of output growth is land productivity. Factors that contributed to the productivity growth need some elaboration. In the absence of any major technological breakthrough in Kerala's agriculture, land productivity can be explained by the following variables: (i) area under irrigation, (ii) rainfall index, and (iii) index of fertilizer use per hectare (FUI). In order to estimate the combined effect of irrigation and rainfall a new variable, water availability index (WAI), is constructed using the formula given below.

$$WAI = W_1 IRI + W_2 RFI$$

where $W_1$ = the proportion of irrigated area to total area,

$W_2 = 1 - W_1$

IRI = irrigated area index,

RFI = rainfall index.

The productivity relations were then estimated using WAI and/or RFI and FUI for all crops and the two sub-groups (see table 3). Fertilizer application seems to increase productivity of all crops as well as the two sub-groups. However, when the results are tested and adjusted for autocorrelation, its effect on foodgrains alone is significant. The effect of irrigation, proxied by water availability index, is not significant in any

Table 3: Productivity Functions: Aggregate and Sub-groups
(1962-63 to 1982-83)

| | | | | | |
|---|---|---|---|---|---|
| **All crops:** | | | | | |
| a) | Y = | 94.7 | - 0.016 WAI | + 0.148 FUI | $R^2$ = 0.71 |
| | | (7.1) | (-0.1) | (5.9) | DW = 0.77 |
| CORC | Y = | 46.4 | - 0.025 WAI | + 0.046 FUI | $R^2$ = 0.16 |
| | | (12.8) | (-0.5) | (1.6) | |
| b) | Y = | 91.7 | + 0.011 RFI | + 0.150 FUI | $R^2$ = 0.71 |
| | | (7.2) | (0.1) | (6.1) | DW = 0.78 |
| CORC: | Y = | 45.5 | - 0.001 RFI | + 0.047 FUI | $R^2$ = 0.15 |
| | | (13.0) | (-0.04) | (1.7) | |
| **Food grains:** | | | | | |
| a) | Y = | 86.2 | + 0.018 WAI | + 0.094 FUI | $R^2$ = 0.66 |
| | | (9.5) | (0.2) | (5.5) | DW = 1.66 |
| b) | Y = | 81.8 | + 0.062 RFI | + 0.097 FUI | $R^2$ = 0.67 |
| | | (9.5) | (0.8) | (5.9) | DW = 1.62 |
| **Non-food grains:** | | | | | |
| a) | Y = | 100.2 | - 0.013 WAI | + 0.147 FUI | $R^2$ = 0.62 |
| | | (6.2) | (-0.1) | (4.9) | DW = 0.65 |
| CORC | Y = | 44.8 | - 0.044 WAI | + 0.011 FUI | $R^2$ = 0.05 |
| | | (14.4) | (-0.8) | (0.4) | |
| b) | Y = | 98.5 | + 0.002 RFI | + 0.149 FUI | $R^2$ = 0.62 |
| | | (6.4) | (0.02) | (5.1) | DW = 0.66 |
| CORC: | Y = | 45.0 | - 0.018 RFI | + 0.015 FUI | $R^2$ = 0.03 |
| | | (14.2) | (-.4) | (0.5) | |

Source: 1) Sivanandan, (1985)
2) GOK, Economic Review (1986).

Note:
Y = yield; WAI = water availability index;
FUI = fertilizer use index; RFI = rainfall index;
DW = Durbin-Watson test;
CORC = Cochrane-Orcutt method.

of the estimated productivity equations confirming the findings of earlier studies (Pillai 1982; Nair and Narayana 1983; and George and Mukherjee 1986). This finding is disturbing, to say the least, given the magnitude of public investment in irrigation. The use of fertilizer to augment production is significant only in paddy production. The empirical evidence suggests that the two most important factors, water availability and fertilizer use, have not made any significant impact on increasing the output of the agricultural sector in Kerala.

However, the findings here are at the aggregate level (except paddy which is the food grain group here) putting together a number of non-paddy crops. Detailed analysis of the performance of individual crops across regions (say districts) is called for. Such an analysis is in progress.

## II

### A Diagnosis of Stagnation

With the help of a simplified model, we attempt here to explain the relationship between stagnation in output and the decline in area via changes in the real wages of labour (measured in terms of output). Given the state of technology in agriculture, it is quite reasonable to assume that there is very limited substitutability between land and labour. To simplify the explanantion, we assume that the two inputs are combined only more or less in fixed proportions. Given these assumptions, an increase in real wages of labour (in the above sense) leads to a reduction in labour use by farmers which then leads to a reduction in area cultivated. The reduction in both inputs implies a reduction in output. Such a decline in output can be explained in terms of the conventional profit maximisation assumption.

If the farmers are profit maximisers, then we have the following relationship:

$$\partial O/\partial L = W/P \ ; \quad \partial O/\partial N = R/P$$

where $P$ = output price,

$\partial O/\partial L$ = marginal (=average) product of labour,

$\partial O/\partial N$ = marginal (=average) product of land,

$W$ = nominal wage rate,

$R$ = nominal rental rate,

Assuming that marginal product is equal to average product and expressing in terms of growth rates,

$$(1) \quad \dot{(O/L)} = \dot{(W/P)}; \; \dot{(O/N)} = \dot{(R/P)}$$

where dot means growth rates.

In order to test the proposition in (1), especially the growth rate in the labor productivity and real wage, we use the following methodology.

Let us assume that the growth rate in labour per unit of land is not fixed but variable and assume that it can be approximated by an exponential function:[3]

$$L = ke^{r.t}N,$$

In terms of productivities,

$$(2) \qquad O/L = (O/N)/ke^{rt}$$

Taking logarithm (natural) of both sides,

$$(3) \qquad \ln O/L = \ln O/N - \ln k - rt.$$

Differentiating with respect to 't',

$$(4) \qquad \dot{(O/L)} = \dot{(O/N)} - r.$$

Equation (4) gives an estimate of growth rate in labour productivity from land productivity if the growth rate in labour-land ratio is known.

When r = 0, we get the fixed proportionality assumption, the assumption behind Leontief production function. When r < 0, the growth rate of land productivity becomes the lower limit of the growth rate in labour prodctivity. If r > 0, the value of $\dot{(O/L)}$ cannot be determined from $\dot{(O/N)}$ without the value of 'r'.

In the case of food grains (paddy), the average labour input per hectare of gross cropped area in Kerala is 1458 man-hours in 1970/71 and 1423 in 1979/80 (Natarajan 1982). It clearly shows 'r' is decreasing but only marginally. This finding may not be different for other crops during this period. Therefore, fixed proportionality assumption is a good approximation in the case of Kerala. Under this assumption, growth rate in land productivity is equal to the growth rate in labour productivity.

Therefore, the level of production can be maintained if the growth rate in land productivity is at least equal to the growth rate in real wage rate (nominal wages deflated by output price).

But this has not been the case in Kerala as shown in Table 4.

The yield increases during the period, 1962/63-85/86, is higher than the increase in real wages for the agricultural sector as a whole. But the picture changes when we look at the food grains and non-food grains separately. For food grains, i.e. paddy, the increase in productivity for the whole period of analysis is not even half of the increase in the growth rate of real wages.

There was a net gain in land productivity in Period I but this changed dramatically in Period II during which the increase in the growth rate of real wages was more than six times that of productivity. But for non-food grains the gain in productivity was higher than that of real wages for the period as a whole as well as for the first period. However the realtionship is not clear in the second period. This means that farmers producing non-food grains have been net gainers whereas farmers producing food grains have been net losers during the period. Period-wise analysis is more striking between food and non-food grain crops. In Period I, productivity gain was more than the increase in the real wages for both food and non-food grains. But since the mid-seventies, there has been dramatic change. The rapid increase in real wages relative to that of productivity (about six times) explains the decline in the output of food grains during the second period. However, the realtionship is not significant in the case of non-foodgrains in the second period. Even though the factor proportionality at the aggregate level is assumed to be constant it could have limited

Table 4: Growth Rates in Land Productivity and Real Wages
(Kerala: 1962/63-85/86)

| Item | Period I | Period II | 1962-63/85-86 |
|---|---|---|---|
| Growth rate (all crops) | | | |
| Land productivity | 1.70* | 0.20 | 1.05* |
| Real wage rate | -0.26 | 2.43* | 0.82** |
| Growth rate (food grains) | | | |
| Land productivity | 1.00* | 1.20* | 1.10* |
| Real wage rate | -0.14 | 7.71* | 3.02* |
| Growth rate (Non-food grains) | | | |
| Land productivity | 2.0* | 0.30 | 0.97* |
| Real wage rate | -0.29 | -0.87 | -0.53 |

Source:Table 2, in Appendix.

