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Growth Trends in Area, Production and Productivity of Coconut in India

M. Lathika and C.E. Ajith Kumar*

I

INTRODUCTION

In India coconut has a documented history of about three thousand years and is acclaimed to be a small-holder's crop. About 10 million people in the country are engaged in coconut cultivation, processing, marketing and trade-related activities. It is the richest source of edible vegetable oil with oil yield of 65 per cent of the kernel weight and the contribution of the crop to the edible oil pool in India is around 6 per cent (Thampan, 1993; Singh, 1998). The crop is the only one in the lauric oil groups produced in the country and provides about 75 per cent of the lauric oils (Green, 1991). The present study seeks to examine the growth trends in coconut area, production and productivity for the past five decades. It focuses on the performance of different States in coconut production and also the relative role of area and yield in explaining the observed trend in production.

Data and Methodology

The study is primarily based on the secondary data of area (in hectares) under cultivation, production (in million nuts) and productivity (nuts per hectare). It covers all the coconut producing States/Union territories in Indian Union (CPS) with coconut area of greater than 20 thousand hectares, as per the revised estimate for 2001-02, for a 52-year period from 1950-51, obtained from the Coconut Development Board, Ministry of Agriculture, Government of India. Three trend equations, namely, semi-log ($\ln Y_t = a + b.t + u_t$), log-quadratic ($\ln Y_t = a + b.t + c.t^2 + u_t$) and log-quadratic (modified) – a log-quadratic model with a transformation applied on 't' $\rightarrow$ t – (n+1)/2, to reduce multi-collinearity (Kumar and Pillai, 1994), are worked out on the data on the three parameters of coconut production for these regions.

*Lecturer (Selection Grade) in the Department of Economics, N.S.S. College for Women, Neeramankara, Thiruvananthpuram, Post-Graduate in Mathematics, is a Programmer, Department of Agricultural Statistics, College of Agriculture (Kerala Agricultural University), Vellayani, Thiruvananthapuram.

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In growth measurement exercise, the choice of trend equation from amongst the available alternatives, demands care and dexterity. Hence the following criteria, as suggested by Chattopadhyay and Das, 2000, are used for selecting the most appropriate trend equation among the three fitted competing trend equations.

1. Choose that equation which satisfies the criteria of goodness of fit, that has sufficiently large adjusted R^2 tested by F test, non- auto correlation tested by Durbin-Watson Statistic (Singh *et al.*, 1991) and heteroscedasticity (Madnani, 1986) tested by the Spearman Rank Correlation test.
2. If all the equations satisfy all the criteria, the equation with the highest $\bar{R}^2$ will be chosen as the best equation for estimation of parameters.
3. If none of the equations satisfies any of these criteria, the equation, which satisfies maximum number of criteria with relatively high $\bar{R}^2$, will be chosen as the best equation, with correction for auto-correlation by Cochrane-Orchutt method (Maddala, 1998).

Deviations from the trend, which is termed as 'instability' is measured using Mac Bean Instability Index, based on the moving average (Mac Bean, 1966).

The plotting of the time-series data on area and production for all India and major coconut producing states (CPS) revealed that the growth/decline had not been smooth all along, but it took turbulent turns during mid-1990s. Further, from a trade perspective, the period of mid-1990s is marked by major policy shifts in economic planning and management in India, having global and far-reaching implications. However, we confine our study to the production performance aspects only. The entire study period has, therefore, been divided into two sub-periods as Phase I (1951 to 1995) and Phase II (1996 to 2002). The usual method of fitting two separate regressions for the two periods is subject to the limitation that it assumes discontinuity between the two periods and that each of the sub-period growth rates may be at sharp variance with the growth rates for the whole period, which is unrealistic. In order to estimate period-wise growth rates without any discontinuity, 'kinked exponential model', as suggested by Boyce (1987), is more appropriate and reliable (Kannan and Pushpangadan, 1988; Nandamohan and George, 1993). Period-wise output growth has been decomposed into area and yield effects. The contribution of components to the variance of output instability and its sources are also measured (Pushpangadhan, 1988).

