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Study the trend in area, production and productivity of tamarind

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Abstract
Tamarindus indicus L is one of the common fruit trees found grown all over India mostly under rain-fed conditions, particularly in India the growing states are Karnataka, Madhya Pradesh, Tamil Nadu, Kerala, Pondicherry and Andhra Pradesh (Horticulture at a glance – 2017). Internationally the utmost tamarind exporting countries were like United Arab Emirates 2,630 MT with the places of Sudan and Belgium. In this perspective an analysis has been made to know the growth trend of area, production and productivity of tamarind. The growth rates in area, production, and productivity of tamarind has been analyzed by obtaining the secondary data on area and production of tamarind from various sources. The data has been collected for a period of 15 years i.e. from 2003-04to 2017-18.The estimated results showed that, compound growth rates for production and productivity were found positive and significant. The significant of a tamarind production exhibited less variation than Area and productivity. Productivity has the highest significant as compared to area and productivity.

Keywords: Trend in area, production, productivity of tamarind, variability and compound growth rate of tamarind, co-efficient of variation

Introduction
Tamarind, its scientific name is *Tamarindus indica* L. it grows specially a part of sub-continent and it is the great significant indigenous fruit tree. The tamarind is an elongated seed vessel like fruit, which consist of edible mush used in different methods of cooking in over the entire world. The origin of tamarind can be finding from Eastern Africa having the place of Madagascar and it diverse as Sudan, Cameroon, Nigeria, Zambia and Tanzania. It is widely distributed throughout the tropical belt, In the 16th century, it was introduced to Mexico and to a lesser degree to South America, by Spanish and Portuguese colonists, to the degree that it became a staple ingredient in the region's cuisine. Seeds can be scarified or briefly boiled to enhance germination. They retain their germination capability for several months if kept dry. Throughout South Asia and the tropical world, tamarind trees are used as ornamental, garden and cash crop plantings. Commonly used as a bonsai species in many Asian countries, it is also grown as an indoor bonsai in temperate parts of the world.

Internationally the countries having large production of tamarind, the countries like India, Malaysia, Myanmar, Bangladesh, Srilanka, Thailand, UAE, and South American countries. In India the growing states are Karnataka, Madhya Pradesh, Tamil Nadu, Kerala, Pondicherry, Maharashtra and Andhra Pradesh. Internationally the product of Tamarind fresh, Tamarind dried and Tamarind seed powder are the major products for exporting to other different countries. The by-product of tamarind kernel seed powder is export majorly US, Australia, China and UK. Internationally the utmost tamarind exporting countries were like United Arab Emirates (2,630 MT) with the places of Sudan and Belgium. Tamarind is cultivated larger area of United States, it brings for mercantile purpose. On an average these hybrid varieties were giving 263 kg of tamarind fruit per tree and local variety tree 150 kg.

These tamarind trees were planted besides the roads by taking responsibility of government for protection of tourists. Tamarind trees will provide livelihood to poor people. It means poor people earn the income by using tamarind tree. The traditional tree has the capacity to develop nutrition, it gives raise the food security, also provided support to rustic and encourage sustainable land custody. The tree is suitable for hot climate but sensitive to Vergas. Tamarind is suited to semi-tropical region with lack of rainfall and multi-usable tree. The fruit dried will used for Asian dishes as spices, strikingly in India a part of southern for a time of long period. Virtually the tree branches, leaves, fruits, flowers and also stem likewise all parts has used in food, chemical, textile industries, medicines or as fodder, timber and fuel.

The tamarind production is relatively greater size in India. The tamarind dried and fresh uses were distributed to all over the Indian sub-continent. As stated by the spice board of India, the

area was 74.20 (000' ha), production was 309.44 (000' MT) and the productivity was 4.0 (MT/ha) in 2017-18. Kolar, Tumkur, Benguluru and Chikkabballapura are the major producing districts in Karnataka. In Andhra Pradesh and Karnataka there are several tamarind crop growers available, because these states having more dry land area and the land is more suitable for tamarind tree, but soil type is different, due to Andhra Pradesh soil the tamarind having less sour but whereas due to suitable soil for tamarind crop in Karnataka and Maharashtra is having more sour content and tamarind dried having big white eyes. These states have more demand in the markets and no loss in this business. About 258.7 (000'MT) to 272.85 (000'MT) of tamarind is processed and lot of labor is engaged in this processing in India. Even though, traditional processing is widespread, its commercial uses are unknown and underdeveloped.

