CHAPTER - III

A SURVEY ON TEA PRODUCTION : GROWTH AND INSTABILITY

Tea is an immemorial crop and its exact antiquity is unknown . However , a definite mention about tea is found in the Chinese ancient history . Some commentaries on the tea tree are observed in Chinese encyclopaedia , ' Pent Sao, ' which was compiled as far back as 2700 B.C. "She King " , one of the classical works by Confucious , contains an elaborate account of tea.[1] It was definitely in use in China for medicinal purpose in the third and fourth century B.C. In any case it had long been grown in China and Japan[2]. China tea was first introduced into England in the seventeenth century and then into United States by the initiative of the East India Company . But tea drinking did not become popular till the middle of the next century.

In India the tea plant was discovered in Assam sometime in 1820s. The East India Company was called upon to explore the possibility of growing this crop on a commercial basis and started an experimental tea garden in 1835 . In 1840 the garden was handed over to the Assam Company , a private enterprise. But the tea estate did not grow with desired pace untill 1852 especially 1859, when the existing restrictions on the grant of land to the prospective planters were relaxed . Thereafter, both production and consumption of tea was encouraged in India because of close trading tie between England and India during the British Empire. By the end of the nineteenth century black tea drinking was firmly established in England and India became the largest tea producer in the World . The green tea producing China was almost ousted from the World's export trade . Java (Indonesia) started to produce sizeable quantities of tea in the mid-nineteenth century and Ceylon (now Sri Lanka) initiated to produce black tea after 1860 and export it after 1896. Thereafter , tea production was promulgated to Africa and by 1920s black tea became a leading beverage in the British East African countries like Kenya and Tanganeyika , and Nyasaland[3].

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1. Monoharan . S, *Indian Tea: A strategy for Development* . S. Chand & Co.(P)Ltd; New Delhi, 1974 , p.1.
2. Sarkar ,G. K. *The World Tea Economy* . Oxford University Press . 1972 , p.2.
3. ibid. p.2.

During three decades ending 1990, World tea production has increased to two and half folds from 984.5 thousand tons in 1961 to 2417 thousand tons in 1990 . The annual compound growth rate worked out to be 3.46 per cent . During the same period 8 other countries namely , India , Sri Lanka , China , Indonesia , Turkey , Japan , Kenya and U.S.S.R. have emerged as the leading producers contributing about 90 per cent of total world production . The production of tea in India has become doubled from 354.4 thousand tons to 720.3 thousand tons. Several Northern and Southern districts have contributed to this expansion. The present chapter purports to examine the relative performance of the major tea producing countries in respect of growth of production , area and yield in the context of global production. And in the national context the growth performance and its stability aspects of several tea producing districts and states have been examined in this chapter with a view to highlighting therefrom the areas having better prospect of future expansion based on historical trend.

3.1 Study on Growth : Methodological Issues

3.1.1 Specification of functional form and growth

A trend growth rate of a quantity time-series provides a quantitative characterisation of the growth path and one can use it for predictive purposes , which Rudra[4] called it as parametric rate in contrast to implicit rate having no significance of behavioural value . Vaidyanathan[5] also defended trend estimation as a convenient way of summarising a long time-series. However, in estimation procedure of trend growth rate on a body of time-series data a number of methodological issues arise . First question comes to the fore as what functional form appears to have good fit and what measure to the 'goodness of fit ' seems to be appropriate. Rudra[6] in his study of growth in the context of West Bengal's agriculture used three functional forms--the linear (diminishing growth-rate), exponential (constant growth rate) and the Gompertz (varying growth rate). And by calculating commonly used measure of "goodness of fit " --coefficient of multiple determination R^2 he observed ' goodness of fit ' more or less equally well for above three functional forms . In identifying the best fitted one he suggested an alternative measure of

4. Rudra, A, " The Rate of Growth of the Indian Economy" in Robinson and Kidron (ed.), *Economic Development in South Asia* ,1970, pp. 35-53.
5. Vaidyanathan . A , "On Analysis of Agricultural Growth", Dr. Rajendra Prasad Memorial Lecture ; the 33rd Annual Conference of Indian Society of Agricultural Statistics , *Jl SAS* , 32 (1), April 1980 , pp. 1-24.
6. Rudra . A, *Indian Agricultural Economics : Myths and Realities*, Allied Publishers, New Delhi .1982, pp. 244-245.

'goodness of fit 'D representing the ratio of residual sum of squares to total sum of squares. Vaidyanathan[7] also observed that different functional specifications with quite different descriptive implications may fit a given body of data equally well . The present study does not, however, attempt alternative functional forms , rather the exponential (log linear) form is chosen based on *a priori* expectation that the change in output in a given year is more likely to be a constant percentage of output over the preceding year. And this presumption appears to have relevance for a perennial crop like tea where leaf production is the question of concern . Moreover , it seems reasonable to assume that larger errors (in the statistical sense of deviations of actual from fitted values) are associated with larger output and hence a multiplicative error term is more appropriate than an additive one . In view of choosing single functional form , the commonly used measure of 'goodness of fit ' R^2 has been taken into account for the present purpose . Initial specification of the functional form is thus

$$Y_t = \alpha(1+r)^t \mu_t \text{ .... } (1.1)$$

which is linearised as

$$\ln Y_t = a + bt + u_t \text{ .... } (1.2)$$

where ,

Y_t = output / area / yield

t = time (in discrete years).

$a = \ln \alpha$ = a constant

r = annual compound growth rate.

$b = \ln(1+r)$

and $u_t = \ln \mu_t$ = error term.

The coefficient of time b, is actually the continuous rate of growth . But for the range of values in question , b closely approximates the annual compound growth rate as pointed out by Dandekar [8] . Following the usual convention , estimate of b has been considered as the growth rate in the present study. This study also aims at investigating sub-period growth rates. In empirical studies the growth rates in different sub-periods are usually worked out by fitting separate exponential trend adopting ordinary least square (OLS) method . In some studies, in stead of estimating sub-period growth rate by separate sub-period regression , a single regression

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7. Vaidyanathan . A , "On Analysis of Agricultural Growth", Dr. Rajendra Prasad Memorial Lecture ; the 33rd Annual Conference of Indian Society of Agricultural Statistics , *JISAS* , 32 (1), April 1980 , pp. 1-24.

8. Dandekar . V.M., " Introduction to Seminar on Data Base and Methodology for the Study of Growth Rate in Agriculture", *Indian Journal of Agricultural Economics* , Vol. XXXV No. 2, pp . 1-12.

equation is fitted by introducing intercept and slope dummies into the model to work out different sub-period growth rates. Either of the two methods may , however , exhibit confusing results such that each sub-period growth rate may exceed or subside the estimated exponential growth rate for the whole period [9] . It may also happen that the estimated growth rate in each sub-period becomes negative while the growth rate for the whole period is worked out to be positive . Such peculiar results arise from the fact that trend estimates are little affected by the values at or near the mid-point of the time-series , while extreme observations -- those at the beginning and at the end of the series have the greatest effect. This inconsistency in estimate arising out of discontinuity between the segment of a piece-wise regression is removed by imposing certain linear restriction as suggested by Boyce[10]. In the case of exponential functional form , such approach , according to him yields kinked exponential model . He explains its superiority in comparing sub-period growth rates. From kinked exponential model with one, two or multiple kink points , the sub-period growth rate can easily be estimated by OLS method . An elaboration of this method is given below.

Let us consider that the time-series for the period $t = 1, 2, 3, \ldots\ldots, n$ be broken at a single point k . The discontinuous growth rate for the two sub-periods can be estimated separately or by fitting the single equation .

$\ln Y_t = a_1 D_1 + a_2 D_2 + (b_1 D_1 + b_2 D_2)\, t + u_t$ .... (2).

where u_t is the error term and D_j is a dummy such that

$D_j = 1$, for the j-th sub-period.

$= 0$, otherwise.

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9. Ahluwalia ,I.J, *Industrial Growth in India : Stagnation Since the Mid-Sixties* , Oxford University Press, Delhi, 1985. pp. 16-17. See, for example, Table 2.4. of the book showing discrepancies as in the following .

