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AGRICULTURAL STAGNATION IN KERALA: AN ECONOMETRIC STUDY OF TAPIOCA.*

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Of course, the usual disclaimer applies.

CONTENTS

I. INTRODUCTION

Kerala's agricultural growth has been stagnating for the last decade or so. But crop specific analysis shows that the stagnation is more severe among food crops, especially rice and tapioca. For example, the index of output of paddy has reached its peak of 124 in 1975/76 from the base year 1962/63 and declined to 107 in 1985/86. In the case of its substitute, tapioca, the index of production has reached 225 (63/64 = 100) in 1972/73 and then declined to 129-30 in 1985/86. But the area under both the crops have declined absolutely during the period (see Appendix). This would imply that for the two major crops, the production has stagnated during the period. Although detailed analyses are available on the performance of two crops, few attempts are available on a systematic testing of the hypotheses emerged from these studies. This paper develops a systematic framework for the statistical testing of the above hypotheses in the case of tapioca.

The outline of the paper is as follows. In section I we take up an analysis of the growth of output and its components, area and yield, for the period 1963/64 to 85/86. It also includes a study on the instability of the above indicators and its sources during the period. In section II, we take up an empirical test of the causes of stagnation. This includes the constraints imposed on output growth by the demand for tapioca and the profitability of cultivation. In the absence of any reliable time series data on the cost of cultivation, the test is based on the cobweb theorem. Finally, section III discusses the allocation of area under tapioca among competing crops which are identified by the relative price movement during the period using dummy variable analysis. Based on the analysis, the acreage allocation function of tapioca has been estimated.

II. Interdistrict Analysis of Growth and Stability

Although statistics on tapioca are available for earlier years, the estimates are based on scientific method-crop cutting experiments - only from 1963/64 onwards. As a result, the data on output, area and yield are not strictly comparable for the years before and after 1963/64 (Ninan, 1982, p. 24). Because of this technical problem, the present study is limited to the period, 1963/64-85/86 (see Appendix for the data).

The interdistrict performance of output, area and yield can be seen from the graphs, 1 (a) -1 (i), given below. The graphs clearly show that the index numbers of production in Quilon, Alleppey, Kottayam, Ernakulam and Kozhikode have either reached or gone below the level of production in 1963/64. This would imply that these districts have lost two decades of growth of output. In the case of area, it has reached the same level as in 1963/64 in all the above districts plus Trivandrum. In the case of yield, it has increased marginally in all the districts except Palghat and Cannanore. This finding is subject to the following limitation as a result of the area taken out for the newly formed districts especially Malappuram in 1969 and Idukki in 1972. But the index numbers of area in Kottayam and Ernakulam, 1 (c) and 1 (d), have remained constant around 1972 and started declining only after 1975/76. Therefore, the decline in area in Kottayam and Ernakulam cannot be attributed to the formation of Idukki. This is not true in the case of Kozhikode since the area index has declined, 1(h), in 1969/70. This means that the declining trend has been accelerated by the area taken out from Kozhikode for the creation of Mallapuram. However, our conclusion will not be affected much, since the share of area in Kozhikode is only about 2 % (triennium average for the years, 1983/84-85/86) of the total area under tapioca in Kerala.

Another interesting point to note is the large variability in the index numbers in all the districts except possibily in Cannanore. Therefore, we have to develop a suitable methodology for the measurement of the growth and instability of output and its components. This is discussed below.

2.1 Growth of output, area and yield

The growth rate can be measured statistically using different functional forms such as linear, semilog, Gompertz, logistic curve, etc. (Chattopadhyay 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:

$$(2.1.1) \quad \ln Y_t = a_0 + a_1 t + u_t$$

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 function is to postulate a linear relationship between a_1 and 't'. This would mean,

$$(2.1.2) \quad a_1 = a_2 + a_3 t$$

Substituting (2.1.2) in (2.1.1),

$$(2.1.3) \quad \ln Y_t = a_0 + a_2 t + a_3 t^2 + u_t$$

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 in the following way.
For an optimum,

$$d\ (\ln\ Y)/dt = 0$$
$$a_2 + 2a_3t = 0$$
$$\text{Therefore, } t = -a_2/2a_3$$

The value of 't' can be used for the calculation of the year in which the growth rate reaches minimum or maximum. Growth rate reaches the maximum if the second derivative is negative and minimum if it is positive. The year given in brackets in Table 1 is obtained 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 the growth rate has no optimum unlike the former.

Both the district level graphs and the statistical test given in Table 1 clearly indicate that there are two distinct phases, acceleration and deceleration, of tapioca production during the period under study. Since the deceleration began as early as in 1969/70 in Alleppey and as late as in 1981/82 in Cannanore, it is very difficult to find a uniform year which demarcates the two phases for all the districts. For reasons of comparability with earlier studies and the introduction of a new methodology in 1975/76, we have taken 1975/76 as the year of deceleration. This implies that the growth rate is different before and after 1975/76. As a result, we have to estimate growth rates separately for the two sub periods: 1963/64 to 1974/75 and 1975/76 to 1985/86.

Table 1. Trend in Growth Rates of Output, Area and Yield of Tapioca. (1963/64-85/86)

District	Trend in Growth Rate		
	Area	Output	Yield
Trivandrum	D(1974/75)[a]	D(1976/77)	ns
Quilon	D(1973/74	D(1974/75)	D(1976/77)
Alleppey	D(1969/70)	D(1973/74)	D(1978/79)
Kottayam	D(-)	D(-)	D(-)
Ernakulam	ns	D(1977/78)	C
Trichur	D(1975/76)	D(1976/77)	D(1978/79)
Palghat	D(1978/79)	D(1978/79)	D(1979/80)
Kozhikode	D(-)	D(1970/71)	D(1974/75)
Cannanore	C	D(1981)82	D(1978/79)

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

Note: D: growth rate is decelerating.

C: constant growth rate.

D(-) the growth rate is decelerating for the entire period.

ns: not statistically significant.

a. The numbers in the brackets refer to the year in which the growth rate reaches the maximum. The year is calculated from the first order condition of maximum growth in the polynomial exponential function.

The usual method is to estimate separate regression for the two periods. 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 give 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 for the two sub-periods could be estimated separately using the following equation.

(2.1.4) $\ln Y = a_1 d_1 + a_2 d_2 + (b_1 d_1 + b_2 d_2)t + u$

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,

$$a_1 + b_1 K = a_2 + b_2 K$$

From the restriction,

(2.1.5) $a_2 = a_1 + b_1 K - b_2 K$ and
$d_2 = 1 - d_1$.

Substituting (2.1.5) in (2.1.4)

$$\ln Y = a_1 d_1 + (a_1 + b_1 K - b_2 K) d_2 + (b_1 + b_2 d_2)t + u$$
$$= a_1 d_1 + a_1 (1 - d_1) + b_1 (d_1 t + d_2 K) + b_2 (d_2 t - d_2 K) + u.$$

$$\text{(2.1.6)} \quad \ln Y = a_1 + b_1(d_1 t + d_2 K) + b_2(d_2 t - d_2 K) + u.$$

This is called the kinked exponential model which is used for the periodwise estimation of the growth rates. Obviously, b_1 is the first period growth rate and b_2 the second period growth rate.

Another issue that need to be tackled is the question of arriving at a single growth rate from the growth rates of different districts. The standard econometric practice is to pool the time series and cross-section data after testing the validity of such a procedure. However an alternative is being suggested in the literature which is not often used in econometric work. The idea is to estimate each equation separately and adjust the coefficient towards a common mean (Maddala, 1978, p. 333). The procedure is given below.

Suppose a_i is the growth rate of the ith district. If there are N districts, then the common growth rate is given by $a = \sum a_i$. The growth rate of the ith district is adjusted in the following way.

$$\hat{a}_i = (w_1 a_i + w_2 a)/(w_1 + w_2)$$

where w_1 = 1/estimated variance of a_i

and $w_2 = \frac{N}{N-1}(\cdot) \frac{N}{N-1} \frac{1}{(\cdot)}$

$$(\cdot) = \sum (a_i - a)^2 - \sum_i \frac{(\text{estimated variance of } a_i)}{N}$$

In this case, the weight w_i is very high relative to w_2. Therefore the adjusted growth rates remain the same as unadjusted growth rates. The results are reported in Table 2.

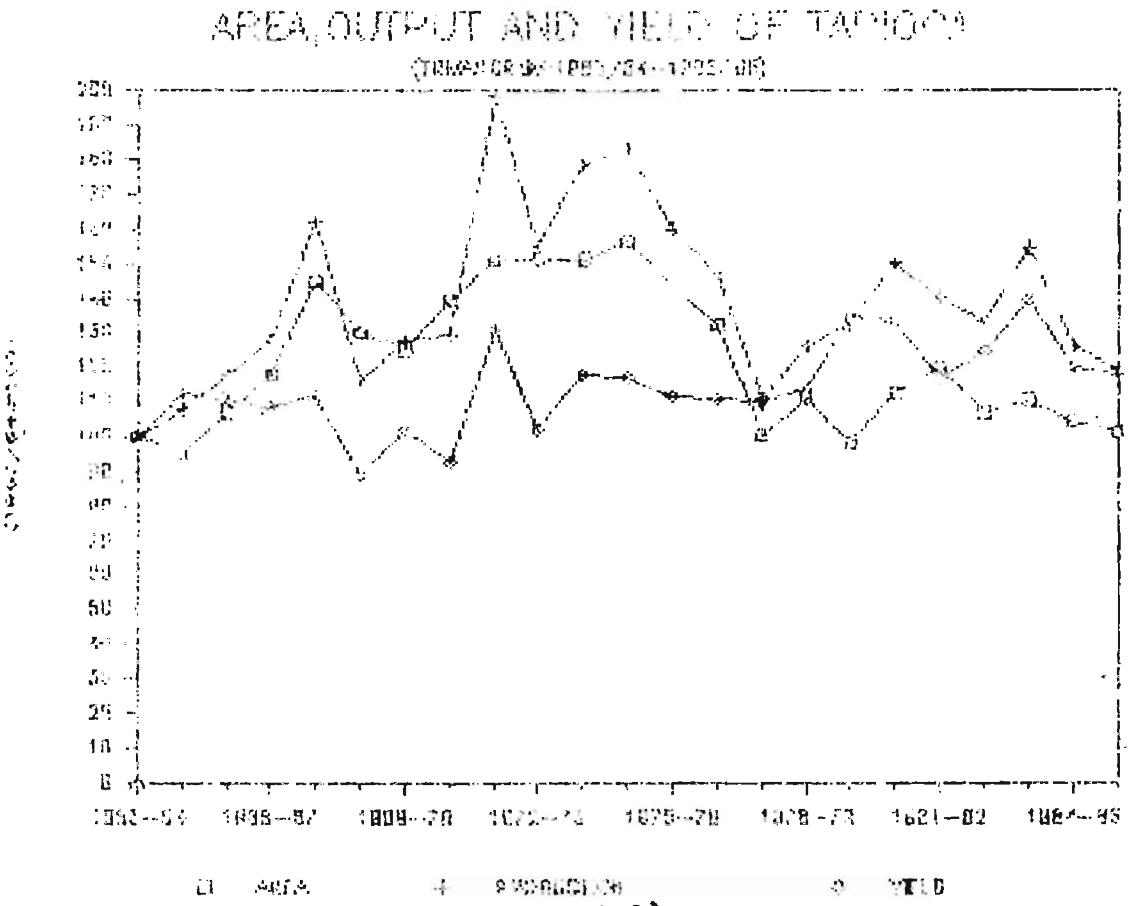
At the same level, the growth rate of output and its components are positive in the first period and negative in the second period. More or less the same pattern emerges at the district level except the growth rate of area in the first period. Eventhough the increase in the growth rate of yield in the first period is higher than the decline in the second period, the negative growth rate in output in the latter period outweights the positive growth in the former period. As a result tapioca has lost more than two decades of growth. It is very clear from the table that the stagnation is due to decrease in area in the absence of any steady increase in the yield during this period. In period I, yield increase led the growth rate in Alleppey and Ernakulam. In all other districts, the growth rate in output is contributed by area increase rather than yield increase. But in the second period, negative growth rate in area is reinforced by negative growth rate in yield. Therefore, the growth rate in output of tapioca is mainly due to area rather than yield.