The tamarind dried or pulp has good export potential and also having good and also having good scope for tamarind based products in the market. Tamarind is exporting internationally in the form of tamarind fresh, tamarind dried, tamarind kernel powder and also processed products and similar findings has been in Velavan, C., 2004. The tamarind dried is a cheapest multi-vitamin and multi-mineral diets for the poor people. During the months of March to May the ripened tamarind fruit is harvested, since harvesting of tamarind fruit is labour intensive, poor people can earn by involving in harvesting activity. They also earn money at the time of lean season during plucking as well as de-seeding stages. By processing of 1kg of tamarind fresh, it will give 55 per cent pulp, 34 per cent seed, 6 per cent shell and 5 per cent fiber. The seed is major by-product of tamarind and it contains about (70 %) kernel and (30 %) of hard brown testa.

Methodology

To fulfill the specific objectives of Karnataka was selected for the study. The state is having dry land area and having highest production of tamarind. In Karnataka, four districts namely Bengaluru, Kolar, Tumkur and Chikkabalapura were selected. From each district one processing unit was selected. For collection of primary data, the respondents were selected by random sampling method. In Karnataka four processing units were selected and 25 farmers, 10 traders, 10 wholesalers, 10 retailers were selected in each district. Thus the total sample size is 224. For this particular objective, total cost and returns were computed for a year of 2018-19 based on primary data were collected from processing units. To present objective was analysis of trend in area, production and productivity of tamarind. However, to analysis data and arrive at valid conclusion. The data used for the study was based on the secondary sources. The data on area, production and productivity of tamarind were collected from India agri.stat.com and directorate of economics and statistics, Benguluru. The secondary data on area, production and yield for the period 2003-04 to 2017-18 were used to analyze the trends.

Growth Rate Analysis

In order to analyze the growth in area, production and productivity of tamarind, compound growth rates were computed using the following model.

$Y_t = abt\ ut$

Where,

Y_t = dependent variable (area/yield/production)

a = intercept term

b = (1+r) and 'r' is the compound growth rate

t = time trend

ut = error term

The above model in the Logarithmic form is expressed as,

Log Y= log a + t log b+ log u

Log a and Log b values were obtained using the ordinary least squares procedures and the R2 was computed for testing the goodness of fit. Antilog of (Log (b -1))* 100 give the per cent growth rate. Significance of the growth rate was tested using 't' test.

Co-efficient of variation

The coefficient of variation (CV) also known as relative standard deviation (RSD) is a standardized measure of dispersion of a probability distribution or frequency distribution. It is often expressed as a percentage, and is defined as the ratio of the standard deviation to the mean (average). It is a measure of relative variability.

$$\text{Coefficient of variation} = \frac{\text{Standard deviation}}{Mean} \times 100$$

Results and Discussion

Growth in area, production and productivity of tamarind in India

During the period 2003-04 to 2017-18, the area under tamarind in India has been increased from 55.40 thousand hectares to 74.20 thousand hectares with an average of 68.02 thousand hectares as presented in Table 1. The compounded annual growth rate of area during the study period was 1.64 per cent which shows the significant at 1 per cent level and the co-efficient of variation was very low as shown by a value of 7.87 per cent. The R^2 value was 0.76 indicating 76 per cent of the variation in the area was explained by over the years. It was observed that the tamarind scenario in India has been incessantly increasing during the study period.

