An Analysis on Performance of Mango Production in India

Abstract

Horticulture has become major role in Indian agriculture as it contributes 33 per cent towards Gross Value Added (GVA) of agriculture by enhancing farmers' income and providing rural employment which is a pathway for rural development. Fruits and vegetable crops share major production (nearly 90%) of horticulture in India. Among fruits, Mango is the most important fruit crop in Indian Economy. India is the leader in mango production (20772 thousand MT) during 2021-22, which accounts for more than 40 per cent of global mango production. Hence, the present study analyses the production performance of mango in India based on secondary data from 1991-92 to 2021-22 for area, production and productivity of mango and of major mango producing states in India. The components like trend, growth rate and instability analysis were used in this study. The increasing trend and positive growth rate were noticed in area and production of mango in the nation as a whole which is a good sign. However, productivity had shown declining trend, negative growth rate and higher instability over the years which need to be addressed by high density planting, replacing old orchards having less productivity trees by high yielding mango varieties with high market demand and so on. Hence, there should be more focus on productivity to improve its growth rate and reduce instability which will eventually improve the mango production since area showed high positive growth rate and low instability. The study also identifies the states showing increasing trend, positive growth and low instability in area, production and productivity which is a good sign for mango cultivation. However, states showing declining trend, negative growth rate and high instability in above mentioned parameters which need to be focused and for which researchers deserve deeds.

Keywords: Mango, area, production, productivity, trend, growth and instability.

Introduction

Horticulture has become major role in Indian agriculture as it contributes 33 per cent towards Gross Value Added (GVA) of agriculture which is a major driver for Indian economy. By enhancing farmers' income and providing higher rural employment, horticulture is a major driver for rural development (MoA & FW, 2023). Fruits and vegetable crops share major production (nearly 90%) of horticulture in India. Among fruits, Mango is the most important fruit crop in

Indian Economy and is known as national fruit of India. Mango is considered as first trinity of fruits and also called as king of fruits in India. Globally India is the leader in mango production (20772 thousand MT) during 2021-22, since contributes more than 40 per cent of mango production. In India, combined Andhra Pradesh & Telangana contributes 28.37 per cent of total mango production during 2021-22, which is 5892.45 thousand MT, whereas the leading individual state in mango production is Uttar Pradesh (4662.45 thousand MT) which accounts for 22.45% of total Indian mango production, followed by Karnataka (1620.21 thousand MT i.e. 7.80%) (Indiastat, 2023). In India, positive and significant growth rate was observed in area and production of mango, whereas productivity showed significant negative growth (Chand 2008; Tirlapur *et al.* 2014). Higher instability and higher variation in mango production was seen in India (Bairwa *et al.* 2012; Kailash *et al.* 2012). The positive and significant growth was found in area, production and productivity of mango in India. Highest variation was observed in production. In case of area and production of states, highest growth rate was found in Odisha state, where as highest variation in same cases was observed in Maharashtra (Patil *et al.* 2018). Mango is mainly cultivated in tropical and sub-tropical regions of India. Different states grow different commercial varieties of mango in India. Some of the commercially grown varieties are Banganapalli, Alphonso, Neelum, Kesar, Subarnarekha, Bombay Green, Chausa, Dashehari and Totapari etc. Considering the importance of mango for Indian economy, the present study is an attempt to analyse its production performance in India.

Methodology:

Study area

India is taken for this study, since our country is the largest producer of mango in the world. In India, major mango producing states like Uttar Pradesh, Andhra Pradesh (including Telangana), Karnataka, Bihar, Gujarat, Tamil Nadu, Odisha, West Bengal, Kerala and Maharashtra are also taken into consideration.

Nature and source of data

The study is based on secondary data from 1991-92 to 2021-22 for area, production and productivity of mango in India. The data is collected from various authenticated sources like publications, reports, portals and websites such as National Horticulture Board (NHB), Indiastat portal, Agricultural and Processed Food Products Export Development Authority (APEDA).

Analytical tools

1. Trend analysis

The long-run linear trend in area, production and productivity of mango is assessed by using ordinary least square (OLS) method.

$$Y_t = a + bt + e \quad \ldots \quad (1)$$

where,

Y_t = Trend values at time t

t = Period in years

a = intercept parameter

b = slope parameter

e = Error

2. Compound Annual Growth Rate (CAGR)

The growth rate in area, production and productivity of mango is calculated by using following formula.

$$Y_t = Y_O(1+r)^t \quad \ldots \quad (2)$$

Take log both side and transform to logarithmic form

$$\ln Y_t = \ln Y_O + t\ln(1+r) \quad \ldots \quad (3)$$

where,

Y_t= Variable for which growth is calculated.

r = Compound growth rate.