Industry	Growth rate (per cent)		
	1959 - 60 to 1965-66.	1966-67 to 1979-80	1959-60 to 1979-80.
Tobacco	1.50	1.30	2.10
Textile.	3.90	4.40	3.10
Footwear	15.30	14.50	12.40
Basic metals	15.00	5.10	4.60
Total Manufacturing	7.60	5.40	7.60

10. Boyce , J.K., *Agrarian Impasse in Bengal* , Oxford University Press, 1987, pp.267-271.

Discontinuity between the lines can be removed by using a linear restriction such that they intersect at the break point k . In that case,

$$a_1 + b_1 k = a_2 + b_2 k \text{ .... (3).}$$

Substituting for a_2 (and noting that $a_1 D_1 + a_2 D_2 = a_1$) we get the restricted form

$$\ln Y_t = a_1 + b_1 (D_1 t + D_2 k) + b_2 (D_2 t - D_2 k) + u_t \text{ .... (4).}$$

The OLS estimates of b_1 and b_2 from the above equation gives the exponential growth rate for two sub-periods with a kink at k and $\hat{b}_1$ not equal to $\hat{b}_2$.

This procedure can equally be extended to the time-series data when they are broken at two points , say k_1 and k_2, so that three sub-periods are created . The unrestricted model becomes

$$\ln Y_t = a_1 D_1 + a_2 D_2 + a_3 D_3 + (b_1 D_1 + b_2 D_2 + b_3 D_3) t + u_t \text{ ....(5).}$$

The two-kink exponential model is derived imposing linear restrictions such that sub- periods' trend lines meet at k_1 and k_2

$$a_1 + b_1 k_1 = a_2 + b_2 k_1 \text{ .... (6)}$$

$$a_2 + b_2 k_2 = a_3 + b_3 k_2 \text{ ....(7)}$$

substituting for a_2 and a_3 We get the two-kinked exponential model ,

$$\ln Y_t = a_1 + b_1 (D_1 t + D_2 k_1 + D_3 k_1) + b_2 (D_2 t - D_2 k_1 - D_3 k_1 + D_3 k_2)$$
$$+ b_3 (D_3 t - D_3 k_2) + u_t \text{ .... (8).}$$

The OLS estimate of b_1 , b_2 and b_3 of equation (8) gives the growth rates of the three different sub-periods . The sub-period growth obtained in this way can not all be greater than or less than the exponential growth rate estimated for the period as a whole. The functional form (8) has been used in this study to derive the growth rate in different sub-periods.

The rationale for using the kink exponential form is that it utilises all the values throughout the period even when the sub-period growth rate is calculated . But in conventional approach values taken by the variable outside each given sub-period is ignored making the system less sensitive to fluctuation and instability.

Further, for verification of existence of statistically significant acceleration or deceleration in growth over the whole period a quadratic in time variable of the form ,

$$\ln y = a + bt + ct^2 \text{ .... (9) is estimated .}$$

The issue of acceleration or deceleration of growth over the sub-periods has been resolved by applying the following test as suggested by Alagh and Sharma.[11]

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11. Alagh, Y.K. , Sharma , P.S. , "Growth in Crop Production 1960-61 to 1978-79 : Is it Decelerating ? " *Indian Journal of Agricultural Economics* , Vol. XXXV, No.2, April -June, p.107.

$$t = \frac{b_2 - b_1}{\sqrt{(S.E.b_1) + (S.E.b_2)}} \quad \text{......... (10)}$$

where , b_1 = regression coefficient of sub-period I.

b_2 = regression coefficient of sub-period II.

$S.E.b_1$ = standard error of b_1.

$S.E.b_2$ = standard error of b_2.

Basic data for this study have been drawn from various issues of Tea Statistics published by Tea Board of India .

In addition to estimating annual growth rate of output , area and yield by adopting aforesaid method , the output growth has been decomposed into the growth of its constituent components , area and yield in order to assess the relative contribution of change in area and yield to the growth of production . The decomposition procedure has been explained by the following illustration .

$$Q_t = A_t\, Y_t \quad \text{....................... (11).}$$

Where , Q_t = output ,

A_t = area ,

Y_t = yield , all at time t.

Given a multiplicative identity such as (11), the exponential growth rate of the components on the right-hand side sum to the growth rate on the left -hand side term , output :

$$b_Q = b_A + b_Y \quad \text{.............................. (12).}$$

Where,

$\ln Q_t = a_Q + b_Q t$

$\ln A_t = a_A + b_A t.$

$\ln Y_t = a_Y + b_Y t.$

Where Q , A and Y respectively denotes output , area and yield and b denotes the growth rate of the corresponding suffixes attached to it .

The same additive property applies to the sub-period growth rates emerging from the kink exponential equations discussed earlier.

In the last part of growth analysis an attempt is made to examine the impact of output growth in changing the relative position of a constituent region to total production. In view of this , the production share of each constituent part to that of total has been calculated over the years under consideration . A simple linear regression of the form $S_t = a + bt$ has been fitted to the temporal share data(S_t) to estimate the slope coefficient of trend (b) in order to examine whether the production share of a constituent area has been changed over the period . This trend analysis is employed in the context of global production and changing the shares of the major tea producing countries . In the context of national level production and changing the shares of the Northern and Southern region and that of the States and also in the context of each of the states and changing the shares of the districts thereunder.

3.1.2 Choice of Period and Sub-Periods

In selecting the time period for growth analysis of a crop, the phases of transition to full establishment, technological acquaintance and thereafter extension of its production and consumption as well as availability of continuous time-series production data are the points which one takes into account . The abnormal period of shaking a society's order like war, devastating natural disaster etc. are also usually kept apart while choosing a continuous time period for any trend analysis . In view of all these , let us cast a glance to the tea production scenario of the major tea producing countries including India . The Second World War in general exerted a stupendous jerk to most of the countries . And in reality the tea production and trade , by and large , was not regained until early fifties (the London auction reopened after World War in 1951). The period 1887 to 1949 was experienced as the declining stage of Chinese tea industry because of political instability [12]. Recovering and developing of Chinese tea industry was started following the establishment of the Peoples' Republic of China in 1949 . The recovery effort got momentum and increasing production was realised only after 1955-56. In Sri Lanka a new thrust in tea production was witnessed during the period 1948-1960 under relatively open trading regime after independence in 1948 . Tea cultivation in Indonesia was started quite a long time back. But within 20 years after World War II Indonesian tea experienced a set back . Many large tea plantations were abandoned and some areas were converted into food crop production [13]. The difficulties were overcome and the tea industry in Indonesia was capable to restore its past glory until mid-sixties . In Turkey tea production began in the Republican era after the possibility of tea production was determined in 1917 around the Eastern Black Sea region . First black tea production ,-however , was started since 1947 . And thereafter till early sixties a spectacular spurt in tea production was recorded in Turkey in order

12. Zongmao . C and Zhenhui . L . " Tea Industry in China", *Tea Science and Human Health (ed)* , Tea Research Association , Jorhat , 1993,p.22.

13. Arifin. M.S., Dharmadi. A. Subarna . N . "Tea Industry in Indonesia ." *Tea Science and Human Health (ed)* . Tea Research Association . Jorhat . 1993 , p.37.

to meet the domestic demand within a shortest possible while [14]. Commercial tea growing was possible in Kenya only after 1920s as stated earlier . But major development did not start untill much later , after the Second World War . Till mid-fifties tea production in Kenya was confined to European settled areas and thereafter from early sixties it was expanded to non-European Kenya highlands after the experimental trials being successful .[15] Japan , the worst affected country by Second World War , could not recoup its position in tea production untill early sixties . India traversed a long way in respect of tea production since the beginning of the present century and no such ups and downs has been recorded in the history of Indian tea economy . It has been delineated in the above discussion that a phase of transition has traversed by major tea producing countries either because of shock generated from World War II , Civil War or time span required for experimentation. And thereafter expansion of the production is brought about during the period extending from late forties to fifties . All these keeping in view , the period of three decades 1961 to 1990 has been chosen for trend analysis .

In most of the trend analyses by apportioning into sub-periods in the context of Indian agriculture the mid-sixties has been taken as the cut-off point in dividing the sub-periods . In justifying the above presumption most of the scholars pointed out the period mid-sixties as turning point of technological change when the release of HYV seeds characterised by higher intake capacity of fertilisers in complementarity with the use of irrigation and plant protection inputs and resulting thereby a shift in production function was brought about. Thus according to them the shifting point , which Boyce [16] calls it as the point of 'trend break ', may aptly be taken as cut-off point of sub-periods . No such point of shifting or trend break can be identified in case of tea. For tea the primary product is green leaf and its volume of production depends on various factors like nutrients , shade , drain etc. as well as biological character of the tea bushes . This biological characteristic can be termed as shift variable in case of tea production . Tea cultivation was initiated by seed . Through sustained breeding effort vegetative method of propagation was successful and some clonal planting materials were released for North India's tea industries only in late forties. Thereafter , continuous release of various types of clones aiming at either increasing volume or value of the produce is witnessed by the results of tea

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14 Vanli , H. " Tea Industry in Turkey ," *Tea Science and Human Health (ed)*, Tea Research Association ,Jorhat, 1993 , p.96.