The production of tamarind during the study period was increased from 113.83 thousand metric tons in 2003-04 to 289.44 thousand metric tons with an average annual production of 192.20 thousand metric tons. The growth in production during the study period has been 7.25 per cent per annum which was highly significant at 1 per cent level. The co efficient of variation was found to be moderately with a high value of 31.29 per cent. The variation can be explained by the vigorous growth in production 2003-04 and up to 2011-12 followed by a considerable increase in production 2012-13 to 2017-18 has been an increased in production and the productivity slightly diseasing because of drought and pest diseases in recent year. The R^2 value was 0.97 indicating 97 per cent of the total variation in the year of production was explained by the tamarind. However, in recently there has been an increased in the production from 289.44 thousand metric tons. The productivity of tamarind in India has increased from 1.84 MT/hectare in 2003-04 to 3.90 MT/ hectare in 2017-18. The average productivity found to be 2.78 MT/ hectare.

The productivity has increases at the rate of 5.60 per cent per annum. This growth was significant at 1 per cent level. The variation with respective to productivity was found to be moderate with a co-efficient of variation of 25.54 per cent. Again this variation can be contributed to the stagnant growth followed by steadily increasing in productivity. The R^2value was 0.94 indicating 94 per cent of the total variation of the

productivity was explained by the tamarind productivity in India. There has been growth in area and spectacularly increase in production and productivity substantially, after 2011-12 which may be attributed to the high production in 2011 on account of good rainfall, 10-12 years before planted trees were came to yielding. The area, production and productivity were highly significant at 1 percent. The results are similar to the findings of Kishore (2017). Also, Buyinza *et al.* (2010) explained undertaking of many developmental and crop improvement activities like improved management practices, pest and disease control measures, which resulted in increased productivity.

Table 1: Growth in area, production and productivity of tamarind in India (2003-04 to 2017-18)

SL. No.	Year	Area ('000 Hectare)	Production ('000 MT)	Productivity (MT/Hectare)
1	2003-04	55.40	113.83	1.84
2	2004-05	58.90	121.89	2.20
3	2005-06	61.70	124.46	2.11
4	2006-07	67.30	133.45	1.98
5	2007-08	68.20	148.75	2.18
6	2008-09	68.80	177.60	2.58
7	2009-10	68.11	170.74	2.51
8	2010-11	69.21	177.46	2.56
9	2011-12	69.54	194.40	2.80
10	2012-13	70.70	207.25	2.93
11	2013-14	72.70	213.00	2.93
12	2014-15	71.50	259.21	3.63
13	2015-16	71.50	267.92	3.75
14	2016-17	72.60	283.72	3.91
15	2017-18	74.20	289.44	3.90
	Total	1020.36	2883.12	41.81
	Mean	68.02	192.20	2.78
	Std	5.35	60.13	0.71
	CV	7.87	31.29	25.54
	CAGR (%)	1.64**	7.25**	5.60**
	R^2	0.76	0.97	0.94

Source: Spice Board, India (2017-18)
Note: ** Significant at 1 percentage

Growth in area, production and productivity of tamarind in different states (2003-04 to 2017-18)

Table 2 shows that during the period 2003-04 to 2017-18, the area under tamarind in Andhra Pradesh has been increased from 4.60 thousand hectares to 6.20 thousand hectares with an average of 5.49 thousand hectares which contribution of 2.33 per cent and significant at 1 per cent level. The coefficient of variation was also 10.56 per cent. The following area under tamarind was in Karnataka has been increased from 12.56 thousand hectares to 18.70 thousand hectares with an average of 15.97 thousand hectares which has been shared 2.00 per cent and significant at 1 per cent level. The coefficient of variation was also 9.20 per cent. The area under tamarind in Tamil Nadu has been increased from 15.40 thousand hectares to 20.50 thousand hectares with an average of 16.84 thousand hectares which has been shared 1.96 per cent and significant at 1 per cent level. But in the case of coefficient of variation was also 9.68 per cent. The area under tamarind shows that the other states together in India has been increased from 10.50 thousand hectares to 12.10 thousand hectares with an average of 12.13 thousand hectares which has been shared 1.52 per cent and significant at 1 per cent level. The coefficient of variation was also 8.49 per cent and the area under tamarind in Maharashtra has been increased from 5.20 thousand hectares to 5.70 thousand hectares with an average of 5.53 thousand hectares which has been shared 0.79 per cent and significant at 1 per cent level. The coefficient of variation was also 3.80 per cent. But The area under tamarind in Kerala has been increased from 19.20 thousand hectares to 11.00 thousand hectares with an average of 14.04 thousand hectares which has been shared -3.77 per cent it was negative growth compare to remaining states because tamarind is a long lasting tree it shows very less trend in the growing of area and shows non- significant. The coefficient of variation was also 21.44 per cent. The R^2 value was highest that was 0.91 indicating 91 per cent of the total variation of the production was explained regarding the tamarind in Andhra Pradesh followed by Maharashtra 0.89 shown as 89 per cent.