II

RESULTS AND DISCUSSION

Table 1 provides the percentage share of the major coconut producing States in India on the area under cultivation and the production (in nuts equivalent), as this will give a first hand information on the share of each state in the matter, over the decades. The percentage allocation of area under coconut out of the net sown area (NSA) of the region, as on 1999-2000, is also presented to ascertain the scope of coconut to penetrate to newer areas.

TABLE 1. PERCENTAGE SHARE OF COCONUT AREA AND PRODUCTION OF THE MAJOR COCONUT PRODUCING STATES IN INDIA

States	Coconut area as per cent of NSA†	Percentage share of the state in the year: Area			Production		
		1960	1980	2002	1960	1980	2002
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andaman and Nicobar Islands	65.0	1.00	1.81	1.30	0.70	1.35	0.69
Andhra Pradesh	0.93	4.81	3.84	5.38	6.42	3.01	8.68
Assam	0.73	0.11	0.50	1.09	0.27	0.64	1.26
Goa	17.54	-	1.74	1.29	-	1.50	0.97
Karnataka	2.81	13.65	15.62	19.14	10.38	15.42	11.60
Kerala	39.39	69.66	61.77	48.62	70.62	53.55	44.31
Orissa	0.90	0.64	1.92	2.42	0.76	1.59	1.61
Tamil Nadu	4.88	7.60	10.72	17.38	9.12	20.84	25.41
West Bengal	0.45	0.95	0.62	1.29	0.47	0.39	2.50
'Others'*	0.01	1.58	1.46	2.08	1.27	1.69	2.98
India	1.35	100	100	100	100	100	100

Note: '-' data not available as the state was formed only after the decade.

* – 'others' comprises all states/ UTs with an area of less than 20 thousand hectares under coconut, in 2001-02.

† - as on 1999-2000.

From the table it is clear that the state of coconut production in the country is largely determined by the four southern and coastal States of India, namely, Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. This group of the major coconut producing States/UTs in India accounted for 90.5 per cent of Indian coconut area in 2002 (as against 95.7 per cent in 1960) and 90.0 per cent of production (as against 96.5 per cent in 1960). The minor CPS (comprising States other than the four states mentioned above) started asserting its position, though its pace is weakened in the latter phase (1980-2002) of the study period. As for the performance of the individual States in these groups, Kerala had more than 70 per cent share in both area and production, during the early fifties, with no other State in the vicinity, its dominance and supremacy successively dwindled with the states of Tamil Nadu, Karnataka and Andhra Pradesh (in that order) registering a significant improvement in the subsequent years. Tamil Nadu has never taken a retreat, over the decades, either in area or production. Thus, all the States, barring Kerala, in the major group have been consolidating their stakes over the decades. As far as the other group of CPS is concerned, coconut is the most dominating crop in Andaman and Nicobar islands with 65 per cent land coverage. With its long and conducive coastlines, Goa also took to coconut cultivation in a big way. Coconut is a less prominent crop in all other CPS with an allocation of less than 1 per cent of their NSA.

Trend equations were fitted to the 52-year time series data on area, production and productivity of coconut for all the CPS and India as a whole. As far as the trend in area is concerned, all the three models corresponding to all the regions excluding 'others', are found to be good fit as $\bar{R}^2$ is sufficiently large with a highly significant F-ratio. All the models are also seen to suffer auto-correlation errors, necessitating a correction by Cochrane-Orchutt method. However, the exponential model is adjudged to be the best fit for all the regions, as it is found that the improvement of $\bar{R}^2$ by the inclusion of the quadratic term, in the few cases in which it occurred, was at the cost of severe heteroscedastic aberrations. As for the trend in production, other models are seen to have an edge over the exponential model for Andhra Pradesh, with a substantially improved $\bar{R}^2$, but they run the risk of high heteroscedasticity. The growth of coconut production in Orissa and Kerala also is seen to be fitting to a log-quadratic trend, with slightly higher $\bar{R}^2$ than a semi-log trend and no significant heteroscedasticity. However, for these cases, as the improvement in $\bar{R}^2$ for the log-quadratic model over the semi-log model was very meagre and either of the two coefficients of the model was found to be non-significant, and also for generality, the semi-log model was finally chosen for production of these regions. The exponential model is qualified to be the best fit to the data for all the other regions, with high $\bar{R}^2$ and a highly significant F-ratio. Thus, for production also, the growth rate based on the exponential model is finally selected for all the regions.

