

## Growth and Instability in Area, Production and Yield of Tea in India

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### Abstract

*The study was carried out with the objective to examine the growth and instability in area, production and yield of tea in major tea growing states of India namely; Assam, West Bengal, Tamil Nadu, Kerala, and Karnataka. The study is based on secondary data collected from Tea Board of India for the period 1990 to 2017. Growth rates and instability index were estimated using Compound Annual Growth Rate (CAGR) and Cuddy Della Index respectively. The total area and production of tea in India was 577.48 thousand ha and 1321.76 thousand tons respectively in 2017. About 80 per cent of tea production in India comes from Assam and West Bengal states. CAGR of production of tea was 2.23 per cent in India during the study period with significant growth rate in area (1.44 %) and yield (0.76%). The instability in yield was high at 6.42 per cent than area (1.52%) and production (0.79%). State wise growth rate of production was positive and significant in Assam, West Bengal, Tamil Nadu and Karnataka whereas positive but non-significant in Kerala. Instability index was high for yield than area in all the selected states.*

**Keywords:** Tea, Compound Annual Growth Rate, Instability index

**JEL Classification:** Q<sub>11</sub>, C<sub>1</sub>

### Introduction

The tea is produced in 36 countries of the world and the major producers are India, China, Kenya, Sri Lanka, Vietnam and Argentina. India's contribution to world tea production was 22.40 per cent in 2017. It is produced in more than 15 states namely Assam, West Bengal, Tamil Nadu, Kerala, Karnataka, Manipur, Tripura, Nagaland, Sikkim, Meghalaya, Himachal Pradesh, Mizoram, Uttarakhand, Bihar, and Arunachal Pradesh. Of these states, Assam occupied 340.40 thousand hectare (TH), followed by West Bengal 140.44 TH, Tamil Nadu 69.62 TH, Kerala 35.01 TH, Karnataka 2.22 TH and other northern states of India 12.29 TH during 2013 (Kumareswaran 2017). Therefore, due to certain characteristics of soil and climate necessity, their cultivation was restricted to only a few areas of the country. Assam, West Bengal, Tamil Nadu, Kerala and Karnataka contributed 97.73 per cent in the total tea production during 2016-17. The major exporting countries of tea include India, China, Kenya, Sri Lanka and Indonesia. India exported about 20 per

cent of its national production, and most (75-80%) of tea production came from the north-east of the country, with Assam and West Bengal being the main contributors. Biggs *et al* (2018) argued that about 70 percent of the tea produced domestically was consumed within India itself. In recent years, there has been a downward trend in the country as one of the largest producers and exporters of tea in the global market, as well as a decrease in domestic consumption (Biggs *et al* 2018). The decline in tea production and exports is associated with the scarcity of new areas for large-scale tea production (Hazarika and Muraleedharan 2011).

Production and export of commodities has assumed an important place in the progress of any economy. In recent years, India's share in world export of tea has significantly decreased showing that India is not capable to take advantage of the expanding world market (Kumar *et al* 2008; 2017). India's export performance of tea showed that during the period 1981-90 the share was 20.16 per cent, decreased to 5.78 per cent in 2001-04. The major determinants responsible for poor performance of India's tea exports were, slow increase

in yield, increase in domestic demand, slow expansion of area under tea cultivation, increase in world supply of tea compared to world demand, unable to compete with major tea exporting countries, lost of traditional tea market and more attraction towards domestic market compared to international market (Nagoor 2009). In this backdrop it is pertinent to analyze the growth and instability in area, production and yield of tea in major tea producing states of India. It will have immense importance to policy makers for devising policies to increase tea production as well as its exports.