15. Othieno , C.O., " Tea Industry in Kenya " *Tea Science and Human Health (ed.)* , Tea Research Association , Jorhat , 1993 , pp. 61.

16. Boyce , J.K. , *Agrarian Impasse in Bengal* , Oxford University Press ,1987, pp. 267-271.

breeding efforts at Toklai Experimental Station [17] at Jorhat of Assam since the initiation of systematic tea breeding at TES in late thirties 163 clonal cultivars were released on continual basis. Out of 163 clonal cultivars released 29 cultivars were belonging to the category of vegetative propagule of TV -series[18] as summarised in **Table 3.1**. One plausibly assumed from the North India's example of plant improvement programme cited above that no such point of in terms of inflectionary change in biological character of tea plant . In absence of turning point the trend analysis for the study has been divided into three equal sub-periods , each spanning one decade i.e., 1961-70 , 1971-1980 and 1981 - 90.

Table 3.1: Release of clones from Toklai Experimental Station

Period	Clones released.
1940 - 49	TV_1 , TV_2 , TV_3
1950-59	TV_4 to TV_9
1960- 69	TV_{10} to TV_{17}
1970 - 79	TV_{18} to TV_{24}
1980 - 89	TV_{25} to TV_{28}
1990	TV_{29}

3.2 Growth Performance : Major Tea Producing Countries

This section is devoted to examine the growth of production and that of its constituent components , area and yield , of tea for major tea producing countries in order to delineate differential growth and growth pattern among the countries , if any therein , and to find out the relative contribution of area and yield to the observed growth of output with a view to arriving at some broad conclusion in respect of growth behaviour of tea production for major tea producing countries in the world . This section also purports to examine the impact of differential growth in changing the relative position of an individual country to the global tea production nexus.

Simple exponential annual growth rate over the whole period (1961-90) and each sub-period for production , area and yield of tea in major tea producing countries are summarised in

17 Singh, I.D, "A Decade of Tea Breeding in North -East India ", *Proceedings of the 31st Tocklai Conference , 1992, Tea Research Association*, TES, Jorhat, pp. 13-25.

18. Tea Research Association . *Toklai Experimental Station :1911 to 1991*,Jorhat , 1992 , pp.36-54.

Table 3.2. Average annual growth rate of production for Turkey , Kenya , China, U.S.S.R. and shift or trend break can be identified Indonesia is found to be higher than that of World average 3.46 per cent . Among the high growth countries annual growth of production for Turkey , Kenya and China are recorded as high as 10.38, 9.08 and 6.53 per cent respectively . A trend in annual growth rate of output , however , appears to be declining significantly in case of Turkey , Kenya and U.S.S.R. while in China and Indonesia annual growth rate of production is found continuously increasing as noticed from **Table 3.3.** In case of Turkey the observed declining trend in growth rate is brought about from both sources of area and yield (**Table 3.3)** . But for Kenya that is caused by drastic fall in growth rate of area which has not been compensated by significant increasing trend in growth rate of yield as demonestrated from **Table 3.3**. The dwindling trend in growth rate of output for U.S.S.R. and increasing trend in output growth rate for Indonesia are , however , caused by comensurating area growth in the respective direction . Among the low growth countries in the counterpart , India is recorded to have relatively high annual growth of output (2.64 per cent) followed by Japan (0.64 per cent). Sri Lanka shows negative growth . Notwithstanding of having lower rate of growth in comparison with that of the World average the trend in annual growth of output in case of India is not decelerating in statistical sense of term and that too has become possible by significant acceleration in area growth . But trend in annual growth of production in Japan has declined significantly because of the fact that trend in growth rate of both area and yield have been decelerated significantly.

At the global level the principal source of output growth is found to be the growth of area and it is also true for the high growth countries like Turkey , Kenya , China and Indonesia. Of the high growth countries U.S.S.R. unveils the contrary picture , where principal source of growth are being the yield as has been conspicuous from **Table 3.2** . Despite the contrasting contribution of area and yield to the output growth as observed between high growth countries , the similarity in growth behaviour amongst the high growth countries is that the growth of yield for almost all of them is noted to be exceedingly higher. Thus one may reasonably lead to the contention that whatever be the relative contribution of area and yield to the growth of production an incidence of higher growth of output is highly associated with the achievement of higher pace of growth in yield.

Now let us turn to the growth analysis over different sub-periods. Both in Turkey and Kenya the growth rate of output are found decreasing from one sub-period to the other. In case of Turkey it diminishes from 19.6 per cent to 4.9 per cent in the third sub-period . And for Kenya it declines from 11.9 per cent in the first to 6.9 per cent in the third sub-period

(**Table 3.2**) . In both countries the area growth rate has been declining and it is declining with relatively high pace in case of Kenya . The contrasting sub-period growth pattern between these two high growth countries is that the former is witnessed with drastic decline in growth rate of area and resulting therefrom high variability in sub-period growth rate of output as against the latter with drastic fall in growth rate of area accompanied by continuous increasing in the rate of growth of yield leading to relatively less variability in sub-period growth rates of output as visualised from **Table 3.2** . China shows a relatively low growth rate (1.69 per cent) followed by a jump (9.38 per cent) and thereafter it is dwindled (5.74 per cent) . The interesting observation is that in China the area growth is found to have been the principal source of growth over the first two sub-periods. While that have been changed qualitatively and the growth of yield has become the principal source of growth by a spectacular increase of yield in the third sub-period despite negative growth of area.

In Indonesia output has retarded to decelerate at an annual rate of about 3 per cent in the first sub-period but thereafter it increases with annual rate 6.4 and 5.4 per cent respectively over second and third sub-period . Growth of yield over the second sub-period is noted a quite high but in the third sub-period yield growth shows decelerating and hence the above noted higher output growth has come out from disproportionate growth of area .

In U.S.S.R. stagnation in output growth over the third sub-period is caused by the stagnation in the growth of yield . In low yielding countries like India , Sri Lanka and Japan an improvement or a deterioration in the pace of output growth in any sub-period over a preceding one has been broadly understood by the growth of yield in the same direction as elicited from **Table 3.2** . From the sub-period growth analyses as from the earlier analysis the matter comes to the fore that the growth of yield is the principal question of concern with an objective of achieving higher rate of growth in tea production in the context of tea production scenario in the major tea growing countries of the World .

Temporal movement of production share of the selected countries to global tea production as well as the regression estimates are furnished in **Table 3.4** in order to examine the direction of change in relative position of the individual countries to global tea production scenario. **Table 3.4** shows statistically significant negative trend coefficient for India , Sri Lanka and Japan , and positive slope coefficients for China , Turkey , Kenya and U.S.S.R. implying that the relative position of the former three countries have been deteriorated over the period while the latter four countries have improved their relative position through the process of growth .Indonesia ,however , exhibits its relative position indifferent.

Table 3. 2: Exponential and Kinked exponential growth rates of output . area and yield of tea in the major tea growing countries during 1961 – 1990 and its sub-periods 1961-70, 1971-80; and 1981-90.