* significant at 1%; ** significant at 10%.

variability at the disaggregate level depending on agro-climatic factors and the type of crop. Since the growth rate in real wages is higher in the second period than that of land productivity, marginal lands will have gone out of cultivation due to declining profitability. This will be the case of lands where labour input requirement is high due to differences in agrarian ecology (e.g. in the low-lying Kuttanad region). This is then shown as an increase in fallow land. However, the shift from fallow to land under non-agricultural use will take place depending on the opportunity cost of this land for non-agricultural uses. This was what was happening in Kerala since the mid-seventies to early eighties, i.e. coinciding with our second period. Land prices during this period increased phenomenally as a result of land speculation for new construction which was stimulated by increased remittances from abroad. The uninterrupted increase in land prices since early seventies to early eighties meant higher levels of returns from speculation compared to that of cultivation. This led to putting more and more marginal lands out of cultivation..

## III

## Empirical Findings: A Discussion of Possible Underlying Causes

The overall picture of deceleration in Kerala's agriculture calls for a detailed examination of the performance of individual crops by regions in order to bring out the inter-crop and inter-regional differences. However, pending such a detailed analysis, it is still possible for us to comment on the factors responsible for the failure to achieve a productivity breakthrough in order to catch up with the increase in real wages.

## 3.1 Role of Price and Non-price Factors

Agricultural growth can be stimulated by price and non-price factors. The former influences the level of output via movement along the supply curve and the latter through shift in the supply function. The relative impact on output and income distribution of the price and non-price factors need careful analysis for policy decisions.

The positive effect of price policy on supply is empirically established beyond doubt. However, the distribution effect of the price change is a relatively neglected area especially in Kerala. If cultivable land is limited in supply, then relative price change along with agro-climatic factors determine the allocation of acreage among various crops. The validity of this allocation model for all the crops need empirical analysis. The nature of the shift in Kerala creates some conceptual difficulties in modelling the role of expected price. In the traditional model (such as in Nerlove 1958 and Narain 1965) the shift is among annual or seasonal crops. But in Kerala the acreage shift has been from annual crop such as paddy and tapioca to perennial crops such as coconut and rubber. Therefore, the traditional price expectation thesis should be modified to incorporate the long term factors that influence the decision.

Two aspects of the distributional impact of price change need further study. The first aspect is the relative price movement and the question of equity among different farmers producing different crops. The inter-crop equity creates interregional equity problems since there exists certain amount of concentration of crops. Therefore the relative gain/loss in the cultivation of different crops imply unequal distribution of development among different regions. The second aspect refers to the intersectoral movement of prices which gives the parity between agriculture and industry. In fact the parity index, i.e. the ratio of prices received by farmers to prices paid by farmers, shows that it is moving against agriculture during the period 1953-54 to 1979-80 (George, P.S. 1982).

However, this aggregate picture may not be true for individual crops. This aspect also needs further analysis.

From the policy point of view, it is very important to know the effect of price and non-price factors on output and income distribution. Quoting Raj Krishna's study de Janvry and Rao (1986:31) points out that the supply response to non-price factors is much higher than that of price factors. In fact the above study has demonstrated that the supply elasticity of technology (a proxy for non-price factors) is three times that of price elasticity. In the case of distribution, de Janvry and Rao (1986) have simulated a computable general equilibrium model to understand the distributional impact on various social classes resulting from price and non-price policy. In the case of price policy, the effects are summarized for short run (i.e. without output response) and for medium run (i.e. with output response). In the short run, the real income of the buyers (rural and urban poor) decreases while the nominal income of the sellers (medium and large farmers) increases. In the medium run, the increase in output increases the nominal income of the landless via employment effect. But the increase in the nominal income of the medium and large farmers is highly inflationary and reduces the real income of the rural poor. The message is very clear: the distributional effect is strongly regressive. In the case of non-price factors, the model distinguishes two cases. (1) output increase with flexible price; and (2) output increase with fixed price. In the case of an increase in output induced by non-price factors such as weather and technology, it benefits the vulnerable sections of the society through more employment and falling prices via increases in productivity. It also helps the urban and rural poor by increasing their purchasing power. It also stimulates the output of industry and services due to increased income in the agricultural sector. However, under fixed price, the social gains are captured by sellers only, i.e. medium and large farmers. This makes it clear that output growth induced by non-price factors is progressive on income distribution under flexible prices but regressive under fixed/administered prices. Therefore, a policy favouring non-price factors is preferable to a price policy for increasing output in the agricultural sector. In the case of Kerala the limitations on the effectiveness of a price policy is likely to be much higher because of the absence of any more cultivable land. This limitation on extensive cultivation is by now well known.

The other route is by increasing the intensity of cultivation. However this option is also limited to seasonal crops mainly, which accounts for only one-third, or even less, of the gross cropped area. The remaining area is accounted for by perennial crops of which the scope for increasing the density of plants (i.e. intensive use of land) in plantations (such as rubber and tea) is also limited. The garden crop land consisting of coconut, arecanut, etc have already been under multiple crops that their intensification seems extremely limited. The only way out for increasing output in the agricultural sector is through increasing productivity. The necessity for increasing productivity is evident from another angle as well. Wage rates have been increasing, both in money and real terms, in agriculture since the mid-seventies. The rate of growth of productivity has not been commensurate with that of real wages especially in paddy cultivation. The solution does not lie in reducing wages because, despite increases in wage rates, the agricultural labourers are not better off. On the contrary they have been losing in terms of employment thus depressing their annual earnings (Panikar, P.G.K. 1978; Kannan, K.P. 1987:Ch.6). At the same time labourers are also adversely affected by a shift in cultivation from food grains to non-food grains because the latter is less labour-absorbing than the former. Thus a relative price advantage in favour of non-food grain crops worsens the distribution of income of the landless labourers. The only way out then seems a breakthrough in productivity to ensure reasonable remuneration to farmers and labourers who are well organized to ensure their share of increases in productivity. While increasing productivity is a necessity for all crops such increase should be higher in food grains because of its low relative price viz-a-viz non-food grains in Kerala and low returns viz-a-viz cultivation in other parts of India due to low wage costs.

The crux of the problem then seems to be one of increasing productivity which, as discussed earlier, is closely related to a policy favouring non-price factors both on grounds of equity and physical constraints in agriculture (such as land-man ratio and crop-mix). There are two main elements to the non-price factor. One is the removal of institutional constraints and the other is the provision of critical inputs for enhancing the technology. Why is it that there is no significant growth in productivity in Kerala then becomes a relevant starting point for a discussion on pursuing a policy based on non-price factors. Kerala has the distinction of removing one of the major institutional constraints in increasing productivity, i.e. the abolition of the system of absentee landlordism. Though immensely significant in socio-political terms, this measure by itself, as born out by the results in section I, need not be a sufficient condition for increasing productivity. It is only a necessary condition. What is missing, it may be hypothesized, is the provision of certain critical inputs upon which the farmers could enhance the technology of cultivation for increasing productivity. It may be pointed out that we are not talking so much in terms of a new technology of agriculture, a la Green Revolution strategy, but in terms of provision of critical inputs. We identify water and land development as the critical inputs. We do not think the provision of these critical inputs are tied to any specific technology of agriculture. Rather the provision of these inputs involves the use of a spectrum of technologies beginning from those based on high labour inputs (such as building minor irrigation systems and land-bunding for control of water) to highly capital and/or skill intensive ones (such as construction of dams, contour bunding, study of water flows and balances in low-lying areas and exploration and exploitation of ground water resources). What is relevant is the locational characteristics of a given agro-climatic region.

## 3.2Role of Critical Inputs: Water and Land Development

Part of the answer for the dismal performance in productivity is related to the question of inadequacy in the supply of critical inputs. These are in the nature of public goods and therefore involves considerable public investment and participation of the farmers for proper implementation. At any rate the role of government becomes crucial. It is here that we believe that Kerala has presented none too enviable an example. First of all, public investment has been rather insignificant in land development in terms of soil conservation and consolidation of holdings. While irrigation has been attracting considerable public investment, the important and comprehensive aspect which should have engaged attention should have been the question of water resource management and development. Secondly, within irrigation, the priority assigned is the opposite of what the state requires. That is to say, most of the resources are committed to building large irrigation dams with minor irrigation accounting only for 12-13 percent of the total irrigation expenditure. However,major irrigation has given only minor benefits and major benefits have come from minor irrigation. To illustrate: the total investment in major and medium irrigation till March has been Rs.460 crores creating a potential for irrigating two lakh hectares as against an investment in minor irrigation of Rs.65.4 crores irrigating 1,62,000 hectares (GOK, Economic Review 1986:36). This means that the per hectare cost of irrigation through major and medium irrigation system works out to Rs.23,000 in the former which is six times that of the latter at Rs.4,022 per hectare. It is interesting to note that the former has created only the potential for irrigation (meaning the inclusion of areas under projects which have not yet started irrigation while the latter shows actual irrigated area).