Table 3 explained throughout the period 2003-04 to 2017-18, the production under tamarind in Maharashtra has been increased from 7.50 thousand hectares to 72.54 thousand hectares with an average of 25.70 thousand hectares which contribution of 17.76 per cent and significant at 1 per cent level. The co-efficient of variation was also 99.42 per cent and followed by Karnataka has been increased from 11.32 thousand hectares to 87.00 thousand hectares with an average of 58.63 thousand hectares which contribution of 15.95 per cent and significant at 1 per cent level. The co-efficient of variation was also 51.77 per cent. The production under tamarind was in Andhra Pradesh has been increased from 11.10 thousand hectares to 38.60 thousand hectares with an average of 20.81 thousand hectares which has been shared 9.36 per cent and significant at 1 per cent level. The co-coefficient of variation was also 41.47 per cent. All other states in India together have been increased from 9.20 thousand hectares to 15.50 thousand hectares with an average of 13.48 thousand hectares which has been shared 4.60 per cent and significant at 1 per cent level. The coefficient of variation was 20.40 per cent. The production under tamarind was in Tamil Nadu has been increased from 48.81 thousand hectares to 67.10 thousand hectares with an average of 57.60 thousand hectares this has been shared 2.71 per cent and significant at 1 per cent level. The co-efficient of variation was also 12.64 per cent and the Kerala production was slightly increased from 25.90 thousand hectares to 28.70 thousand hectares with an average of 27.98 thousand hectares this has been shared 0.64 per cent it was significant at 5 per cent level. The co-efficient of variation was also 4.86 per cent. The R^2 value was highest that was 0.97 indicating 97 per cent of the total variation of the production was explained regarding the tamarind in Andhra Pradesh followed by Tamil Nadu 0.87 shown as 87 per cent.

During the period 2003-04 to 2017-18, the productivity under tamarind in Maharashtra has been increased from 1.44 thousand hectares to 12.73 thousand hectares with the central value of 4.56 thousand hectares which contribution was high 16.84 per cent and significant at 1 per cent level. The co-efficient of variation was also 97.59 per cent and followed by Karnataka has been increased from 1.19 thousand hectares to 4.65 thousand hectares with an average of 3.57 thousand hectares which contributed to 12.90 per cent and significant at 1 per cent level. The co-efficient of variation was also 46.78 per cent at Table 4. The productivity under tamarind was in Andhra Pradesh has been increased from 2.41 thousand hectares to 6.23 thousand hectares with an average of 3.69 thousand hectares which has been shared 6.88 per cent and significant at 1 per cent level. The coefficient of variation was also 32.25 per cent,

All other states in India together have been increased from 0.88 thousand hectares to 1.28 thousand hectares with an average of 1.10 thousand hectares which has been shared 3.02 per cent and significant at 1 per cent level. The coefficient of variation was 13.64 per cent. The production under tamarind was in Tamil Nadu has been increased from 3.17 thousand hectares to 3.27 thousand hectares with an average of 3.42 thousand hectares this has been shared 0.74 per cent and significant at 1 per cent level. The co-efficient of variation was also 7.02 per cent and the Kerala productivity was decreased from 1.35 thousand hectares to 0.79 thousand hectares with an average of 1.07 thousand hectares this has been shared negative growth of -6.83 per cent it shows decreasing growth in productivity and non-significant. The co-efficient of variation was also 47.66 per cent. The R^2 value was highest that was 0.93 indicating 93 per cent of the total variation of the production was explained regarding the tamarind in Andhra Pradesh followed by remaining states together in India was 0.88 shown as 88 per cent.

