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ARTICLES

A DISAGGREGATE ANALYSIS OF THE GROWTH PERFORMANCE OF RICE IN KERALA

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Rice, the most important food crop grown in Kerala, accounts for about 28 per cent of the cropped area and for more than 99 per cent of the cereals produced in the State.[1] The 1983-84 production of 1.21 million tonnes of rice[2] was below the peak level of 1.38 million tonnes in 1972-73. The average growth rate of production during 1960-61 to 1974-75 was 2.06 per cent but it dropped to 0.21 per cent during 1975-76 to 1983-84. While at the all-India level agricultural growth rate in the seventies was higher than that in the sixties, rice production in Kerala after mid-seventies was somewhat stagnant.[3] This paper attempts to analyse the changes in the growth pattern of rice in Kerala over and across time (prior to the mid-seventies and afterwards), across seasons (autumn, winter and summer), and across space (major rice growing districts). It also analyses the role played by technology (especially high-yielding varieties), irrigation, and relative prices in explaining the changes in area, yield, and production of rice.

GROWTH RATES

The annual growth rate of rice area between 1960-61 and 1983-84 was only 0.15 per cent. While the annual growth rate of area was positive (1.14 per cent) for the first period, it turned out to be negative (—1.50 per cent) for the second period.[4] Among the seasons, the highest growth rate for the first period was during summer, but for the second period the highest negative growth rate also occurred during summer.

The average annual growth rate of yield for the combined period was 1.01 per cent. In both the periods, the smallest growth rate of yield among the three seasons was during winter. While the highest growth rate of yield for the first period was during summer, for the second period and the combined period it was during autumn that the highest growth rate occurred.

While the growth rates of production were positive during all seasons and the combined seasons for the first period, they were negative during second period winter and summer because of the dominant role played by the negative growth rates of area over the positive growth rates of yield. Though the growth rate of

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1. Of the total area of 7,40,086 hectares under rice during 1983-84, 44.3 per cent was cultivated in autumn, 43.9 per cent in winter and 11.8 per cent in summer. The area under rice gradually increased from 779 thousand hectares in 1960-61 to 881 thousand hectares in 1974-75 before the decline had set in.

2. The shares of autumn, winter and summer production in the total production were 43.1 per cent, 43.1 per cent and 13.8 per cent respectively.

3. See Alagh and Sharma (1980), Rath (1980) and Panikar (1980).

4. The period 1960-61 to 1974-75 is referred to as the first period, and 1975-76 to 1983-84 as the second period.

area was negative during the second period autumn also, the positive growth rate of yield had offset the negative impact of area.

TABLE I. GROWTH RATES OF AREA, YIELD AND PRODUCTION OF RICE IN KERALA

(per cent)

Particulars		Growth rates during			
		Autumn	Winter	Summer	All seasons
Period I					
Area	...	0.10	1.79	2.72	1.14
Yield	...	1.34	0.23	1.71	0.92
Production	...	1.44	2.02	4.42	2.06
Period II					
Area	...	—1.19	—1.58	—2.39	—1.50
Yield	...	2.46	1.07	1.74	1.70
Production	...	1.27	—0.52	—0.65	0.21
Combined period					
Area	...	—0.64	0.63	1.59	0.15
Yield	...	1.41	0.49	1.14	1.01
Production	...	0.78	1.11	2.73	1.16

In the first period all districts had positive growth rates of production. However, in six districts the positive growth rates of production were associated with positive growth rates of both area and yield, and in the seventh district (Palghat) the growth rate of production was positive in spite of a negative growth rate of area. In the second period, Palghat was the only district where area, yield and production had positive growth rates simultaneously. All the remaining districts had negative growth rates of area, but positive growth rates of yield in Quilon, Alleppey and Ernakulam were sufficient to provide positive growth rates of production. However, in Trivandrum, Kottayam and Trichur because of the dominant negative growth rates of area, production growth rates were negative.

When the two periods were combined Quilon, Alleppey, Ernakulam and Trichur had positive growth rates of area, yield and production; Kottayam and Palghat had positive growth rates of yield and production, but negative growth rates of area; and Trivandrum had negative growth rates of area and production, but positive growth rate of yield.

Both area and yield for the first period had the highest growth rates during summer leading to the highest growth rate of production, but because of the reversal in both area and yield rates for the second period, production growth rate was minimum during summer.

