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Production Performance of Fresh Mango in India: A Growth and Variability Analysis

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ABSTRACT

Mango is one of the most consumed fresh fruit in the world, it continues to dominate the Indian fruit basket contributing 34.9 per cent to total fruit area and 20.7 per cent to total fruit production. The necessary time series data were collected for a period of 25 years from 1987-88 to 2014-15.The growth in the area, production and productivity of top ten major mango producing states of India were estimated using the compound annual growth rate function.The results revealed that the area under mango cultivation has registered a statistical non significant positive compound growth rate of 3.78 per cent per annum, while its production registered growth rate of 3.00 per cent during the same period of time. The productivity (-9.6 % pa) of mango in India was registered negative highly significant at 1 % (P<0.01). Itimplies that yield of mangodeclined by 0.96 per cent per annum.The Andhra Pradesh ranksfirst in average area (19.35 %) under mango cultivation and production (25.39 %), the compound annual growth rate, in caseof area (3.36%pa) and production (1.38% pa) is positive and highly significant at 1 % level of significance whereas Uttar Pradesh occupied top position in case of average productivity (10.65 Mt ha.$^{-1}$) followed by Karnataka and Bihar. The total acreage of mango cultivation and production of India has accelerated annually. The overall productivity of mango is revealed to be decreasing annually.Thus, there is a need to take productivity enhancing measures in mango cultivation like adoption of high density planting techniques, appropriate orchard system, provide the facility of modern infrastructure services, enhanced technical awareness level of growers regarding the cultivation of mango to tackle the natural calamity and disease attack with respect to fruit protection.

Key word: *Compound growth rates, Area, Production, Productivity Mean and Variation.*

INTRODUCTION

Variable geological and geographical conditions existing in India are very much favorable for growing a large array of horticultural crops throughout the country. The country observed sharper increased acreage in horticulture crops compared to food grains over the last five years (2010-11 to 2014-15). The contribution of fruits crops, in terms of area is about 26.89% and production of 31.07% in horticulture industry.

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About the fruit production and area devotion, mango stands at top position in coverage of total fruit crops area (21.83%) and hold second rank in total fruits production (35.53%) next to banana crop (HSD, 2014-15). Mango is one of the most consumed fresh fruit in the world, it is continues to dominate the Indian fruit basket, it is comes first among the top rated delicious fruits and mango farmers are used to get considerable income.

India is the home of about 1,000 varieties of mango as it is cultivated by man, for more than 4000 years. However, only a few varieties are commercially cultivated throughout the country. More than 90 countries in the world grow mangoes. Global production of the mango has doubled in the past thirty years. Mango is native to Asia and itis the largest mango producer, representing 77% of global production, followed by the America with 13% and Africa with 10%[11]. India is a front runner in production of fresh mango with share in more than 44 percent area under mango cultivation and of 38 percent in production. The world productivity of mango is 7.74 M.T. /ha. The mango productivity in India is estimated at 6.92 metric tonnes per hectare while that of Brazil is 16 metric tonnes per hectare[10].

The fresh mango and mango products earn foreign exchanges as well as source of food & household income to the growers and helps in poverty reduction by providing employment opportunities to the rural peoples both male and female, for the non growers through various activities such as marketability of fresh mangos and processing of different products, both in raw and ripe stages. Therefore, it is considered to be a fruit with significant potential for employment generation. In spite of this, India (80.27 percent) takes third position in increase of total production followed by Indonesia (130.88 percent) and Pakistan (90.71 percent)[6], the average yield per hectare of mangoes in India is one of the lowest in the world – even behind countries like Bangladesh and Pakistan. The mango productivity in India was estimated at 8.56metric tonnes per hectare while that of Brazil was 16 metric tonnes per hectare (2014-15). The area and production of mango in share of global market has creeping decline. In this paper discussed the present state of mango production in India and its growth rate.

MATERIAL AND METHODS

Data Source

The time series data on area, production, productivity of mango was available from 1987-882014-15. Hence the analysis was covered from 1987-88 to 2014-15 period. Data used for the study was collected from various published sources i.e., National Horticulture Board, Agricultural and Processed Food Product Export Development Authority (APEDA) New Delhi, Directorate General of Commercial Intelligence and Statistics, Annual Export Report[5].

Analysis of data

The year wise data on area, production and productivity of mango in India for the period of 25 years i.e. from the year 1987-88 to 2014-15 have been collected and mean, standard deviation, coefficient of variation and compound annual growth rate were calculated.