### Data Sources and Methodology

The study is based on secondary data for the period 1990 to 2017. Data related to area, production and yield of tea were collected from Tea Board, Government of India (GOI). The compound annual growth rate of area, production and yield of tea in selected states were estimated using the following equation:

$$Y = a b^t \quad (1)$$

Where, Y = Dependent variable, t = Time variable, a and b are unknown constants to be estimated. The unknown constants a and b were obtained by using method of least square by changing the equation into logarithmic form:

$$\ln Y = \ln a + t \ln b \quad (2)$$

Where,  $\ln Y$  = Natural logarithm of Y,  $\ln a$  and  $\ln b$  area similarly defined. The compound annual growth rate (CAGR) was calculated as:

$$\text{CAGR} = \{(b) - 1\} \times 100 \quad (3)$$

The significance of the estimated compound annual growth rate was tested with the help of student's *t* test.

To measure the instability in export value of tea, Cuddy Della Index was worked out.

$$\text{Cuddy Della Index (\%)} = \text{CV} = \text{CV} \times (1 - R^2)^{0.5} \quad (4)$$

Where, C.V = Coefficient of variation in per cent, and  $\bar{R}$  = Coefficient of determination from a time trend regression adjusted for its degree of freedom.

The whole period of 27 years, i.e., 1990 to 2017 was divided into four sub-periods for the analyze purpose. Period I from 1990-1999, period II from 2000-2009, period III from 2010-2017 and period IV (overall period) from 1990-2017.

## Results and Discussion

### Trends in area, production and yield of tea in India

The details of area, production and yield of tea in India during 1991-2017 is presented in Table 1. The area under tea in India had been moderately increased from 419.01 thousand ha during triennium ending (TE) 1992 to 573.87 thousand ha during TE 2017. Therefore, the production of tea in India had been almost doubled i.e. from 745.15 thousand tons during TE 1992 to 1265.93 during TE 2017. This was because of the increase in productivity of tea during the last decade. The average yield of tea in India was 1755.33 kg/ha during TE 1992 and reached 2205.67 kg/ha during TE 2017.

It is visible in the figure 1 that the area under tea in India has been increasing over time since 1990s. From the period 1990 to 2007, the production of tea has been increasing but followed by a constant trend. Thus, the increase in production is associated with the increased in area and yield and the implementation of trade liberalization policies adopted in the country during 1991-1992 (Kumar *et al*, 2017). The trend of yield was almost straight line parallel to the x-axis from 1990 to 2007, and from 2007 (1633.00 kg/ha) increased and achieved 2289 kg/ha in 2017, because of the increase in area under tea in India.

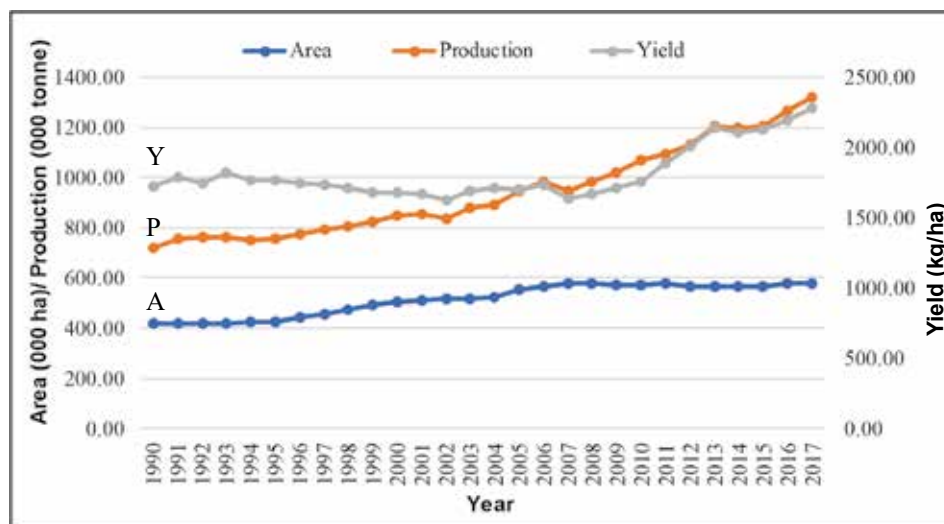
### Growth and Instability Index of tea in India