While the growth rates of production were positive for the first period during all seasons and for the combined seasons, winter and summer seasons of the second period recorded negative growth rates of production: an outcome of the dominant role played by the negative growth rates of area over the positive growth rates of yield. Though the second period growth rate of area was negative during autumn season also, the positive growth rate of yield during this period had offset the negative impact of area to provide a positive growth rate of output. A classification of the

districts according to positive and negative growth rates of area, yield and production in the different seasons of the two periods is given in Table II.

TABLE II. CLASSIFICATION OF DISTRICTS ACCORDING TO GROWTH RATES OF AREA, YIELD AND PRODUCTION OF RICE (SEASONWISE)

Growth rates	Period I			Period II		
	Autumn	Winter	Summer	Autumn	Winter	Summer
+A, +Y ...	QLN ALP KOT TCR	— — KOT TCR PLGT	TVM ALP KOT TCR	QLN ALP KOT PLGT	PLGT	ALP EKM TCR
	(4)	(3)	(4)	(4)	(1)	(3)
+A, —Y ...		TVM QLN ALP EKM	QLN EKM			
		(4)	(2)			
—A, +Y ...	TVM EKM PLGT		PLGT(P_)	TVM(P_) EKM TCR	ALP(P_) QLN(P_) KOT(P_) EKM TCR(P_)	TVM(P_) QLN(P_) KOT(P_) PLGT(P_)
	(3)		(1)	(3)	(5)	(4)
—A, —Y ...	—	—	—	—	TVM(P_) (1)	—

Notes:— (P_) corresponds to negative growth rate of production. In all other cases, output growth rate is positive. +indicates positive growth rates, —indicates negative growth rates.

QLN = Quilon; ALP = Alleppey; KOT = Kottayam; TCR = Trichur; TVM = Trivandrum; EKM = Ernakulam; and PLGT = Palghat.

GROWTH AND STABILITY

The measures adopted for accelerated growth of agricultural production in India have often resulted in increasing annual fluctuations in production, especially after the introduction of high-yielding varieties (HYVs).[5] Since increased fluctuations in output levels lead to a number of problems in food management operations, often measures are initiated to reduce variability in output levels along with measures for achieving sustained levels of growth.

The growth rates of area under paddy during the second period declined over those for the first period for all the three seasons individually and for the combined seasons. However, between the two periods, annual fluctuation in area declined during autumn and winter; and it remained stable during summer and the combined seasons. Some of the important factors responsible for acreage adjustments include changes in the physical conditions (especially irrigation facilities), weather conditions, and relative price changes. A change induced by weather conditions is of a short-term nature and therefore weather induced changes in the cropping pattern have a tendency to increase the fluctuation in area. The fact that the growth

5. See Sen (1967) and Rao (1975).

rates of area remained negative during all seasons in the second period and that the fluctuations remained either at stable or decreased levels indicates that the reduction in area was the result of conscious decisions made at the farm level in favour of substituting other crops for paddy. This can be either because land diverted from paddy is brought under long duration crops (perennial crops) or because disadvantageous relative price situation prevailed over a long period.

While the growth rates of area for the second period were negative (and also a fall in the growth rates during this period), the growth rates of yield for the second period were consistently above those of the first period for all the three seasons. However, the fluctuations of yield have declined during winter and summer, and remained stable during autumn, indicating an overall reduction in the variability of yield during the second period. This is somewhat contradictory to the experience in the early phase of HYVs when the yield increases associated with the new varieties induced higher levels of fluctuations over time. At the same time, the reduced level of fluctuations of yield is consistent with the reduced level of fluctuations of area, indicating that the land retained under paddy cultivation was suitable for this purpose and that there was no major in-built technology bias towards inducing higher levels of fluctuations.

In general, a situation of improved growth rates of yield associated with reduced variations would be most desirable. However, the performance of rice in Kerala during the second period does not provide such an encouraging outlook. The increased growth rate of yield for the second period was only a mild recovery from the near stagnant growth rate for the first period.

Along with the fall in the growth rate of output in the second period, there had been a decline in the fluctuations of output levels. Reductions in the fluctuations of both area and yield of rice have contributed towards a reduced level of variability in the output of rice.

The observed behaviour of changes in the growth rates and fluctuations for the State was not uniformly consistent for all the districts. While there was no instance of increased fluctuations at the State level in area, yield and output for the combined seasons, the fluctuations of area for the combined seasons increased in Trivandrum, Alleppey and Kottayam. Increased fluctuations of area were observed during autumn in Kottayam; during winter in Trivandrum, Alleppey and Trichur; and during summer in Alleppey. Fluctuations of yield levels increased in Trichur (autumn), Alleppey (winter) and Quilon (summer); and fluctuations of output levels increased in Kottayam (autumn), Alleppey (winter), and Alleppey, Trivandrum and Quilon (summer). Thus, in general, fluctuations of area, yield and output indicated an increasing tendency in some of the southern districts of Kerala. However, the opposite tendency in the northern districts and some of the southern districts had a dominant role so that for the State as a whole, the fluctuations of area, yield and output declined or remained stagnant.