	Simple exponential growth rate (1961-90)						Kinked exponential growth rate											
							OUTPUT				AREA				YIELD			
	Output	R^2	Area	r^2	Yield	r^2	1961-70	1971-80	1981-90	R^2	1961-70	1971-80	1981-90	R^2	1961-70	1971-80	1981-90	R^2
India	2.64** (0.00070)	0.9804	0.83** (0.00024)	0.9768	1.81** (0.00087)	0.9384	2.41** (0.0030)	3.01** (0.0022)	2.20** (0.0026)	0.9807	0.75** (0.00088)	0.72** (0.00067)	1.07** (0.00077)	0.9826	1.66** (0.0036)	2.29** (0.0027)	1.13** (0.0031)	0.9428
Sri Lanka	-0.14 (0.0012)	0.2483	-0.25** (0.00055)	0.4316	0.11 (0.0015)	0.3176	0.30 (0.0038)	-1.33** (0.0029)	1.51** (0.0033)	0.4839	0.16 (0.00098)	0.04 (0.00074)	-1.10** (0.00086)	0.8975	0.14 (0.0036)	-1.37** (0.0028)	2.61** (0.0032)	0.6943
Indonesia	3.92** (0.0053)	0.6608	2.44** (0.0040)	0.5674	1.48** (0.0049)	0.3344	-2.95 (0.0185)	6.44** (0.0141)	5.39** (0.0162)	0.7680	-2.84** (0.0081)	2.33** (0.0061)	7.08** (0.0071)	0.9023	-0.11 (0.0207)	4.11* (0.0157)	-1.69 (0.0181)	0.4583
China[(a)]	6.53** (0.0026)	0.9579	4.93** (0.0037)	0.8649	1.61** (0.0041)	0.3586	1.69* (0.0061)	9.38** (0.0046)	5.74** (0.0053)	0.9868	5.06** (0.0072)	8.54** (0.0055)	-1.37* (0.0063)	0.9711	-3.37** (0.0053)	0.84 (0.0043)	7.11** (0.0050)	0.9293
Japan	0.64** (0.0016)	0.4725	0.94** (0.00098)	0.7664	-0.30** (0.00096)	0.4594	2.06** (0.0032)	1.27** (0.0024)	-1.62** (0.0028)	0.8579	1.00** (0.0022)	1.87** (0.0017)	-0.68** (0.0019)	0.9353	1.06** (0.0028)	-0.60** (0.0021)	-0.94** (0.0024)	0.6578
Kenya	9.08** (0.0027)	0.9759	5.77** (0.0033)	0.9161	3.31** (0.0025)	0.8661	11.87** (0.0090)	9.00** (0.0068)	6.89** (0.0078)	0.9851	9.82** (0.0036)	6.47** (0.0028)	1.16** (0.0032)	0.9943	2.05* (0.0089)	2.53** (0.0068)	5.73** (0.0078)	0.9022
East Africa	6.46** (24.775)	0.9564	4.19** (15.616)	0.8970	2.27** (13.328)	0.8638	10.59* (15.413)	5.29** (10.145)	4.99** (8.296)	0.9830	7.66** (26.639)	4.63** (21.201)	0.54* (2.146)	0.9934	2.93** (5.248)	0.66 (1.568)	4.45** (9.100)	0.9177
U. S. S. R.	4.86** (0.0039)	0.8445	0.74** (0.00042)	0.9147	4.12** (0.0039)	0.7972	2.31 (0.0114)	9.34** (0.0087)	-0.65 (0.0100)	0.9266	1.42** (0.0012)	0.53** (0.0008)	0.54** (0.0010)	0.9653	0.89 (0.0113)	8.81** (0.0086)	1.19 (0.0099)	0.9062
Turkey	10.38** (0.0067)	0.8957	6.34** (0.0021)	0.9708	4.04** (0.0058)	0.6326	19.59** (0.0181)	9.04** (0.0137)	4.91** (0.0158)	0.9574	7.64** (0.0076)	6.78** (0.0057)	4.47** (0.0066)	0.9783	11.95** (0.0178)	2.26 (0.0135)	0.44 (0.0156)	0.8074
World	**3.46** (0.00069)**	**0.9890**	**2.58** (0.0015)**	**0.9162**	**0.88** (0.0015)**	**0.5589**	**2.35** (0.0021)**	**4.18** (0.0016)**	**3.16** (0.0018)**	**0.9945**	**2. 34** (0.0029)**	**4.18** (0.0022)**	**0.04 (0.0025)**	**0.9820**	**0.0031 (0.0033)**	**0.0006 (0.0025)**	**3.12** (0.0029)**	**0.8784**

Figures in the parenthesis indicate S. E. of estimates.

* **Indicate significant at 5 % level by two-tailed test.**

** **Indicate significant at 1 % level by two-tailed test.**

(a) Data for 1981-90 is obtained from Tea Statistics of Tea Board of India. But prior to 1981 it is obtained by interpolation from the data given with certain interval of time in the article cited under foot note 7 of Chapter II.

Table 3.3 : Quadratic in 't' fitted to output , area and yield of tea for the different major countries , 1961 - 1990.

	Output				Area				Yield			
	Constant	t	t^2	R^2	Constant	t	t^2	R^2	Constant	t	t^2	R^2
India	13.1174	0.0264	-0.000073 (0.000092)	0.9794	12.8150	0.0083	0.000084** (0.000027)	0.9816	0.3023	0.0181	0.00015 (0.00011)	0.9384
Sri Lanka	12.2348	-0.0014	0.00034* (0.00014)	0.2574	12.3994	-0.0025	-0.00032** (0.000038)	0.8240	-0.1646	0.0011	0.00066** (0.00015)	0.3627
Indonesia	11.0869	0.0392	0.0020** (1.00058)	0.7415	11.0942	0.0244	0.0024** (0.00025)	0.8935	-0.0073	0.0148	-0.00046 (0.00064)	0.2005
China [(a)]	12.2582	0.0653	0.00087** (0.00029)	0.9658	13.5861	0.0493	-0.0018** (0.00034)	0.9255	-1.3279	0.0161	0.0026** (0.00017)	0.9280
Japan	11.5026	0.0064	-0.00093** (0.00010)	0.8314	10.9624	0.0094	-0.00046** (0.000094)	0.8687	0.5402	-0.0030	-0.00047** (0.000088)	0.6112
Kenya	11.0764	0.0908	-0.0012** (0.00026)	0.9855	11.0173	0.0577	-0.0022** (0.00011)	0.9936	0.0590	0.0331	0.00095** (0.00026)	0.9022
U. S. S. R.	11.4244	0.0486	-0.0010* (0.00048)	0.8578	11.2488	0.0074	-0.00021** (0.000038)	0.9585	0.1755	0.0412	-0.00082 (0.00049)	0.8029
Turkey	11.0605	0.1038	-0.0036** (0.00053)	0.9583	10.6790	0.0634	-0.00085** (0.00021)	0.9800	0.3815	0.0404	-0.0028** (0.00055)	0.7963
World	**14.2044**	**0.0346**	**0.00065 (0.000085)**	**0.9896**	**14.4694**	**0.0258**	**-0.00064** (0.00015)**	**0.9469**	**-0.2650**	**0.0088**	**0.00081** (0.00011)**	**0.8306**

Figures in the parenthesis indicate S. E. of estimates.

* **Indicate significant at 5 % level by two-tailed test.**

** **Indicate significant at 1 % level by two-tailed test.**

(a) Data for 1981-90 is obtained from Tea Statistics of Tea Board of India. But prior to 1981 it is obtained by interpolation from the data given with certain interval of time in the article cited under foot note 7 of Chapter II.

Table 3.4 : Distribution of production share of individual countries to World's total tea production over 1961-90

Year \ Country	India	Sri Lanka	Indonesia	China	Japan	Turkey	Kenya	U. S. S. R.
1961	0.36	0.21	0.08	0.13	0.08	0.01	0.01	0.04
1962	0.36	0.22	0.05	0.12	0.08	0.01	0.02	0.05
1963	0.35	0.23	0.04	0.12	0.08	0.01	0.02	0.05
1964	0.36	0.21	0.08	0.10	0.08	0.01	0.02	0.05
1965	0.36	0.23	0.05	0.10	0.08	0.01	0.02	0.05
1966	0.36	0.21	0.04	0.10	0.08	0.02	0.02	0.06
1967	0.35	0.20	0.07	0.10	0.08	0.02	0.02	0.05
1968	0.35	0.20	0.07	0.10	0.07	0.02	0.03	0.05
1969	0.35	0.19	0.04	0.11	0.08	0.03	0.03	0.05
1970	0.35	0.18	0.04	0.11	0.08	0.03	0.03	0.03
1971	0.36	0.18	0.04	0.12	0.08	0.03	0.03	0.06
1972	0.35	0.16	0.04	0.13	0.07	0.04	0.04	0.06
1973	0.35	0.16	0.04	0.13	0.07	0.03	0.04	0.06
1974	0.36	0.15	0.04	0.14	0.07	0.03	0.04	0.06
1975	0.34	0.15	0.04	0.15	0.07	0.04	0.04	0.06
1976	0.34	0.13	0.04	0.15	0.07	0.04	0.04	0.06
1977	0.34	0.13	0.04	0.15	0.06	0.06	0.05	0.07
1978	0.33	0.12	0.04	0.16	0.06	0.06	0.06	0.07
1979	0.32	0.12	0.05	0.16	0.06	0.06	0.06	0.07
1980	0.32	0.11	0.06	0.17	0.06	0.05	0.05	0.07
1981	0.31	0.12	0.06	0.19	0.06	0.03	0.05	0.08
1982	0.31	0.10	0.05	0.22	0.05	0.04	0.05	0.08
1983	0.30	0.09	0.06	0.21	0.05	0.05	0.06	0.08
1984	0.31	0.10	0.06	0.20	0.04	0.05	0.06	0.07
1985	0.30	0.10	0.06	0.20	0.04	0.06	0.07	0.07
1986	0.29	0.10	0.06	0.21	0.04	0.07	0.07	0.07
1987	0.30	0.10	0.06	0.23	0.04	0.06	0.07	0.05
1988	0.30	0.10	0.06	0.23	0.04	0.07	0.07	0.05
1989	0.30	0.09	0.06	0.23	0.04	0.06	0.08	0.05
1990	0.30	0.10	0.06	0.22	0.04	0.05	0.08	0.05
$\hat{b}$	-0.0027*	-0.0053*	0.0001	0.0048*	-0.0017*	0.0020*	0.0022*	0.0008*
t	(13.62)	(21.08)	(0.55)	(14.30)	(19.25)	(11.67)	(27.51)	(3.88)
r^2	0.8689	0.9407	0.0109	0.8796	0.9298	0.8294	0.9643	0.3499
F	185.58*	444.52*	0.308	204.47*	370.63*	136.17*	757.01*	15.07*

*** Significant at 1 % level.**

Fig. in the parenthesis indicates t-value.