The trend of productivity of coconut in Indian states presented a different picture, from that of the other two parameters of area and production. None of the three models attempted could elicit a fairly good $\bar{R}^2$. Wherever the $\bar{R}^2$ is found to have improved over the exponential model, by a considerable level, they faced severe heteroscedasticity risks. The modified log-quadratic model is seen to be best fitting to the data, compared to the other two models, in India, Andaman and Nicobar islands, Andhra Pradesh, Assam, Orissa and Kerala, in which case also the $\bar{R}^2$ ranged from as low as 23 per cent (Andaman and Nicobar islands) to 48 per cent (Andhra Pradesh). For these States, this model is also seen to be less prone to significant heteroscedasticity. West Bengal is the only state with sufficient $\bar{R}^2$ (0.76) for exponential model in which case the growth rate is 3.84. For Tamil Nadu and Karnataka, for which States the exponential model is found to be the best fit (but with less $\bar{R}^2$ -46 per cent and 37 per cent respectively), the growth rates are 0.73 and 0.50 respectively. Owing to the reasons outlined above, we refrain from providing a uniform growth rate for coconut productivity for the whole period for the rest of the States. However, as it was later found that the kinked exponential model of productivity for the regions Andaman and Nicobar islands, Andhra Pradesh and Assam, encompassing both the periods of study was not a good fit, when 1995 is taken as the break year, the log-quadratic model (modified) which is found to be the best fit among the three models tried, is given below:

Andaman and Nicobar islands: $\ln Y_t = 8.2929 + 0.0065^{*} t - 0.0008^{**} t^2$ ($F_{2,49} = 8.00^{**}$; $\bar{R}^2 = 0.23$)
Andhra Pradesh: $\ln Y_t = 8.5212 + 0.0044^{*} t + 0.0015^{**} t^2$ ($F_{2,49} = 23.57^{**}$; $\bar{R}^2 = 0.48$)
Assam: $\ln Y_t = 8.2890 - 0.0054 t + 0.0019^{**} t^2$ ($F_{2,49} = 16.81^{**}$; $\bar{R}^2 = 0.40$)

The growth rates based on the exponential model and Mac Bean instability index overing the whole period of study are presented in Table 2.

TABLE 2. AREA, PRODUCTION AND PRODUCTIVITY OF COCONUT IN DIFFERENT STATES IN INDIA AND THEIR GROWTH RATE (GR) * AND MAC BEAN INSTABILITY INDEX (MBI) FOR THE PERIOD 1950-51 TO 2001-02

	Area			Production			Productivity	
States (1)	'000 ha 2001-02 (2)	GR (3)	MBI (4)	Million nuts 2001-02 (5)	GR (6)	MBI (7)	Nuts/ha 2001-02 (8)	MBI (9)
Andaman and Nicobar Islands	25.2	5.31	6.154	90.0	5.96	9.990	3571	8.733
Andhra Pradesh	104.0	2.20	1.472	1125.0	2.65	9.783	10817	10.008
Assam	21.1	6.73	5.231	163.3	6.19	6.276	7754	9.005
Goa $	25.0	0.94	0.980	125.1	1.54	3.734	5004	3.904
Karnataka	369.8	2.84	1.712	1503.6	3.34	3.458	4066	3.183
Kerala	939.5	1.56	1.055	5744.0	1.21	3.411	6114	3.223
Orissa	46.7	5.29	5.749	208.2	4.75	13.822	4458	12.339
Tamil Nadu	335.8	3.93	4.148	3293.6	4.66	6.346	9808	6.492
West Bengal	25.0	3.08	5.042	324.2	6.92	5.380	12968	4.116
'Others'	40.2	2.81	12.650	385.9	4.71	18.575	9600	19.856
India	1932.3	2.28	1.412	12963.2	2.48	2.536	6709	2.456