SOURCE OF GROWTH

An additive decomposition model was used to identify the contributions of area, yield and interactions in explaining the changes in production over the

period.[6] The changes in production were analysed for each season and for the annual data in the first and second periods separately and in the combined period.

Autumn: For the first period, 90 per cent of the changes in autumn rice production levels in the State were accounted by yield, 8 per cent by area and 2 per cent by interaction between area and yield.[7] However, for the second period, yield had a positive contribution of 205 per cent, and the area effect was —93 per cent. When the two periods are pooled together the contribution of yield was 170 per cent and that of area was —53 per cent. For the combined period the yield effect was positive in all the districts, but the area effect was positive only in Quilon, Alleppey, Kottayam, Ernakulam and Trichur. In spite of the positive contribution of area in these five districts, the negative contribution of area in Trivandrum and Palghat influenced the negative overall contribution of area in the State. The contributions of yield were positive in all districts for the first and second periods. However, the contribution of area for the first period remained negative in Trivandrum and Palghat, and for the second period it was negative in Trivandrum, Kottyam, Ernakulam and Trichur.

Winter: A major share of increase in production of winter paddy for the first period was accounted for by the changes in area. For the second period, the contribution of area had a large negative value. However, for the combined period, area changes contributed to 53 per cent of the changes in production and the contribution of yield was 42 per cent.

Summer: In the first period 68 per cent of the changes in summer production of the State was accounted for by area and 24 per cent by yield. For the second period the negative contribution of area exceeded the positive contribution of yield. For the combined period 55 per cent of the changes in summer production was accounted by area and 36 per cent by yield.

All seasons: Area accounted for 53 per cent of the production changes for the first period and the contribution of yield was 41 per cent. However, for the second period area accounted for a large negative share as against a larger positive share of yield. For the combined period, 89 per cent of the change in output was accounted for by yield and only 9 per cent was explained by area.

At the State level, yield was the dominant factor influencing production changes during autumn for both the periods separately and for the combined period. However, during winter and summer, area changes dominated production changes for both the periods and the combined period. Thus, for the first period, the dominance of yield during autumn was nullified by the dominance of area during winter and summer, thereby area emerged as the overall dominant factor for the annual data. For the second period, the dominance of yield during autumn had offset the dominance of area during winter and summer to emerge as the dominant factor for the annual data. For the combined period also the dominant role of yield (autumn) prevailed over the dominant area (winter and summer) to emerge as the dominant force influencing annual changes in production.

ANNUAL CHANGES

The analysis of the sources of growth based on changes over a period can be

6. See Minhas and Vaidyanathan (1965), Dharm Narain (1977) and Vidya Sagar (1980).
7. Three-year average levels for the base year and final year were used.

considered as trends emerging over a medium-term or a long-term horizon depending on the duration of the period. At the time same, analysis of annual changes in area, yield and production, all of which can be considered as short-term changes, is also important to understand the change pattern.

During autumn of the first period, production increased in ten years and declined in four years. That yield was the major factor responsible for all changes was consistent with the result obtained from the analysis of terminal values. During winter, yield was the dominant factor for seven out of ten cases of production increases and for all the four cases of production decline. Thus, when yield dominated annual changes in production in most years, area emerged as the dominant factor in the interval. The results for the summer and for the combined seasons were consistent with the winter season.

Of the four cases of production increase and three cases of production decline in the second period, yield was the dominant factor in all cases of production increase and two cases of decline. During winter yield dominated only one of the two cases of production increase and one of the five cases of decline in production: during summer yield dominated all the four cases of production increases and two out of three cases of production decline. However, when the changes during the interval were considered, area was the dominant factor explaining production changes. The dominance of yield in the combined seasons was also consistent with the changes over the interval.

Annual changes in area under paddy had a dominant role in production changes in a fewer number of years than the annual changes in yield.[8] However, area changes over an interval had emerged as the dominant factor in winter and summer for both the first and second periods.