Table 2: Growth in area under tamarind in different states (2003-04 to 2017-18) (Area '000 ha)

Sl. No.	Year	AP	Karnataka	Kerala	Tamil Nadu	Maharashtra	India
1	2003-04	4.60	12.56	19.20	15.40	5.20	10.50
2	2004-05	4.80	14.70	15.80	15.40	5.20	10.80
3	2005-06	4.80	14.70	15.70	15.40	5.20	10.80
4	2006-07	4.80	14.70	16.90	15.40	5.30	11.20
5	2007-08	4.80	15.70	20.50	15.65	5.40	11.50
6	2008-09	5.60	15.60	14.10	15.70	5.50	11.50
7	2009-10	5.50	15.90	12.70	15.91	5.60	12.50
8	2010-11	5.60	16.00	11.90	16.60	5.70	12.80
9	2011-12	5.70	16.00	12.70	16.64	5.70	12.80
10	2012-13	5.80	16.50	12.70	16.90	5.70	13.10
11	2013-14	5.90	16.80	14.00	17.10	5.70	13.20
12	2014-15	6.00	16.80	11.20	18.00	5.70	13.80
13	2015-16	6.10	17.10	11.20	18.20	5.70	13.20
14	2016-17	6.20	17.80	11.00	19.80	5.70	12.10
15	2017-18	6.20	18.70	11.00	20.50	5.70	12.10
	Total	82.40	239.56	210.60	252.60	83.00	181.90
	Mean	5.49	15.97	14.04	16.84	5.53	12.13
	Std	0.58	1.47	3.01	1.63	0.21	1.03
	CV	10.56	9.20	21.44	9.68	3.80	8.49
	CAGR (%)	2.33**	2.00**	-3.77	1.96**	0.79**	1.52**
	R^2	0.91	0.86	0.71	0.86	0.89	0.61

Source: Spice Board, India (2017-18)
Note: ** Significant at 1 percentage

Table 3: Growth in production of tamarind in different states in India (2003-04 to 2017-18) (000'MT)

Sl. No.	States	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Maharashtra	India
1	2003-04	11.10	11.32	25.90	48.81	7.50	9.20
2	2004-05	11.45	17.55	24.83	49.66	9.20	9.20
3	2005-06	12.64	18.52	26.20	48.10	9.20	9.80
4	2006-07	13.40	22.55	28.80	48.10	10.20	10.40
5	2007-08	13.90	25.85	29.40	56.70	11.40	11.50
6	2008-09	13.90	55.80	29.90	54.10	11.40	12.50
7	2009-10	18.70	65.54	27.50	53.10	11.40	14.50
8	2010-11	19.50	70.96	27.80	53.00	11.40	14.80
9	2011-12	22.70	75.50	28.10	61.50	11.40	15.20
10	2012-13	22.15	85.30	28.20	63.60	12.50	15.50
11	2013-14	23.58	85.52	28.50	64.40	15.20	15.80
12	2014-15	25.40	85.52	28.50	64.79	58.70	16.30
13	2015-16	30.60	85.52	28.60	65.20	61.20	16.80
14	2016-17	34.60	87.00	28.70	65.90	72.32	15.20
15	2017-18	38.60	87.00	28.70	67.10	72.54	15.50
	Total	312.22	879.45	419.63	864.06	385.56	202.20
	Mean	20.81	58.63	27.98	57.60	25.70	13.48
	Std	8.63	30.35	1.36	7.28	25.55	2.75
	CV	41.47	51.77	4.86	12.64	99.42	20.40
	CAGR (%)	9.36**	15.95**	0.64*	2.71**	17.76**	4.60**
	R^2	0.97	0.82	0.32	0.87	0.75	0.83