Ln= Natural logarithm.

Take, $\ln Y_0 = \beta_1$ and $\ln(1+r) = \beta_2$

Then, equation (3) becomes,

$$\ln Y_t = \beta_1 + \beta_2 t \quad \ldots \quad (4)$$

By using OLS method, β_1 and β_2 are estimated in the above equation and the CAGR is represented in percentage (Gujarati, 2003).

$$r = (anti \log \beta_2 - 1) \times 100$$

3. Instability (Cuddy-Della Valle Index)

The instability in area, production and productivity of mango is estimated by the Cuddy-Della Valle Index (Cuddy & Valle 1978), which facilitates to know the variability and risk in those variables.

$$\text{Cuddy-Della Valle Instability Index (\%)} = CV \times \sqrt{(1 - \bar{R}^2)} \quad \ldots \quad (5)$$

where,

CV= Coefficient of variation in per cent= (Standard Deviation/Mean) x 100

R^2 = Coefficient of determination from a time trend regression adjusted to its degrees of freedom.

Results and Discussion

Trend, growth and instability in area, production and productivity of mango in India

Figure 1 represents the trends in area, production and productivity of Indian mangoes based on secondary data from 1991-92 to 2021-22. The figure shows that area and production had almost doubled over the years. The increasing trend was noticed in both the cases, but area decreased in last few years. However productivity had decreased in the beginning and later it increased.

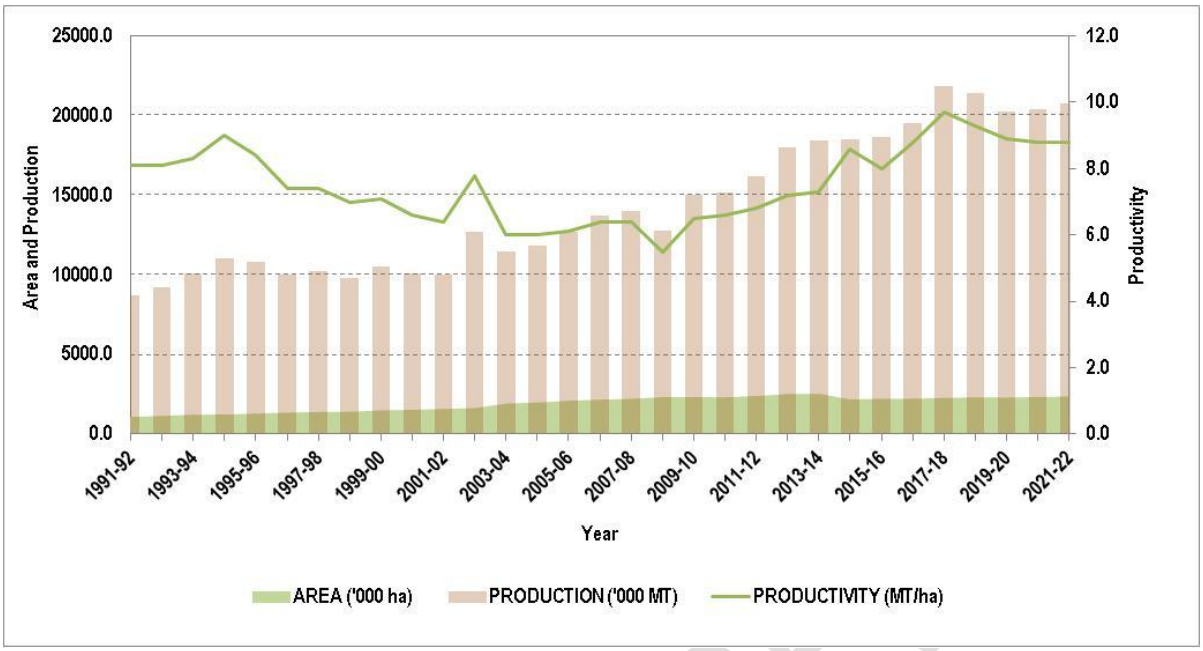

Figure 1 Trends in area, production and productivity of mango in India (1991-92 to 2021-22)

Table 1: Trend, growth and instability in area, production and productivity of mango in India (1991-92 to 2021-22)