3.3 Growth Performance : Regions , States and Districts

This section is attempted to explain the growth of output , area and yield of made tea for the whole period and for each sub-period at the national , regional , state and the district level in order to understand the spatial variation in growth and growth pattern and to examine the inter-spatial variability in the relative contribution of area and yield to the growth of output with an objective to come into an inference in respect of inter-spatial variability in growth behaviour of tea production in India.

Annual growth rate of output , area and yield for tea for the entire period and for each sub-period at national as well as Northern and Southern regions are presented in **Table 3.5** . It reveals from **Table 3.5** that the growth rate of output for the entire period is higher in the North than that in the South . As the North itself accounts for a little over three-fourths of national production the production growth rate at the national level too is registered higher than that of the South. The growth behaviour , however, differs from one sub-period to another and again sub-period growth pattern of the North differs from that of the South as evinced by **Table 3.5** . Annual growth rate of output in the North as well as at the national level increases from the first to the second and thereafter decreases in the third sub-period . While in the South it increases althrough from the first to the third sub-period. The North can also be distinguished from the South by decomposing the production growth into its constituent components , area and yield . In the North as well as at the highest aggregate national level both the area and yield have significantly contributed to the output growth . While in the South the observed expansion of output at higher pace is solely attributable to the growth of yield as revealed by **Table 3.5** . It is interesting to note that the growth of yield in the third sub-period as observed in the North is found to be non-significant and therefore , the output growth is totally ascribed to the area growth.

Let us turn to the question whether any differences in growth rate or in sub-period growth pattern is noted between the states and between the constituent districts of each state comprising the respective region . The state Assam and West Bengal together with accounts for about 98 per cent of production of the Northern region. Considering the whole period the annual growth rate in Assam is recorded higher (2.93 per cent) and that of West Bengal is lower (2.28 per cent) than the national level (2.64 per cent) as shown by **Table 3.6.** The sub-period growth rates , however , follow the same pattern , increasing followed by decreasing , for both the states. At further disaggregated district level under each of the two states a differential growth and growth pattern is visualised from **Table 3.6.** Annual growth rate in Darrang and

~~Cachar~~ district of Assam is noted higher than state level . Among the remaining three districts , Lakhimpur and Dibrugarh combined , Nowgaon and Sibsagar ,the lowest growth rate (2.10 per cent) is accorded to Nowgaon. For sub - period growth pattern the district Darrang, Lakhimpur and Dibrugarh combined and Sibsagar follow the same growth pattern as is shown at the state level . While in Nowgaon a high growth rate (3.44 per cent) is realised in the first sub-period followed by miserably decline in the second sub-period and thereafter it gets recovery. And in Cachar a higher growth (3.23 per cent) in the first sub-period followed by a fall in growth rate to 2.79 and 1.74 per cent in the subsequent periods are recorded. Among the three districts in West Bengal namely , Darjeeling , Terai and Dooars the annual growth rate for Terai is recorded as high as 3.35 per cent while that for Darjeeling is found as low as 1.16 per cent , the position of Dooars in this respect is lying inbetween . The districts Darjeeling and Dooars follow the growth pattern of the state. But the Terai shows a steady growth in three sub-periods as noticed from **Table 3.6.** Notwithstanding above noted variability in growth rate and in the pattern of growth among the states and between the districts within a state, the edge of area growth over that of yield to the growth of production is found in the last sub-period for all the Northern district and states as revealed from a careful examination of **Table 3.6.**

Out of nearly one-fourth of India's tea production accounted by the South , individual share of both Tamil Nadu and Kerala is noted by and large equal and they jointly account for about 20 per cent , the share of Karnataka is being less than 1 per cent . Again about two-thirds of Tamil Nadu's production and three-fourths of Kerala's production are contributed by the respective district Nilgiris and Idduki . Thus the growth and growth pattern of these two districts have largely influenced that of the respective state. Average annual growth rate of production over the whole period recorded for Tamil Nadu as well as for Nilgiris is higher than that of the growth of Southern region and that too is largely attributable to the growth of yield as shown in **Table 3.6**. Similar revelation is also observed for sub-period's growth . In Kerala and also in Idduki annual growth rate of production for the whole period appears to be less than that of the Southern region . But the growth of output is brought about by the notable yield augmentation despite dwindling the area under the crop . Analogous growth behaviour is witnessed here also for the sub-period's growth.

From the foregoing discussion one may plausibly lead to the contention that the observed higher annual rates of growth in the North over the whole period (1961-90) is attributable both to the area expansion and yield augmentation while that for the South is caused solely by yield enhancement . Growth analysis by sub-period in the North also reveals that the output growth of tea in the last sub-period (1981-90) is principally brought about by area

Table 3.5 : Annual growth rate of output , area and yield of tea at national and regional level during 1961-90 and its sub-periods 1961-70; 1971-80; 1981-90.

	OUTPUT						AREA						YIELD					
	Simple exponential growth rate		Kinked exponential growth rate				Simple exponential growth rate		Kinked exponential growth rate				Simple exponential growth rate		Kinked exponential growth rate			
Region	1961-90	r^2	1961-70	1971-80	1981-90	R^2	1961-90	r^2	1961-70	1971-80	1981-90	R^2	1961-90	r^2	1961-70	1971-80	1981-90	R^2
North India	2.71** (0.00087)	0.9719	2.52** (0.0035)	3.21** (0.0027)	2.02** (0.0031)	0.9742	1.04** (0.00027)	0.9807	0.99** (0.0011)	0.91** (0.00079)	1.30** (0.00091)	0.9842	1.67** (0.0011)	0.8997	1.53* (0.0041)	2.30** (0.0031)	0.72 (0.0036)	0.9131
South India	2.41** (0.0014)	0.9140	2.04** (0.0061)	2.34** (0.0046)	2.82** (0.0053)	0.9081	0.0009 (0.00012)	0.0003	-0.09 (0.00052)	0.01 (0.00039)	0.06 (0.00045)	0.1805	2.41** (0.0013)	0.9198	2.13** (0.0059)	2.33** (0.0045)	2.76** (0.0052)	0.9133
All India	2.64** (0.0070)	0.9804	2.40** (0.0030)	3.01** (0.0022)	2.20** (0.0026)	0.9807	0.83** (0.00023)	0.9786	0.75** (0.00084)	0.73** (0.00064)	1.07** (0.00074)	0.9839	1.81** (0.00086)	0.9397	1.65** (0.0035)	2.28** (0.0027)	1.13** (0.0031)	0.9440

Fig. in the parenthesis indicates S.E. of the estimate.

**** Significant at 1 % level**

*** Significant at 5 % level**

Table 3.6: Annual growth rate of output , area and yield of tea in different tea producing districts and states 1961 - 1990 and its sub-periods 1961 - 1970 ; 1971 - 1980 and 1981 - 1990.