Note: $ - for a period of only 38 years ending the year 2002; * - all Significant at p=0.01.

The table reveals a positive growth rate in coconut area and production for India as well as at the state level. The positive growth rate in coconut area among the Indian States suggests that the expansion phase of the crop is not yet over in India. Expansion of the area under coconut had been a vigorous process in many states like Assam, Orissa and the Union Territory of Andaman and Nicobar islands, when the whole period is considered. Tamil Nadu, which stands just behind Karnataka in coconut cultivation in India, continues to expand its coconut area at a fairly better rate (3.93) than the latter (2.84), despite its stringent per capita land availability position (Government of India, 2004), which suggests that it can jump into the second slot in coconut area in India, in the near future, beating Karnataka. As coconut palms take a long gestation period to bear, production growth may not immediately follow an area growth, in equal measure, which is also amply demonstrated in the table. The palm has a long ageing phase also during which it can bear but at a much sub-optimal rate. Thus, the age composition of coconut palms in a farm also plays a decisive role on productivity of coconut farms, apart from the actual efficiency of the production system. West Bengal is seen to be the topper in production growth (6.92), though its area growth rate is only 3.08 – much below than that of many other states – indicative of a favourable age-composition of the palms there. Kerala, the highest contributor of coconut to the national pool, has only a low growth in both area (1.56) and production (1.21). Goa also has shown poor performance both in terms of area and production growth, though coconut is one of the prominent crops cultivated. As a general observation it could be stated that the performance of the crop in the group of major CPS is not in strict conformity with what was observed in Table 1. The States in the minor group of CPS are seen to surge ahead of the States in the major group in both area and production. We will examine the growth pattern by taking a more dilated view of the study period in the following section.

Instability is but a bad companion of growth. The table discloses that production instability is found to be higher than area instability in India and in all the States, underlining the role of the other parameter, namely, productivity, in the instabilities in production. Area instability is found to be lower than the yield instability in all the Indian States except West Bengal. The stability of growth in yield thus emerges to be a greater problem to tackle with. Though a traditional coconut grower with much conducive conditions for crop growth, Andaman and Nicobar islands reports the highest instability (6.154) in area and second highest (9.990) in production, among the regions other than ‘others’ are considered. Orissa, where coconut cultivation is limited to very small area, turns out to be the state with highest instability in production and productivity.

As already pointed out, the exponential model was not operative for many cases of productivity. Either no model considered was found to be suitable for the data, or the other models that do not propose a uniform growth rate for the whole period were found to be the best fitting ones. For the parameter of production also, much variability was seen to be left unexplained by the exponential model in the cases of some regions. These strongly suggest that the growth in these cases could be in a phased manner. As explained in the methodology section of this paper, growth rates were computed for the two phases for all the three parameters of growth and for all the regions, and they are presented in Table 3.

The general assessment of Table 3 highlights that the advances made by the minor group of CPS in India, as evidenced vide Table 2, were not of a perennial or consistent nature spanning the whole period. The second phase witnessed a wavering growth pattern in many States in this group. India, as a whole, could attain higher levels of growth in area, production and productivity in the second phase, though the increase is marginal (only by 0.412 per cent from 2.249 per cent) in the case of area.