Particulars	**Area**	**Production**	**Productivity**
Intercept	1148316.13	7132230.97	7.00
Slope	47162.90***	448943.83***	0.03^{NS}
R^2	0.84	0.91	0.07
CAGR (%)	2.75	3.18	0.40
CV (%)	24.65	29.82	15.12
Cuddy-Della Valle index (%)	9.99	8.72	14.59

*** indicates significant at 1 per cent level.
NS indicates Not Significant.

Table 1 shows trend, growth and instability analysis in area, production and productivity of mango in India as a whole from 1991-92 to 2021-22. The linear trend was estimated to determine the long-run movement in area, production and productivity of mango in India over the years. The table reveals that, in the long-run, there was increasing trend of mango in area and production due to their 1 per cent significant positive slopes i.e. 47162.90 and 448943.83, respectively, but almost stagnant trend in productivity because of its non-significant slope i.e.

0.03. These show that annual increase in area and production of Indian mangoes were found to be 47162.90 ha and 448943.83 MT, respectively, while productivity was almost stagnant at 0.03 MT per annum. Area and production had R^2 values of 0.84 and 0.91, respectively, which states that change in area (84%) and production (91%) were due to the influence of independent variable i.e. time, while productivity was found to be low R^2 value of 0.07 indicates that independent variable (time) is not explaining the variations efficiently in productivity. It could also be noted from table that area, production and productivity have intercepts of 1148316.13 ha, 7132230.97 MT and 7.00 MT, respectively.

Compound annual growth rate (CAGR) was analysed to represent the percentage increase or decrease in selected indicators. The positive growth rate was observed in production (3.18%), followed by area (2.75%) and productivity (0.40%). Sendhil e*t al.* (2012) stated that when there is no-time trend series, the extent of risk in variables can be examined using the coefficient of variation (CV). However, when time trend series is present, Cuddy-Della Valle instability index is more suitable measure for examining the extent of risk in those variables. From the Table 1, it could be noted that highest variation was found in production (29.82%), followed by area (24.65%) and productivity (15.12%). However Gini index, a measure of inequality stated that more risk in productivity (14.59%) followed by area (9.99%) and production (8.72%) which need to be addressed.

Over the years, increase in area of mangoes in India may be due to increase in economic importance of the crop triggered by high demand in domestic and international markets. Likewise, increase in mango production may be due to Agri Export Zones created by Government and establishment of cooperatives in major mango producing states. However, almost stagnant productivity may be due to low density planting, old orchards having less productivity trees, poor mango yielding varieties, pests and diseases, physiological disorder, reduction of water table, climate problems and so on for which researchers deserve deeds (Trivedi 2012; Singh *et al.* 2018).

Trend, growth and instability of mango area across different states in India

The trend, growth and instability of area under mango cultivation across different states in India during the period 1991-92 to 2021-22 are shown in the Table 2. The increasing trend of area

under mango was observed in all the states except Kerala (Table 2 and Figure 2). The highest annual increase in area under mango was found in Andhra Pradesh (including Telangana) (10830.47 ha per year), followed by Maharashtra (6330.33 ha per year), Odisha (5844.78 ha per year) and Gujarat (5155.10 ha per year), while lowest annual increase in mango area was observed in Bihar (255.92 ha per year), followed by Uttar Pradesh (645.82 ha per year), whereas annual decrease in area was seen in Kerala (292.02 ha per year) which is showing insignificant trend in mango area. Except Bihar, all other states have 1% significance in long-run trend in mango area, whereas Bihar has 10% significance in long-run trend. The highest R^2 value was observed in Gujarat (0.98) which states that 98 per cent the change in area was explained by independent variable (time). Likewise, R^2 values in West Bengal (0.97), Odisha (0.95), Karnataka (0.88), Andhra Pradesh (0.85) and Tamil Nadu (0.82) were explained. However, low R^2 value was observed in Kerala (0.09), followed by Maharashtra (0.12), Bihar (0.12) and Uttar Pradesh (0.32), which reveals that independent variable (time) is not influencing the change in area efficiently.