The figures, 1 (a) & 1 (i), show that the index numbers of output, area and yield fluctuate widely. Therefore, the nature and causes of such fluctuations need careful examination. In this regard quantitative measures developed to study similar problems in international trade (Murray, 1978, for a survey) are very useful. Specifically, we follow Murray's analytical framework for the present analysis which is explained below.

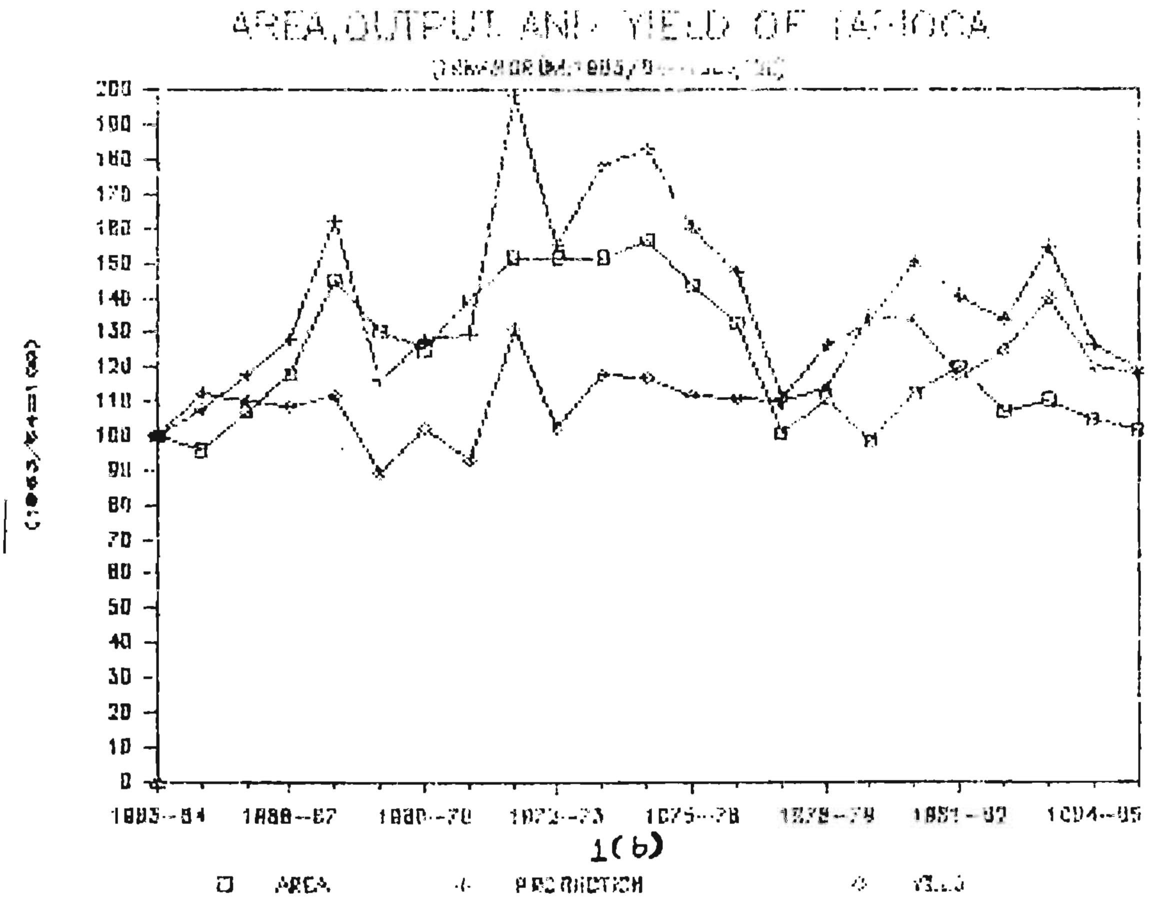
2.2 Indices of instability and its sources:

The instability can be defined as the deviation from the trend. The counterpart of the measure in the regression analysis is the variation which is not explained by the regression equation. Therefore the instability index is based on the trend eliminated value of the variables. There are different measures of instability depending on the method of trend elimination. The simplest among them is the MacBean index based on moving average. This index is defined as:

$$MBI = (100/n-4) \sum_{t=3}^{n-2} (|X_t - MA_t|/MA_t)$$

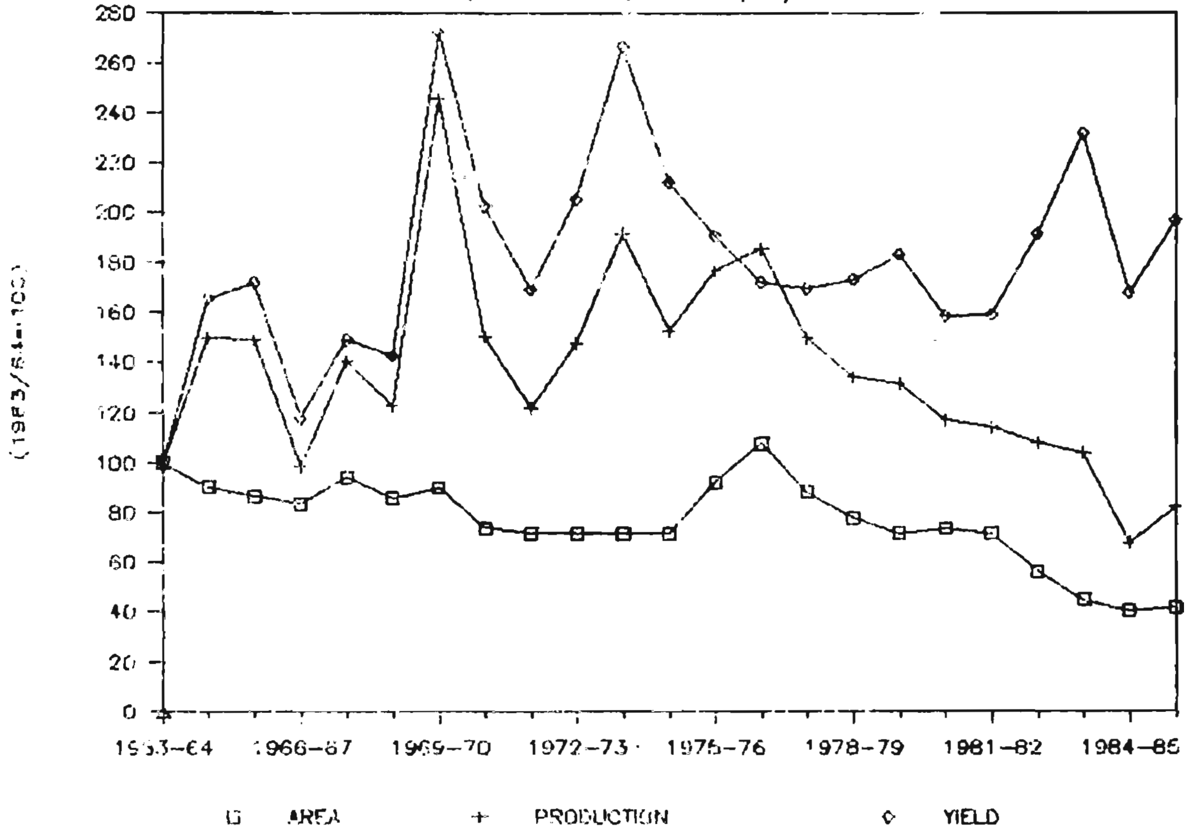

AREA, OUTPUT AND YIELD OF TAPIOCA
AREA
PRODUCTION
YIELD

1(a)