Source: Spice Board, India (2017-18)
Note: ** Significant at 1 percentage

Table 4: Growth in productivity under tamarind in selected different states in India (2003-04 to 2017-18) (MT/ha)

SL. No.	States	Andhra Pradesh	Karnataka	Kerala	Tamil Nadu	Maharashtra	India
1	2003-04	2.41	1.19	1.35	3.17	1.44	0.88
2	2004-05	2.39	1.19	1.57	3.22	1.77	0.85
3	2005-06	2.63	1.26	1.67	3.12	1.78	0.91
4	2006-07	2.79	1.53	1.70	3.12	1.92	0.93
5	2007-08	2.90	1.65	1.43	3.62	2.11	1.00
6	2008-09	2.48	3.58	2.12	3.45	2.07	1.09
7	2009-10	3.40	4.12	0.59	3.34	2.04	1.16
8	2010-11	3.48	4.44	0.66	3.19	2.00	1.16
9	2010-12	3.98	4.72	0.64	3.70	2.00	1.19
10	2010-13	3.82	5.17	0.65	3.76	2.19	1.18
11	2010-14	4.00	5.09	0.61	3.77	2.67	1.20
12	2010-15	4.23	5.09	0.76	3.60	10.30	1.18
13	2010-16	5.02	5.00	0.77	3.58	10.74	1.27
14	2010-17	5.58	4.89	0.79	3.33	12.69	1.26
15	2010-18	6.23	4.65	0.79	3.27	12.73	1.28
	Total	55.34	53.57	16.10	51.24	68.45	16.54
	Mean	3.69	3.57	1.07	3.42	4.56	1.10
	Std	1.19	1.67	0.51	0.24	4.45	0.15
	CV	32.25	46.78	47.66	7.02	97.59	13.64
	CAGR (%)	6.88**	12.90**	-6.83	0.74**	16.84**	3.02**
	R^2	0.93	0.78	0.49	0.57	0.72	0.88

Source: Spice Board, India (2017-18)
Note: ** Significant at 1 percentage

Growth in area under tamarind in different districts (2003-04 to 2017-18)

Table 5 revealed that the Karnataka has major tamarind growing districts were chikkaballapura which contributes 6.95 per cent to total area followed by Kolar (4.02 per cent), Bengaluru (4.00 per cent) and Tumkur (3.60 per cent). The mean value for the study period was computed to assess the ranking of districts. All the districts in the study area were shown that 1 per cent level of significant. Among top fifteen districts together contribution around 45 to 50 per cent of the state's total area under tamarind. Here Chikkaballapura and Kolar contributed around more than 80 per cent of the total area showing their importance. In terms of growth in area during the study period, the top performing districts chikkaballapura 6.95 per cent per annum growth followed by Kolar 4.02 per cent annum and Bengaluru 4.00 per cent per annum and Tumkur 3.6 per cent followed by other districts and growth rates were highly significant. The mean value with respective study area chikkaballapura has been shown highest central value of 4,355.60 followed by Kolar 3,033.40, Tumkur 2,942.70 and Benguluru 318.80. The coefficient of variation was high in the district of Bengaluru as shown by a value of 21.38 per cent followed by Chikkaballapura 20.30 per cent, Kolar 18.41 per cent and Tumkur 11.30 per cent respectively and others. The R^2 value was highest that was 0.97 indicating 97 per cent of the total variation of the area was analyzed through time series data regarding the tamarind in Tumkur followed by Chikkaballapura 0.96 shown as 96 per cent.