The highest positive annual growth in area was found in Gujarat (5.94%), followed by Odisha (4.77%) and Maharashtra (4.28%). The increase in area of Odisha may be due to switching of paddy fields into mango orchards over the years due to higher profitability of mango crop. The increase in Maharashtra may be because of increase in demand of Alphonso varieties in international market which leads to Maharashtra farmers to enlarge their area of mango cultivation (Trivedi, 2012).The negative growth of 0.42 per cent was noticed in Kerala, while lowest positive growth was observed in Bihar (0.17%), followed by Uttar Pradesh (0.25%) due to their low value of coefficient of determination. The highest variation in area was found in Maharashtra (68.40%) followed by Gujarat (46.43%) and Odisha (38.32%), while lowest was noticed in Uttar Pradesh (3.98%), followed by Bihar (4.45%). However, highest instability value was in Maharashtra (64.22%), followed by Kerala (11.35%) and Tamil Nadu (11.19%), while least was observed in Uttar Pradesh (3.29%), followed by Bihar (4.16%) and West Bengal (4.25%).

Trend, growth and instability of mango production across different states in India

Table 3 shows trend, growth and instability of mango production across different states in India. Except Bihar, all other states show long-run increasing trend in mango production with 1 per

cent significant (Table 3 and Figure 3). The annual increase in mango production was highest in Uttar Pradesh (115009.94 MT per year) during the study period with R^2 value of 0.84 i.e. independent variable (time) influences the change in production by 84 per cent. The mango production in Andhra Pradesh, Gujarat, Karnataka and Tamil Nadu was observed to increase in long-run by 110117.82, 36227.39, 35191.90 and 20954.64 MT per year, respectively, with R^2 values of 0.73, 0.77, 0.80, and 0.51, respectively. The least positive annual trend in mango production was found in Kerala (8136.06 MT), followed by Maharashtra (11724.38 MT) and Odisha (18668.23 MT). Bihar showed declining trend in mango production (-2985.32 MT per year) with lowest R^2 value of 0.01 which reveals that only 1 per cent of the change in production was explained by independent variable (time).

The highest positive annual growth rate was found in Gujarat (5.55%) followed by Uttar Pradesh (3.83%), Odisha (3.55%) and Tamil Nadu (3.37%). As said earlier, the increase in mango production may be due to Agri Export Zones by Government and establishment of cooperatives for mangoes in major mango producing states (Trivedi 2012). However Bihar had lowest negative growth rate of 0.17 per cent which needs to be addressed. The highest variation in production was observed in Gujarat (52.79%) followed by Maharashtra (42.90%) and West Bengal (39.47%), while least was found in Bihar (21.81%) and Kerala (25.94%). The more risk (instability value) in production was observed in Maharashtra (37.33%) followed by Tamil Nadu (27.06%) and Gujarat (25.43%), which needs to be minimized, while less risk was noticed in Karnataka (11.89%) and Uttar Pradesh (14.27%) which is a good sign for mango production.

Trend, growth and instability of mango productivity across different states in India

The trend, growth and instability of mango productivity across different states in India from 1991-92 to 2021-22 is represented in Table 4. Except Uttar Pradesh, Odisha, Kerala and Karnataka, all other states have insignificant long-run trend in mango productivity. The states like Uttar Pradesh (0.41 MT per year), Kerala (0.12 MT per year), West Bengal (0.04 MT per year), Karnataka (0.02 MT per year) and Tamil Nadu (0.009 MT) showed increasing trend, while declining trend was observed in Odisha (0.05 MT per year), Maharashtra (0.05 MT per year), Bihar (0.04 MT per year), Gujarat (0.03 MT per year) and Andhra Pradesh (0.02 MT per year) (Table 4 and Figure 4). Except Uttar Pradesh (0.82) and Kerala (0.72), all other states have less

R^2 values which reveals that independent variable (time) is not explaining the change in productivity efficiently.

It could be noted from the Table 4 that positive growth rates in mango productivity were seen in Uttar Pradesh (3.58%), Kerala (2.81%), West Bengal (0.83%), Tamil Nadu (0.33%) and Karnataka (0.24%). The states like Maharashtra, Odisha, Gujarat, Bihar and Andhra Pradesh registered negative growth rates of 1.28, 1.16, 0.37, 0.34 and 0.19 per cent, respectively, which needs action. As mentioned in earlier sections, the various problems for decline in productivity of mangoes have to be addressed. The highest variation in productivity was observed in Maharashtra (54.88%) followed by Uttar Pradesh (33.74%) and Kerala (28.53%), while least variation was observed in Karnataka (6.53%) and Bihar (20.59%). The instability value was highest in Maharashtra (52.52%) followed by Tamil Nadu (27.09%) and West Bengal (25.76%) which needs to be minimized, while lowest was found in Karnataka (6.17%) and Uttar Pradesh (14.29%) which is a good sign for mango productivity.