Even within major irrigation systems the scarce resources have been spread so thinly that realization of these investment seems distant. Thus out of 28 major irrigation systems only 10 are in operation. Of the remaining 12 are reported to be under construction for periods varying from 12 to 30 years! Of these five projects are under construction for more than 20 years! The remaining six projects have not seen beyond some initial construction activities. Some of these may turn out to be sunk costs, i.e. dead investment as availability of additional resources seems very remote.

It is not evident whether any priority is assigned in matters relating to completion and taking up of new projects. Based on available evidence, our impression is that resources are scattered over a number of projects thereby lengthening the period of construction and, more seriously, leading to cost escalation. The magnitude of such cost escalation is so alarming and debilitating to the resource position of Kerala. For example, the original estimate of costs for 10 major irrigation projects (reported as under construction for 12 to 30 years) was Rs.79.81 crores and the latest estimate (as of 1986) is Rs.697.58 crores, i.e. an increase of 8.2 times. However, this average conceals the fantastic cost escalation in the case of some individual projects. These are nearly 14 times increase in the case of Pamba, 18 times for Periyar Valley, 17 times for Chitturpuzha and Kallada and nearly 16 times for Pazhassi.

There is a further aspect to the already available irrigation which limits the potential for increasing overall productivity. The irrigation systems are designed as gravity irrigation and as such are available only to the paddy crop whereas availability of water to other crops could make a significant difference to their productivity. For example, results of experiments on the effect of irrigation on yield of coconut of different palms and soil types reveal that the post-irrigation yield increase vary from 33 per cent to 300 per cent (Bhaskaran, U.P. and Leela, K. 1978, quoted in Sivanandan, P.K. 1984:129). In sum, it would not be an exaggeration to say that the problem of water resource management and development has been reduced to one of constructing large irrigation dams viewed essentially as feats of engineering with as little input of agronomy (crop-mix, soil characteristics and crop-specific water demand) and agrarian ecology (such as topography, role of forests in retaining water, soil erosion and siltation problems).

It is for this reason, we believe, that irrigation and productivity shows no meaningful correlation in our statistical analysis. The nature of data itself on irrigation seems to raise doubts on its authenticity because we find a sudden and sharp decline in net area irrigated in the mid-seventies.[4]

As for land development, it is also a multifaceted task. The central element is soil conservation. However what is prevailing is only a minor programme for soil conservation and a couple of schemes for land bunding. Given the difference in topography in Kerala compared to that of most other states, land development should have been a major element in agricultural development. Kerala presents, within a breadth of 60 to 120 kms, problems of both water-logging in coastal areas and soil erosion in mountaneous regions.

## 3.3 Environmental Degradation and Agricultural Stagnation

The second factor responsible for the decline in productivity, in our view, relates to the environmental changes taking place in Kerala. We hypothesize that the environmental degradation, that have become more manifest and acute since the mid-seventies, has resulted in an overall decline in agricultural productivity. The most important element of this environmental degradation is the one relating to deforestation and the consequent adverse changes in micro-climate, water availability and soil erosion.

Deforestation in Kerala is rooted in the commercial exploitation of its natural resources under colonial rule. But in the subsequent period, the pressure of increasing population seem to have accelerated this process which started around the forties. However the linkage between population pressure and deforestation does not seem to be a straight forward one. In our view, state policy played a crucial role in the pace and manner of deforestation.

Here we do not intend to go into the history of the socio-economic process leading to large scale deforestation, some of which are already documented. What we would emphasize is the fact that the area under forests in Kerala estimated at 44 percent of the total geographical area in 1905 (i.e. around 17,120 sq.kms) declined to 27 percent (around 10,720 sq. kms) in 1965 and to 17 percent (around 6,620 sq. kms) in 1973 and to between 7 and 10 percent (i.e. between 3,100 and 3,900 sq. kms) in 1983 (Chattopadhyay, S. 1985). Such an alarming decline in area is the result of a cumulative process of a number of trends all of which are still at large in Kerala. These are: (i) the process of encroachment of forest areas by powerful rural interests who have successfully made use of a large army of land-poor and land-hungry peasants, (ii) the clear-felling of large areas of forests by the government for a number of projects such as irrigation and electricity, plantations (including those for rehabilitation of refugees and ex-servicemen ) (Prasad, et. al., 1978; Nair, et. al. 1986) and, (iii) the illegal felling of trees and indiscriminate plundering of forest resources by private interests mainly timber contractors.

In the once dense natural forest areas of the present Idukki and Wynad districts, the scene is one of denudation of large areas resulting in a perceptible change in the micro-environment. Rainfall has been declining during the last decade, as it is for Kerala as a whole[5], and the people have experienced shortage of water in ponds and wells and reservoirs. Temperature has been rising slowly. Absence of forest cover has resulted in land slides and soil erosion. The latter has been accelerated by the introduction of such crops as tapioca in slopes and hilly areas. In sum, the absence of adequate forest cover in an undulating topography without adequate soil or water management might have resulted in declining productivity, so much so, a process of laterization seem to have set in in some of the high range areas. A telling illustration of this process in the Indukki district has recently been documented in a report on the land use survey (GOK, Land Use Board 1983). Soil tests conducted there in selected locations (Devikulam, Idukki and Ayyappankoil) reveal a laterite number of close to or more than 50. A laterite number of 50 and above is considered a congenial atmosphere for laterization provided other conditions are suitable. In terms of the problem of soil erosion, 42 per cent of the cultivable area (excluding cardamom) in Idukki district (i.e. 88,390 hectares) have been identified as requiring immediate soil conservation measures. Of these, 23 per cent of the total cultivated area (i.e. as high as 48,600 hectares) have been identified as 'first priority area' which means

> "severely eroded cultivated areas where soil conservation measures regardless of cost, are an urgent necessity and the areas which are most vulnerable to erosion due to slope and lack of vegetation or faulty cultural practices." (GOK, Land Use Board 1983:17)

Apart from deforestation, the other important aspect of environmental degradation relates to problems in low-lying areas as a result of the counter-productive nature of the water control projects. The prime example is that of the Kuttanad region (comprising 52,000 hectares of area under paddy) where the existing water control projects, far from alleviating propblems, have contributed to an ecological crisis leading to the unchecked and widespread growth of acquatic weeds, infertility of the soil and lack of proper drainage of paddy fields (see Kannan, K.P. 1979). Large areas have therefore been put out of the second paddy crtop. Problems of water-logging and related issues continue to hinder agricultural productivity in other low-lying areas such as the Kole lands (in Trichur district) and in Ponnani (Malappuram district)[6].

The third aspect of environmental degradation has arisen out of what may be called external shocks. Whether forest cover is a sufficient condition for rainfall or whether the two are exclusively related is a subject beyond our competence to comment. While some meteriologists do not believe in a one-to-one correspondence between deforestation and monsoon failure, they admit that denudation of forest cover may cause local variations and can be harmful in many other ways (e.g. Joseph, P.V. 1987)[7]. But the fact remains that densely forested areas like Idukki and Wynad have recorded much higher as well as more spread over rainfall in the past, say till 20 years ago. But there has been the phenomenon of declining rainfall experienced throughout Kerala in the last decade. More particularly, during the sixties there was not a single year when the reduction in total rainfall was 25 per cent or more, a situation of one type of drought as defined by the National Commission on Agriculture. However, during the seventies there was two years when the deficiency in rainfall was more than 25 per cent. In the first six years of the eighties, there have already been two years with very deficient rainfall (including 1982 with 52% and 1986 with 41%) causing a situation of severe drought (including crop losses). And 1987 was also a drought year which recorded 43% deficiency in rain fall during the South-West monsoon and 67% deficiency during the North-East monsoon[8].

In fact the mean rainfall shows a declining tendency since the sixties. As Table 5 shows the mean rainfall during the eighties (1980 to 1986) was less than that of the seventies which was less than that of the sixties. At the same time, the variability (i.e. intensity of year to year fluctuations) has been increasing as seen in the figures of the coefficient of variation.

At this stage it is not possible to talk about any precise link between environmental degradation, rainfall deficiency and declining agricultural performance since this calls for a detailed analysis taking into account the seasonal variations in rainfall and its impact on individual crops and regions. However, a study (Meher Homji, V.M. 1980)[9] using 12 different climatic criteria (six measuring annual rainfall and six measuring the number of rainy days in a year) to measure the relationship between deforestation and rainfall in different locations in the Western Ghats has revealed that larger the deforested area, larger was the number of climatic criteria showing a diminishing trend. Munnar in Idukki district was one of the locations in this study and it qualified on 11 out of the 12 criteria. One of the important conclusions of the study was that deforestation per se does not seem to reduce the total annual precipitation but it reduces the number of rainly days. There is therefore reason enough to begin to take a serious view of the linkage between environmental degradation (particularly deforestation) and the dismal performance of agriculture since the mid-seventies.