TABLE 3. GROWTH RATES OF AREA, OUTPUT AND YIELD OF COCONUT IN INDIA FOR THE TWO SUB-PERIODS

States	Area		Production		Productivity	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andaman and Nicobar Islands#	6.200	-9.696	7.030	--	0.830	--
Andhra Pradesh#	1.758	9.662	1.810	16.690	--	--
Assam#	6.912	--	5.929	10.545	--	--
Goa$	0.963	--	1.670	--	0.708	--
Karnataka	2.712	4.972	3.375	2.811	0.663	-2.161
Kerala	1.637	--	1.007	4.562	-0.630	4.342
Orissa	5.804	--	4.777	--	-1.026	7.649
Tamil Nadu	3.826	5.646	4.707	3.878	0.881	--
West Bengal	2.782	8.140	6.755	--	3.974	--
'Others'	2.294	11.479	4.334	11.045	2.040	--
India	2.249	2.661	2.317	5.246	--	2.719

Note: $ - growth rate for a reduced period of only 38 years ending the year 2002..

' --' indicates that the co-efficient is not Significant even at p=0.05.

- For productivity of these regions, the plotted growth path was observed to be bi-modal with the latter peak during early 1990's. However, for generality, same model was considered for productivity of these states also, assuming a break in the same year (1995).

Growth in all the parameters in Andaman and Nicobar islands is marked by lower rates (or, no growth) during the latter phase. Orissa presents an altogether different picture. With its impressive growth in area expansion in the first phase, Orissa could manage to attain substantial rate of growth (4.78 per cent) in output. But the sudden surge in production despite the violent depressions in area in late 1990s (Source: Coconut Development Board) salvaged it from its poor productivity levels, though, as the data reveal, this phenomenon is not seen to extend to the next decade. State-level growth rates in the major group of States present a mixed trend. Riding on the back of productivity, Kerala scaled impressive heights in production in the second phase. Andhra Pradesh had performed extremely well in the second phase, for both area and production. In Karnataka, the leap in area expansion in the second phase did not reflect on the production levels – a consequence of its negative growth in productivity in the second phase.

Production of coconut in phase-II had not followed the same trend as that of the previous period. While India as a whole and some States, namely, Andhra Pradesh, Assam and Kerala experienced a spurt (with a growth rate of more than 4.5 per cent) in production in the second phase, some other regions, namely, Andaman and Nicobar islands, Karnataka, Orissa, Tamil Nadu and West Bengal which had fairly high growth rate (more than 3.0) during phase I, registered a considerably lesser or no growth subsequently. Goa also followed an identical growth path as these States, though the decline was not as sharp.

With regard to the productivity growth, many of the Indian States witnessed a sharp decline in the yield of coconut in the latter phase and the coconut producing Indian States/UTs namely Andaman and Nicobar islands, Andhra Pradesh, Assam, Goa, Tamil Nadu, and West Bengal posted practically no growth in productivity. Karnataka is found to be the only State that registered a negative growth in productivity in the second phase. Kerala and Orissa had impressive recovery in productivity growth in the second phase, which is reflected at the national level also.