	OUTPUT						AREA						YIELD					
	Simple exponential growth rate		Kinked exponential growth rate				Simple exponential growth		Kinked exponential growth				Simple exponential growth rate		Kinked exponential growth rate			
Region	1961-90	R^2	1961-70	1971-80	1981-90	R^2	1961-90	R^2	1961-70	1971-80	1981-90	R^2	1961-90	R^2	1961-70	1971-80	1981-90	R^2
Darrang	3.55*	0.9721	3.31*	4.17*	2.68*	0.9758	1.49*	0.9936	1.57*	1.40*	1.57*	0.9933	2.06*	0.9082	1.74*	2.77*	1.11**	0.9144
	(0.0011)		(0.0046)	(0.0036)	(0.0041)		(0.00022)		(0.00097)	(0.00073)	(0.00057)		(0.0012)		(0.0050)	(0.0038)	(0.0044)	
Lakhimpur	2.82*	0.9627	2.68*	3.46*	1.84*	0.9682	1.25*	0.9926	1.45*	1.01*	1.51*	0.9962	1.57*	0.8646	1.23*	2.45*	0.35	0.8943
& Dibrugarh	(0.0010)		(0.0041)	(0.0031)	(0.0036)		(0.00020)		(0.00062)	(0.00047)	(0.00054)		(0.0012)		(0.0044)	(0.0033)	(0.0038)	
Nowgaon	2.10*	0.7732	3.44**	0.88	3.06*	0.7777	1.17*	0.9724	1.40*	0.91*	1.41*	0.9748	0.93*	0.4066	2.04**	-0.03	1.65*	0.3897
	(0.0021)		(0.0090)	(0.0068)	(0.0079)		(0.00037)		(0.00051)	(0.0011)	(0.0013)		(0.0021)		(0.0091)	(0.0069)	(0.0080)	0.3897
Sibsagar	2.79	0.9497	2.00*	3.08*	2.97*	0.9494	1.40*	0.9636	1.11*	1.17*	2.07*	0.9821	1.39*	0.7908	0.89	1.91*	0.90	0.7799
	(0.0012)		(0.0051)	(0.0039)	(0.0045)		(0.00051)		(0.0015)	(0.0012)	(0.0013)		(0.0013)		(0.0058)	(0.0044)	(0.0051)	
Cachar	2.60*	0.9039	3.23*	2.79*	1.74*	0.9060	0.61*	0.9185	0.34*	0.48*	1.04*	0.9648	1.99*	0.8134	2.89*	2.31*	0.70	0.8358
	(0.0016)		(0.0067)	(0.0051)	(0.0058)		(0.00034)		(0.00094)	(0.00071)	(0.00082)		(0.0018)		(0.0071)	(0.0054)	(0.0062)	
All Assam	2.93*	0.9736	2.74*	3.38*	2.33*	0.9742	1.24*	0.9840	1.20*	1.05*	1.64*	0.9904	1.68*	0.8943	1.54*	2.33*	0.69	0.9085
	(0.00093)		(0.0038)	(0.0029)	(0.0033)		(0.00030)		(0.00098)	(0.00075)	(0.00086)		(0.0011)		(0.0043)	(0.0033)	(0.0038)	
Darjeeling	1.16*	0.6198	0.32	2.10*	0.26	0.6238	0.36*	0.5552	-0.44**	0.45*	0.87*	0.8109	0.80*	0.4284	0.76 (NS)	1.65*	-0.61	0.4761
	(0.0017)		(0.0072)	(0.0055)	(0.0063)		(0.00060)		(0.0017)	(0.0013)	(0.0015)		(0.0081)		(0.0071)	(0.0054)	(0.0062)	
Terai	3.35*	0.9425	3.49*	3.18*	3.50*	0.9361	1.23*	0.9631	1.78*	0.60*	1.82*	0.9878	2.12*	0.8625	1.71**	2.58*	1.68**	0.8513
	(0.0016)		(0.0070)	(0.0058)	(0.0061)		(0.00045)		(0.0011)	(0.00083)	(0.00096)		(0.0016)		(0.0070)	(0.0053)	(0.0061)	
Dooars	2.26*	0.9368	2.12*	3.07*	0.97*	0.9554	0.74	0.9641	0.73*	0.58*	1.01*	0.9715	1.52*	0.8422	1.40*	2.49*	-0.04	0.8997
	(0.0011)		(0.0039)	(0.0030)	(0.0034)		(0.00026)		(0.0010)	(0.00076)	(0.00088)		(0.0012)		(0.0042)	(0.0032)	(0.0037)	

Fig. in the parenthesis indicates S.E. of the estimate.

Contd..............

** **Significant at 1 % level**

- **Significant at 5 % level**

Table 3.6. Contd..

	OUTPUT						AREA						YIELD					
	Simple exponential growth		Kinked exponential growth				Simple exponential growth		Kinked exponential growth				Simple exponential growth		Kinked exponential growth			
Region	1961-90	R^2	1961-70	1971-80	1981-90	R^2	1961-90	R^2	1961-70	1971-80	1981-90	$\bar{R}^2$	1961-90	R^2	1961-70	1971-80	1981-90	$\bar{R}^2$
All West	2.28*	0.9440	2.08*	3.00*	1.24*	0.9544	0.72*	0.9483	0.60*	0.56*	1.09*	0.9668	1.56*	0.8600	1.48*	2.44*	0.15	0.9034
Bengal	(0.0011)		(0.0040)	(0.0030)	(0.0035)		(0.00031)		(0.0011)	(0.00081)	(0.00093)		(0.0012)		(0.0042)	(0.0032)	(0.0037)	
Coimbatore	2.36*	0.8991	2.23*	2.89*	1.56*	0.8960	0.53 (NS)	0.4124	-1.80	4.51	-4.32	-0.4052	1.83	0.1283	4.03	-1.62	5.88	0.0884
	(0.0015)		(0.0064)	(0.0049)	(0.0056)		(0.0089)		(0.0381)	(0.0289)	(0.0333)		(0.0090)		(0.0309)	(0.0298)	(0.0340)	
Nilgiris	3.50*	0.9273	3.71*	2.48*	5.08*	0.9349	0.82*	0.9791	0.92*	0.92*	0.57*	0.9863	2.68*	0.8783	2.79*	1.56*	4.51*	0.8991
	(0.0019)		(0.0074)	(0.0056)	(0.0065)		(0.00022)		(0.00077)	(0.00058)	(0.00067)		(0.0019)		(0.0073)	(0.0055)	(0.0063)	
Total	3.19*	0.9426	3.29*	2.74*	3.86*	0.9396	0.59*	0.9786	0.64*	0.66*	0.41*	0.9847	2.60	0.9172	2.65*	2.08*	3.45*	0.9161
Tamil Nadu	(0.0015)		(0.0064)	(0.0049)	(0.0056)		(0.00016)		(0.00058)	(0.00044)	(0.000051)		(0.0015)		(0.0063)	(0.0048)	(0.0055)	
Wynaad	1.34*	0.5692	2.50**	1.36***	0.34(NS)	0.5795	0.04	0.1498	0.03	0.12***	-0.08	0.1506	1.30*	0.5591	2.47**	1.24***	0.42	0.5645
	(0.0022)		(0.0092)	(0.0070)	(0.0081)		(0.0002)		(0.00085)	(0.00064)	(0.00074)		(0.0022)		(0.0092)	(0.0070)	(0.0080)	
Idduki	1.67*	0.8029	0.63	2.31*	1.44**	0.8004	-0.52*	0.9036	-0.96*	-0.48*	-0.24*	0.9615	2.19*	0.8831	1.59**	2.79*	1.68*	0.8772
	(0.0016)		(0.0066)	(0.0050)	(0.00580		(0.00032)		(0.00086)	(0.00065)	(0.00075)		(0.0015)		(0.0065)	(0.0050)	(0.0057)	
Total Kerala	1.33*	0.7195	0.44	1.82*	1.25**	0.7088	-0.57	0.9553	-0.74*	-0.62*	-0.34*	0.9707	1.90*	0.8512	1.19	2.44*	1.59*	0.8429
	(0.0016)		(0.0068)	(0.0051)	(0.0059)		(0.00023)		(0.00079)	(0.00060)	(0.00069)		(0.00150		(0.0065)	(0.0050)	(0.0057)	
Total	2.89*	0.8958	4.98*	2.56*	1.70*	0.9313	0.27*	0.6398	0.46*	0.06(NS)	0.47*	0.6441	2.62*	0.8669	4.52*	2.50*	1.23**	0.9071
Karnataka	(0.0019)		(0.0064)	(0.0049)	(0.0056)		(0.00038)		(0.0016)	(0.0012)	(0.0014)		(0.0019)		(0.0068)	(0.0052)	(0.0060)	

Fig. in the parenthesis indicates S.E. of the estimate.

**** Significant at 1 % level**
*** Significant at 5 % level**

expansion . And this revelation is also true for most of the districts constituting the Northern region. The Dooars , in particular , shows a negative growth of yield during the last sub-period . Therefore , in the North and particularly in the Dooars the question as how to increase the yield of tea comes to the fore . It entails a detail analysis of yield determining factors to which we will turn in the subsequent chapter. In the South , however, the supremacy of yield increase to the growth of output is witnessed over the whole period as well as over the sub-periods . And it is also true for the individual districts and states constituting the Southern region.