AREA, OUTPUT AND YIELD OF TAPIOCA
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
AREA
PRODUCTION

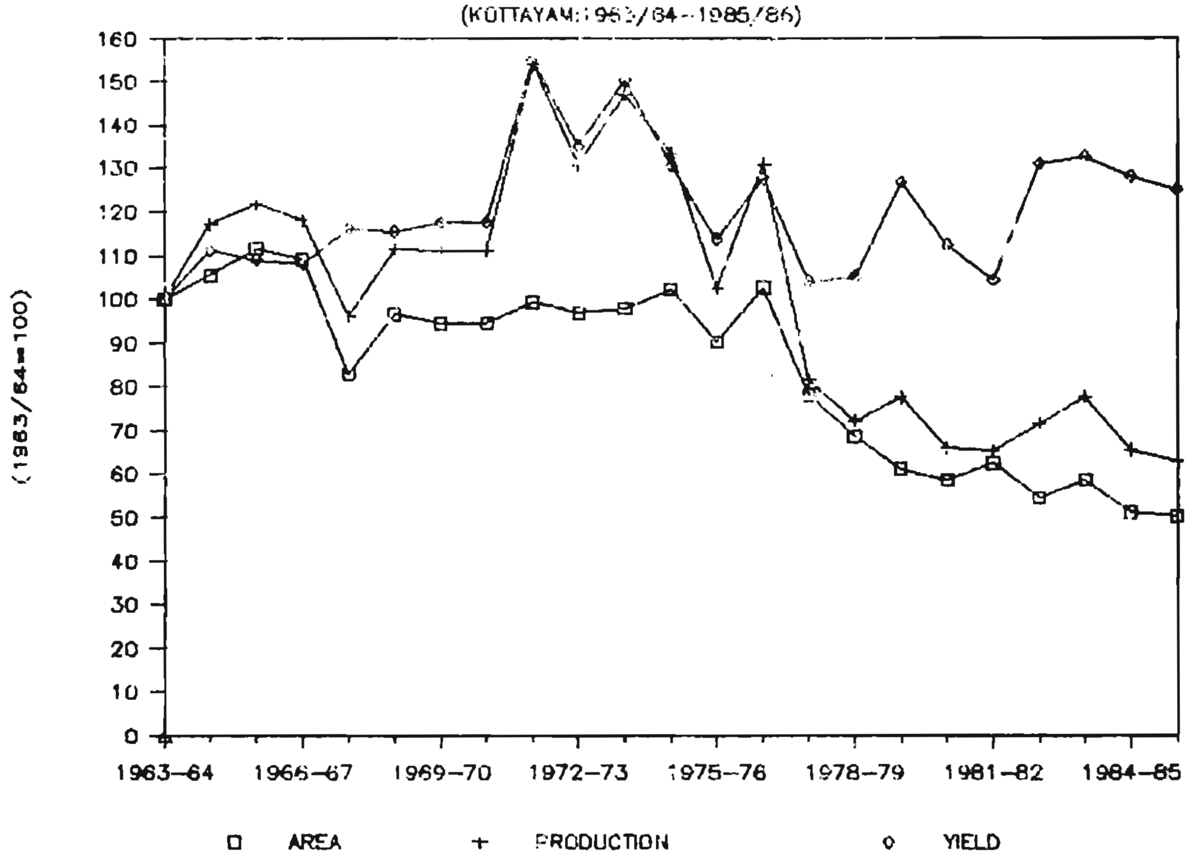
1(b)

AREA,OUTPUT AND YIELD OF TAPIOCA
(ALLEPPY:1963/84–1985/86)



1(c)

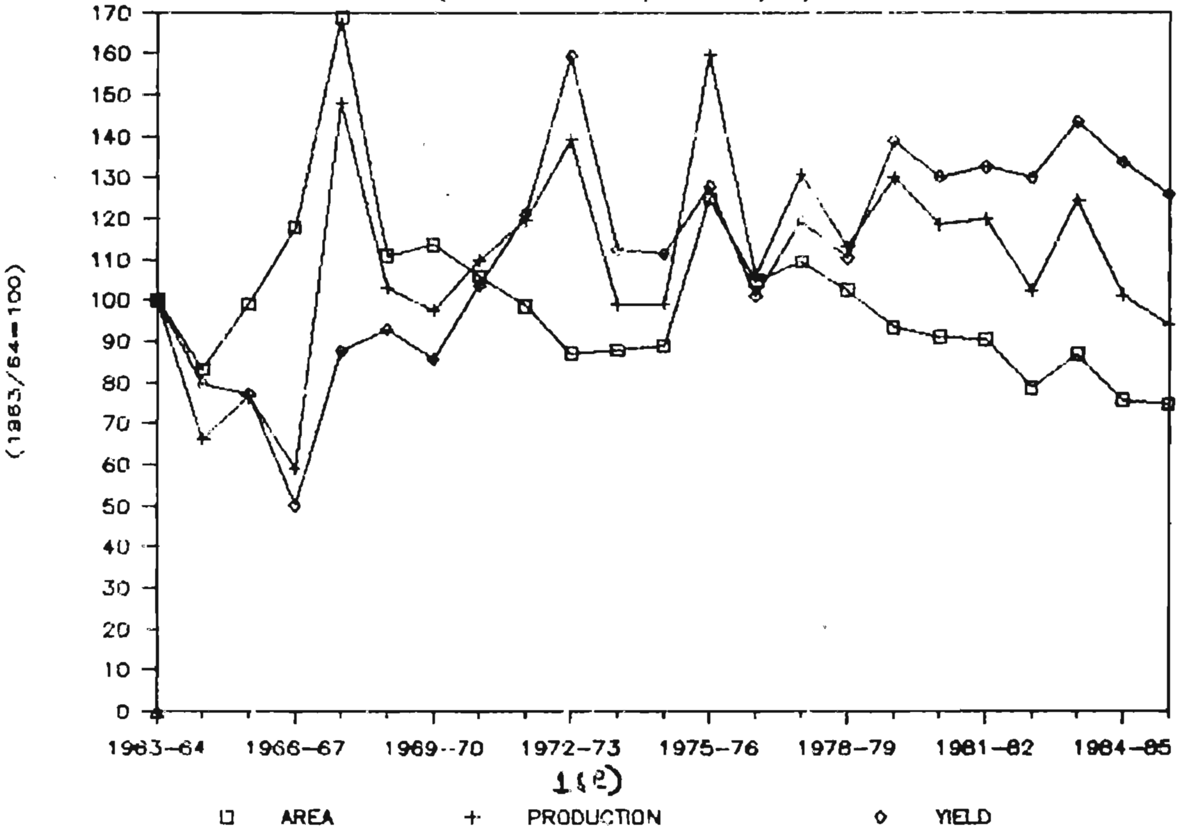
AREA,OUTPUT AND YIELD OF TAPIOCA
(KOTTAYAM:1963/84–1985/86)



1(d)

AREA,OUTPUT AND YIELD OF TAPIOCA

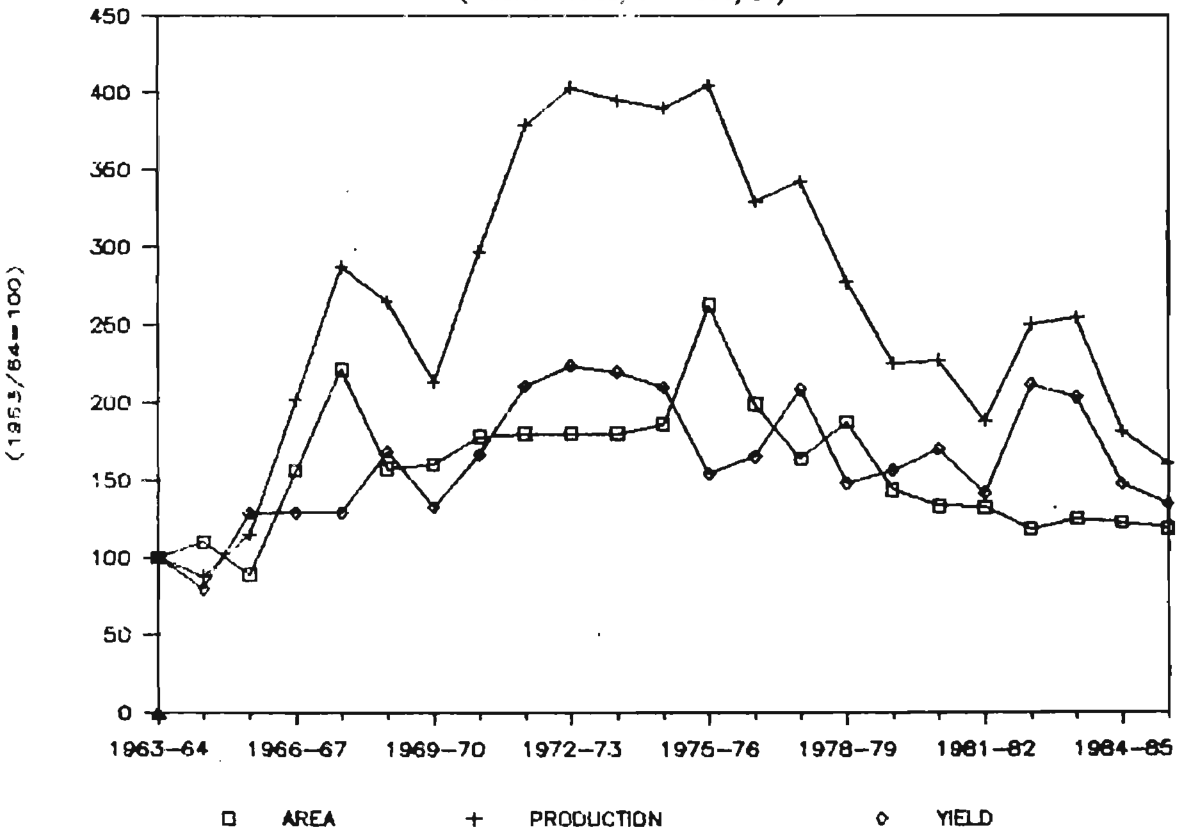
(ERANAKULAM:1963/64–1985/86)



1(e)

AREA,OUTPUT AND YIELD OF TAPIOCA

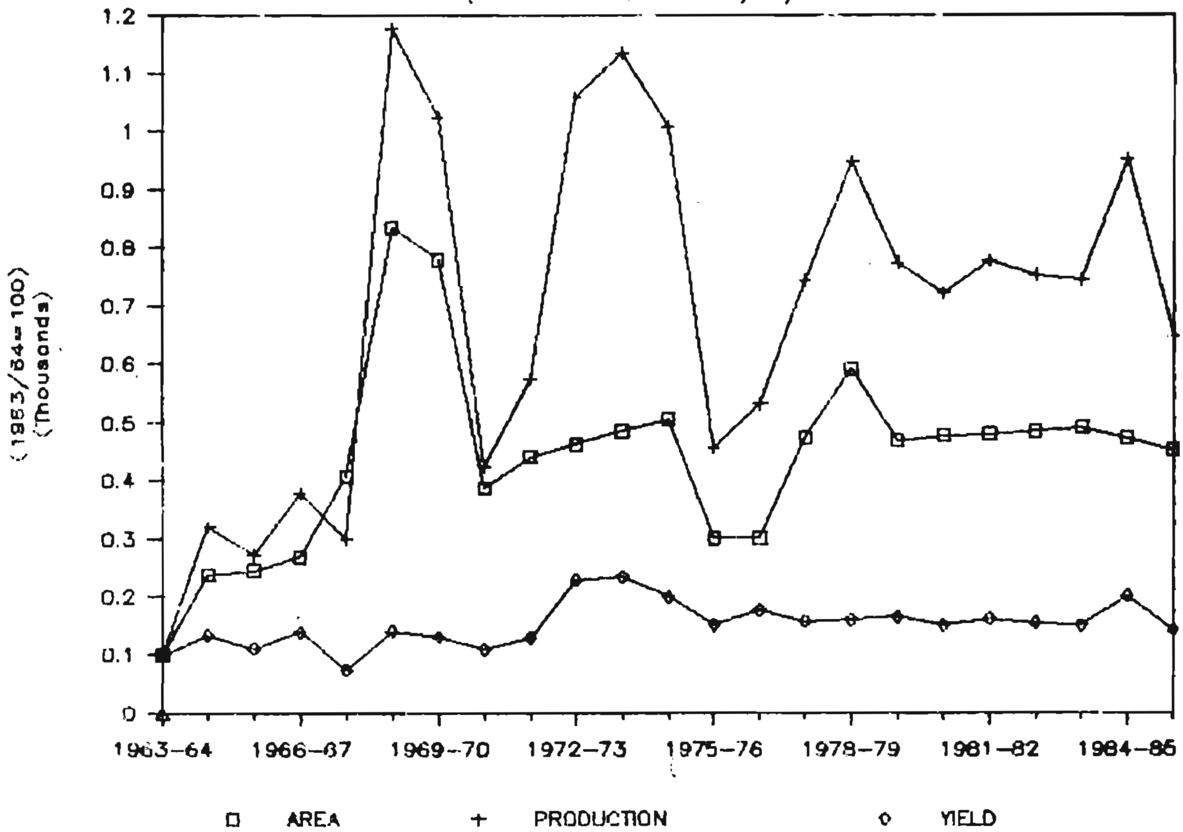
(TRICHUR:1963/64–1985/86)