## Table 5: Mean and Variability of Rainfall in Kerala
(1960-1985)

| | 1960/69 | 1970/79 | 1980/85 |
|---|---|---|---|
| Mean(in mm) | 2973.8 | 2641.8 | 2356.4 |
| Std deviation | 498.2 | 465.7 | 516.1 |
| C.V. | 16.8 | 17.6 | 21.9 |

Source: see footnote 5.

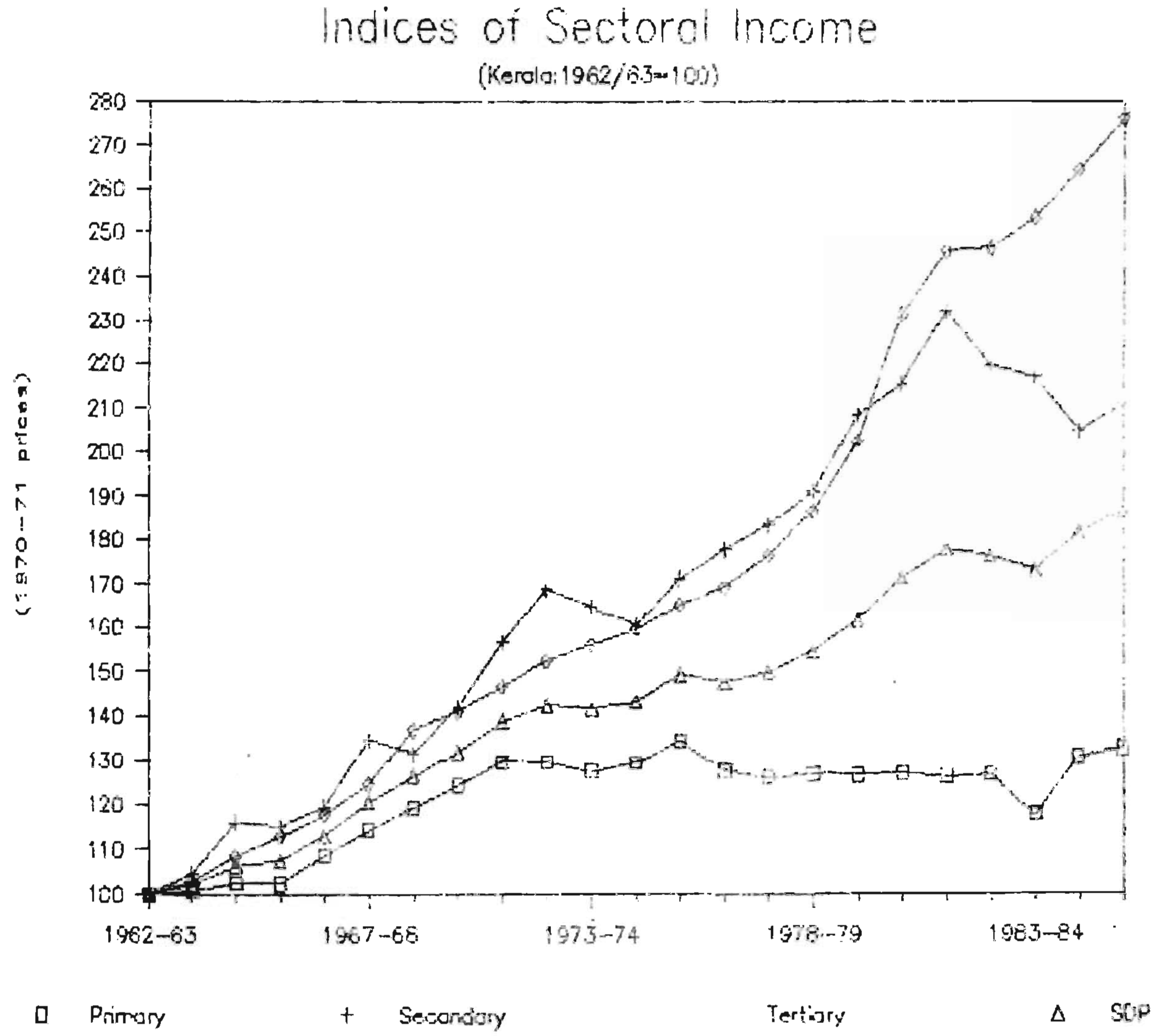
## IV

## Agricultural Stagnation and the Growth of the Overall Economy

The conclusion emerging from the foregoing analysis is that the decline that took place in Kerala's agriculture since the mid-seventies has been such that it has wiped off the growth rate achieved during the sixties and early seventies. In short, Kerala has lost two decades of growth in agriculture. This leads us to examine the performance of the economy in general so as to identify the main sources of growth during this period. This we do by examining the growth rates in the primary, secondary and tertiary sectors for the entire period of our analysis as well as for the two sub-periods. In Figure 1 we give the index numbers of sectoral as well as aggregate income (i.e. net state domestic product at factor cost) and in Table 6 we give the growth rates in sectoral and aggregate income for the entire period as well as the two sub-periods.

From Figure 1 it is clear that the performance of the primary sector (i.e. agriculture, livestock, fisheries, forestry and mining and quarrying) is not as dismal as crop production which, we believe, is due to a relatively better

FIGURE 1


Indices of Sectoral Income
(Kerala: 1962/63=100)
(1970-71 prices)
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1962-63
1967-68
1973-74
1978-79
1983-84
□ Primary
+ Secondary
Tertiary
Δ SDP

performance of the other sub-sectors. Of these, the important ones are livestock and fisheries. However, fisheries sector shows that it has also been on a deceleration track as far as growth in income was concerned. Therefore, it is the livestock sector which has been showing some tendencies of buoancy that is accountable for the relatively better performance of the primary sector viz-a-viz crop production. Figure 1 also shows that the secondary sector (i.e. manufacturing, construction and electricity generation and water supply), registered a more than doubling of its income and hence shows higher growth rates than the primary sector. In fact the growth rate of the secondary sector has been the highest of all the sectors in Period I but it declined by half during Period II indicating that, if this continues, it would also give rise to a process of deceleration. However, one should not be carried away by the higher growth rates of the secondary sector because we find, on a closer examination, that these growth rates are largely due to the growth in electricity generation and water supply and not manufacturing.

The tertiary sector is the one which shows consistently high growth rates for both the periods with Period II registering a higher growth rate than Period I. It also shows that whatever growth in aggregate income has been achieved has been due to the buoyancy of this sector.

Table 6: Growth rates of sectoral and aggregate income of Kerala: 1962/63 to 1985/86 (1970/71 prices)

| | Trend in growth rates | Growth rates | | |
|---|---|---|---|---|
| | | Period I | Period II | Periods I&II |
| I.Aggregate | - | 3.21 | 1.76 | 2.40 |
| a) Primary | D (1977/78)[a] | 2.23 | -0.70 | 1.05 |
| b) Secondary | D (1987/88)[a] | 4.71 | 2.15 | 3.68 |
| c) Tertiary | | 4.24 | 5.32 | 4.67 |
| II.Population | | 2.10 | 1.55 | 1.93 |
| III.Net growth rate = I - II | | 1.11 | 0.21 | 0.47 |

Note: a The year of start of deceleration has been calculated from the polynomial given in Table A7 in Appendix.

Population growth rate has been calculated from end point population figures using compound growth rate formula.

Aggregate growth rate is the weighted average of sectoral growth rates; the weights being the base year shares of sectoral incomes.

Source: Table A7 in Appendix.

However it could not prevent a decline in the growth rate of aggregate income for Period II thus giving a mere 2.4 per cent growth for the period as a whole. This is because of the importance of the primary sector in the economy and the depressing effect of a negative growth in this sector during Period II. For the primary sector the positive growth rate of 2.23 in the first period is turned into a negative growth rate of -0.70 in the second period indicating that deceleration has set in just after the mid-seventies. It may be recalled that deceleration in the growth of crop production started earlier, i.e. 1975-76.

The conclusion is that the growth rate in the second period for the economy as a whole is sustained largely by the growth rate in the tertiary sector, especially since 1981/82.

When we look at the growth rate in aggregate income with that of the growth rate in population we find that the net growth rate for Kerala for the period as a whole is less than 0.5. If we look at the growth rate in the second period, we find that the population growth rate has declined compared to the first period. Had this not been the case - thanks to the demographic transition in Kerala - there would have been a decline in per capita income as estimated in the net domestic product of the state. In fact in the absence of a demographic transition (and population growth rate had kept pace), Kerala would have lost a decade's growth rate in real per capita income.