The growth rate of area, production and yield of tea in different periods in India is illustrated in Table 2. The annual growth rates of production of tea were positive and significant in all the periods and showed increasing trend over successive periods. For the overall period the production of tea increased at 2.23 per cent per annum. The increase in production of tea during period I and period II were due to significant growth in area under tea at 1.76 per cent and 1.81 per cent per annum respectively and in period III the yield increased significantly at CAGR 2.82 per cent resulting into significant increase in production. The CDV index referred as instability index was the highest for yield at 6.42 per cent for the overall period followed by area at 1.52 per cent and least for the production at 0.79 per cent. Higher CDV index shows more instability in the area, production and yield and vice versa. The CDV index in different periods varied for area, production and yield of tea in India. Area was more stable during period II, than period I, period III and period IV overall period.

**Table 1. Area, production, and yield of tea in India, 1990-2017**

Triennium Ending (TE)	Area (000 ha)	Production (000 tons)	Yield (kg/ha)
1992	419.01	745.15	1755.33
2002	510.00	846.44	1659.67
2012	571.86	1099.38	1605.78
2017	573.87	1265.93	2205.67

Source: Tea Board, GOI (2018)

**Fig. 1: Trend in area, production, and yield of tea in India****Table 2. Growth in area, production and yield of tea in India, 1990-2017**

Periods	CAGR (%)			CDV INDEX (%)		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-1999)	1.76***(0.00)	1.20***(0.00)	-0.42*(0.08)	1.03	0.74	1.67
Period II (2000-2009)	1.81***(0.00)	2.24***(0.00)	0.14 <sup>ns</sup> (0.56)	0.59	0.78	2.18
Period III (2010-2017)	0.08 <sup>ns</sup> (0.68)	2.90***(0.00)	2.82***(0.00)	1.28	0.44	1.04
Period IV (1990-2017)	1.44***(0.00)	2.23***(0.00)	0.76***(0.00)	1.52	0.79	6.42

Note: Figures in parentheses indicate *p*-value of respective values  
 \*\*\* and \* denotes significant at 1 and 10 per cent level; ns: non-significant

However, production was found more unstable during overall period than period I, period II and period III, while yield was more stable in period III as compared to period I, period II and overall period.

#### Area and production of tea in major producing states

The details of area and production of tea during the study period are indicated in triennium ending

(TE) in Table 3. The area and production of tea in important producing states had been increased over time. Therefore, the production of tea in West Bengal had been doubled i.e. from 155.88 thousand tons during TE 1992 to 355.10 during TE 2017. This was because of the increase in area of tea during the last decade. The average area of tea in Tamil Nadu was 38.63 thousand ha during TE 1992 and reached 64.82 thousand ha during TE 2017.

**Table 3. State wise area and production of tea in India, 1990-2017 (Triennium Ending)**

States	1992		2002		2012		2017	
	Area	Production	Area	Production	Area	Production	Area	Production
Assam	232.43	400.25	268.78	445.38	316.2	549.9	290.39	658.64
West Bengal	101.35	155.88	110.47	185.47	127.24	262.34	141.54	355.1
Tamil Nadu	38.63	116.01	75.22	135.78	75.27	168.48	64.82	158.68
Kerala	34.63	63.16	36.95	63.96	36.12	64.04	35.79	60.57
Karnataka	1.99	4.33	2.13	5.6	2.18	5.79	2.22	5.77

Note: Area in thousand ha and production in thousand tons

**Table 4. Growth and instability in area, production and yield of tea in Assam, 1990-2017**

Periods	CAGR (%)			CDV INDEX (%)		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-1999)	0.71 <sup>ns</sup> (0.11)	0.36 <sup>ns</sup> (0.58)	-0.35 <sup>ns</sup> (0.42)	3.32	5.77	3.78
Period II (2000-2009)	2.65*** (0.00)	1.54*** (0.01)	-1.08*** (0.00)	1.15	2.68	1.36
Period III (2010-2017)	-1.84*** (0.00)	3.97*** (0.00)	5.91*** (0.00)	1.19	2.56	2.40
Period IV (1990-2017)	1.38*** (0.00)	2.08*** (0.00)	0.70*** (0.01)	3.65	2.76	10.84