Compound Annual growth rate Analysis

The compound annual growth rate of area, production and productivity of mango were worked out by using an exponential form of equation and in modeling time trend used for this study, the exponential trend or log- linear employed by Ahmed et al., Nmadu *et al*[9]. and Samuel at al. was used. The exponential trend equation for production specified as fallows

$$Y_t = e\beta_o + \beta_1 t_1 + u_t \ldots\ldots\ldots\ldots (1)$$

Bytakingthenaturallogarithmofbothsides,theli nearformofthe equation was obtained by making it amenable to OLS as;

$$\text{Lin}Y_t = \beta_o + \beta_i t_i + u_t \ldots\ldots\ldots\ldots\ldots (2)$$

Where:

Y = Area or Productivity,
t = Time trendvariable,
β_o = Interceptofthetrendequation,
β_1 = Trend coefficient,
U_t = Disturbance term/stochastic term or error term for the year t.

Fromequation-2thecompoundgrowthratewascomputedasfollows.

$$r = (e^{\beta 1} - 1) * 100 \ldots\ldots\ldots\ldots (3)$$

Where:

R = Compoundgrowthrate,
B_i = Estimated coefficient fromequation-2,
E= Euler's exponential constant (=2.71828).

Coefficient of Variation (C.V.)

In order to study the variability in the time series data, coefficient of variation (CV) was used as an index of consistency. We compare the consistency of area with production and productivity of mango. If the less consistent of area, production and productivity i.e., it has a higher coefficient of variation among area, production and productivity, coefficient of variation is the ratio of standard deviation to the arithmetic means which is presented in percentages was calculated as follow

$$C.V. = \frac{\text{Standard Deviation}}{\text{Mean}} * 100 = \frac{\sigma}{\mu} * 100$$

The value of standard deviation from the time series data can be calculated using the following formula as fallows

$$\textbf{Variance} = \sum_{i=1}^{n} = \frac{(Xi - \bar{X})2}{n}$$

Where:

Xi	=	Individual observations in the time series data observation,
X	=	Mean,
(Xi – X)	=	Deviation from the mean,
n	=	Number of observation.

Tabular Analysis

In the present study, tabular analysis was used to find out the mean, standard deviation, coefficient variance and percentage of total acreage under cultivation, production and productivity of mango among the prime mango growing states or pockets of India.

RESULTS AND DISCUSSION

State- wise Share in Area, Production and productivity of mango in India

The state wise data on area, production and productivity of mango for the year 1987-88 to 2014-15 have been collected and percentage shares have been worked out and shown in table 1. The average area, production and productivity of mango in India were 17.73 lakh hectares,12.05 million tons and 6.92tonsper hectare respectively. Top ten states under mango cultivation in India are Andhra Pradesh (19.35%), Uttar Pradesh (15.12%), Maharashtra (8.23%), Bihar (7.11%), Karnataka (6.94%), Odisha (6.32%), Tamil Nadu (4.23%), Gujarat (4.06%) and West Bengal (3.95%), respectively.

The average production of major mango producing states in India areAndhra Pradesh, Uttar Pradesh, Maharashtra, Bihar, Karnataka, Odisha, Tamil Nadu, Gujarat and West Bengal. Andhra Pradesh rankfirst in average acreage and production of mango in India. It has occupied almost one fifth area of total area under mango cultivation of the countryand contributed 25.39 per cent of total production followed by Uttar Pradesh (23.46%), Bihar (11.57%), Karnataka (10.21%), Tamil Nadu (4.97 %), Gujarat (4.47%), Maharashtra (4.14%), West Bengal (4.02%), Odisha (3.86%) and Kerala (2.64%) respectively. While the productivity (9.35 Mt ha.$^{-1}$) was lowest so that it ranked fourth next only Uttar Pradesh, Karnataka and Bihar states. The productivity of mango was satisfactory in northern states like Uttar Pradesh (10.65 M t ha.$^{-1}$), Bihar (9.49 Mt ha.$^{-1}$), and southern states like Andhra Pradesh (9.35 Mt ha.$^{-1}$) and Karnataka (9.66 Mt ha.$^{-1}$).

The utmost similar study was also concluded by[7], which was revealed that the productivity of mango was satisfactory in northern states like Uttar Pradesh, Bihar and Jharkhand and southern states like Andhra Pradesh, Telangana and Karnataka. The productivity of these states increases in constant order. The productivity of remaining major mango producing states of India was less than the average productivity of the country likeGujarat (6.35 Mt ha.$^{-1}$), Tamil Nadu (5.50 Mt ha.$^{-1}$), Kerala (4.28 Mt ha.$^{-1}$), Odisha (3.96 Mt ha.$^{-1}$) and Maharashtra (2.89 Mt ha.$^{-1}$).