While this performance of Kerala, as reflected in the estimates of state income as well as independent estimates of calorie intake, there are strong contra-indicators which suggest that Kerala's state income (and by implication per capita income) is actually higher than official estimates. This has recently been suggested by T.N. Krishnan (1987) who states that:

> "[ ]During the ten years betwen 1973/74 and 1983/84 there has been a significant and dramatic change in the level of per capita consumption in Kerala. The per capita annual expenditure on consumption was estimated by the National Sample Survey to be Rs.550 in 1973/74, constituting 68 per cent of the per capita state income. The per capita annual consumption expenditure was estimated at Rs.1857 in 1983/84 against an estimated per capita income of Rs.1761 for the same year. This excess of per capita consumption expenditure over it's per capita income can only be explained by the inflow of remittance incomes from the Middle East migrants. Economists know that a given sum of remittance would produce an income two or three times that amount due to rounds of expenditure incurred by the recepients at various stages of transactions. If we assume that consumer expenditure formed roughly about 70 per cent of the disposable income, then an estimate of per capita income would work out to about Rs.2650 in 1983/84. The remittances and its multiplier effects would have added about Rs.890 to the per capita income in 1983/84 - or 50

per cent more to the state income."

The point to note here is that the extra income coming from outside does not go into the calculation of state income. However, the multiplier effect of this income is being captured in the state income which prevented the Kerala economy from a recessionary situation manifested in the primary and secondary sectors. This means that the growth in the tertiary sector is largely unrelated to the primary and secondary sectors (contrary to normal pattern of growth) and has been largely based on the flow of income from outside the system.

Even the growth rate in he tertiary sector income, as given in Table 6, based on the sectoral income figures is an underestimation because it has been found that the trade and commerce sub-sector has been showing huge losses - in all probability artificial losses for evading taxes - hence depressing the sectoral income figures. The impact of this would be an increase in the circulation of black money which might be going into speculative activities.

Therefore, the disparity between consumption expenditure and income in Kerala should be viewed in the light of these two factors, i.e. remittances and unaccounted money.

What this shows is that the income available from abroad has not been attracted, or channelled by conscious policy, to strengtnen the directly productive primary and secondary sectors and has gone largely to quick-money-making activities in the tertiary sector especially in such ventures as luxury hotels and restaurants, proliferation of commercial cinema, private health care enterprises, financing for speculation through non-banking lending agencies, etc. To this list should also be added housing and such other construction activities though this may not qualify as quick-money-venture but bears a social premium. Therefore the semblance of prosperity has largely been maintained by such unproductive activities.

The danger of such a growth is that it cannot be sustained for long as there is no guarantee of continued remittances. The indications, if any, are to the contrary. It is therefore imperative that conscious efforts be made to generate income in primary and secondary sectors by investments and breakthrough in productivity so as to put the economy on a real sustainable growth path. While this is an area demanding detailed investigation and analysis so as to identify the constraints and potentialities, for the agricultural sector we have argued here the need for the proper management and development of critical inputs, land and water, and the need for eco-restoration which is so crucially linked to the availability of critical inputs.

## Footnotes

1 See, for example, Nair, G. (1981), Krishnan (1976) and Panikar and Soman (1984).

2 For a detailed discussion of issues relating to the data base of the agricultural sector in Kerala, see Somasekharan Nair,G. (1983).

3 We are grateful to T.N. Krishnan for suggesting to develop this general version so as to take account of the possibility of substitution. An earlier version was based on fixed proportionality assumption.

4 Following are the figures of net area irrigated (in lakh hectares) in Kerala. See the sharp decline in area in 1975/76.

| | | | | | |
|---|---|---|---|---|---|
| 1962/63 | 3.36 | 1969/70 | 4.23 | 1976/77 | 2.21 |
| 1963/64 | 3.47 | 1970/71 | 4.31 | 1977/78 | 2.28 |
| 1964/65 | 3.52 | 1971/72 | 4.39 | 1978/79 | 2.30 |
| 1965/66 | 3.82 | 1972/73 | 4.46 | 1979/80 | 2.31 |
| 1966/67 | 3.93 | 1973/74 | 4.57 | 1980/81 | 2.38 |
| 1967/68 | 4.11 | 1974/75 | 4.65 | 1981/82 | 2.39 |
| 1968/69 | 4.18 | 1975/76 | 2.28 | 1982/83 | 2.58 |

Source: GOK, Statistics for Planning (various issues).

5 The following is the rainfall data for Kerala as a whole for the period 1960 to 1985.

Normal annual rainfall for Kerala (3018.9 mm)

| Year | Rainfall (mm) | As % of normal rainfall |
|---|---|---|
| 1960 | 3380.3 | 112 |
| 1961 | 4008.5 | 133 |
| 1962 | 3350.0 | 111 |
| 1963 | 2588.4 | 86 |
| 1964 | 2821.9 | 93 |
| 1965 | 2374.9 | 79 |
| 1966 | 2565.9 | 85 |
| 1967 | 2636.4 | 87 |
| 1968 | 3388.0 | 112 |
| 1969 | 2623.6 | 87 |
| 1970 | 2591.8 | 86 |
| 1971 | 3007.1 | 100 |
| 1972 | 2745.9 | 91 |
| 1973 | 2389.0 | 79 |
| 1974 | 2768.6 | 92 |
| 1975 | 3527.7 | 117 |
| 1976 | 2044.2 | 68 |
| 1977 | 3086.6 | 102 |
| 1978 | 2322.7 | 77 |
| 1979 | 1934.6 | 64 |
| 1980 | 2861.1 | 95 |
| 1981 | 2977.0 | 99 |
| 1982 | 1464.9 | 49 |
| 1983 | 2318.8 | 77 |
| 1984 | 2620.3 | 87 |
| 1985 | 2481.8 | 82 |
| 1986 | 1772.0 | 59 |

Source: compiled from GOK, Statistics for Planning, (various issues).

6 Trichur district, despite having fertile soil, consistently lags behind all other districts (except ) in productivity of paddy. This, we believe, could be due to lack of proper water management in the Kole areas.

7 Using the data presented by Joseph (1987), Ashok Kumar in a letter to the Indian Express of 6 October 1987

pointed out that "there is a strongly decreasing trend of rainfall; the gross nature product depends on the quantum of rainfall and this quantum's average (1965/86) now stands at 93.5 per cent of the average for the years 1880/89"(which represents the earliest period data presented in the article).

8 see GOK (1987:34)

9 Quoted in Centre for Science and Environment (1987).

# Technical Note 1

The growth rate can be measured statistically using different functional forms such as linear, semilog, Gompertz, logistic curve, etc (Chattopadhyay, G. and Bhattacharya, 1987). However, we have used only the semilog function since it can be extended to a second degree polynomial as a case of varying parameter regression. This polynomial can then be used to test the acceleration, deceleration or constant growth rate as restrictions on the parameters (Reddy, 1978). The logic behind the methodology is explained below. If the growth rate is constant, then it can be estimated by the semilog function:

$$(1) \quad \ln Y_t = a_0 + a_1 t + u_t$$

If the growth rate is changing, then the regression coefficient `$a_1$' is not constant but varying. This varying parameter can be modelled as a function of time (Maddala, 1978). *The simplest relationship is to postulate a linear* relationship between $a_1$ and `t'. This would mean,

$$(2) \quad a_1 = a_2 + a_3 t$$

substituting (2) in (1),

$$(3) \quad \ln Y_t = a_0 + a_2 t + a_3 t^2 + u_t$$

Note that if $a_2$ and $a_3$ are significantly different from zero implies that the growth rate is not constant. The growth rate is accelerating if $a_3 > 0$ and decelerating if $a_3 < 0$. Moreover, this functional form can also be used for the calculation of the year of the optimum.

For an optimum,

$$d(\ln Y)/dt = 0$$

$$a_2 + 2a_3 t = 0$$

$$\text{Therefore, } t = -a_2/2a_3$$

The value of `t' can be used for the calculation of the year in which the growth rate accelerates or decelerates. The year of deceleration in the tables are calculated in this way. If $a_2 = 0$, then the growth rate during this period is either increasing or decreasing depending on the sign of the parameter $a_3$. But there is one important difference between the former and the latter. In the latter case, the growth rate has no optimum unlike the former.

## Technical Note 2

The performance of the Kerala's agricultural sector shows that the growth rate is not uniform throughout the period. In fact the grwoth rate is different before and after 1975/76. As a result, we have to estimate growth rates separately for the two sub periods: 1962/63 to 1974/75 and 1975/76 to 1985/86. The usual method is to estimate separate regressions for the two periods separately. This assumes that there is a discontinuity in the growth rate between the two periods. Boyce's (1986) recent empirical study shows that the assumption of discontinuity can lead to misleading growth rates. He also suggests a new way of estimating the growth rates without the above assumption. The technique is given below.