1(f)

AREA, OUTPUT AND YIELD OF TAPIOCA

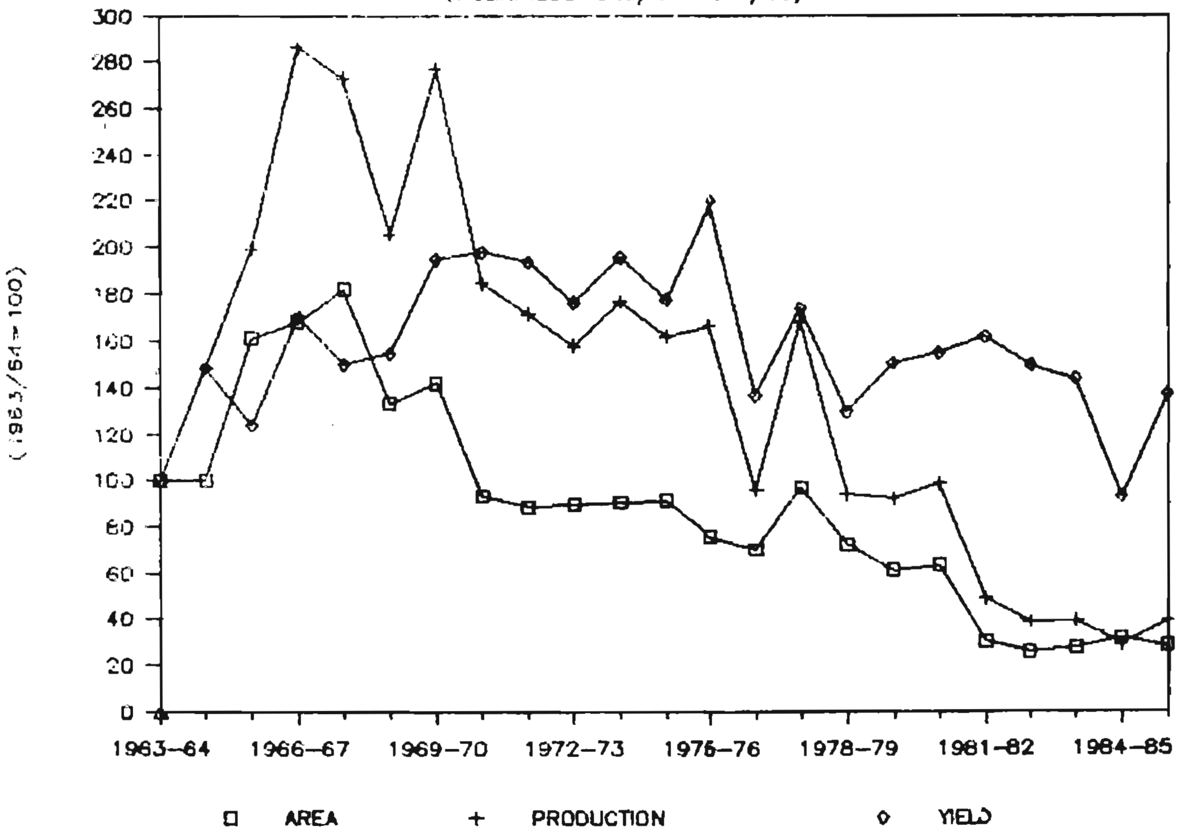
(PALGHAT:1963/64-1985/86)



1(g)

AREA, OUTPUT AND YIELD OF TAPIOCA

(KOZHIKODE:1963/64-1985/86)



1(h)

AREA,OUTPUT AND YIELD OF TAPIOCA

(CANNANORE:1963/64–1985/86)

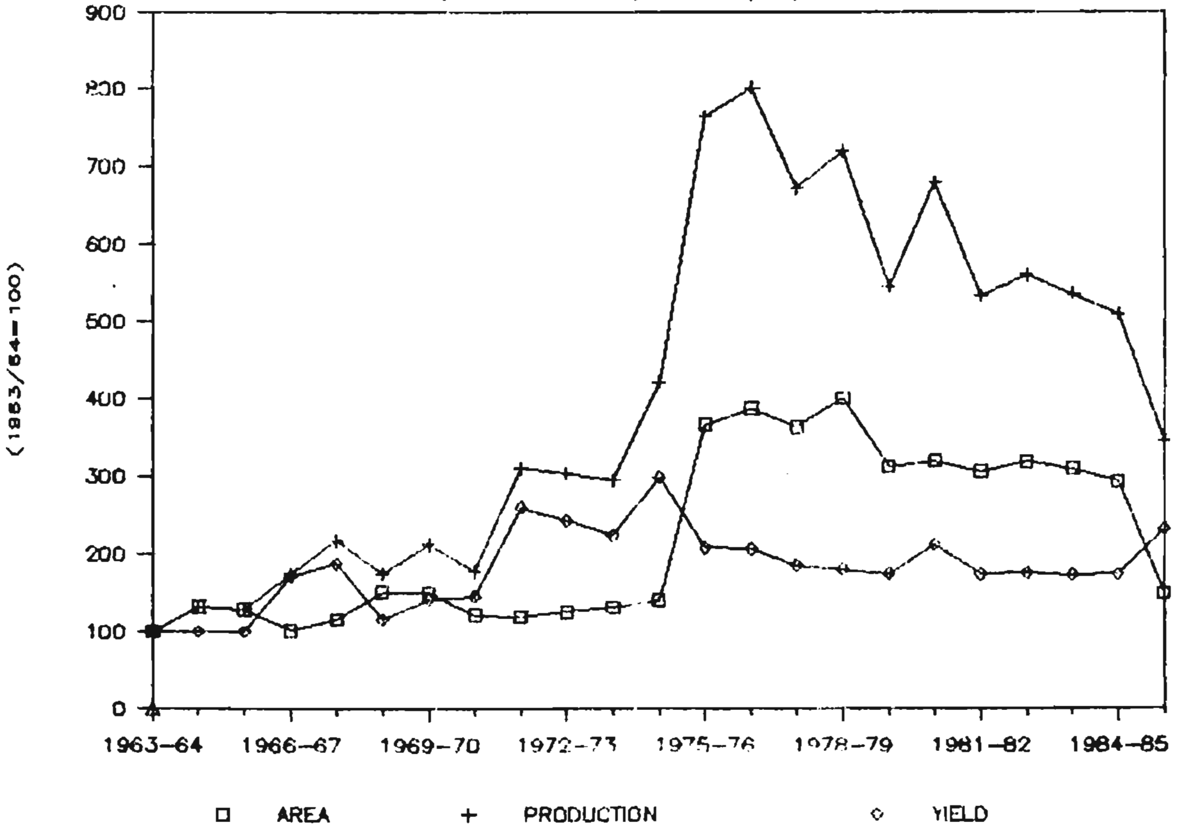


Table 2. Growth Rates of Output, Area and Yield of Tapioca (1963/64-74/75 and 1975/76-85/86)

District	Period I			Period II		
	Area	Output	Yield	Area	output	yield
Trivandrum	2.66	3.44	ns	-4.15	-2.86	ns
Quilon	4.80	8.57	3.78	-10.05	-12.93	-2.87
Alleppey	ns	3.73	3.74	-6.10	-7.85	ns
Kottayam	ns	ns	ns	-6.61	-7.29	ns
Ernakulam	ns	4.33	4.32	-3.01	ns	ns
Trichur	5.83	11.96	6.12	-6.82	-10.09	-3.28
Palghat	6.89	11.94	5.04	ns	ns	ns
Kozhikode	-3.45	ns	3.54	-12.75	-17.67	-4.92
Cannanore	8.44	15.57	7.12	ns	ns	-3.15
Kerala Mean	3.17	8.51	4.81	-7.07	-9.78	-3.56

Source: same as in Table 1.

Note : Period I : 1963/64-74/75

Period II: 1975/76-85/86.

where MA_t is a 5 - year moving average of the X_t values (output, yield or area) centered on year t. The calculated indices are given in Table 3.

The mean instability index, at the state level, is higher in the acceleration period than in the deceleration period.

Table 3. Instability Index of Area, Output and Yield of Tapioca (1963/64-74/75 and 1975/76-85/86)

District	Period I			Period II		
	Area	Output	Yield	Area	Output	Yield
Trivandrum	12.49	4.85	8.04	7.75	5.80	7.57
Quilon	7.94	7.72	6.95	9.88	5.98	8.92
Alleppey	20.32	4.70	18.72	4.32	6.64	9.22
Kottayam	8.24	5.23	4.60	9.61	5.21	9.26
Ernakulam	18.80	9.65	14.38	5.80	3.57	4.62
Trichur	15.17	13.67	10.16	11.06	6.95	15.40
Palghat	38.56	24.54	20.09	8.37	7.62	4.03
Kozhikode	13.31	11.07	8.21	19.97	17.06	6.30
Cannanore	12.02	11.31	21.71	7.07	6.02	6.45
Kerala Mean	16.32	10.30	12.54	9.31	7.21	7.97
C.V. (%)	57.10	60.40	50.60	48.40	41.60	42.41

Source: same as in Table 1.

Although area instability is higher than that of yield in both periods, the difference in the magnitude between the two has narrowed down in the second period. Palghat in the first period and Kozhikode in the second period have recorded maximum instability in output growth. The same districts have also recorded the maximum area instability. But in the case of yield, no such relationship holds for the two districts. In fact, Cannanore in period I and Trichur in period II have experienced very high fluctuations in yield. The interdistrict variability in the instability has also declined in the second period. However, the contribution of the components to the variance of the output instability and its sources need further analysis. This is measured in the following way (Murray, 1978).