Note: Figures in parentheses indicate p-value of respective values  
\*\*\*, denotes significant at 1 per cent level; ns: non-significant

### State-wise CAGR and Instability Index

#### Assam

There was significant growth of area (1.38%), production (2.08%), and yield (0.7%) of tea in Assam during the period 1990-2017. The highest growth in area was observed during period II (2000-2009) at 2.65 per cent followed by growth in production at 1.54 per cent. The yield of tea recorded during this period (period II) registered a significant decline at 1.08 per cent. The deceleration in yield resulted into deceleration in area under tea in Assam State in the subsequent period. The growth rate of area was negative at 1.84 per cent during 2010-17 (period III). The yield registered highest growth at 5.91 per cent during 2010-17.

The highest instability of production was seen during the period I (1990-1999) at 5.77 per cent. The highest instability of yield was observed during the overall period (1990-2017) at 10.84 per cent. The lowest instability of area and yield was 1.15 and 1.36 per cent respectively in the second period (2000-2009), and production was 2.59 per cent at third period (2010-2017). The overall instability of area, production and yield of tea in Assam was 3.65, 2.76 and 10.84 per cent respectively (Table 4).

#### West Bengal

The production of tea in West Bengal was significantly increased in successive periods. Overall, there was significant growth in area (1.42%), production (3.36%) and yield (1.96%) in the state during the period of study. The CAGR of production (6.64%) of tea was the highest during period III (2010-2017) due to the highest growth (4.27%) in the yield as well as area (2.27). Growth rate of area, production and yield was positive and significant in period I and period II.

Instability index of the area, production and yield of tea in West Bengal during the study period was also estimated during different periods and reported in Table 5. Overall, instability index for area, production and yield was 1.49, 2.15, and 2.18 per cent. The highest instability was observed in yield of tea that too in period 2010-2017. The period III is marked with having high growth of production and instability. The area and yield of tea in West Bengal showed high instability during this period.

#### Tamil Nadu

The CAGR of area under tea in Tamil Nadu during period III (2010-2017) was negative at 3.07 per cent resulting into negative CAGR in production (1.07%).

**Table 5. Growth and instability in area, production and yield of tea in West Bengal, 1990-2017**

Periods	CAGR (%)			CDV INDEX (%)		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-1999)	0.53***(0.01)	1.22 ***(0.01)	0.92 ***(0.01)	1.05	2.10	1.42
Period II (2000-2009)	0.91***(0.00)	3.01 ***(0.00)	2.09***(0.01)	0.75	2.00	3.67
Period III (2010-2017)	2.27**(0.05)	6.64 ***(0.00)	4.27 <sup>ns</sup> (0.11)	4.15	1.07	8.65
Period IV (1990-2017)	1.42***(0.00)	3.36 ***(0.00)	1.96***(0.00)	1.49	2.15	2.18

Note: Figures in parentheses indicate p-value of respective values  
 \*\*\*, and \*\* denotes significant at 1, and 5 per cent level; ns: non-significant

The CAGR of production was 2.63 per cent during 2000 to 2009. This was mainly because to the increased in area under tea in the state since the CAGR of area was 0.86 per cent. The CAGR in area was high in the period I (1990 to 1999) at 6.35 per cent; production and yield were 1.72 and -3.97 per cent respectively during this period. The CAGR of yield was high during the period III (2010-2017) at 2.07 per cent. Furthermore, the CAGR of area, production and yield of tea during the overall period was 2.27, 1.70 and -0.47 respectively and were all significant at 1 per cent level of significance except production and yield during 2010 to 2017 and yield during the overall period which were non-significant (Table 6).

The instability of area and yield under tea in Tamil Nadu were observed to be the highest during the overall period at 11.68 and 14.63 per cent respectively. The highest instability of production was 4.86 per cent in the period III (2010-2017), and the corresponded area was 2.13 per cent, and yield 5.93 per cent. The lowest instability in area of tea in Tamil Nadu was observed in period II (2000-2009). The lowest instability of production and yield was seen during the period I (1990-1999) at 2.18 and 4.42 per cent respectively.