State- wise growth rate of Area, Production and productivity of mango in India

(1) Compound growth rate in area

The compound annualgrowth rate for area under mango cultivation of India was 3.78 % which was non significant at 95% confidence interval. All major mangos producing states of India has non significant compound annual growth rates except Andhra Pradesh, which was highly significant at 1% with 3.36 %pa. This is may be due to farmers diversified food grain crops into fruit crops or cultivators shifting the nature of cultivation seasonal to annual and weather or the climatic condition

are considerable support for the mango cultivation and may be one of the more rational reason for extension of acreage under mango cultivation like financial support by government in terms subsidy, availability of prime inputs amble planting materials, suitable irrigation facility, extension services provided by farming community regarding market information about price of the product and quantity of demand and supply, surfeit necessary infrastructure like market hut, storage, pack houses with automatic sorting, washing, waxing, packing, pre-cooling standardization, grading and processing facilities.

The analysis of compound growth and R^2value in area was done by using the estimating regression coefficient of time trend/ independent variable or explanatory variable as in equation which is given already explained. The adjusted R^2 was calculated for India along with key mango producing states were 0.90, 0.62, 0.04, 0.97, 0.84, 0.06, 0.74, 0.91, 0.90, 0.03, 0.95 and 0.83 respectively. This shows that time trend as a very important accounting for 90 % variation in area of the country under mango cultivation and 62%, 4%, 97%, 84%,6%,74%,91%,90%,3%, 95%, and 83% of variation in area of Andhra Pradesh, Uttar Pradesh, Maharashtra, Bihar, Karnataka, Odisha, Tamil Nadu, Gujaratand West Bengal respectively.

Table 1: State wise growth in acreage (in lakh ha.) under mango cultivation during the period of 1987-88 to 2014-15

	AP	Bihar	Gujarat	Karnataka	Kerala	Maharashtra	Odisha	T N	U P	W B	Others	India
Mean area(lakh ha.)	3.43 (19.35)	1.46 (8.23)	0.75 (4.23)	1.26 (7.11)	0.72 (4.06)	2.58 (14.55)	1.23 (6.94)	1.12 (6.32)	2.68 (15.12)	0.70 (3.95)	1.87 (10.55)	17.73 (100)
S.D	0.98	0.05	0.47	0.31	0.18	1.83	0.48	0.32	0.52	0.15	1.37	4.77
C.V. (%)	28.53	3.43	62.02	24.59	24.74	70.93	38.54	28.80	19.44	20.79	73.21	26.89
CAGR (%)	3.36*	-0.13^{NS}	8.55^{NS}	3.40^{NS}	-0.69***	12.43^{NS}	5.56^{NS}	4.35^{NS}	-0.5^{NS}	2.78^{NS}	8.79^{NS}	3.78^{NS}
Multi. R^2	0.80	0.28	0.99	0.92	0.32	0.87	0.95	0.95	0.26	0.97	0.91	0.97
R^2	0.60	0.08	0.97	0.85	0.10	0.75	0.91	0.90	0.07	0.95	0.84	0.94
Adj.R^2	0.62	0.04	0.97	0.84	0.06	0.74	0.91	0.90	0.03	0.95	0.83	0.94
SE	0.19	0.03	0.09	0.11	0.15	0.51	0.13	0.11	0.14	0.05	0.28	0.07
P value	0.000	0.174	7.527	6.617	0.110	2.290	1.811	4.468	0.202	2.602	1.667	1.054
95% C.I. Lower	0.022	-0.003	0.075	0.027	-0.016	0.088	0.047	0.037	-0.013	0.025	0.068	0.033
95% C.I. Upper	0.044	0.001	0.089	0.040	0.002	0.146	0.062	0.049	0.003	0.030	0.100	0.041

(2)Compound growth rate in Production

Table2revealed that an average mango production of India was 12.5 million tons. In India, Andhra Pradesh contributesfor maximum production with 25.39% followed by Uttar Pradesh (23.46%), Bihar (11.57%), Karnataka (10.21%), Tamil Nadu (4.97%), Gujarat (4.47%), Maharashtra (4.14%), West Bengal (4.02%), Odisha (3.86%) and Kerala (2.64%). The Andhra Pradesh standsat top position, two major things behind it is, some farmers adopted modern planting technique called Ultra- High Density planting method, well aware about the crucial management and fruit handling practices. The second important thing is the majority of farmers fallow the suitable mango orcharding system.