From the identity,

$$\ln O = \ln A + \ln Y,$$

But the instability is defined as

$$\ln O - \ln \hat{O} = \ln A - \ln \hat{A} + \ln Y - \ln \hat{Y}$$

$$\ln (O_I) = \ln (A_I) + \ln (Y_I)$$

where " $\hat{}$ " means that they are trend values from an exponential growth function.

Taking the variance, we have

$$\mathrm{Var}(\ln O_I) = \mathrm{Var}(\ln A_I) + \mathrm{Var}(\ln Y_I) \pm 2\,\mathrm{Cov}(\ln A_I, \ln Y_I)$$

The contribution of each component is defined as the ratio of the variance of the component to the variance of the output. The covariance term shows whether they are moving in the same direction or in the opposite direction. The empirical results are given in Table 4.

Table 4. Components of Variance of Output (%) (1963/64-74/75 and 1975/76-85/86.)

District	Var (ln A) / Var (ln O)	Var (ln Y) / Var (ln O)	2 cov (ln A, ln Y) / Var (ln O)
Trivandrum			
Period I	164.3	69.3	-133.6
Period II	74.6	45.2	-19.8
Quilon			
Period I	76.4	20.3	3.3
Period II	31.4	88.3	-19.7
Alleppey			
Period I	6.7	84.2	9.1
Period II	114.3	129.7	-144.0
Kottayam			
Period I	49.9	45.8	4.3
Period II	40.1	34.4	25.5
Ernakulam			
Period I	58.9	85.0	-43.9
Period II	17.7	57.0	25.3
Trichur			
Period I	73.0	33.7	-6.7
Period II	63.8	130.8	-94.6
Palghat			
Period I	87.8	30.2	-18.0
Period II	85.6	23.9	-9.5
Kozhikode			
Period I	64.8	18.8	16.4
Period II	92.0	47.3	-39.3
Cannanore			
Period I	9.2	27.3	63.5
Period II	245.4	83.6	-228.4
Kerala (Mean)			
Period I	65.7	46.1	-11.8
Period II	85.0	71.1	-56.1

Source: Same as in Table 1.

It is interesting to note that the contribution of the variance of area and yield instability to the variance of output instability has increased although the mean instability indexes have reduced during the period. Moreover, the contribution of area instability to output variance is higher than that of yield variability in both periods. In other words, the relative importance of area instability remains the same during the period. The covariance term is negative, at the aggregate level, for both the periods. But its value has increased fivefold in the second period. This would mean that the factors-the fertility of the soil and the climate-contributing to the movement of the instability in area and yield in the opposite direction have become stronger in the second period.

It must be mentioned that the state level finding is not valid even for a single district. This reminds us the dangers of ignoring the regional dimension of the problem. The contribution of area instability to the variance of output instability has reduced in the second period for six districts. But it shows an increase at state level. An examination of the Table shows that it is due to the unusually high value of Alleppey and Cannanore. At the same time, the contribution of yield instability has increased during the period for six of the nine districts. This is consistent with the State average. For majority of the districts, the covariance is positive in the first period and negative in the second period. The positive covariance in the first period is not consistent with the findings at the state level. This is again due to the high negative value of Trivandrum. Therefore, it can be concluded from the regional analysis that the contribution of area has decreased and yield increased during the period for majority of the districts. It can also be stated that the positive covariance in the first period has become negative for a majority of the districts. This finding can be interpreted in the following way.

In the first period, more fertile land was brought under tapioca which was primarily responsible for the yield increase since there was not any technical change in the production. As a result, instability in both area and yield increased which explains the positive covariance of the two in most of the districts. In the second period, the area which has alternative uses has been shifted away from tapioca leaving only more or less stable marginal land of low quality under cultivation. Therefore the area instability has decreased and that of yield increased. This would explain the negative covariance in the second period.

Our analysis thus far has been concentrated on the different aspects of the performance of tapioca production. From the policy point of view, it is very important to understand the causes of stagnation.

III Empirical Analysis of the Causes of Stagnation.

In an earlier paper, we have developed an analytical framework to explain the agricultural stagnation in Kerala (Kannan and Pushpangadan, 1987). The test based on the growth rate version of the productivity of land and real wage rate (nominal wage/price of output) shows that cultivation of tapioca is profitable. Therefore, alternative models have to be developed to explain the stagnation in its production. These issues are taken up for detailed empirical analysis below.

3.1 Demand constraints; an empirical test.

It is argued that the demand has constrained the growth of tapioca production (Ninan, 1982, p. 58). The demand for tapioca comes from two sources: (i) as a substitute for rice; and (2) as an intermediate input for industries. However the industrial demand is not increasing because of its uneconomical price due to low productivity (George, 1987, p72). Therefore the growth of output is determined by the consumption demand. The consumer demand depends on its own price, price of its substitute, rice, and the level of income. Let us analyse the behaviour of these factors during the period under study. In the first period, 1963/64-74/75, the price of rice relative to tapioca was high compared to the relative price in the second period, 1975/76-85/86 (George, 1987, p. 41). Therefore, the deamd for tapioca in the second period should be lower than the demand for the period. In the case of income effect, the demand should be lower since tapioca is an inferior substitute. Therefore, both factors, price and income, have contributed to the decline in the demand causing the decline in production. But this hypothesis has not been tested with the available data.

We test this hypothesis in the following way. First, we specify and estimate the demand function for tapioca and using the estimated demand function we calculate the mean per capita consumption for the two periods. If this hypothesis is valid then the per capita demand in the second period estimated from the model should be less than the per capita demand in the first period. From our knowledge on the consumer's preference for tapioca, the demand for tapioca can be specified as:

$$D = D(P_t, P_r, Y)$$

Where P_t: Price of tapioca,

P_r: Price of rice,

Y : per capita income,

D : per capita consumption.

The effect of the variables on the demand for tapioca is given by the sign on top of it. It indicates that the effect of own-price is negative, price of its substitute positive, and the income of the consumer negative. The income effect is negative since tapioca is an inferior substitute for rice for low income consumers. Different linear versions of the model were tried and the one with theoretically expected sign is given below.

$$D = \underset{(10.5)}{12.0} - \underset{(-2.7)}{0.009\,Y} + \underset{(3.3)}{0.051\,P_r} - \underset{(-1.5)}{0.135\,P_t} + \underset{(2.6)}{0.589\,t}$$

R^2 = .64

D-W = .79

Since our aim is only to estimate the demand for the two periods, we have used the above equation eventhough the Durbin-Watson statistic falls in the inconclusive region. The estimated per capita average demand for the first period is 0.35 Kg. and -0.67 Kg. for the second period. This seems to suggest that the demand has constrained the growth of tapioca production in the during the period.

This finding in itself is not a convincing argument for stagnation unless it is shown that the market constraints imposed by falling demand affect the profitability of cultivation. A cursory look at the movement of prices suggest that the market is unstable. In fact, an year of high prices would be followed by increase in area and low prices would be followed by decrease in area under cultivation (George, 1987, p. 38). Therefore, the cultivation of tapioca is subject to increased risk. The effect of this risk on the profit/loss of the cultivator is explained below with the help of cobweb theorem.

3.2 Profitability; a test using cobweb theorem

We use the following version of the cobweb model for the analysis of the stability of the market and its impact on income of the producers. In this model (Nerlove, 1958, p. 56) demand is assumed to be a function of current price and the supply function of lagged price. We introduce time as an additional variable in the specification to include all other variables that influence both demand and supply systematically.
Therefore the modified model becomes,
Demand function,

$$D_t = a_0 + a_1P_t + a_2t$$

Supply function,

$$S_t = b_0 + b_1P_{t-1} + b_2t$$

In equilibrium,

$$P_t = \frac{(b_0 - a_0)}{a_1} + \frac{b_1P_{t-1}}{a_1} + \frac{(b_2-a_2)t.}{a_1}$$

In first difference,

$$P_t-P_{t-1} = \frac{(b_2-a_2)}{a_1} + \frac{b_1}{a_1}(P_{t-1}-P_{t-2}) + E_t$$

Depending on the coefficient of the lagged price variable, b_1/a_1, we can identify three types of cobweb cycle. If the absolute value of the coefficient is greater than 1, the cycle is divergent; equal to 1, dampant; and less than one, convergent. Buchanan's (1939) theorem on cobweb model states that under a divergent cycle farmers producing mainly for the market incur loss. Therefore, the stagnation can be explained if we can show that there exists a divergent cobweb cycle in this market. In fact the first difference version of the model shows that it is a divergent cycle as is evident from the equation below:

$$P_t - P_{t-1} = 5.1 - 1.64 \ (P_{t-1} - P_{t-2}) \quad R^2 = .48$$
$$(1.4) \quad (-4.5)$$

Since the absolute value of the ratio of the slope of supply to demand is greater than 1, the tapioca market follows a divergent cobweb cycle. This implies that the farmers lose income along the cycle[2]. Therefore producers interested only in profit will shift acreage under tapioca to other competing profitable crops. This aspect is taken up in the next section.

IV. Acreage Allocation among Competing Crops

The empirical analysis clearly shows that the sources of stagnation are falling demand coupled with high unstability in the market resulting in loss of income. In such a situation profit motivated farmers shift the area under tapioca to other competing crops. In order to identify such crops that might have gained area from tapioca, we have given the index numbers of area under major competing crops in figure 2. Among the five crops, only rubber and cashew show substantial increase in area during the second period when area under tapioca declined. However, farmers shift area to these crops only if these crops area relatively profitable. The profitability of the crops is taken up in the next section.