Discontinuous growth rate estimate for the two subperiods could be estimated separately using the following equation.

$$(2.1) \quad \ln Y = a_1d_1 + a_2d_2 + (b_1d_1 + b_2d_2)t + u$$

where $d_1 = 1$ for 1962/63 to 1974/75

= 0 otherwise;

$d_2 = 1$ for 1975/76 to 1985/86

= 0 otherwise.

The discontinuity is eliminated by a linear restriction at the break point, K,

$$a_1 + b_1K = a_2 + b_2K$$

From the restriction,

$$a_2 = a_1 + b_1K - b_2K \quad \text{and} \tag{2.2}$$

$$d_2 = 1 - d_1.$$

Substituting (2.2) in (2.1)

$$\ln Y = a_1d_1 + (a_1 + b_1K - b_2K)d_2 + (b_1 + b_2d_2)t + u$$

$$= a_1d_1 + a_1(1 - d_1) + b_1(d_1t + d_2K) + b_2(d_2t - d_2K) + u.$$

$$\ln Y = a_1 + b_1(d_1t + d_2K) + b_2(d_2t - d_2K) + u. \tag{2.3}$$

This is called the kinked exponential model. This is used for the periodwise estimates of the growth rates throughout the analysis. Obviously $b_1$ is the first period growth rate and $b_2$ the second period growth rate.

## Technical Note 3

The shift in acreage from food grains to nonfood grains, under profit maximization assumption, should be explained by the price of food grain relative to that nonfood grains. In the case of paddy, the agroclimatic factors restrict the competing crops to tapioca, coconut and rubber. But tapioca is a substitute for rice. If two crops are substitutes in their uses, prices will not exert any significant influence on the allocation of area from one to another. Instead it will more readily reorder consumption of their outputs into different uses rather than reallocate areas between the different crops (Narain, D. 1965:7). Therefore the acreage under paddy can be shifted to coconut and/or rubber. But a cursory look at the shift in acreage shows that it is mostly from paddy to coconut. Therefore, the acreage shift should be explained in terms of the price of paddy relative to the price of coconut. The allocation decision is based on expected price rather than actual price. Therefore the allocation function becomes,

$$(3.1) \quad A_t = f(P_t)^e$$

where $P_t^e$ = expected relative price of paddy,

$A_t$ = acreage under paddy.

Any estimation of the above relationship is possible only if the expected prices are related to observed prices. Under perfect foresight, expected prices become actual prices. Then the estimable equation becomes:

$$\text{(Model 1)} \quad A_t = a_0 + a_1 P_t + u_t$$

Another formulation of the allocation model is to assume that the expectations are of the Nerlovian type. Nerlovian expectation is given by (Nerlove, M.1958:53):

$$(3.2) \quad P_t^e = P^e_{t-1} + b[P_{t-1} - P^e_{t-1}]$$

$$0 < b \leq 1$$

where b is the coefficient of expectation. This assumes that the expected `normal' price is equal to the last year's expected `normal' price plus a proportional difference between the actual price and expected normal price in the previous period. If b = 1, then the expected price becomes last year's price. Under this assumption the allocation function is given by:

$$\text{(Model 2)} \quad A_t = a_0 + a_1 P_{t-1} + u_t$$

If b = 0, the expected price cannot be related to actual price and estimation becomes impossible.

A general model of the acreage allocation under Nerlovian expectation can be formulated as follows. Solving (3.2) as a first order difference equation in `t', we have

$$(3.3) \quad P_t^e = \sum_{\lambda=0}^{t} b(1-b)^{t-\lambda} P_{\lambda-1}$$

substituting (3.3) in (3.1), we get a non-linear equation in the parameters where the expected price becomes a weighted average of past prices (Nerlove, M.1958:55). Although non-linear methods are available for the estimation of the above expectation, we have used a simple distributed lag technique, the polynomial inverse lag, proposed by Mitchell and Speaker (1986). The advantage of this method is that it can be estimated using ordinary least squares technique. Following Mitchell and Speaker

(1986:331-2), the estimated equation becomes:

$$(3.4) \quad A_t = a_0 + \sum_{i=0}^{\alpha} w_i P_{t-i} + e_t$$

where

$$\sum_{i=0}^{\alpha} w_i P_{t-i} = P_t^e = \sum_{\lambda=0}^{t} b(1-b)^{t-\lambda} P_{\lambda-1};$$

$e_t$ = the error term.

But current prices are not included in the Nerlovian expectation. Therefore, $w_0 = 0$ in (3.4). Then the general model becomes:

$$A_t = a_0 + \sum_{i=1}^{\alpha} w_i P_{t-i} + e_t$$

Now the weights `w' are approximated by

$$w_i = \sum_{j=2}^{n} a_j / (i+1)^j, \quad i = 1, \ldots \alpha.$$

where the `a's are the parameters to be estimated. The weights are assumed to fall on an $n^{th}$ degree polynomial in 1/(i + 1) where `i' is the lag number. Substituting this number in (3.4)

$$A_t = a_0 + \sum_{i=1}^{\alpha} \sum_{j=2}^{n} \frac{a_j}{(i+1)^j} P_{t-i} + e_t$$

$$= a_0 + \sum_{j=2}^{n} \left[ \sum_{i=1}^{t-1} P_{t-i} + \sum_{i=t}^{\alpha} P_{t-i} \right] \frac{a_j}{(i+1)^j} + e_t$$

$$(3.5) \qquad A_t = a_0 + \sum_{j=2}^{n} a_j Z_{jt} + R_t + e_t$$

where, $Z_{jt} = \sum_{i=1}^{t-1} \frac{P_{t-i}}{(i+1)^j}$; $R_t = \sum_{j=2}^{n} \frac{a_j}{(i+1)^j} \sum_{i=t}^{\alpha} P_{t-i}$

Mitchell and Speaker suggests that $R_t$ is negligible, if t 8. In other words, the term $R_t$ is simply be dropped from (3.5) if we estimate the equation without first eight observations. In that case (3.5) becomes

$$(\text{Model } 3) \qquad A_t = a_0 + \sum_{j=2}^{n} a_j Z_{jt} + e_t$$

where

$$Z_{jt} = \sum_{i=1}^{8} \frac{P_{t-i}}{(i+1)^j}$$

Model 3 is the general version of the supply response function. In order to estimate this model Mitchell and

Speaker suggest that it can be determined using nested OLS regressions. Nested regression analysis shows that only $z_{2t}$ is significant in Model 3. Therefore the supply response function is estimated with $z_{2t}$ only. The results are given in Table 3.1.

Durbin-Watson test shows that autocorrelation is significant in all the three models. Therefore the equations need correction for autocorrelation. A common method used for the correction is the one proposed by Cochrane and Orcutt (CORC) (Madalla, 1977). The regression based on CORC method is also given for each model. The results show that there is no evidence to believe that the assumption of perfect foresight is valid in the acreage allocation decision. Both versions of the Nerlovian model support the view that acreage allocation depends on the weighted average of past prices. However, the explanatory power of the acreage function with only one lagged price is very weak compared to the model with lagged prices of several periods. In terms of the elasticity , it varies from 0.05 to 0.2.

## Table 3.1: Acreage Response Functions

| | | | |
|---|---|---|---|
| Model 1: | a) | $A_t = 741.72 + 67.29\,P_t$<br>(2.8) | $R^2 = 0.26$<br>$DW = 0.43$ |
| | b) | CORC: $A_t = 0.40 + 17.81\,P_t$<br>(0.7) | $R^2 = 0.02$ |
| Model 2: | a) | $A_t = 714.62 + 90.97\,P_{t-1}$<br>(4.3) | $R^2 = 0.47$<br>$DW = 0.61$ |
| | b) | CORC: $A_t = 231.6 + 43.42\,P_{t-1}$<br>(2.1) | $R^2 = 0.81$ |
| Model 3: | a) | $A_t = 579.5 + 344.02\,Z_{2t}$<br>(7.8) | $R^2 = 0.81$<br>$DW = 1.09$ |
| | b) | CORC: $A_t = 346.9 + 306.52\,Z_{2t}$<br>(4.6) | $R^2 = 0.61$ |

Data source: GOK, Statistics for Planning (1972,1975, 1977, 1980, 1983 and 1986).

Note: $A_t$ = acreage; $P_t$ = price of paddy/coconut;
$Z_{2t}$ = as defined in model (3).