The analysis of compound growth rate of mango production in India as well as major mango producing states for last 25 corresponding years; The compound growth rate of India was 3% which was non significant at 95% confidence interval. The compound growth rate of Andhra Pradesh (1.38%), Gujarat (9.44%), Kerala (2.85%), Maharashtra (6.26%), Tamil Nadu (3.79%) and Uttar Pradesh (3.35%) were positively highly significant at 1 % ($P<0.01$). The compound growth rate of Odisha (4.32%) and West Bengal (3.06%) were positively significant at 5% ($P<0.05$).The compound growth rate of Bihar (-1.43%) was negatively significant at 5% and Karnataka (3.06%) was non significant. The value of adjusted R^2 for

India and prime mango producing states of India were 0.86 and 0.22, 0.16, 0.54, 0.83, 0.52, 0.43, 0.21, 0.42, 0.53 and 0.32 percents respectively. This implies that time trend as variable account for 86% of the variation perceived in mango production of India. The trend as variable account for Andhra Pradesh (22%), Bihar (16%), Gujarat (54%), Karnataka (83%), Kerala (52%), Maharashtra (43%), Odisha (21%), Tamil Nadu (42%), Uttar Pradesh (53%) and West Bengal (32%) of the variation perceived in prime mango producing states of India, respectively.

Table 2: State wise growth in Production (in MT) of Fresh mango during the period 1987-88 to 2014-15

Particular		AP	Bihar	Gujarat	Karnataka	Kerala	Maharashtra	Odisha	T N	U P	W B	Others	India
Mean area (lakh ha.)		3.06 (25.39)	1.39 (11.57)	0.54 (4.47)	1.23 (10.21)	0.32 (2.64)	0.50 (4.14)	0.47 (3.86)	0.60 (4.97)	2.83 (23.46)	0.48 (4.02)	0.98 (8.13)	12.05 (100)
S.D		0.60	0.31	0.36	0.35	0.11	0.24	0.19	0.19	0.91	0.15	0.94	3.71
C.V. (%)		19.74	22.48	67.30	28.63	34.01	48.80	40.03	31.46	32.09	30.98	96.41	31.23
CAGR (%)		1.38*	-1.43**	9.44*	3.92^{NS}	2.85*	6.26*	4.32**	3.79*	3.35*	3.06*	8.61^{NS}	3.00^{NS}
Multi. R^2		0.51	0.45	0.75	0.92	0.73	0.67	0.49	0.66	0.74	0.59	0.86	0.93
R^2		0.26	0.20	0.56	0.84	0.54	0.45	0.24	0.44	0.55	0.34	0.74	0.86
Adj.R^2		0.22	0.16	0.54	0.83	0.52	0.43	0.21	0.42	0.53	0.32	0.73	0.86
SE		0.18	0.22	0.53	0.13	0.19	0.50	0.57	0.31	0.22	0.31	0.35	0.08
P value		0.010	0.026	0.000	1.276	0.000	0.002	0.013	0.000	0.000	0.002	6.420	5.018
95% Confidence Interval	Lower	0.004	-0.027	0.053	0.031	0.017	0.032	0.010	0.019	0.020	0.012	0.061	0.024
	Upper	0.024	-0.002	0.127	0.046	0.040	0.090	0.075	0.055	0.046	0.048	0.104	0.035

Table3 shows that average productivity (M t/ha.) of India was considerable low and it was lower than Uttar Pradesh (10.65%), Karnataka (9.66%), Bihar (9.49%), Andhra Pradesh (9.35%) and West Bengal (6.89%). The average productivity of the country was greater than the states of Gujarat (6.35%), Tamil Nadu (5.50%), Kerala (4.28%), Odisha (3.96%) and Maharashtra (2.89%). The compound growth rate of India (-.96%pa) was negatively highly significant at 1% (P<0.01) and also Andhra Pradesh (-1.91) and Maharashtra (-5.48) were negative highly significant at 1% (P<0.01). The growth rate of average productivity of Bihar (-1.30%) was found that the negatively significant at 5% (P<0.05). The remaining all others key mango producing states of India, Gujarat (0.81%), Kerala (3.57%), Odisha (-1.17%), Tamil Nadu (-0.54%), Uttar Pradesh (3.89%) and West Bengal (0.27%) were revealed that the compound growth rate was not significant at 95% confidence interval.

The adjusted R^2 value of India was 0.23% and it is implies 23 percent variation in average productivity of mango. The R^2value was 0.76, 0.73, 0.39, 0.38, 0.27 and 0.16 percents for average productivity of major mango producing states respectively. This implies that the trend as variable account for Uttar Pradesh (76%), Kerala (73%), Andhra Pradesh (39%), Maharashtra (38%),Karnataka (38%) and Bihar (16%) of the variation perceived in prime mango producing states of India, correspondingly.