FACTORS INFFUENCING PERFORMANCE

The contributions of area and yield in explaining changes in production of rice during different periods indicated differential pattern across the districts and seasons over the years. The factors responsible for changes in area and yield are analysed with particular reference to the role of relative prices in acreage adjustments, and the role of HYVs and irrigation in explaining yield levels. Since yield data for HYV and non-HYV according to irrigation facilities were available only for the second period, the analysis was confined to this period.

Acreage Adjustments

Farm level decisions on acreage allocations under different crops are often considered to be influenced by changes in relative prices of different crops. Along with changes in yield and cost, price changes influence the relative profitability of different crop enterprises and this shift in profitability influences acreage adjustments through increased total cropped area or shifts in the existing cropping pattern.

8. For the combined period, yield was the dominant factor for all the 15 cases of production increases during autumn, eight out of 12 increases during winter, 11 out of 13 increases during summer, and ten out of 12 increases in the combined seasons. As far as production decline was considered, yield was the dominant factor in six out of seven cases during autumn, six out of ten cases during winter, eight out of nine cases during summer, and five out of ten cases in the com bined seasons.

Though acreage adjustments of paddy can be influenced by the changes in the relative profitability with respect to a number of crops such as sugarcane, bananas, vegetables, and coconut, in the Kerala context it is often mentioned about the conversion of paddy land to coconut. In view of this and considering the data availability, the present analysis is confined to the adjustments of paddy area in response to changes in paddy prices relative to coconut prices.[9]

$$A_p = f(P_p, P_c, t)$$

where A_p = area under paddy,
P_p = farm level price of paddy,
P_c = farm level price of coconut,[10]
and t = time trend.

Different functional forms were tried with and without introducing the time variable. The best estimate based on the goodness of fit and significance of the coefficient was obtained from a semi-log specification with time trend included as a variable. The estimated equation had the following coefficients and t values.[11]

Variable		Coefficient	t value
Paddy price (P_p)	...	0.0006	2.59
Coconut price (P_c)	...	—0.0002	3.13
Time (t)	...	0.0101	2.44

All the coefficients had expected signs and the t values were significant. Further, the F value for the total equation was also significant. The elasticities at the mean values indicated that for one per cent increase in paddy price, paddy area increased by 0.0702 per cent and for one per cent increase in coconut price, paddy area decreased by 0.1257 per cent. Thus, paddy area was inelastic with respect to both paddy price and coconut price, though both had statistically significant influence on area.

Conversion of paddy area to coconut involves a permanent shift in the cropping pattern. However, it is likely that farmers may not shift from a seasonal crop to a perennial crop based on relative price changes in the short run. When prices and wages turn out to be unfavourable, the first reaction may be to keep land fallow for the current year and to watch the situation before a permanent shift is contemplated. In such situations, the current fallow might be a good indicator of the farmer's response.[12]

While the current fallow (F_t) was related with lagged paddy price (P_{t-1}) and

9. An analysis of agricultural price movements in Kerala indicated that the increase in wholesale price of non-food crops was much higher than the increase in wholesale price for food crops. Among food crops, the lowest increase was for cereals (see George, 1982).

10. When paddy land is converted to coconut land, small bunds are created for planting coconut and in most cases no other intercrop is grown with coconut. Therefore, only coconut price is included in the model.

11. When lagged prices were used, the results were quite similar.

12. The area under current fallow in 1969-70 was 22,866 hectares and it increased to 44,487 hectares in 1981-82.

wage rate (W_{t-1}), it was observed that wage rate had a very significant influence on current fallow. The estimated equation was

$$F_t = -3.811 \underset{(1.23)}{P_{t-1}} + \underset{(7.46)}{4.6325^{***}} W_{t-1}; \quad R^2 = 0.86$$

(***Significant at 0.1 per cent.)

Since paddy is grown during different seasons, it is possible that annual lags can be modified by seasonal lags. Thus, based on the first season's experience the farmers might change their decision to keep land fallow in the second season, and therefore the area under fallow could respond to prices and wages in the same period. The relationship among current fallow (F_t), paddy price (P_t) and wage rate (W_t) indicated that both P_t and W_t had a significant influence on current fallow. The estimated equations indicated that current fallow declined with increased paddy price and it increased with increased wage rate.

$$F_t = \underset{(2.71)}{-8.9427^{*}} P_t + \underset{(7.26)}{4.2582^{***}} W_t; \quad R^2 = 0.84$$

*(Significant at 5 per cent, ***Significant at 0.1 per cent.)