Table 5: Growth in area of tamarind in various selected different districts of Karnataka (2008-09 to 2017-18) (ha)

Sl. No.	Districts	Mean	Std	CV	CAGR (%)	R^2
1	Tumkur	2,942.70	332.46	11.30	3.60**	0.97
2	Kolar	3,033.40	558.35	18.41	4.02**	0.85
3	Benguluru	318.80	68.17	21.38	4.00**	0.83
4	Chikkaballapura	4,355.60	884.07	20.30	6.95**	0.96
5	Mysuru	95.60	9.98	10.44	3.46**	0.82
6	Gadag	30.80	1.32	4.27	1.32*	0.02
7	Bidar	203.10	53.51	26.35	-1.40	0.65
8	Kalaburagi	183.30	59.44	32.43	-14.45	0.56
9	Koppal	211.40	28.57	13.52	-3.53	0.56
10	D.Kannada	192.60	44.34	23.02	-7.21	0.89
11	Udupi	79.30	29.59	37.31	-8.58	0.72
12	Chitradurga	588.60	30.54	5.19	0.22*	0.01
13	Ramanagara	497.10	322.20	64.82	-22.76	0.69
14	Bagalkot	67.90	23.09	34.01	-10.96	0.91
15	Davanagere	80.60	10.80	13.40	2.81*	0.34
16	Total Karnataka	3,126.70	140.85	4.50	1.43**	0.88

Source: Directorate of Economics and Statistics of India, Benguluru.
Note: ** Significant at 1 percentage
* Significant at 5 percentage

Growth in production under tamarind in different districts (2003-04 to 2017-18)

Table 6 study area was revealed that the Karnataka has major tamarind growing districts were chikkaballapur which contributes 8.05 per cent to total area followed by Tumkur 7.41 per cent, Bengaluru 7.14 per cent and Kolar 5.93 per cent. The mean value for the study period was computed to assess the ranking of districts. Among top fifteen districts together contribution around 60 to 70 per cent of the state's total production under tamarind. Here Chikkaballapura and Tumkur contributed around more than 80 per cent of the total area showing their importance. In terms of growth in production during the study period, the top performing districts Chikkaballapura 8.05 per cent per annum growth followed by Tumkur 7.41 per cent annum and Bengaluru 7.14 per cent per annum and Kolar 5.93 per cent followed by other districts and growth rates were highly significant. The mean value with respective study area Chikkaballapura has been shown highest central value of 22,520.70 followed by Tumkur 19,789.80, Kolar 18,363.40 and Benguluru 2,250.30. The coefficient of variation was high in the district of Benguluru as shown by a value of 61.63 per cent followed by Chikkaballapura 23.99 per cent, Tumkur 22.50 per cent and Kolar 19.25 per cent respectively and others. The R^2 value was highest that was 0.95 indicating 95 per cent of the total variation of the production was explained regarding the tamarind in Chikkaballapura followed by Tumkur 0.96 shown as 96 per cent by analyzing time series data on production of tamarind in districts of Karnataka.

Table 6: Growth in production of tamarind in various districts of Karnataka (2008-09 to 2017-18) (MT)

SL. No.	District	Mean	Std	CV	CAGR (%)	R^2
1	Tumkur	19789.80	4452.34	22.50	7.41	0.93
2	Kolar	18363.40	3534.77	19.25	5.93	0.90
3	Bengaluru	2250.30	1386.97	61.63	7.14	0.91
4	Chikkaballapura	22520.70	5403.16	23.99	8.05	0.95
5	Mysore	365.10	128.57	35.21	13.72	0.81
6	Gadag	231.80	75.66	32.64	4.91	0.16
7	Bidar	819.90	208.57	25.44	-0.80	0.01
8	Kalaburagi	1118.10	490.58	43.88	-10.37	0.71
9	Koppal	1039.60	164.87	15.86	-4.18	0.56
10	D. Kannada	896.60	213.31	23.79	-7.16	0.86
11	Udupi	436.70	155.44	35.59	-7.95	0.69
12	Chitradurga	1928.30	626.71	32.50	-10.40	0.7
13	Ramanagara	2670.70	1767.93	66.20	-20.74	0.62
14	Bagalkot	442.70	167.70	37.88	-5.75	0.23
15	Davanagere	516.80	148.11	28.66	10.15	0.73
16	Total Karnataka	81401	7125.83	8.75	1.57	0.95