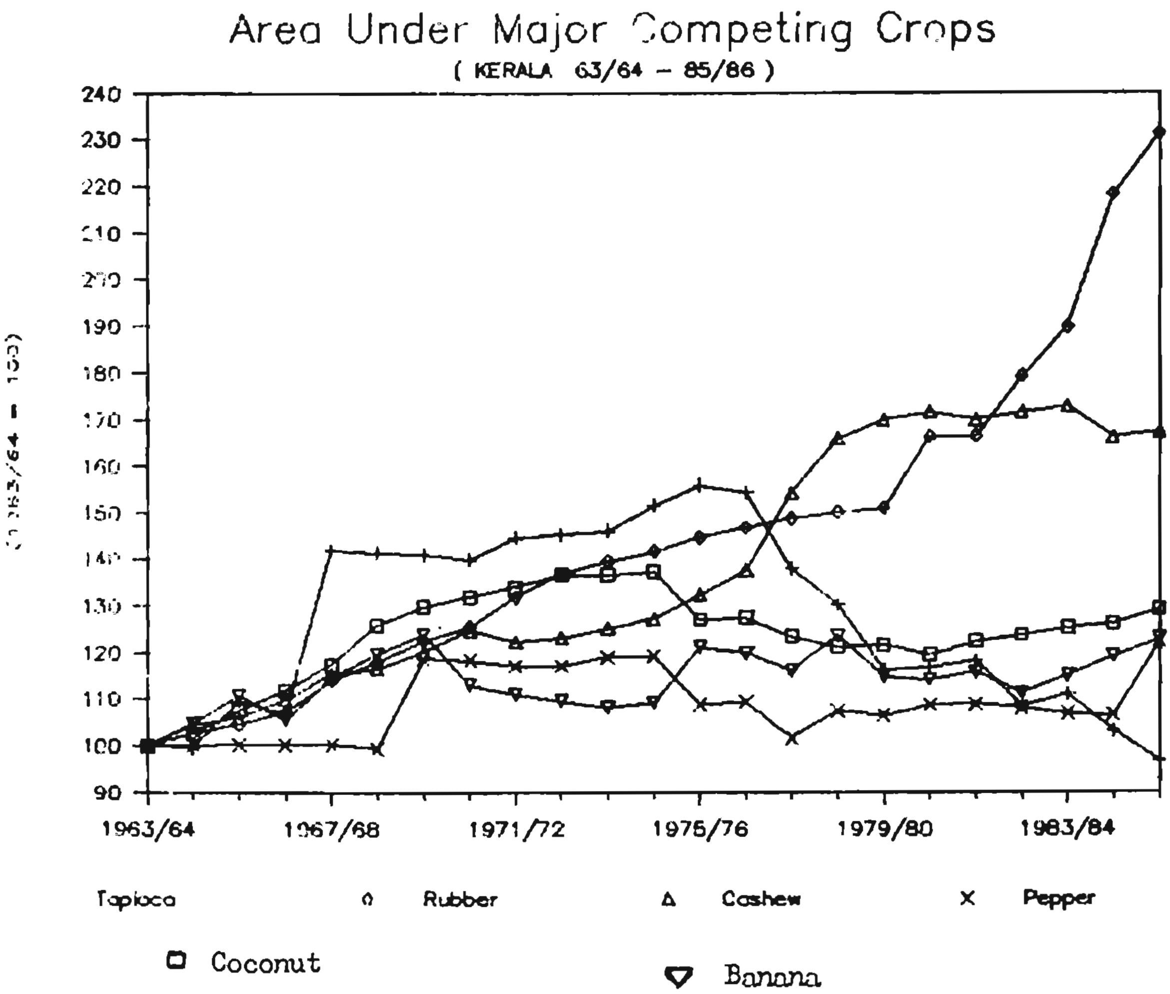

Area Under Major Competing Crops
(KERALA 63/64 – 85/86)
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
1963/64
1967/68
1971/72
1975/76
1979/80
1983/84
Tapioca
Rubber
Cashew
Pepper
Coconut
Banana

Fig. 2.

3.1 Relative profitability of competing crops.

The area under tapioca will be allocated to another crop, only if the farmers are convinced that the crop is relatively profitable. The best indicator would have been the relative profitability of the competing crops. Unfortunately, no such information is available for all the crops. Instead, we have used the relative price as a crude measure of relative profitability. This has been examined using dummy-variable functional form which has several advantages for our purpose:

$$P_i/P_t = a_{0i} + a_{1i}D,$$

where P_i, the price of competing crops,

P_t, the price of tapioca,

D = 1 for the period 1975/76-85/86,

= 0 otherwise.

Several observations can be made about the above model (Goldberger, 1968). The intercept term is the mean relative price for the first period, 1963/64-74/75. The slope is the change in the relative price in the second period, 1975/76-85/86. Therefore, the mean relative price in the second period is given by the sum of the intercept and slope. If the mean value = 1, then the prices are the same. If it is less than 1, then the relative price is moving in favour of tapioca; and if > 1, it is against tapioca. But the farmers are interested in the income not in the price as such from a given area. In such a situation another version of the model is used which deals with relative income position.

$$P_iY_i/P_tY_t = b_{0i} + b_{1i}D,$$

Where Y_i, the yield of ith crop,

Y_t, the yield of tapioca.

The results based on the above models are given in Table 5.

Table 5. Relative Price and Income of Competing Crops (Kerala: 1963/64-85/86)

	Relative Price	Relative income
Coconut	RP = 0.86 + 0.26D R^2=.20 (12.6) (2.5)	RI = 0.36 - 0.04D R^2 = .01 (11.8) (-.1)
Rubber	RP = 0.69 + 0.01D R^2 =.001 (13.7) (.1)	RI = 0.58 + 0.29D R^2 = .54 (14.2) (5.0)
Cashew	RP = 1.19 + 1.05D R^2 =.51 (7.7) (4.6)	RI = 0.54 + 0.01D R^2 = .001 (11.6) (.2)
Pepper	RP = 0.89 + 0.47D R^2 =.31 (8.5) (3.0)	RI = 0.36 + 0.21D R^2 = .34 (8.0) (3.3)
Banana	RP = 0.85 + 0.11D R^2 =.14 (20.5) (1.8)	RI = 0.39 - 0.02D R^2 = .03 (15.7) (-.8)

Source: same as in Table 1.

The mean relative price for the first period is highest for cashew and lowest for rubber. Only cashew had a price advantage over tapioca in the first period since its mean relative price is greater than one. The maximum increase in price in the second period is for cashew followed by pepper and coconut. It is also worth noticing that the crops which have gained maximum price increase during the second period are cash crops meant for exports. But yield adjusted relative price movements have some interesting findings. Rubber, not doing well in terms of relative price, has become the most profitable crop in both periods. The price advantage of coconut and cashew had disappeared in the second period when the yield adjustments were made. Only pepper shows **price increase** over tapioca by both tests.

This finding is used for the estimation of the acreage allocation of tapioca to competing crops.

4.2 Estimation of acreage allocation function.

The relative price analysis clearly shows that rubber and pepper have distinct advantage over tapioca in the second period. Therefore, the area under tapioca can be allocated to rubber and pepper if the farmers are profit maximisers. But the relative income of rubber is higher than that of pepper in both periods. As a result rubber becomes the only competitor for the area under tapioca. The farmer's allocation decision is based on expected real income. Therefore, the allocation function becomes:

$$A = f(RI^e)$$

Where A: area under tapioca,

RI^e: the expected income from rubber relative to tapioca from a given unit of land.

In order to estimate the function we have to specify the expected value in terms of observed price. Assuming that the expectations are based on past prices, we have

$$A_t = f(RI_{t-1}, RI_{t-2}, \ldots)$$

Although several methods are available for the estimation of distributed lag models, 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:

$$(4.2.1)\quad \ln A_t = a_0 + \sum_{i=1}^{\infty} w_i \ \ln \ RI_{t-i} + u_t$$

Now the weights 'w' are approximated by

$$(4.2.2)\quad w_i = \sum_{j=2}^{n} a_j/(i+)^j \qquad i = 1, \ldots, \infty$$

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 (4.2.2) in (4.2.1)

$$(4.2.3)\quad \ln A_t = a_0 + \sum_{i=1}^{\infty} \sum_{j=2}^{n} \frac{a_j}{(i+1)^j} \ \ln \ RI_{t-i} + u_t$$

$$= a_0 + \sum_{i=1}^{\infty} \sum_{j=2}^{n} \frac{a_j \ln \ RI_{t-i}}{(i=1)^j} + R_t + u_t$$

$$= a_0 + \sum_{j=2}^{n} a_j z_{jt} + R_t + u_t$$

Where, $z_{jt} = \sum_{i=1}^{t-1} \frac{\ln RI_{t-i}}{(i+1)^j}$ $j=2 \ldots, n;$ $R_t = \sum_{i=1}^{\infty} \sum_{j=2}^{n} \frac{a_j \ln RI_{t-i}}{(i = 1)^j}$

Mitchell and Speaker suggests that R_t is negligible, if $t > 8$. In other words, the term R_t is simply be dropped from (4.2.3) if we estimate the equation without first eight observations. The model can be estimated only if the degree of polynomial, n, is known. Mitchell and Speaker suggest that it can be determined using nested OLS regressions (p. 331). However, we have estimated the equation assuming that n=2. The estimated equation suffers from autocorrelation since Durbin-Watson statistic is significant. Therefore, the equation need adjustments for autocorrelation. Two of the most commonly used transformations are: (1) Cochrane-Orcutt method ; and (2) Prais-Winsten method. But recent investigation on the efficiency of the two methods suggests that latter is the most efficient method for autocorrelation (Thornton, 1987). The adjusted equations using the two methods are given below:

$$\log A_t = \underset{(224)}{2.10} - \underset{(-6.0)}{1.16} \log Z_{2t} \quad R^2 = .73 \quad D\text{-}W = .79$$

Cochrane-Orcutt Method (C-O):

$$\log A_t = \underset{(122)}{0.84} - \underset{(-3.7)}{0.88} \log Z_{2t} \quad R^2 = .53$$

Prais-Winsten Method (P-W):

$$\log A_t = \underset{(40)}{1.25} - \underset{(-0.8)}{0.71} \log Z_{2t} \quad R^2 = .05$$

It is very interesting to find that C-O method of transformation gives better result than P-W method. This result is contrary to the findings of Thornton. Maybe, C-O method is preferable to P-W method when both autocorrelation and lagged variables are present which needs further research. The response function shows that the **supply** elasticity is 0.88. This implies that a 1% increase in the relative income of rubber reduces .88% of area under tapioca.

Concluding Remarks.

The analysis shows that the growth rate of output of tapioca has slowed down during the period under study, 1963/64-85/86. The periodwise analysis indicates that it has increased rapidly in the first period, 1963/64-74/75 and decreased in the second period, 1975/76-85/86. In other words, tapioca production has lost more than two decades of growth.

At the same time, the mean instability in production and its components, area and yield, has declined during the period for the State as a whole. The inter district variability in the instability has also declined during the period. In other words, the level and variability was higher during the acceleration period of growth in tapioca production. The decomposition of output instability shows that the main source of instability during the period was from area instability. An interesting finding is that the covariance between the instability of area and of yield in the decomposition formula is negative for both periods. In fact, the covariance is higher in the second period. This implies that the factors contributed to this behaviour is stronger during the deceleration period. This may be due to the allocation of fertile land under tapioca to profitable crops like rubber and only marginal land with no alternative use is used for tapioca. As a result, the instability in area should reduce and yield instability should increase. These opposite forces might be responsible for the above negative covariance between area and yield instability.