As indicated earlier, changes in relative prices constitute only a partial explanation for acreage adjustments. Following Nerlove's lagged expectation models,[13] a number of studies have explained current year's acreage adjustments through lagged responses to previous year's actual experience on the farm. Since profitability of a particular crop enterprise depends on yield, price and cost of production, the farmers base their current expectation on their previous experience with these factors. The acreage response of paddy area was analysed using the following specifications:

$$A_t = f(Y_{t-1}, P_{t-1}, C_{t-1}),$$

where A_t = area under paddy during period
Y_{t-1} = yield in t—1.
P_{t-1} = price in t—1,
C_{t-1} = a measure of cost of production in t—1.,

Wage rate (W_t) and fertiliser price (N_t) were used as two indicators of cost of production. The estimated equations had the following coefficients

Dependent variable	Equation 1	Equation 2
Lagged yield (Y_{t-1})	0.2329 (1.82)	—0.0528 (1.32)
Lagged price (P_{t-1})	89.4587** (3.81)	28.3148 (0.93)
Lagged wage rate (W_{t-1})	—17.1311* (2.67)	—28.2452* (2.41)
Lagged fertiliser price (N_{t-1})		17.8116 (0.75)

(*Significant at 5 per cent, ** Significant at 1 per cent)

13. Nerlove (1958).

From the first equation it is apparent that both lagged price and lagged wage rate turned out to be significant in explaining the area under paddy. Both these variables had the *a priori* expected signs, indicating that the paddy area increased with increased paddy price and it declined with increased wage rate. When fertiliser price was also introduced to represent the cost of production in the second equation, it did not improve the results.

High-Yielding Varieties

The growth rates of area under HYV[14] and non-HYV paddy indicated that during the second period, there had been an overall decline in the area under both HYV and non-HYV. While the area under HYV declined by —1.57 per cent annually, the area under non-HYV declined by —1.51 per cent. During autumn, the HYV area had a positive growth rate of 2.06 per cent while the non-HYV area had a negative growth rate of —2.73 per cent, indicating that along with the decline in the area under paddy there had been a shift from non-HYV to HYV. During winter, both HYV and non-HYV area declined, but the decline was more pronounced in the case of non-HYV.

During summer, while HYV area declined at an annual rate of —10.04 per cent, non-HYV area increased at an annual rate of 6.63 per cent, indicating that while the overall area under paddy declined during summer (—2.39 per cent), simultaneously there was a shift from HYV to non-HYV. Since autumn paddy is largely dependent on monsoon, it appears that the farmers found it profitable to shift from traditional varieties to HYV. However, their experience with HYV during summer might have been discouraging and therefore they might have shifted back to non-HYV.

During winter, HYV area indicated a positive growth rate only in one district (Quilon) and there was no region where non-HYV area increased. During summer, HYV area increased only in Quilon, but the non-HYV area increased in Alleppey, Ernakulam and Trichur. Thus, the positive growth rate of summer paddy area in Alleppey, Ernakulam and Trichur for the second period can be explained by the increase in non-HYV area. For the combined seasons, positive growth rates were obtained for HYV in Quilon and Palghat; and for non-HYV in Alleppey, Ernakulam and Trichur. Trivandrum district had consistently negative growth rates for both HYV and non-HYV area during all seasons.

When growth rates of HYV and non-HYV yield were obtained separately, it was observed that at the State level, all the rates were positive. However, during autumn, the growth rate of HYV yield (3.61 per cent) was much higher than the growth rate of non-HYV yield (0.93 per cent). This was also true during winter when HYV and non-HYV growth rates of yield were 2.64 per cent and 0.67 per cent respectively. However, during summer the growth rate of HYV yield (1.13 per cent) was much below the rate for non-HYV yield (6.68 per cent). The observed fall in HYV area during summer season can be explained, at least partially, through the relatively low increase in the HYV yield. When all seasons are com-

14. During 1982-83, 25.2 per cent of the cropped area under paddy in all seasons was covered under HYV. Among the districts, Trivandum had the least coverage (5.3 per cent) and the highest was in Kottayam (54.1 per cent). The coverage of area under HYV during 1982-83 autumn, winter and summer were 33.1 per cent, 14.7 per cent and 37.6 per cent respectively.

bined, HYV yield had a growth rate of 2.62 per cent against the growth rate of 1.24 per cent for non-HYV yield.