### Kerala

In Kerala the performance of tea production during the study period was very poor. The CAGR of area, production and yield were either negative or positive during the period of study except during 1990s (Period I). During the period (1990-2017), the CAGR of area, production and yield of tea in Kerala were 0.02, -0.07, and -0.01 per cent respectively. The negative growth rate of area was observed in period II (2000-2009) and period III (2010-2017) at -0.06, and -0.16 per cent respectively. The negative growth rate was noted in production and yield being -0.86 and -0.70 per cent respectively during period III and -0.07 and -0.01 per cent respectively for the overall period. The general CAGR was insignificant except in first period (1990-1999) which area (0.89%) was significant at 1 per cent level of significance, and production (0.93%) at 5 per cent level of significance (Table 7).

The overall instability of area, production and yield of tea in Kerala was 2.68, 5.68 and 6.24 per cent respectively. The instability of area was the lowest at 0.82 per cent during 2000 to 2009, and the highest at 2.68 per cent during the overall period. The instability of production and yield were lowest at 2.76 and 5.66

**Table 6. Growth and instability in area, production and yield of tea in Tamil Nadu, 1990-2017**

Periods	CAGR (%)			CDV INDEX (%)		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-1999)	6.35***(0.00)	1.72***(0.00)	-3.97***(0.00)	3.12	2.18	4.42
Period II (2000-2009)	0.86***(0.01)	2.63***(0.01)	1.74**(0.05)	1.67	3.73	5.64
Period III (2010-2017)	-3.07***(0.00)	-1.07 <sup>ns</sup> (0.24)	2.07 <sup>ns</sup> (0.11)	2.13	4.86	5.93
Period IV (1990-2017)	2.27***(0.00)	1.70***(0.00)	-0.47 <sup>ns</sup> (0.18)	11.68	3.35	14.63

Note: Figures in parentheses indicate p-value of respective values  
 \*\*\*, and \*\* denotes significant at 1, and 5 per cent level; ns: non-significant

**Table 7. Growth and instability in area, production and yield of tea in Kerala, 1990-2017**

Periods	CAGR (%)			CDV INDEX (%)		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-1999)	0.89 *** (0.00)	0.93 ** (0.04)	0.43 <sup>ns</sup> (0.51)	0.95	2.76	5.66
Period II (2000-2009)	-0.06 <sup>ns</sup> (0.55)	0.59 <sup>ns</sup> (0.50)	0.64 <sup>ns</sup> (0.45)	0.82	7.69	7.50
Period III (2010-2017)	-0.16 <sup>ns</sup> (0.69)	-0.86 <sup>ns</sup> (0.27)	-0.70 <sup>ns</sup> (0.44)	2.60	4.45	5.73
Period IV (1990-2017)	0.02 <sup>ns</sup> (0.73)	-0.07 <sup>ns</sup> (0.59)	-0.01 <sup>ns</sup> (0.92)	2.68	5.68	6.24

Note: Figures in parentheses indicate p-value of respective  
\*\*\*, and \*\* denotes significant at 1, and 5 per cent level; ns: non-significant

**Table 8. Growth and instability in area, production and yield of tea in Karnataka, 1990-2017**

Periods	CAGR (%)			CDV INDEX (%)		
	Area	Production	Yield	Area	Production	Yield
Period I (1990-1999)	0.80 *** (0.00)	3.19 *** (0.00)	2.25 *** (0.01)	0.50	2.04	3.63
Period II (2000-2009)	0.14 ** (0.03)	0.35 <sup>ns</sup> (0.59)	0.21 <sup>ns</sup> (0.74)	0.39	5.97	5.92
Period III (2010-2017)	0.66 ** (0.03)	-0.26 <sup>ns</sup> (0.86)	-0.63 <sup>ns</sup> (0.66)	1.13	10.32	8.91
Period IV (1990-2017)	0.35 *** (0.00)	1.20 *** (0.00)	0.88 *** (0.00)	0.50	4.81	10.58

Note: Figures in parentheses indicate p-value of respective values  
\*\*\*, and \*\* denotes significant at 1, and 5 per cent level; ns: non-significant

per cent during 1990s (Period I) and the highest at 7.69 and 7.50 per cent respectively during the period II.