The hypothesis that falling demand constrained the growth of output growth seems to be empirically valid. As a result of falling demand and lagged supply response, the market for tapioca became highly unstable. The effect of the fluctuation in the prices in the market on the income of the farmers is estimated using a cobweb model. The econometric estimation shows that the market for tapioca follows a divergent cobweb which results in the loss of income for the cultivators. Therefore, profit motivated farmers would minimise the risk by allocating the area under tapioca to competing profitable crops. The competing crops are selected on the basis of relative profitability, These are proxied by relative prices adjusted for the yield differences in the absence of any reliable time series estimates on the cost of production of crops. The statistical analysis shows that only pepper and rubber have a clear advantage over tapioca in terms of gross income per unit of land during the period. Therefore the decline in area should be explained by the relative income of the two crops. The allocation model is valid only if tapioca is not intercropped with the competing crops.

Only rubber satisfies this assumption, since tapioca can be cultivated along with pepper. The allocation function, with relative income of rubber, indicates that a 1 % increase in the relative income of rubber reduces the area under tapioca by .9 per cent.

Two areas need further work. First is the implication of falling demand and supply on the nature of the cobweb. Also, the stability of the cobweb under changing slopes of both demand and supply. The second area of research is the development of a system approach for the estimation of supply response since the acreage under different crops change at the same time which cannot be modelled in the traditional single equation approach.

APPENDIX

A = '000 hectares
O = 000 tones
Y = hectare

Table A: Area, Output and Yield of Tapioca

Year	TRIVANDRUM Area	Prod.	Yield	QUILON Area	Prod.	Yield	ALLEPPEY Area	Prod.	Yield	KOTTAYAM Area	Prod.
1963/64	50183.00	642520.00	12.80	54841.00	605803.00	11.05	26590.00	233639.00	8.79	39263.00	621016.00
1964/65	48114.00	691802.00	14.38	53089.00	626450.00	11.80	24060.00	350314.00	14.56	41413.00	727626.00
1965/66	53844.00	758662.00	14.09	57599.00	695220.00	12.07	23085.00	349211.00	15.13	43815.00	755809.00
1966/67	59228.00	823269.00	13.90	63359.00	949118.00	14.98	22262.00	230857.00	10.37	42838.00	732873.00
1967/68	72735.00	1042293.00	14.33	94165.00	1292885.00	13.73	25113.00	328980.00	13.10	32526.00	597503.00
1968/69	65385.00	747351.00	11.43	100889.00	1450784.00	14.38	22901.00	287408.00	12.55	37888.00	692057.00
1969/70	62937.00	823216.00	13.08	101813.00	1652425.00	16.23	24008.00	574271.00	23.92	37107.00	689819.00
1970/71	70084.00	834700.00	11.91	90965.00	1649195.00	18.13	19715.00	351321.00	17.82	37120.00	690432.00
1971/72	76111.00	1277904.00	16.79	94745.00	1604980.00	16.94	19124.00	284565.00	14.88	39008.00	956086.00
1972/73	76111.00	997815.00	13.11	94745.00	2013331.00	21.25	19124.00	345188.00	18.05	38040.00	813023.00
1973/74	76111.00	1147754.00	15.08	94745.00	1761310.00	18.59	19124.00	448267.00	23.44	38420.00	913243.00
1974/75	78625.00	1176230.00	14.96	99688.00	1820988.00	18.27	19124.00	356663.00	18.65	40120.00	827676.00
1975/76	72035.00	1029296.00	14.29	82538.00	1595363.00	19.33	24568.00	412720.00	16.80	35429.00	636959.00
1976/77	66633.00	946189.00	14.20	85816.00	1414248.00	16.48	28677.00	433596.00	15.12	40262.00	812487.00
1977/78	50668.00	711885.00	14.05	79365.00	1003967.00	12.65	23369.00	349688.00	14.90	30714.00	506167.00
1978/79	55796.00	813506.00	14.58	58150.00	988175.00	14.50	20648.00	314263.00	15.22	26957.00	448025.00
1979/80	49362.00	850507.00	17.23	64391.00	1030256.00	16.00	19065.00	306947.00	16.10	24015.00	481501.00
1980/81	56545.00	965789.00	17.08	59097.00	989875.00	16.75	19592.00	292917.00	13.93	23003.00	408993.00
1981/82	60220.00	904800.00	15.00	60451.00	826970.00	13.68	19094.00	266934.00	13.98	24560.00	405240.00
1982/83	53733.00	859728.00	16.00	55425.00	903428.00	16.30	14972.00	251979.00	16.83	21468.00	445032.00
1983/84	55432.00	993896.00	17.93	41624.00	595223.00	14.30	11900.00	242522.00	20.38	23008.00	482708.00
1984/85	52629.00	811539.00	15.42	42093.00	713897.00	16.96	10764.00	158661.00	14.74	20084.00	406902.00
1985/86	51010.00	769231.00	15.08	35614.00	487200.00	13.68	11102.00	192065.00	17.30	19741.00	390477.00

Table A (Contd.....)

		ERNAKULAM			TRICHUR			PALGHAT		
	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
1963/64	15.82	13680.00	202624.00	14.81	4636.00	40726.00	8.78	2648.00	24597.00	9.29
1964/65	17.57	11881.00	134296.00	11.81	5107.00	35902.00	7.03	6276.00	78764.00	12.55
1965/66	17.25	13568.00	155218.00	11.44	4137.00	46789.00	11.31	6476.00	67027.00	10.35
1966/67	17.11	16105.00	1195[illegible].00	7.42	7243.00	82136.00	11.34	7124.00	92825.00	13.03
1967/68	18.37	23072.00	299706.00	12.99	10278.00	116964.00	11.38	10757.00	73822.00	6.86
1968/69	18.27	15181.00	208891.00	13.76	7287.00	107775.00	14.79	22111.00	288991.00	13.07
1969/70	18.59	15552.00	197666.00	12.71	7439.00	86962.00	11.69	20628.00	252280.00	12.23
1970/71	18.60	14500.00	222720.00	15.36	8262.00	120956.00	14.64	10248.00	104325.00	10.18
1971/72	24.51	13500.00	242190.00	17.94	8345.00	154466.00	18.51	11664.00	140901.00	12.08
1972/73	21.37	11931.00	281917.00	23.63	8345.00	164230.00	19.68	12247.00	260126.00	21.24
1973/74	23.77	12050.00	200753.00	16.66	8345.00	160808.00	19.27	12859.00	279297.00	21.72
1974/75	20.63	12171.00	201065.00	16.52	8617.00	158897.00	18.44	13373.00	247668.00	18.52
1975/76	17.98	17091.00	323702.00	18.94	12178.00	154884.00	13.54	7965.00	112298.00	14.10
1976/77	20.18	14334.00	215010.00	15.00	9225.00	134224.00	14.55	7954.00	130605.00	16.42
1977/78	16.48	14985.00	264935.00	17.68	7610.00	139415.00	18.32	12553.00	183023.00	14.58
1978/79	16.62	14015.00	229145.00	16.35	8681.00	113027.00	13.02	15659.00	233319.00	14.90
1979/80	20.05	12789.00	263452.00	20.60	6673.00	91754.00	13.75	12397.00	190294.00	15.35
1980/81	17.78	12462.00	240267.00	19.28	6191.00	92555.00	14.95	12644.00	177648.00	14.05
1981/82	16.50	12382.00	243059.00	19.63	6157.00	76655.00	12.45	12714.00	191346.00	15.05
1982/83	20.73	10782.00	207554.00	19.25	5493.00	102060.00	18.58	12831.00	185151.00	14.43
1983/84	20.98	11874.00	252323.00	21.25	5797.00	103650.00	17.88	12990.00	183159.00	14.10
1984/85	20.26	10364.00	205207.00	19.80	5688.00	73773.00	12.97	12515.00	234281.00	18.72
1985/86	19.78	10216.00	190528.00	18.65	5515.00	65242.00	11.83	11960.00	158829.00	13.28

Table A (Contd......)

	KOZHIKODE			CANNANORE			KERALA		
Year	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
1963/64	12208.00	101102.00	8.28	5861.00	51500.00	8.79	209.91	2523.97	120.24
1964/65	12208.00	150158.00	12.30	7726.00	67885.00	8.79	209.37	2763.20	131.98
1965/66	19687.00	201595.00	10.24	7523.00	66127.00	8.79	229.68	3095.66	134.78
1966/67	20537.00	289572.00	14.10	5956.00	89518.00	15.03	224.65	3409.67	151.78
1967/68	22214.00	275898.00	12.42	5786.00	111901.00	16.49	297.65	4198.36	141.05
1968/69	16247.00	207962.00	12.80	8822.00	89896.00	[illegible]	296.66	[illegible]	137.57
1969/70	[illegible]	279900.00	16.14	8759.00	109225.00	[illegible]	[illegible]	4665.76	157.85
1970/71	11381.00	186535.00	16.39	7136.00	91269.00	[illegible]	293.60	4617.19	157.26
1971/72	10812.00	173533.00	16.05	6994.00	159813.00	[illegible]	303.30	5429.28	179.01
1972/73	10920.00	159432.00	14.60	7344.00	156488.00	[illegible]	304.80	5692.36	186.76
1973/74	11029.00	178560.00	16.19	7711.00	151830.00	[illegible]	306.45	5659.52	184.68
1974/75	11139.00	163743.00	14.70	8251.00	[illegible]	[illegible]	317.36	5625.12	176.96
1975/76	[illegible]	167970.00	18.21	21499.00	393420.00	[illegible]	[illegible]	5390.22	164.90
1976/77	8574.00	96715.00	11.28	22706.00	412795.00	[illegible]	323.28	5125.52	158.55
1977/78	11807.00	169785.00	14.38	21329.00	346596.00	16.25	289.72	4188.57	144.57
1978/79	8836.00	94722.00	10.72	23461.00	371153.00	15.82	273.48	4044.50	147.89
1979/80	7470.00	92852.00	12.43	18322.00	281243.00	15.35	243.76	4088.92	167.74
1980/81	7756.00	99277.00	12.80	18765.00	349967.00	18.65	244.99	4060.91	165.76
1981/82	3694.00	49426.00	13.38	17963.00	274834.00	15.30	248.07	3745.14	150.97
1982/83	3154.00	38952.00	12.35	18711.00	288711.00	15.43	227.62	3848.72	169.09
1983/84	3361.00	39929.00	11.68	18124.00	276029.00	15.23	233.01	3903.17	167.51
1984/85	3850.00	29607.00	7.69	17196.00	262583.00	15.27	216.74	3694.27	170.45
1985/86	3461.00	39282.00	11.35	8719.00	177955.00	20.41	202.92	3276.88	161.49

Index numbers (tapioca)

Table 3: Index numbers of area, output and yield of Tapioca.