The overall growth rate of HYV production was 1.05 per cent against the non-HYV growth rate of —0.27 per cent. The growth rate of HYV production was positive during autumn and winter, but it was negative during summer. The growth rate of non-HYV production was also negative during summer. It may be recalled that during autumn both area and yield of HYV had positive growth rates. The positive growth rate of HYV yield during winter dominated over the negative growth rate of area, but during summer the negative growth rate of HYV area dominated over the positive growth rate of yield. However, for non-HYV, the positive growth rate of yield was not sufficient to offset the negative growth rates of area during autumn and winter. During summer, the growth rates of both non-HYV area and yield were positive.

Thus, the observed positive growth rate of production for paddy during autumn was influenced by a high rate of growth of HYV. The negative growth rate during winter was influenced by the negative growth rate of non-HYV, and the negative growth rate during summer was influenced by the negative growth rate of HYV.

Irrigation

About one-third of the area under paddy in the State had access to irrigation facilities. While the dependence on irrigation was very much limited during autumn on account of the extended monsoon season, about half the area under paddy during winter and three-fourths area during summer were irrigated. During autumn and winter, the percentage of HYV area under irrigation exceeded the percentage of non-HYV area under irrigation, but during summer, the shares of irrigated area in HYV and non-HYV areas remained more or less the same. Palghat district accounted for a large share of the total irrigated HYV area in the State during autumn and winter. For non-HYV varieties, Ernakulam and Trichur had a higher percentage of irrigated area than Palghat. During summer, Alleppey and Trichur had large areas under irrigated HYV, but for non-HYV Ernakulam and Trichur had the highest share of irrigated areas.

Since Kerala has an extended monsoon season, most areas do not require extended irrigation during autumn and a part of winter. It is during summer that the role of irrigation is crucial, and as pointed out earlier, the farmers might have gone back to non-HYV varieties during summer because of inadequate irrigation facilities. This is also substantiated by field observations in many areas where the field channels had insufficient water during summer.[15]

Since a number of inconsistencies were observed in the existing data on production from irrigated and unirrigated areas, it was decided to analyse the significance of the proportion of irrigated area in explaining the yield level. Along with the proportion of irrigated area, area under HYV, variations across the dis-

15. Nair and Narayana (1983) have concluded that irrigation has contributed to increased yield only during autumn. Further, there is some stabilisation of yield as a result of irrigation during autumn, doubtful stabilisation effect during winter and negligible stabilisation effect during summer. Thyagarajan and Nambiar (1983) have pointed out that when rainfall was not available during summer, solar radiation was maximum and availability of irrigation facilities was poor, and the consequence was that the impact of irrigation on both yield and area expansion had been negligible.

tricts, and variations across the seasons were included in the analysis. The model specified for the analysis was as follows:

For each season

$$Y_j = f_j(P_{hi}, P_{nhi}, D_d, T) \quad \text{.....(1) and}$$

For all seasons

$$Y = f(P_{hi}, P_{nhi}, P_h, D_d, D_s, T) \quad \text{.....(2)}$$

where Y_j = yield in jth season (j = autumn, winter, summer),
P_{hi} = proportion of HYV area irrigated,
P_{nhi} = proportion of non-HYV area irrigated,
P_h = proportion of area under HYV,
D_d = dummy variable for district (Trivandrum excluded),
D_s = dummy variable for season (autumn excluded),
T = time trend,
and Y = average yield.

The estimated coefficients indicated the following tendencies:

(1) The coefficients of the proportion of HYV area irrigated and the proportion of non-HYV area irrigated turned out to be quite close to zero and statistically insignificant for all seasons and for the combined seasons. This strengthens the earlier hypothesis that development of irrigation has not made any significant contribution towards increased yield.

(2) The proportion of area under HYV had a significant influence on yield during autumn and winter, but it was insignificant during summer. This is consistent with the result that during autumn and winter, the growth rates of HYV yield had been much higher than those for non-HYV yield and that during summer, the HYV yield had a growth rate which was smaller than that for non-HYV yield. When all seasons were combined, the proportion of area under HYV turned out to be an insignificant variable in explaining yield levels although the coefficient had a positive sign. Thus, for the annual data, the proportion of HYV area was not a significant factor explaining yield changes in spite of its significance during the autumn and winter seasons.

(3) Variations in yields across the districts were significant for many districts.[16] During autumn the coefficient of district dummy variables turned out to be significant in Quilon, Alleppey, Ernakulam and Trichur, all with a negative sign. During winter, the dummy coefficients were significant in Quilon, Kottayam and Trichur (with a positive sign for Quilon and negative signs for the other two districts) and during summer the district dummy variables were significant in all districts, except Quilon, with a positive sign for all the districts.[17] When annual yield was considered, the district dummy variables with a positive sign turned out to be significant in Alleppey, Kottayam and Palghat.