Source: Directorate of Economics and Statistics of India, Benguluru.
Note: CAGR: Compound annual growth rate
CV: Co-efficient of variation
Std: Standard deviation
** Significant at 1 percentage
* Significant at 5 percentage

Growth in productivity under tamarind in different districts (2003-04 to 2017-18)

Table 7 study areas was revealed that the Karnataka has major tamarind growing districts were Tumkur which contributes 3.67 per cent to total area followed by Bengaluru 3.03 per cent, Kolar1.85 per cent and Chikkaballapura1.03 per cent. The mean value for the study period was computed to assess the ranking of districts. Among top fifteen districts together contribution around 60 to 70 per cent of the state's total production under tamarind. Here Tumkur and Bengaluru contributed around more than 80 per cent of the total area showing their importance. In terms of growth in production during the study period, the top performing districts Tumkur 3.67 per cent per annum growth followed by Bengaluru 3.03 per cent annum and Kolar 1.85 per cent per annum and Chikkaballapura 1.03 per cent followed by other districts and growth rates were highly significant. The mean value with respective study area Bengaluru has been shown highest central value of 6.91 followed by Tumkur 6.66, Kolar 6.13 and Chikkaballapura 5.17. The coefficient of variation was high in the district of Benguluru as shown by a value of 47.36 per cent followed by Kolar 14.82 per cent, Tumkur 12.73 per cent, Chikkaballapura 10.27 per cent and respectively and others. The R^2 value was highest that was 0.92 indicating 92 per cent of the total variation of the production was explained regarding the tamarind in Tumkur followed by Kolar 0.80 shown as 80 per cent.

Table 7: Growth in productivity under tamarind in different districts of Karnataka (2008-09 to 2017-18) (MT/ha)

SL. No.	Districts	Mean	Std	CV (%)	CAGR (%)	R^2
1	Tumkur	6.66	0.85	12.73	3.67	0.92
2	Kolar	6.13	0.91	14.82	1.85	0.80
3	Benguluru	6.91	3.27	47.36	3.03	0.73
4	Chikkaballapura	5.17	0.53	10.27	1.03	0.79
5	Mysuru	3.74	1.07	28.67	9.91	0.71
6	Gadag	7.51	2.45	32.57	3.54	0.09
7	Bidar	4.05	0.13	3.32	0.60	0.32
8	Kalaburagi	5.37	0.97	18.13	4.76	0.33
9	Koppal	4.90	0.17	3.52	-0.67	0.33
10	D. Kannada	4.66	0.33	7.03	0.06	0.02
11	Udupi	5.54	0.24	4.41	0.68	0.22
12	Chitradurga	3.28	1.04	31.82	-10.60	0.74
13	Ramanagara	5.47	0.75	13.78	2.62	0.36
14	Bagalkot	7.03	3.26	46.33	5.85	0.18
15	Davanagere	6.38	1.67	26.13	7.14	0.60
16	Total Karnataka	2.66	2.58	97.22	-29.93	0.96

Source: Directorate of Economics and Statistics of India, Benguluru.
Note: ** Significant at 1 percentage
* Significant at 5 percentage

Conclusions

There has been a sharp increase in area and production in Karnataka since 2003 up to 2018 indicated by high growth rates revealing the enhanced demand for tamarind products. Thus the very potential of tamarind in Karnataka needs to be utilized in the ensuing years for the benefits by northern Karnataka. Where tamarind production is specifically located and demand for tamarind is spread ones the entire state. In this perspective an analysis has been made to know the growth trend of area, production and productivity of tamarind. The estimated results showed that, compound growth rates for area, production and productivity were found positive and significant. The growth in area and production of tamarind showed increasing trend in four districts explained undertaking of many developmental and crop improvement activities like improved management practices, pest and disease control measures, which resulted in increased productivity. The production enhancing and extension activities can be taken up in low productivity districts by the department of horticulture.

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