	TRIVANDRUM			QUILON			ALLEPPEY			KOTTAYAM		
Year	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
1963/64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1964/65	95.88	107.67	112.30	96.81	103.41	106.82	90.49	149.94	165.70	105.48	117.17	111.08
1965/66	107.30	118.08	110.05	105.03	114.76	109.26	86.82	149.47	172.16	111.59	121.71	109.06
1966/67	118.02	128.13	108.56	115.53	156.67	135.61	83.72	98.81	118.02	109.11	118.01	108.16
1967/68	144.94	162.22	111.92	171.71	213.42	124.29	94.45	140.81	149.09	82.84	96.21	116.14
1968/69	130.29	116.32	89.27	183.97	239.48	130.18	86.13	123.01	142.83	96.50	111.44	115.48
1969/70	125.41	128.12	102.16	185.65	272.77	146.92	90.29	245.79	272.23	94.51	111.08	117.53
1970/71	139.66	129.91	93.02	165.07	272.23	164.12	74.14	150.37	202.81	94.54	111.18	117.60
1971/72	151.67	198.89	131.14	172.76	264.93	153.35	71.92	121.80	169.35	99.35	153.96	154.96
1972/73	151.67	155.30	102.39	172.76	332.34	192.37	71.92	147.74	205.42	96.89	130.92	135.13
1973/74	151.67	178.63	117.78	172.76	290.74	168.29	71.92	191.86	266.77	97.85	147.06	150.28
1974/75	156.68	183.07	116.84	181.78	300.59	165.36	71.92	152.66	212.25	102.18	133.28	130.43
1975/76	143.54	160.20	111.60	150.50	263.35	174.98	92.40	176.65	191.19	90.24	102.57	113.67
1976/77	132.78	147.26	110.91	156.48	233.45	149.19	107.85	185.58	172.08	102.54	130.83	127.59
1977/78	100.97	110.80	109.74	141.72	165.72	114.52	88.26	149.67	169.57	78.23	81.51	104.19
1978/79	111.19	126.61	113.87	124.27	163.12	131.26	77.65	134.51	173.22	68.66	72.14	105.08
1979/80	98.36	132.37	134.57	117.41	170.06	144.84	71.70	131.38	183.23	61.16	77.53	126.76
1980/81	112.68	150.31	133.40	107.76	163.40	151.63	73.68	116.81	158.53	58.59	65.86	112.41
1981/82	120.20	140.82	117.16	110.23	136.51	123.84	71.81	114.25	159.10	62.55	65.25	104.32
1982/83	107.07	133.81	124.97	101.06	149.13	147.56	56.31	107.85	191.54	54.68	71.66	131.06
1983/84	110.46	154.69	140.04	75.90	98.25	129.45	44.75	103.80	231.94	58.60	77.73	132.64
1984/85	104.87	126.31	120.44	76.75	117.84	153.53	40.48	67.91	167.75	51.15	65.52	120.09
1985/86	101.65	119.72	117.78	64.94	80.42	123.84	41.75	82.21	196.89	50.28	62.88	125.06

Table B (Contd.....)

	ERNAKULAM			TRICHUR			PALGHAT		
Year	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
1963/64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1964/65	83.19	66.28	79.67	110.16	88.15	80.02	237.01	320.22	135.11
1965/66	99.18	76.60	77.24	89.24	114.89	128.74	244.56	272.50	111.42
1966/67	117.73	58.98	50.10	156.23	201.68	129.09	269.03	377.38	140.27
1967/68	168.65	147.91	87.70	221.70	287.20	129.54	406.23	300.13	73.88
1968/69	110.97	103.09	92 .90	157.18	264.63	168.36	835.01	1174.90	140.71
1969/70	113.68	97.55	85.81	160.46	213.53	133.07	779.00	1025.65	131.66
1970/71	105.99	109.92	103.70	178.21	297.00	166.65	387.01	424.14	109.59
1971/72	98.68	119.53	121.12	180.00	379.28	210.71	440.48	572.84	130.05
1972/73	87.21	139.13	159.53	180.00	403.26	224.03	462.50	1057.55	228.66
1973/74	88.08	99.08	112.48	180.00	394.85	219.36	485.61	1135.49	233.83
1974/75	88.97	99.23	111.53	185.37	390.16	209.91	505.02	1006.90	199.38
1975/76	124.93	159.76	127.87	262.68	404.86	154.13	300.79	456.55	151.78
1976/77	104.78	106.11	101.27	198.99	329.58	165.63	300.38	530.98	176.77
1977/78	109.54	130.75	119.37	164.15	342.32	208.54	474.06	744.09	156.96
1978/79	102.45	113.09	110.39	187.25	277.53	148.21	591.35	948.57	160.41
1979/80	93.49	130.02	139.08	143.94	225.30	156.52	468.16	773.65	165.25
1980/81	91.10	118.58	130.17	133.54	227.26	170.18	477.49	722.23	151.26
1981/82	90.51	119.96	132.53	132.81	188.22	141.72	480.14	777.92	162.02
1982/83	78.82	102.43	129.97	118.49	250.60	211.50	484.55	752.74	155.35
1983/84	86.80	124.53	143.47	125.04	254.51	203.53	490.56	744.64	151.79
1984/85	75.76	101.27	133.68	122.69	181.14	147.64	472.62	952.48	201.53
1985/86	74.68	94.03	125.91	118.96	160.20	134.66	451.66	645.73	142.97

T ABLE B: (Contd....)

Year	KOZHIKODE Area	KOZHIKODE Prod.	KOZHIKODE Yield	CANNANORE Area	CANNANORE Prod.	CANNANORE Yield	KERALA Area	KERALA Prod.	KERALA Yield
1963/64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1964/65	100.00	148.52	148.52	131.82	131.82	100.00	99.74	109.48	109.76
1965/66	161.26	199.40	123.65	128.36	128.40	100.04	109.42	122.65	112.09
1966/67	168.23	286.42	170.26	101.62	173.82	171.05	107.02	135.09	126.23
1967/68	181.96	272.89	149.97	115.78	217.28	187.67	141.80	166.34	117.31
1968/69	133.08	205.70	154.56	150.52	174.56	115.97	141.33	161.69	114.41
1969/70	142.05	276.85	194.89	149.45	212.09	141.92	140.81	184.86	131.28
1970/71	93.23	184.50	197.91	121.75	177.22	145.56	139.87	182.93	130.79
1971/72	88 .56	171.64	193.80	119.33	310.32	260.05	144.49	215.11	148.87
1972/73	89.45	157.69	176.29	125.30	303.86	242.50	145.21	225.53	155.32
1973/74	90.34	176.61	195.49	131.56	294.82	221.08	145.09	224.23	153.59
1974/75	91.24	161.96	177.50	140.78	421.68	299.54	151.44	222.87	147.17
1975/76	75.55	166.14	219.91	366.81	763.92	208.26	155.72	213.56	137.15
1976/77	70.23	95.66	136.21	387.41	801.54	206.90	154.01	203.07	131.86
1977/78	96.72	167.93	173.64	363.91	673.00	184.93	138.02	165.95	120.24
1978/79	72.38	93.69	129.44	400.29	720.69	180.04	130.28	160.24	123.00
1979/80	61.19	91.84	150.09	312.61	546.10	174.69	116.13	162.00	139.51
1980/81	63.53	98.19	154.56	320.17	679.55	212.25	116.71	160.89	137.86
1981/82	30.26	48.89	161.56	306.48	533.66	174.12	118.18	148.38	125.56
1982/83	25.84	38.53	149.13	319.25	560.60	175.60	108.44	152.49	140.62
1983/84	27.53	39.49	143.45	309.23	535.98	173.33	111.00	154.64	139.31
1984/85	31.54	29.28	92.86	293.40	509.87	173.78	103.25	146.37	141.76
1985/86	28.35	38.85	137.05	148.76	345.54	232.28	96.67	129.83	134.30

Table C.

	Paddy			Index of		
	Area (000 hct)	Prod. (000tons)	Yield (Ql/ha)	Area	Prod.	Yield
1962/63	802.66	1093.21	13.62	100.00	100.00	100.00
1963/64	805.08	1128.00	14.01	100.00	103.18	102.87
1964/65	801.12	1121.38	14.00	99.81	102.58	102.77
1965/66	802.33	997.49	12.43	99.96	91.24	91.28
1966/67	799.44	1084.06	13.56	99.60	99.16	99.56
1967/68	809.54	1123.90	13.88	100.86	102.81	101.93
1968/69	873.87	1251.35	14.32	108.87	114.47	105.14
1969/70	874.06	1226.41	14.03	108.90	112.18	103.02
1970/71	874.80	1298.01	14.84	108.99	118.73	108.94
1971/72	875.20	1351.74	15.44	109.04	123.65	113.40
1972/73	873.70	1376.37	15.75	108.85	125.90	115.66
1973/74	874.68	1257.07	14.37	108.97	114.99	105.52
1974/75	881.47	1333.93	15.13	109.82	122.02	111.11
1975/76	884.97	1364.87	15.42	110.25	124.85	113.24
1976/77	854.37	1254.00	14.68	106.44	114.71	107.77
1977/78	840.37	1294.64	15.41	104.70	118.43	113.11
1978/79	799.24	1273.32	15.93	99.57	116.48	116.97
1979/80	793.27	1299.70	16.38	98.83	118.89	120.30
1980/81	801.70	1271.96	15.[illegible]7	99.88	116.35	116.49
1981/82	806.85	1339.39	16.60	100.52	122.52	121.88
1982/83	778.49	1306.20	16.78	96.99	119.48	123.19
1983/84	740.09	1207.92	16.[illegible]2	92.20	110.49	119.83
1984/85	730.38	1255.90	17.20	90.99	114.88	126.25
1985/86	678.28	1173.05	17.29	84.50	107.30	126.98

Foot Notes

1. The consumption figures are derived from production using the proportion of domestic consumption, 70%, in 1981 given in Table 13 (George, 1987, p. 29).

2. Buchanan (1939, 68–73) has proved diagramatically that the producer loses income under divergent cobweb cycle but makes profit under convergent and oscillatory cycle. A simple mathematical proof is given below.

   The cobweb becomes divergent, oscillatory or convergent according as the slope of the supply function is greater than, equal to or less than the slope (absolute value) of the demand function. This implies.

   i.e. $$\frac{dS}{dq} \gtreqless \frac{dD}{dq}$$

   Integrating both sides with respect to price,

   $$\int \frac{dS}{dq}\, dq \gtreqless \int \frac{dD}{dq}\, dq$$

   $$S \gtreqless D$$

   Under competitive conditions

   $$MC = S; \quad P = D$$

   Therefore, $S > D$ implies loss of income,

   $S = D$ implies normal profit.

   $S < D$ implies excess profit which is over and above the 'normal profit!

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