(4) The time trend for autumn and summer seasons and for the combined seasons turned out to be significant. Thus, it is only during winter that a trend factor other than variables considered in the equation was not a signi-

16. As mentioned earlier, across the districts variations were measured by comparing with the Trivandrum district.

17. The poor performance of summer paddy in Trivandrum district was already pointed out.

ficant factor in explaining variations in yield.[18] The estimated coefficients are available in Appendix 1.

All these observations are based on the average yield data derived from total production and total area. The analysis was repeated for HYV and non-HYV yield separately deleting the proportion of non-HYV area irrigated (P_{nhi}) and the proportion of area under HYV (P_h) from equation (2) and modifying the variables for irrigation. The estimated equations indicated more or less the same tendencies observed for seasonal and annual yield (see Appendix 2).

SUMMARY AND CONCLUSIONS

The growth rates of area, yield and production indicated considerable variations across the districts, over seasons and over time. In spite of the overall decline in area, some districts recorded positive growth rates of area for certain seasons. The growth rate of yield for the second period was much higher than that for the first period during autumn and winter seasons, but during summer the growth rate of yield remained more or less constant for both the periods. The fall in the growth rate of production was maximum during summer.

For the first period all the seven districts had positive growth rates of production associated with positive growth rates of both area and yield in six districts and with positive growth rates of yield and negative growth rate of area for the seventh district (Palghat). For the second period, positive growth rates of area, yield and production were simultaneously noticed in only one district; negative area, positive yield and positive production in three districts; and negative area, positive yield and negative production in the remaining three districts.

For the first period, both area and yield had the highest growth rates during summer leading to the highest growth rate of production, but for the second period production growth rate was minimum during summer. Because of the dominant role played by the negative growth rates of area over the positive growth rates of yield, negative growth rates of production were observed during winter and summer of the second period.

The variability of area for the first and second periods indicated that during autumn, variability increased in one district (Kottayam) and declined in all other districts. During winter, variability of area increased in three districts and declined in four districts; and during summer it increased in five districts. In general, most areas had experienced reduced variability of yield. The stagnation in production was associated with reduced variability of output levels over time.

The reduction in area and variability indicated that paddy land was either converted to perennial crops or there was a tendency to keep land fallow for longer periods. The reduced rate of variability in rice production was influenced by reductions in the fluctuations of both area and yield.

18. In order to explain this trend, an attempt was made to analyse the fertiliser consumption pattern and changes in the relative prices of paddy and fertilisers. Though cropwise fertiliser consumption data were not available since paddy was the major crop using fertilisers, it was assumed that the trend of fertiliser consumption for all crops would also represent the trend of fertiliser use for paddy. The regression equation with paddy yield as dependent variable and fertiliser consumption and time trend as independent variables indicated that the fertiliser coefficient was non-significant but the time variable still remained significant. However, yield and fertiliser consumption was correlated in some cases. The relative price change also did not indicate a relationship with paddy yield. Thus, we are unable to explain the time trend.

During the first period, contributions of area accounted for most of the changes in output during winter and summer; and yield was the dominant factor during autumn. While yield was the dominant factor influencing production changes during autumn for both the periods separately and for the combined period, area changes dominated in production changes during winter and summer for both the periods. In areas where output levels had declined over time, reduction in area emerged as the dominant factor. Thus, the observed stagnation in annual production in the State was the net result of a number of adjustments of positive and negative effects of area and yield across seasons and districts.

The changes in both paddy and coconut prices had influenced the adjustments in paddy area. Though paddy area was inelastic with respect to both paddy and coconut prices, both had a statistically significant influence on acreage adjustments of paddy. In the short run, wage rate and paddy price had influenced the farmer's decision of retaining land fallow. Thus, increased wage rate and a disproportionate increase in paddy price expanded current fallow, but this tendency together with increased relative price of coconut influenced the farmers to switch over from paddy to coconut cultivation.

During autumn there had been a tendency to switch over to HYV paddy from the traditional varieties and during summer the tendency was in the reverse direction. During autumn the growth rate of HYV yield was substantially higher than the non-HYV growth rate, but during summer HYV yield had a much lower growth rate than the non-HYV rate. Thus, while HYV adoption was considered profitable during the monsoon period, it was not the case during summer; inadequate facilities could be a major limiting factor in expanding HYV coverage during summer.