Positive and significant growth is observed for area in all regions in the first phase. This trend did not follow in the second phase, for many regions. The second phase witnessed an improvement in the area expansion for India as a whole and the regions of Andhra Pradesh, Karnataka, Tamil Nadu and West Bengal. Andaman and Nicobar islands registered a significant negative growth in area in the latter phase at a much faster rate than the rate at which it had grown in the first phase. Orissa, Kerala, Goa and Assam tended to stagnate in the area expansion process after the first phase. As already spelt out, the area expansion in Kerala and Andaman and Nicobar islands may face with severe land pressures as the former one already reeling under poor per-capita availability of land (Government of Kerala, 2001) and the latter, with a much less proportion of land left by coconut farms which are, in fact, traditionally proved to be least productive ones in India (3571 nuts/ha. in 2002 with poor growth rate) seeking ways to accommodate other crops also. Moreover, the area gains in these regions could also be at the cost of area of other crops or a shift in cropping pattern. Thus, the strategy of area expansion of coconut in India should be through an augmented level of promotional activities to spread coconut cultivation in the two regions, namely, Andhra Pradesh and Karnataka and possibly West Bengal. It may also be noted that the scope of coconut, or for that matter any crop, to grow into more areas is very limited in some major coconut growing regions of the country. The land-man ratio in Kerala is very low, with 0.07 hectare of NSA per person and coconut already pushed the major calorie-donors of the state, namely, paddy and tapioca to a distant second and fourth positions respectively in area in the state (Lathika, 2002). The situation also seems to be grim in Tamil Nadu, a major producer of coconut in India, with very less land-man ratio (0.09 ha.) (Government of India, 2004). In Andaman and Nicobar islands also, the possibility of area expansion of coconut does not appear to be very bright as the crop already occupies a sizeable portion (65 per cent) of its NSA. But, the growth in production is a combined phenomenon involving both the area growth and productivity growth, the effects of which may now be examined.

Decomposing the output growth rate into area effect and yield effect isolates the sources of growth in output and would reveal the strength of forces behind the observed changes in output growth. Period-wise decomposition of output growth into area effect and yield effect is given in Table 4. Output growth of coconut in the nation during phase I is marked by the dominance of area effect in India, as a whole, and in the individual States/UTs. But the situation changed in phase II when the output growth of coconut in the country was contributed almost equally by area effect (50.73 per cent) and yield effect (49.27 per cent). With a much lower share of yield effect on output growth, the negative growth of output in Andaman and Nicobar islands explained by the high decline rate (-9.70 per cent) in area after 1995 (see, Table 3). Karnataka and Tamil Nadu, two of the major coconut producing States in India, suffered a setback in output growth during the second phase of the study. Both these States posted sharp increases in coconut area during the second phase. As the area was seen to be almost the sole contributor towards output growth in these States, in both periods, this suggests that the negative or no growth in yield in these states might be due to the sudden increase in the incidence of pre-bearing palms.

TABLE 4. DECOMPOSITION OF OUTPUT GROWTH INTO AREA EFFECT AND YIELD EFFECT FOR THE TWO SUB-PERIODS

States	Period I			Period II		
	Output	Area	Yield	Output	Area	Yield
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andaman and Nicobar islands	7.03	88.19	11.81	-12.024	80.64	19.36
Andhra Pradesh	1.81	97.13	2.87	16.69	57.89	42.11
Assam	5.929	116.58	-16.58	10.545	34.94	65.06
Goa	1.67	57.65	42.35	0.356	217.06	-117.06
Karnataka	3.375	80.36	19.64	2.811	176.88	-76.88
Kerala	1.007	162.57	-62.57	4.562	4.83	95.17
Orissa	4.777	121.49	-21.49	4.321	-77.03	177.03
Tamil Nadu	4.707	81.28	18.72	3.878	145.58	-45.58
West Bengal	6.755	41.18	58.82	9.727	83.69	16.31
'Others'	4.334	52.92	47.08	11.045	103.93	-3.93
India	2.317	97.08	2.92	5.246	50.73	49.27

Note: $ - for a reduced period of only 38 years ending the year 2002.

Output growth in Kerala and Assam is more due to the improvement in coconut productivity during the second phase, as the yield effect was seen dominating in the second phase, over the area effect. A sharp increase in the growth in yield in Kerala – where area growth ceases to be a feasible route to output growth - in the second phase spells brightens the national coconut scenario, especially since this comes after a turbulent phase of growth of the crop in the State on account of the devastating mite infestation, sharp price falls and the century long and yet unbridled deadly root (wilt) disease (Government of India, 2001; Lathika, 2002; Government of Kerala, 1997; Thampan, 1999).

Growth in output cannot be viewed in isolation of its instabilities. The Mac Bean's index for area, output and productivity corresponding to both periods of study are presented in Table 5.