### Karnataka

The production of tea in Karnataka increased at CAGR 1.20 per cent per annum in the state during 1990-2017 with significant increase in area and yield at 0.35 and 0.88 per cent per annum respectively during this period (Table 8). The area under tea showed significant increase in all the periods, the CAGR was 0.80, 0.14, 0.66 per cent per annum during period I, period II and period III respectively. The CAGR of yield of tea was positive and significant being 3.19 per cent in period I but non-significant in period II and III resulting into non-significant increase in production in these periods.

The instability of area, production and yield of tea in Karnataka is presented in Table 8 in different periods. It is clear from the table that the instability index was the highest in case of yield at 10.58 per cent followed by production at 4.81 per cent and the lowest for area at 0.50 per cent for the overall period of study. Period wise analysis indicates that the highest instability in production (10.32%), yield (8.91%) and area (1.13%) was observed in period III (2010-2017) and minimum in period I (1990-1999).

### Conclusion and Policy Implications

The study brought out that India produced about 22 per cent of global tea and was 2<sup>nd</sup> largest producer of this crop after China during study period. The area, production and yield of tea in India have been increasing over time. The CAGRs of production was 2.23 per cent during 1990-2017. The increase in production of tea was due to significant increase in area during 1990s and first decade of 2000s and yield during the period 2010-2017. The instability index was higher for yield of tea at 6.42 per cent, low for area (1.52%) and production (0.79%). The major tea producing states in India are Assam, West Bengal, Tamil Nadu, Kerala, and Karnataka contributing 52.56 per cent, 28.58 per cent, 11.49 per cent, 4.69 per cent and 0.41 per cent in the total production of tea in the country respectively. Thus, more than 80 per cent of tea production in India comes from Assam and West Bengal states. State wise growth rates and instability index varied between different periods. The CAGR of production was significant in all the periods and the highest in period III (2010-2017) in Assam and West Bengal. Different trend was observed in other tea producing states with respect to CAGR of area, production and yield in different periods. Overall, high instability was observed in yield than area in all

the states. The area under tea must be stabilized through crop insurance scheme to preserve the producers from variations in net returns. Furthermore, development of quality varieties of tea resistant to insects and pests and technologies to moderate effect of weather on productivity, might help in reducing instability in area, production and yield of tea in the unstable states of India.

## References

- Biggs E M, Gupta N, Saikia S D and Duncan J M 2018. Tea production characteristics of tea growers (plantations and smallholdings) and livelihood dimensions of tea workers in Assam, India. *Data Brief* **17**: 1379-87.
- Hazarika M and Muraleedharan N 2011. Tea in India: An overview. *Two Bud* **58**: 3-9.
- Kumar N S, Joseph B and Muhammed J P K 2017. Growth and instability in area, production, and productivity of cassava (*Manihot esculenta*) in Kerala. *Int J Adv Res, Ideas Innov Technol* **4**: 446-48.
- Kumar P, Badal P S, Singh N P and Singh R P 2008. Tea Industry in India: Problems and prospects. *Ind J Agri Econ* **63**: 87-95.
- Kumareswaran T 2017. Production and export performance of Tea and Coffee in India. M.Sc. Thesis. Banaras Hindu University, Varanasi, India.
- Nagoor B H 2009. Performance of India's tea exports: comparative study of major tea exporting countries of the world. *Fourth Ann Int Conf Public Policy Mgmt*. Pp 1-30. Karnataka University, Dharwad.
- Restiau M M A 2007. The economic development of India and China in a globalization world. M.Sc. Thesis. Tilburg University, Noord-Brabant, Netherlands.

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