The proportion of irrigated area (both HYV and non-HYV) turned out to be a non-significant variable in explaining paddy yield. While the proportion of area under HYV had a significant influence on yield during autumn and winter, it was non-significant during summer. Because of this difference, in the annual data HYV area turned out to be unimportant in explaining rice yields. While inter-district variations in paddy yield had been significant in many situations, inter-seasonal variations were not significant.

In terms of prospects for increased paddy production in the State, it is unlikely that the area under paddy can be increased. While maintaining the parity between paddy prices and wage rates might prevent farmers from keeping land fallow, price incentives are unlikely to induce a shift in the cropping pattern in favour of paddy. At the same time, there is scope for increased production through changes in technology, particularly HYV and fertiliser application. However, this can be effective only if irrigation facilities, both surface and groundwater, are utilised efficiently. Thus, the strategy for increased rice production in Kerala should be based on improved utilisation of irrigation facilities, use of HYV and efforts to maintain farm level income either through remunerative output prices or through stable cost of production. In this connection, it is also important to explore the possibilities of increasing yield through institutional mechanism, particularly consolidation of holdings.[19]

19. Raj (1985).

APPENDIX I

Estimated Regression Coefficient for Total Yields (Seasonwise)

Regressors	Regression coefficients with dependent variables as yield during		
	Autumn	Winter	Summer
1. Proportion of HYV area irrigated ...	0.0341 (0.28)	—0.0355 (0.31)	0.0218 (0.1131)
2. Proportion of Non-HYV area irrigated	—0.0668 (0.50)	0.2352 (1.39)	0.1184 (0.72)
3. Proportion of area under HYV ...	0.5305* (3.68)	0.4521* (3.79)	0.1109 (0.45)
4. Dummy variables for districts			
(*i*) Quilon	—0.1576*	0.1752*	0.690
(*ii*) Alleppey	—0.1780*	—0.0158	1.1189*
(*iii*) Kottayam	—0.1751	—0.1958*	0.9453*
(*iv*) Ernakulam	—0.1972*	—0.0899	0.5293*
(*v*) Trichur	—0.3266*	—0·0899*	0.6775*
(*vi*) Palghat	0.0814	0.0659	0.6041*
5. Time	0.0186* (3.37)	0.0093 (1.24)	0.0475* (2.85)
R^2 value	0.8799	0.7595	0.9132
F value	22.71**	9.79**	26.31**
Number of observations	42	42	36

* Significant at 5 per cent level (two sided).

** Significant at 0.5 per cent level.

(*Note:* — Figures in parentheses correspond to t values).

APPENDIX 2

ESTIMATED REGRESSION COEFFICIENTS FOR HYV, NON-HYV AND AVERAGE YIELD

Regressors	Regression coefficients with dependent variables					
	Average yield		HYV yield		Non-HYV yield	
	Coefficient	(t value)	Coefficient	(t value)	Coefficient	(t value)
1. Proportion of HYV area irrigated ...	0.0258	(0.18)	0.0144	(0.12)		
2. Proportion of non-HYV area irrigated ...	0.0421	(0.29)			0.1408	(1.05)
3. Proportion of area under HYV ...	0.1345	(0.9)				
4. Dummy variables for districts						
(*i*) Quilon ...	0.0699	(0.89)	0.0920	(1.19)	—0.0077	(0.09)
(*ii*) Alleppey ...	0.3386*	(3.79)	0.5100**	(6.46)	0.1946*	(2.08)
(*iii*) Kottayam ...	0.2851*	(2.57)	0.3260**	(3.80)	0.2308*	(2.47)
(*iv*) Ernakulam ...	0.1572	(1.70)	0.1338	(1.49)	0.0923	(0.98)
(*v*) Trichur ...	0.0871	(1.08)	0.1758	(2.22)	0.0145	(0.17)
(*vi*) Palghat ...	0.3787*	(4.21)	0.4965**	(5.96)	0.1365	(1.60)
5. Dummy variables for season						
(*i*) Winter ...	0.0282	(0.44)	—0.0438	(0.77)	0.1145	(1.86)
(*ii*) Summer ...	—0.1212	(1.49)	—0.1614*	(2.21)	—0.0560	(0.69)
6. Time ...	0.0354*	(2.83)	0.0436**	(3.51)	0.0395**	(2.90)
R^2 values ...	0.3939		0.494		0.222	
F values ...	5.79**		10.65**		3.12***	
Number of observations ...	120		120		120	

* Significant at 5 per cent level (two sided).

** Significant at 1 per cent level (two sided).

*** Significant at 0.5 per cent level (two sided).

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