# Appendix

## Table A1. Growth Rates of Area, Output and Yield of All Crops
(Kerala: 1962/63 to 1985/86)

| Dependent variable | Constant | Independent variable |  | $R^2$ | Year of Deceleration |
|---|---|---|---|---|---|
|  |  | time | $time^2$ |  |  |
| ln A | 4.56 | 0.036 | -0.001 | 0.83 | 80/81 |
|  | (226.7) | (9.8) | (-8.4) |  |  |
| ln O | 4.56 | 0.062 | -0.002 | 0.86 | 77/78 |
|  | (119.7) | (8.9) | (-6.7) |  |  |
| ln Y | 4.62 | 0.026 | -.001 | 0.83 | 75/76 |
|  | (196.4) | (5.9) | (-3.6) |  |  |

| Dependent Variable | constant | Independent variable |  | $R^2$ |
|---|---|---|---|---|
|  |  | $D_1t+D_2K$ | $D_2t-D_2K$ |  |
| ln A | 4.60 | 0.018 | -.010 | 0.83 |
|  | (281.3) | (10.6) | (-4.6) |  |
| ln O | 4.63 | 0.036 | -.008 | 0.87 |
|  | (158.5) | (11.6) | (-2.1) |  |
| ln Y | 4.64 | 0.017 | 0.002 | 0.85 |
|  | (260.4) | (9.2) | (0.9) |  |

Note: A=Area; O=Output; Y=Yield.
Source:GOK, Statistics for Planning (various issues).

Table A2. Growth Rates of Area, Output and Yield of Food Crops
(Kerala: 1962/63 to 1985/86)

| Dependent variable | Constant | Independent variable time | $time^2$ | $R^2$ | Year of Deceleration |
|---|---|---|---|---|---|
| ln A | 4.52 | 0.027 | -0.001 | 0.86 | 76/77 |
| | (265.3) | (8.5) | (-10.2; | | |
| ln O | 4.52 | 0.036 | -0.002 | 0.63 | 80/81 |
| | (131.6) | (5.7) | (-4.8) | | |
| ln Y | 4.56 | 0.009 | -0.0001 | 0.81 | - |
| | (185.6) | (2.0) | (-0.5) | | |

| Dependent Variable | constant | Independent variable $D_1t+D_2K$ | $D_2t-D_2K$ | $R^2$ |
|---|---|---|---|---|
| ln A | 4.59 | 0.008 | -0.021 | 0.85 |
| | (324.3) | (5.5) | (-11.5) | |
| ln O | 4.57 | 0.018 | -0.008 | 0.61 |
| | (160.0) | (6.0) | (-2.3) | |
| ln Y | 4.58 | 0.010 | 0.012 | 0.81 |
| | (230.1) | (4.8) | (4.8) | |

Note: A=Area; O=Output; Y=Yield.
Source:Same as in $A_1$.

Table A3. Growth Rates of Area, Output and Yield of Non-food Grains
(Kerala: 1962/63 to 1985/86)

| Dependent variable | Constant | Independent variable time | $time^2$ | $R^2$ | Year of Deceleration |
|---|---|---|---|---|---|
| ln A | 4.56<br>(169.2) | 0.043<br>(8.6) | -0.001<br>(-6.4) | 0.85 | 83/84 |
| ln O | 4.59<br>( 90.9) | 0.075<br>(8.1) | -0.002<br>(-6.0) | 0.84 | 81/82 |
| ln Y | 4.64<br>(149.1) | 0.033<br>(5.7) | -.001<br>(-4.1) | 0.74 | 78/79 |

| Dependent Variable | Constant | Independent variable $D_1t+D_2K$ | $D_2t-D_2K$ | $R^2$ |
|---|---|---|---|---|
| ln A | 4.61<br>(206.5) | 0.024<br>(10.2) | -0.004<br>(-1.5) | 0.84 |
| ln O | 4.67<br>(118.9) | 0.044<br>(10.6) | -0.008<br>(-1.5 ) | 0.86 |
| ln Y | 4.67<br>(199.6) | 0.020<br>(8.1) | 0.003<br>(1.0) | 0.78 |

Note: A=Area; O=Output; Y=Yield.
Source:Same as in $A_1$.

## Table A4. Growth Rates of Area, Output and Yield: aggregate and sub-groups
(All India: 1962/63 to 1984/85)

I. All Crops:

$$a)\ \ln A = 4.56 + \underset{(2.9)}{0.008t} - \underset{(-.9)}{0.0001t^2} \qquad R^2 = 0.78$$

$$b)\ \ln O = 4.41 + \underset{(2.7)}{0.024t} + \underset{(.4)}{0.0001t^2} \qquad R^2 = 0.89$$

$$c)\ \ln Y = 4.45 + \underset{(2.3)}{0.017t} + \underset{(.8)}{0.0002t^2} \qquad R^2 = 0.90$$

II. Food Crops:

$$a)\ \ln A = 4.55 + \underset{(2.8)}{0.008t} - \underset{(-1.2)}{0.0001t^2} \qquad R^2 = 0.86$$

$$b)\ \ln O = 4.37 + \underset{(2.5)}{0.028t} + \underset{(0.1)}{0.0001t^2} \qquad R^2 = 0.86$$

$$c)\ \ln Y = 4.43 + \underset{(2.3)}{0.020t} + \underset{(.5)}{0.0002t^2} \qquad R^2 = 0.87$$

III. Non-food crops:

$$a)\ \ln A = 4.59 + \underset{(1.4)}{0.005t} + \underset{(0.6)}{0.0001t^2} \qquad R^2 = 0.78$$

$$b)\ \ln O = 4.48 + \underset{(2.7)}{0.017t} + \underset{(1.2)}{0.0003t^2} \qquad R^2 = 0.93$$

$$c)\ \ln Y = 4.49 + \underset{(2.3)}{0.012t} + \underset{(1.1)}{0.0002t^2} \qquad R^2 = 0.91$$

Note: A = Area; O = Output; Y = Yield.

Source of data: 1) GOI, Area, Poduction of Principal Crops (19
2) GOI, Agricultural situation in India.(1986).

## Table A5. Growth Rates of Area, Output and Yield: aggregate and sub-groups
(All India: 1962/63 to 1984/85)

---

I. All Crops:

a) $\ln A = 4.57 + 0.0053t$ $R^2 = 0.77$
(8.4)

b) $\ln O = 4.39 + 0.0275t$ $R^2 = 0.89$
(13.0)

c) $\ln Y = 4.43 + 0.0222t$ $R^2 = 0.89$
(13.2)

II. Food Crops:

a) $\ln A = 4.56 + 0.0045t$ $R^2 = 0.68$
(6.8)

b) $\ln O = 4.36 + 0.0290t$ $R^2 = 0.86$
(2.5)

c) $\ln Y = 4.41 + 0.0245t$ $R^2 = 0.87$
(11.6)

III. Non-food crops:

a) $\ln A = 4.58 + 0.0070t$ $R^2 = 0.78$
(8.6)

b) $\ln O = 4.45 + 0.0244t$ $R^2 = 0.92$
(15.8)

c) $\ln Y = 4.47 + 0.0174t$ $R^2 = 0.91$
(14.2)

---

Note: A = Area; O = Output; Y = Yield.
Source: Same as in $A_4$.

## Table A6. Growth Rates of Real Wages
## Kerala: 1962/63 to 1984/85)

---

### I. All Crops:

a) $\ln Y = 4.68 + \underset{(8.0)}{0.0105t}$ $\qquad R^2 = 0.75$

b) $\ln (NW/PAC) = 4.42 + \underset{(1.9)}{0.0082t}$ $\qquad R^2 = 0.15$

c) $\ln (NW/PAC) = 4.49 - \underset{(-.03)}{0.0026(D_1t+D_2K)} + \underset{(2.2)}{0.0243(D_2t-D_2K)}$

$R^2 = 0.13$

---

### II. Food Grains:

a) $\ln Y = 0.27 + \underset{(10.3)}{0.0110t}$ $\qquad R^2 = 0.83$

b) $\ln (NW/PFG) = 4.14 + \underset{(3.8)}{0.0302t}$ $\qquad R^2 = 0.41$

c) $\ln (NW/PFC) = 4.35 - \underset{(-0.1)}{0.0014(D_1t+D_2K)} + \underset{(4.2)}{0.0771(D_2t - D_2K)}$

$R^2 = 0.57$

---

### III. Non-food Grains:

a) $\ln Y = 4.74 + \underset{(5.4)}{0.0097t}$ $\qquad R^2 = 0.57$

b) $\ln (NW/PNFG) = 4.62 - \underset{(-1.4)}{0.0053t}$ $\qquad R^2 = 0.08$

c) $\ln (NW/PNFG) = 4.60 - \underset{(-.4)}{0.0030(D_1t+D_2K)} + \underset{(0.8)}{0.0087(D_2t - D_2K)}$

$R^2 = 0.07$

---

See next page for note and source of data.