To examine the relative position of the North and the South and of the individual states in the context of national production their respective production share over years and regression estimates are shown in **Table 3.7**. It is conspicuous from **Table 3.7** that the relative position of North and South has remained unchanged over time . While Assam in the North and Tamil Nadu in the South have gained as against West Bengal in the North and Kerala in the South have lost their relative position . Within the state Assam , in the context of state level production , the only district Darrang has improved its relative position . The districts namely , Lakhimpur and Dibrugarh, Nowgaon and Cachar have shown a set back in relative contribution of their respective share to state production (**Table 3.8**) . The position of Sibsagar has remained by and large unchanged . Out of three districts in West Bengal , only the Terai district shows an improvement in its relative production contribution. The largest tea producing district Dooars accounting for a little over three-fourths of state's production , has shown no movement to its relative position in either direction as revealed from **Table 3.8**. The position of Darjeeling has been declined . Nilgiris of Tamil Nadu and Idduki of Kerala , the two major tea producing districts in the South, have enhanced their relative strength in contributing to the respective state's production as highlighted by **Table 3.8.**

3.4 Instability in Production : Methodological Issues

The validity of the growth estimates are often questioned from the stand point of fluctuation . Thus the analysis of fluctuation (instability) is an interwoven aspect in growth analysis. A good number of studies on growth of Indian agriculture though available , much work has not been done so far to the analysis of growh of agriculture taking into account its fluctuation . A few notable studies in the recent years are undertaken by Sen (1967) [19], Mehra[20]

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19. Sen, S.R., "Growth and Instability in Indian Agriculture" , *Journal of the Indian Society of Agricultural Statistics*, Vol.19, No.1 , 1967.
20. Mehra, S., "Instability in Indian Agriculture in the Context of the New Technology" , International Food Policy Research Institute , Washington , Research Report 25,1981.

(1981) and Boyce (1987)[21] . In the sphere of tea production no such work is still available . The present section deals with the method to be adopted in estimating the instability after a brief review of the past works on this subject.

Most of the studies mentioned above suffer from serious methodological problems . The methodology which most of the researchers have used in analysing instability in crop production is the coefficient of variation (CV) defined as the standard deviation of output from its trend divided by the mean level of output. The standard error of the simple (discontinuous) growth rates have sometimes been used as a measure of instability . An alternative method of assessing the change in instability over time has been suggested by S.R.Sen (1967) . He has suggested to separate trends for 'peak' and 'trough' years and to see whether they are converging or diverging.

A serious drawback of measuring instability by estimating the C.V. of the variable around time trend for two separate periods is that it fails to capture the large and frequent fluctuation of the variable concerned. Again this measure only shows the extent of instability and does not give the trend of instability . That means the question as to whether the fluctuations are stabilising over the period or the system becoming unstable cannot be resolved from this analysis. To the question of measuring instability by comparison of standard errors of the growth rates for two separate sub-periods , it is argued that the standard error estimated for the two sub-periods may be strongly affected by instability throughout the time-series and hence cannot be used for inter -temporal comparison (Boyce , 1987).

The method used by S.R.Sen (1967) raises serious objection as to the definition of 'trough ' and 'peak' year .It is argued that a small variation in the values of the variable can cause certain year to be excluded or included and this will seriously affect the estimates.

The method suggested by Boyce (1987) of testing the change in instability over time is similar to the Glejser's test for hetero-skedasticity (Koytsiannis,1977)[22] and has some distinctive advantage over the other methods in that it utilises all the values of the varriable for the entire period without considering any *a priori* break to measure the changes in instability of

21. Boyce, J.K., *Agrarian Impasse in Bengal*, Oxford University Press, New Delhi, 1987, pp 271-273

22. Koutsoyiannis, A, *Theory of Econometries*, 2nd edn., McMillan Publishers Ltd., 1979, pp. 186-187.

Table 3.7 : Production share of individual regions and states to India's total tea production over 1961 - 90.

State/Region / Year	Assam	West Bengal	North India	Tamilnadu	Kerala	South India
1961	0.51	0.24	0.77	0.11	0.11	0.23
1962	0.50	0.24	0.76	0.12	0.12	0.24
1963	0.49	0.24	0.74	0.13	0.12	0.26
1964	0.53	0.24	0.78	0.11	0.10	0.22
1965	0.50	0.24	0.75	0.13	0.12	0.25
1966	0.50	0.23	0.75	0.13	0.12	0.25
1967	0.50	0.26	0.76	0.12	0.11	0.24
1968	0.50	0.24	0.76	0.13	0.10	0.24
1969	0.52	0.23	0.76	0.13	0.11	0.24
1970	0.51	0.24	0.76	0.13	0.10	0.24
1971	0.51	0.24	0.76	0.13	0.10	0.24
1972	0.52	0.24	0.77	0.12	0.10	0.23
1973	0.53	0.23	0.78	0.12	0.10	0.22
1974	0.54	0.24	0.80	0.11	0.09	0.20
1975	0.54	0.23	0.78	0.12	0.09	0.22
1976	0.54	0.23	0.78	0.12	0.09	0.22
1977	0.53	0.23	0.77	0.13	0.09	0.23
1978	0.53	0.23	0.77	0.13	0.09	0.23
1979	0.51	0.23	0.75	0.14	0.11	0.26
1980	0.53	0.23	0.77	0.13	0.09	0.23
1981	0.54	0.23	0.78	0.13	0.08	0.22
1982	0.53	0.24	0.78	0.13	0.09	0.22
1983	0.55	0.24	0.80	0.12	0.08	0.20
1984	0.53	0.23	0.77	0.13	0.09	0.23
1985	0.54	0.24	0.78	0.13	0.08	0.22
1986	0.54	0.23	0.78	0.14	0.08	0.22
1987	0.55	0.22	0.78	0.13	0.08	0.22
1988	0.53	0.21	0.75	0.15	0.09	0.25
1989	0.55	0.21	0.77	0.15	0.08	0.23
1990	0.54	0.21	0.76	0.15	0.08	0.24
$\hat{b}$	0.0015*	-0.0008*	0.0005	0.0007*	-0.0013*	-0.0005
t	(6.23)	(5.00)	(1.76)	(3.81)	(8.99)	(1.76)
r^2	0.5813	0.4719	0.0996	0.3412	0.7420	0.0994
F	**38.87***	**25.02***	**3.10***	**14.50***	**80.95***	**3.092**

***Significant at 1 % level.**
Fig. in the parenthesis indicates t-value.

Table 3.8 : Distribution of production share of the individual districts to total tea production of the respective state over 1961 - 1990.