Barring Orissa, the Instability indices for area and production of the nation and the States are observed to be lower during phase II. The productivity of coconut in the post-1995 phase in all the States has been found to be much more stable. Output instability is generally in association with area instability and yield instability.

TABLE 5. MACBEAN'S INSTABILITY INDEX OF AREA, OUTPUT AND YIELD OF COCONUT

	Area		Production		Productivity	
States (1)	Phase I (2)	Phase II (3)	Phase I (4)	Phase II (5)	Phase I (6)	Phase II (7)
Andaman and Nicobar islands	7.133	0.268	11.642	0.235	10.192	0.038
Andhra Pradesh	1.469	0.486	8.935	3.593	9.37	3.225
Assam	5.835	0.391	6.212	1.101	9.231	1.53
Goa$	1.123	0.053	4.545	0.31	4.757	0.361
Karnataka	1.739	0.378	3.733	1.326	3.574	1.502
Kerala	1.031	0.259	3.623	1.187	3.417	0.922
Orissa	4.637	9.275	10.148	15.752	10.024	7.271
Tamil Nadu	4.071	1.022	6.106	1.291	6.415	0.374
West Bengal	5.698	0.435	5.581	0.376	4.034	0.821
'Others'	6.403	16.552	13.98	11.728	19.042	1.714
India	1.152	0.811	2.493	1.19	2.382	0.132

Note: $ - for a reduced period of only 38 years ending the year 2002.

The contribution of the components of variance of the output instability are estimated and presented in Table 6. At the national level, the contribution to output variance of both area and yield increased during the latter phase. But, as against area, yield contribution increased tremendously, that too, with highly negative interaction between the two in that phase, suggesting that the per-palm productivity might have increased. The disaggregated State level analysis reveals that the contribution of variance of area has declined in all the States except Karnataka (where area growth was favourable than yield growth, see Table 3), and the contribution of variance of yield has increased in all states but Kerala and Goa – two traditional growers whose interaction contribution also increased substantially - during the post-1995 period. Co-variance term for Kerala and Orissa have become positive in the second phase, indicating that the factors contributing to the movement of the instability in area and yield in the opposite direction have weakened or defunct during this period.

TABLE 6. COMPONENTS OF VARIANCE OF OUTPUT FOR THE TWO SUB-PERIODS

(per cent)

	Phase I			Phase II		
States (1)	Area (2)	Yield (3)	Interaction (4)	Area (5)	Yield (6)	Interaction (7)
Andaman and Nicobar islands	62.063	11.125	26.812	43.254	17.46	39.286
Andhra Pradesh	18.124	58.391	23.484	5.675	90.301	4.024
Assam	118.89	55.653	-74.543	20.678	84.841	-5.519
Goa$	30.901	68.503	0.596	6.471	61.176	32.353
Karnataka	62.087	9.077	28.836	197.99	176.082	-274.072
Kerala	139.094	58.493	-97.587	29.282	37.569	33.149
Orissa	127.572	26.718	-54.29	47.923	42.425	9.652
Tamil Nadu	65.242	7.034	27.725	58.93	125.417	-84.347
West Bengal	22.302	34.073	43.625	21.406	45.367	33.227
'Others'	29.952	60.959	9.089	150.862	23.279	-74.141
India	85.111	11.564	3.325	101.597	97.059	-98.655

Note: $ - for a reduced period of only 38 years ending the year 2002.