Note: NW = Nominal wage rates of male agricultural labourers.
PAC = Price of all crops: PFG = Price of food grains;
PNFG = Price of non-food grains.

Source of data: 1) Statistics for planning (various issues).
2) Cardamom price: Nair and Narayana (1984) and Cardamom Statistics (various issues).
3) Rubber statistics (v. issues).
4) Tea and Coffee prices: Agricultyural prices in India (1978) and Wholesale prices in India, Monthly Bullettin.
[illegible]
) Indian Labour Journal ( ).
6) GOK, Statistics for Planning, Various issues.

Table A7. Growth Rates of Sectoral Incomes (1970/71 prices)
(Kerala: 1962/63 to 1985/86)

---

I. Polynomial semilog function:

1. $\ln (PRI): 4.58 + 0.0381t - 0.0012t^2$ $R^2 = 0.84$
   $(7.8)$ $(-6.0)$

2. $\ln (SEI): 4.58 + 0.0640t - 0.0012t^2$ $R^2 = 0.97$
   $(11.2)$ $(-4.9)$

3. $\ln (TEI): 4.61 + 0.0403t + 0.0003t^2$ $R^2 = 0.99$
   $(8.8)$ $(1.5)$

---

II. Semilog function:

1. $\ln (PRI): 4.67 + 0.0105t$ $R^2 = 0.56$
   $(5.3)$

2. $\ln (SEI): 4.68 + 0.0368t$ $R^2 = 0.93$
   $(17.5)$

3. $\ln (TEI): 4.59 + 0.0467t$ $R^2 = 0.99$
   $(38.9)$

---

III. Kinked semilog function:

1. $\ln (PRI) = 4.67 + 0.0223(D_1t + D_2K) - 0.007 (D_2t - D_2K)$
   $(9.2)$ $(-2.1)$

   $R^2 = 0.83$

2. $\ln (SEI) = 4.62 + 0.0471 (D_1t + D_2K) - 0.0215 (D_2t - D_2K$
   $(14.7)$ $(4.1)$

   $R_2 = .96$

3. $\ln (TEI) = 4.61 + 0.0424 (D_1t + D_2K) - 0.0532 (D_2t - D_2K$
   $(20.4)$ $(18.7)$

   $R_2 = .99$

---

Note: PRI = Primary sector income;
SEI = Secondary sector income;
TEI = Tertiary sector income.

Source of data: 1) GOK, Statistics for planning, 1977.
2) GOK, Economic review, 1982 and 1986.

# References

Alauddin, M. and Tisdell, C.(1986)

"Decomposition methods, agricultural productivity growth and technological change: a critique supported by Bangladesh data", in *Oxford Bullettion of Economics and Statistics*, 48.

Boyce, J.K. (1986)

"Kinked exponential models for growth rate estimation", in *Oxford Bulletin of Economics and Statistics*, 48.

Cardamom Board

*Cardamom* (various issues), Cochin.

Centre for Science and Environment (1987)

*The wrath of nature: The impact of environmental destruction on floods and droughts*, New Delhi.

Chattopadhyay, M. and Bhattacharya, G. (1987)

"Growth of Indian agriculture: a reappraisal", in *Indian Journal of Agricultural Economics*, 42(1).

Chattopadhyay, M. (1985)

"Deforestation in parts of Western Ghats, Kerala (India)", in *Journal of Environmental Management*, London, Vol.20.

de Janvry, Allen and Rao, K. S. (1986)

*Agricultural price policy and income distribution in India*, Oxford University Press, Madras.

George, P. S. and Mukherji, C. (1986)

"Rice economy of Kerala: a disaggregated analysis of performance", in *Indian Journal of Agricultural Economics*, March.

George, P. S. (1982)

"Agricultural price movements in Kerala " in P.P. Pillai (ed.), *Agricultural Development in Kerala*, Agricole Publishing Academy, New Delhi.

Government of India (GOI)

*Wholesale price in India* (variuos issues), Ministry of Industry, New Delhi.

Government of India (GOI)

*Bulletin on commercial crops statistics*, 1953/64 to 1968/69, Ministry of Agriculture, New Delhi.

Government of India (GOI). (1984)

*Estimates of area, production and yield of principal crops*, Ministry of Agriculture, NewDelhi.

Government od India (GOI). (1984,1985)

*Agricultural situation in India*. Ministry of Agriculture, New Delhi.

Government of India (GOI). (1960, 1978)

*Agricultural prices in India*, Ministry of Agriculture, New Delhi.

Government of Kerala (GOK). (1982, 1986 and 1987)

*Economic Review*, Planning Board, Trivandrum.

Government of Kerala (GOK)

*Season and crop reports* (varcous issues), Bureau of Economics Statistics, Trivandrum.

Government of Kerala (GOK)

*Statistics for planning (various issues), Department of economics and statistics*, Trivandrum.

Government of Kerala (GOK) (1983)

Land Use Board, Land use plan for Idukki district, Trivandrum.

Labour Bureau (1987)

Indian Labour Journal, Simla.

Joseph, P.V. (1987)

"Monsoon mischief",in Indian Express, 8 September.

Kannan, K. P. (1979)

"Ecological and socio-economic consequences of water control projects in the Kuttanad region of Kerala", in Proceedings of the Indian Academy of Sciences, Section C, Engineering Sciences, December.

Kannan, K. P (1988)

Of rural proletarian struggles: mobilization and organization of rural workers in south west India, Oxford University Press, Delhi.

Krishnan, T. N. (1976)

"Demographic transition in Kerala: facts and figures" in Economic and Political Weekly, August.

Krishnan, T. N. (1987).

"Kerala: progress, warning signals", in The Hindu, Saturday, September 5.

Maddala, G.S. (1977).

Econometrics, McGraw-Hill, Book Company, New York.

Meher-Homji, V.M. (1980)

"Repurcussions of deforestation on precipitation in Western Karnataka",in Archiv fur Meteorologie Geophysik und Bioklimatologie, Ser.B, Springer-Verlag.

Minhas, B.S. and Vaidyanathan, A. (1965).

"Growth of crop output in India, 1951/54 to 1958/61: an anlysis by component elements",in *Journal of the Indi* *Society of Agricultural Statistics*, 17(2).

Mitchell, D. W. and Speaker, P. J. (1986)

"A simple flexible distributed lag technique: the polynomial inverse lag",in *Journal of Econometrics*, 31.

Nair, Gopinathan, P.R. (1981)

*Primary education, population growth and socio - economic change: a comparative study with particular reference to Kerala*, Allied Publishers, New Delhi.

Nair, K.N. and Narayana, D. (1983)

"Linking irrigation with development - The Kerala experience", in *Economic and Political Weekly*, Nos.24 and 2 June.

Nair, K. N., Narayana, D. and Sivanandan, P. (1986)

*Development of cardamom plantations in the high ranges of Kerala: report of an expost evaluation study*, Working Paper No.      Centre for Development Studies.

Narain, D. (1965).

*Impact of price movements on areas under selected crops in India: 1900-1939*, Cambridge university press, London.

Natarajan, S. (1982).

"Labour input in rice farming in Kerala- an inter-regional, inter-temporal analysis", in P. P. Pillai (ed.) *Agricultural development in Kerala*, Agricole Publishing Company, New Delhi.

Nerlove, M. (1958)

The dynamics of supply: estimation of farmer's response to price, John Hopkins Press, Baltimore.

Panikar, P.G.K.(1978)

"Employment, income and food intake among selected agricultural labour households", in Economic and Political Weekly, Special Number, August.

Panikar, P.G.K. and Soman, C.R. (1984)

Health status of Kerala: the paradox of economic backwardness and health development, Centre for Development Studies, Trivandrum.

Pillai, P.P. (1982).

"Growth of agricultural output in Kerala during 1952/53 to 1978/79" in P. P. Pillai (ed.) Agricultural development in Kerala, Agricole Publishing academy, New Delhi.

Reddy, V.N. (1978).

"Growth rates", in Economic and Political Weekly, May 13.

Rubber board.

Rubber India (various issues), Kottayam.

Rubber Board.

Rubber statistical news, Kottayam.

Sivanandan, P.K. (1985).

Kerala's agricultural performance: differential trends and determinants of growth, Centre for Development Studies, Trivandrum.( M. Phil thesis, Jawharlal Nehru University, New Delhi.

Somasekharan Nair, G.(1983)

"Agricultural statistics in Kerala", in Kurup, R.S.(et.al.) (1983), Data base of the Kerala economy, Department of Economics and Statistics, Trivandrum.

United Nations (1975)

*Poverty, unemployment and development policy: A case stu of selected issues with special reference to Kerala*, N York.