Table 3: State wise Average Productivity (in Mt/ha.) of Fresh mango during the period 1987-88 to 2014-15

		AP	Bihar	Gujarat	Karnataka	Kerala	Maharashtra	Odisha	T N	U P	W B	Others	India
Mean area (lakh ha.)		9.35	9.49	6.35	9.66	4.28	2.89	3.96	5.50	10.65	6.89	5.50	6.92
S.D.		1.97	1.94	3.11	0.64	1.49	1.75	1.56	1.34	3.43	1.69	3.47	1.68
C.V.(%)		21.11	20.44	48.93	6.62	34.91	60.49	39.33	24.44	32.19	24.60	63.07	24.36
CAGR		-1.91*	-1.30**	0.81^{NS}	0.50*	3.57^{NS}	-5.48*	-1.17^{NS}	-0.54^{NS}	3.89^{NS}	0.27^{NS}	-0.79^{NS}	-0.96*
Multi. R^2		0.64	0.44	0.10	0.55	0.86	0.64	0.17	0.11	0.88	0.07	0.16	0.51
R^2		0.41	0.19	0.01	0.30	0.75	0.40	0.03	0.01	0.77	0.00	0.03	0.26
Adj.R^2		0.39	0.16	-0.04	0.27	0.73	0.38	-0.01	-0.03	0.76	-0.04	-0.02	0.23
SE		0.17	0.20	0.52	0.06	0.15	0.52	0.50	0.35	0.16	0.31	0.35	0.12
P value		0.001	0.029	0.649	0.005	7.347	0.001	0.405	0.584	7.001	0.753	0.455	0.010
95% Confidence Interval	Lower	-0.029	-0.025	-0.028	0.002	0.026	-0.086	-0.041	-0.026	0.029	-0.015	-0.029	-0.017
	Upper	-0.009	-0.001	0.045	0.008	0.044	-0.027	0.017	0.015	0.047	0.020	0.014	-0.002

Source: Horticulture at a Glance, 2014-15, Ministry of Agriculture and Farmer's Welfare, Govt. of India.

Note: Figures in parentheses represent percent of the total.* denotes significant at 1% level of significant (P<0.01), **denotes significant at 5% level of significant (P<0.05), ***denotes significant at 10% level of significant (P<0.1), NS denotes Non Significant S.D. denotes standard deviation, C.V. coefficient of variation, CAGR denotes compound annual growth rate, R^2 coefficient of determination.

CONCLUSIONS

According to the finding of this study, it was concluded that average area, production and productivity of mango in India were 17.73 lakh hectares,12.05 million tonnes and 6.92 tonnesper hectare respectively. Under top ten states of mango cultivation in India, Andhra Pradesh (19.35%) occupied first position in area and contributing to total production slightly greater than one fourth (25.39%) of the country. The Uttar Pradesh occupied second position in area (15.12%) and production (23.46%), while the in terms of average productivity of mango (10.65 Mt ha.$^{-1}$) it is greater than that of the average productivity of Andhra Pradesh9.35 million tons/ha. Nevertheless, Maharashtra stands third position by contributing 14.55% of mango production of the country next only to Andhra Pradesh and Uttar Pradesh. In spite of this, productivity of mango was plenty of low, which was only 2.89 million tons/ha. The compound annual growth rate of area and production of mango in India were 3.78, 3.00 percents per annum respectively and statistically positive, highly significant at 1% ($P<0.01$), while average productivity was -0.96statistical negatively significant. This implies that a relatively sluggish growth rate in area, production and negative growth rate for productivity of mango during the corresponding period (1987-88 to 2014-15) was observed. This negative growth in productivity of mango may be due to adoption of poor cultivation management practices, method and system of orcharding by cultivators. The standard deviation in average area was 4.77 lakh hectares and average production was 3.71 lakh metric tons and the variability in area and production was 26.89, 31.23 percents, respectively during same period of time. The standard deviation and variability of mango in productivity were 1.68, 24.36 metrictons per hectare.

Suggestions

The total area and production of mango in India has accelerated annually. The overall productivity of mango is reveled to be decreasing annually. Thus there is a need to take productivity enhancing measures in mango cultivation like adoption of high density planting technique, appropriate orcharding system, provide the facility of modern infrastructure services, enhanced the level technical awareness of growers about the cultivation of mango to tackle the natural calamity and disease attack with respect to fruit protection.

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