State / District	ASSAM					WEST BENGAL			TAMILNADU			KERALA
Year	Darrang	Lakhimpur & Dibrugarh	Nowgaon	Sibsagar	Cachar	Darjeeling	Terai	Dooars	Coimbatore	Nilgiris	Idduki	Wynaad
1961	0.17	0.40	0.03	0.27	0.11	0.12	0.11	0.77	0.35	0.61	0.74	0.15
1962	0.17	0.41	0.03	0.27	0.10	0.12	0.11	0.77	0.35	0.60	0.73	0.14
1963	0.18	0.41	0.03	0.25	0.10	0.12	0.11	0.77	0.34	0.62	0.64	0.16
1964	0.17	0.40	0.04	0.27	0.10	0.11	0.11	0.78	0.35	0.60	0.70	0.18
1965	0.18	0.39	0.04	0.27	0.11	0.11	0.11	0.78	0.36	0.60	0.72	0.14
1966	0.17	0.39	0.04	0.26	0.10	0.10	0.10	0.80	0.34	0.62	0.70	0.15
1967	0.18	0.39	0.04	0.25	0.12	0.11	0.12	0.77	0.35	0.61	0.71	0.18
1968	0.18	0.40	0.04	0.25	0.11	0.10	0.11	0.78	0.32	0.64	0.72	0.18
1969	0.18	0.42	0.03	0.25	0.10	0.11	0.12	0.77	0.34	0.61	0.73	0.16
1970	0.18	0.41	0.04	0.25	0.11	0.10	0.12	0.78	0.32	0.63	0.72	0.18
1971	0.18	0.41	0.03	0.25	0.10	0.10	0.12	0.78	0.32	0.63	0.72	0.18
1972	0.19	0.40	0.04	0.25	0.10	0.11	0.12	0.77	0.33	0.62	0.72	0.18
1973	0.19	0.41	0.03	0.25	0.10	0.10	0.12	0.78	0.33	0.61	0.72	0.18
1974	0.19	0.39	0.03	0.25	0.11	0.10	0.12	0.78	0.34	0.60	0.75	0.16
1975	0.19	0.40	0.03	0.25	0.10	0.10	0.12	0.78	0.34	0.64	0.73	0.18
1976	0.17	0.41	0.02	0.26	0.11	0.10	0.12	0.78	0.35	0.59	0.74	0.18
1977	0.20	0.39	0.03	0.24	0.11	0.09	0.12	0.79	0.31	0.63	0.74	0.18
1978	0.19	0.41	0.03	0.24	0.10	0.09	0.13	0.78	0.31	0.63	0.74	0.18
1979	0.19	0.41	0.03	0.25	0.10	0.09	0.12	0.79	0.34	0.59	0.76	0.16
1980	0.21	0.39	0.03	0.24	0.10	0.10	0.12	0.78	0.32	0.61	0.74	0.18
1981	0.19	0.43	0.03	0.23	0.10	0.10	0.12	0.78	0.33	0.62	0.76	0.16
1982	0.20	0.40	0.03	0.23	0.10	0.11	0.12	0.77	0.33	0.61	0.76	0.15
1983	0.19	0.39	0.25	0.25	0.10	0.10	0.12	0.78	0.29	0.66	0.76	0.17
1984	0.19	0.40	0.03	0.26	0.10	0.09	0.13	0.78	0.31	0.64	0.74	0.19
1985	0.20	0.40	0.03	0.25	0.09	0.08	0.14	0.78	0.31	0.63	0.76	0.16
1986	0.20	0.39	0.02	0.25	0.10	0.07	0.15	0.78	0.31	0.64	0.75	0.16
1987	0.20	0.39	0.03	0.26	0.08	0.08	0.14	0.78	0.30	0.64	0.77	0.16
1988	0.20	0.39	0.03	0.26	0.09	0.08	0.16	0.76	0.27	0.68	0.75	0.16
1989	0.21	0.39	0.03	0.25	0.10	0.08	0.14	0.78	0.24	0.70	0.77	0.16
1990	0.21	0.38	0.03	0.25	0.10	0.10	0.14	0.76	0.26	0.69	0.78	0.15
b	0.0012**	-0.0004*	-0.0003**	-0.0003	-0.0004*	-0.0011**	0.0013**	-0.0002	-0.0025**	0.0020**	0.0025**	0.000001
t	(8.77)	(2.16)	(3.89)	(1.87)	(2.61)	(7.61)	(8.94)	(1.43)	(6.93)	(4.62)	(7.09)	(0.0028)
r^2	0.7331	0.1430	0.3511	0.1112	0.1959*	0.6741	0.7408	0.0678	0.6319	0.4328	0.6426	0.00001
F	76.90**	4.62*	15.15**	3.50	6.82	57.91**	80.01**	2.04	48.07**	21.36**	50.35**	0.00001

** Significant at 1 % level. * Significant at 5 % level. Fig. in the parenthesis indicate t-value.

the variable. This method can also be applied to any functional specification of the growth process . The present study has employed this method of instability estimation.

According to this method the difference between the actual and predicted values of the variable are calculated and expressed as a percentage of the predicted value as ,

$$Z_t = \frac{Q_t - \hat{Q}_t}{\hat{Q}_t}$$

Where Q_t = observed value at time t

$\hat{Q}_t$ = estimated value at time t

The absolute value of Z_t or if one wishes to attach greater weight to larger deviations, the square of this percentage deviations, the square of these percentage deviations is regressed on time by using the functional form ,

$$\left| Z_t \right| \text{ or } Z_t^2 = \alpha + \beta t$$

Now, if β, the estimated coefficient on time, is statistically significant (determined by t - test) the instability in the process is confirmed . The nature of instability – whether increases or decreases is determined by the associated ' sign ' of the t-value . If it is negative , the instability decreases and if positive it increases . In stead of breaking the entire period into different sub-periods as has been done in estimating growth rate , it considers the instability for the whole period.

3.5 Instability in Tea Production

It is unquestionable that the growth is a necessary condition for the success of tea industry. Low instability without growth does not have any meaning . Thus , instability can only be used as a sufficient condition in assessing the performance of tea industry . It is , therefore , relevant to examine the magnitude and direction of instability in relation with the growth.

The measure of instability for the selected countries over the whole period have been cited in **Table 3.9** . The countries like Turkey , Kenya , China and Indonesia exhibiting higher growth rate of production are also accompanied with declining instability as displayed in **Table 3.9**. The U.S.S.R. is being the exception in this context . At the global level a good pace of growth with declining instability is also recorded . In case of low growth countries like India , Sri Lanka and Japan the instability is noted to have been increasing over the period . One may ,

Table 3.9 : Measures of instability in tea production of different countries over 1961 - 90.

	Trend Coefficient ^{b}	
Country	$\lvert Z_t \rvert^{a}$	Z_t^2
India	0.0000042 (0.136)	0.000000018 (0.104)
Sri Lanka	0.00011* (1.730)	0.0000015** (2.227)
Indonesia	-0.00087*** (-4.015)	-0.000043*** (3.748)
China	-0.00049*** (-4.126)	-0.000012*** (-3.228)
Japan	0.000070 (1.079)	0.00000080 (0.983)
Kenya	-0.00011 (-0.741)	-0.0000042 (-1.201)
USSR	0.000512** (2.21)	0.0000046 (0.3353)
Turkey	-0.00065* (-1.93)	-0.000039* (-1.778)
World	-0.000055** (-2.117)	-0.00000032** (-2.187)

Figures in the parenthesis indicate t-values.

***** Significant at 1 % level.**
**** Significant at 5 % level.**
*** Significant at 10 % level.**

(a) $Z_t = \dfrac{Q_t - \hat{Q}_t}{\hat{Q}_t}$ Where Q_t = actual production.

$\hat{Q}_t$ = estimated production.

(b) Trend coefficient (β) is estimated from Z_t or $Z_t^2 = \alpha + \beta t$.

Table 3.10 : Measures of instability in tea production of different districts, states and regions of India over 1961 - 90.

Districts, States and Regions	Trend Coefficient [b] $\lvert Z_t \rvert$ [a]	Trend Coefficient [b] Z_t^2
Darrang	-0.000052 (-0.90)	-0.0000007 (-0.42)
Lakhimpur & Dibrugarh	-0.00005 (-1.20)	-0.0000005 (-1.23)
Nowgaon	-0.00011 (-0.75)	-0.00000008 (-0.19)
Sibsagar	-0.00012** (-2.29)	-0.0000012* (-2.03)
Cachar	-0.000057 (-0.600)	-0.00000024 (-0.147)
All Assam	-0.000087** (-2.39)	0.0000038* (1.80)
Darjeeling	0.000000044 (1.48)	0.000000004 (0.42)
Terai	0.000097 (1.24)	0.0000014 (1.25)
Dooars	0.000084 (1.37)	0.0000007 (1.18)
All West Bengal	0.000048 (0.86)	0.00000036 (0.72)
Coimbatore	0.00017* (1.72)	0.00003 (1.54)
Nilgiris	0.00024*** (2.84)	0.0000035** (2.66)
Tamil Nadu	0.00015** (2.22)	0.0000021* (1.94)
Wynaad	0.00021* (1.90)	0.0000047* (1.95)
Idduki	0.000087 (1.12)	0.0000017 (1.32)
Kerala	0.00016** (2.11)	0.0000044** (2.080)
Karnataka	-0.00011 (-0.74)	-0.0000026 (-0.79)
North India	-0.000031 (-0.95)	-0.00000023 (-1.17)
South India	0.00016** (2.25)	0.000002** (2.02)
All India	0.000025 (0.07)	0.00000005 (0.255)

Figures in the parenthesis indicate t-values.
***** Significant at 1 % level.** **** Significant at 5 % level.** *** Significant at 10 % level.**

(a) $Z_t = \dfrac{Q_t - \hat{Q}_t}{\hat{Q}_t}$ Where Q_t = actual production. $\hat{Q}_t$ = estimated production.

(b) Trend coefficient (β) is estimated from Z_t or $Z_t^2 = \alpha + \beta t$.

therefore , reasonably come to the conclusion that the countries namely , Turkey , Kenya , China and Indonesia are in the most favourable position in global tea production nexus . Since the yield being their principal source of growth (as discussed earlier) one can further contend that the said countries have been able to augment yield sufficiently on continuing basis with stability.

Measures of instability in tea production for various districts , states as well as for North and South region are presented in **Table 3.10** . The North exhibiting high pace of output growth shows its association , though feeble with dwindling instability . Within the North , the state Assam and also all of its constituent districts are recorded to have decelerating instability while in West Bengal and in all of its districts the direction of instability is noted positive , though not statistically significant . The implication is that the state Assam is stood in a relatively good position in the North in comparison with West Bengal . In the Southern counterpart all districts and states (Karnataka keeping aside) are found to have increasing instability . Increasing instability emanated in the Southern districts may plausibly be attributed largely to the instability in yield as yield is being the principal source of growth for the Southern districts.