III

CONCLUSIONS

Area effect continues to assume greater role in output growth by almost all coconut regions of the country, though some States like Kerala and Orissa recently showed signs of a productivity-based growth of output. Being a crop with a long gestation period, prudence should prevail before displacing other crops and a relative assessment of consequent gains and losses of this crop against other stakeholding crops of the respective regions may prove worthwhile in the long run. Though some States like Andhra Pradesh and Karnataka are already on the path of vast area expansion, some other regions, particularly, Kerala, Tamil Nadu, Andaman and Nicobar islands, which reportedly experience severe land pressures, have registered a retarded growth in area recently. Avenues of re-planting or dense-planting of the crop should be explored vigorously in some of the traditionally coconut-growing regions like Goa, Andaman and Nicobar islands etc., where the current yield level is abysmally low with practically no growth in the second phase and a substantial share of the net sown area was already claimed by the crop. Generally, in phase II, high-area-growth with low-area-instability was a more prevalent phenomenon among Indian States than high-yield-growth with low-yield-instability. Although area expansion of the crop is still a viable option for certain regions of the country, it emerges that the problem of growth stability in yield had been trickier to tackle with than the problem of stability in area growth and it warrants urgent attention.

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REFERENCES

Boyce, James K. (1987), *Agrarian Impasse in Bengal. Institutional Constraints to Technological Change,* Oxford University Press, Oxford, U.K.

Chattopadhyay, Arup Kumar and Purendu Sekhar Das (2000), "Estimates of Growth Rate: A Critical Analysis with Reference to West Bengal Agriculture", *Indian Journal of Agricultural Economics,* Vol. 55, No. 2, April-June, pp. 116-135.

Government of India (2001), *Report of the Commission for Agricultural Costs and Prices of Crops Sown during 2000-2001 Season,* Ministry of Agriculture and Cooperation, New Delhi.

Government of India (2004), website of Department of Agriculture and Co-operation, New Delhi.

Government of Kerala (1997), *Coconut Root (wilt) survey 1996,* Department of Agriculture, Thiruvananthapuram.

Government of Kerala (2001), *Databook on Agriculture 2000,* State Planning Board, Thiruvananthapuram.

Green, A.H. (1991), *Coconut Production: Present Status and Priorities for Research,* World Bank Technical Paper 136, The World Bank, Washington, D.C., U.S.A.

Kannan, K.P. and K. Pushpangadan (1988), *Agricultural Stagnation and Economic Growth in Kerala: An Exploratory Analysis,* Working Paper No. 227. Centre for Development Studies, Thiruvananthapuram, Kerala.

Kumar, Ajith N. and P. Sudarsanan Pillai (1994), "Rubber Plantation Industry in Kerala – A Study of Trends in Wheat", *Indian Journal of Agricultural Economics,* Vol. 47, No.3, July-September.

Lathika, M. (2002), "Productivity of Coconut Cultivation in Kerala", Ph.D. Thesis submitted to Mahatma Gandhi University, Kerala, (unpublished).

Mac Bean, Alasdair I. (1966), *Export Instability and Economic Development,* George Allen and Unwin, London, U.K.

Maddala, G.S. (1998), *Econometrics,* Mc Graw Hill, pp. 278.

Madnani, G.M.K. (1986), *Introduction to Econometrics: Principles and Applications,* Oxford & IBH Publishing Company, New Delhi.

Nandamohan, V. and Sunny George (1993), "Growth and Instability in Rubber Plantation Industry in India", *Productivity,* Vol. 34, No.3, pp. 504-509.

Pushpangadhan, K. (1988); Agricultural *Stagnation in Kerala: An Econometric Study of Tapioca,* Working Paper No. 226, Centre for Development Studies, Thiruvananthapuram.

Singh, H.P. (1998), "Coconut Industry in India: Challenges and Opportunities", *Indian Coconut Journal,* Vol.29, No.4, August, pp. 4-12.

Singh, S.P., Anil K. Parashar and H.P. Singh (1991), *Econometrics and Mathematical Economics,* S. Chand and Co. Limited, New Delhi, pp. 139-142.

Thampan, P.K. (1993), *Handbook on Coconut Palm,* Third Edition, Oxford & IBH Publishing Co., New Delhi.

Thampan, P.K. (1999), *Enhancing the Income and Employment in Coconut Sector through Conservation and Use of Special Coconut Ecotypes in India,* Peekay Tree Crops Development Foundation, Kerala, p. 304.