Mango cultivation is a pathway for rural development

Fruits and vegetable crops share major horticulture production in India. Mango is the most important fruit crop in Indian Economy, and is known as national fruit and king of fruits in India. Mango cultivation enhances farmers' income and provides employment in rural areas (GetFarms, 2023). High yielding varieties improves the yield of mangoes. Proper infrastructure facilities like storage facilities etc provide the farmers to keep their produce safely. Good quality mangoes are used for export to the international markets which provides good prices to the farmers which will eventually improve farmers' income. Mango processing units also gives income to the farmers by producing various processed items. In all the way, it provides employment to the rural people from planting, maintenance, harvesting, loading etc. In this way, mango cultivation is a pathway for rural development.

Table 2: Trend, growth and instability of mango area across different states in India (1991-92 to 2021-22)

Particulars	Andhra Pradesh	Bihar	Gujarat	Karnataka	Kerala	Maharashtra	Odisha	Tamil Nadu	Uttar Pradesh	West Bengal
Intercept	222839.28	144291.09	19589.26	85342.12	80963.00	143276.83	48856.70	70554.81	250425.91	44666.32
Slope	10830.47***	255.92*	5155.10***	3411.95***	-292.02^{NS}	6330.33*	5844.78***	3213.68***	645.82***	2123.76***
R^2	0.85	0.12	0.98	0.88	0.09	0.12	0.95	0.82	0.32	0.97
CAGR (%)	3.05	0.17	5.94	2.60	-0.42	4.28	4.77	3.04	0.25	2.77
CV (%)	26.96	4.45	46.43	23.64	11.87	68.40	38.32	26.44	3.98	24.92
Cuddy-Della Valle Index (%)	10.42	4.16	6.85	8.22	11.35	64.22	8.67	11.19	3.29	4.25

*** and * indicate significant at 1 and 10 per cent level, respectively.
NS indicates Not Significant.

Table 3: Trend, growth and instability of mango production across different states in India (1991-92 to 2021-22)

Particulars	Andhra Pradesh	Bihar	Gujarat	Karnataka	Kerala	Maharashtra	Odisha	Tamil Nadu	Uttar Pradesh	West Bengal
Intercept	1962178.04	1534444.54	132377.60	786520.59	217872.04	316278.95	228884.76	353210.61	1341444.21	249407.36
Slope	110117.82***	-2985.32 ^{NS}	36227.39***	35191.90***	8136.06***	11724.38***	18668.23***	20954.64***	115009.94***	19061.93***
R^2	0.73	0.01	0.77	0.80	0.67	0.24	0.73	0.51	0.84	0.63
CAGR (%)	2.86	-0.17	5.55	2.84	2.38	2.96	3.55	3.37	3.83	3.62
CV (%)	31.46	21.81	52.79	26.53	25.94	42.90	37.66	38.71	35.83	39.47
Cuddy-Della Valle Index (%)	16.33	21.73	25.43	11.89	14.86	37.33	19.57	27.06	14.27	24.10

*** indicates significant at 1 per cent level.
NS indicates Not Significant.

Table 4: Trend, growth and instability of mango productivity across different states in India (1991-92 to 2021-22)

Particulars	Andhra Pradesh	Bihar	Gujarat	Karnataka	Kerala	Maharashtra	Odisha	Tamil Nadu	Uttar Pradesh	West Bengal
Intercept	9.94	10.58	7.65	9.22	2.66	3.62	4.68	5.53	5.60	6.29
Slope	-0.02 ^{NS}	-0.04 ^{NS}	-0.03 ^{NS}	0.02*	0.12***	-0.05 ^{NS}	-0.05***	0.009 ^{NS}	0.41***	0.04 ^{NS}
R^2	0.01	0.03	0.03	0.11	0.72	0.08	0.27	0.00	0.82	0.04
CAGR (%)	-0.19	-0.34	-0.37	0.24	2.81	-1.28	-1.16	0.33	3.58	0.83
CV (%)	21.08	20.59	24.73	6.53	28.53	54.88	22.85	27.13	33.74	26.34
Cuddy-Della Valle Index (%)	20.97	20.33	24.32	6.17	14.96	52.52	19.53	27.09	14.29	25.76

*** and * indicate significant at 1 and 10 per cent level, respectively.
NS indicates Not Significant.

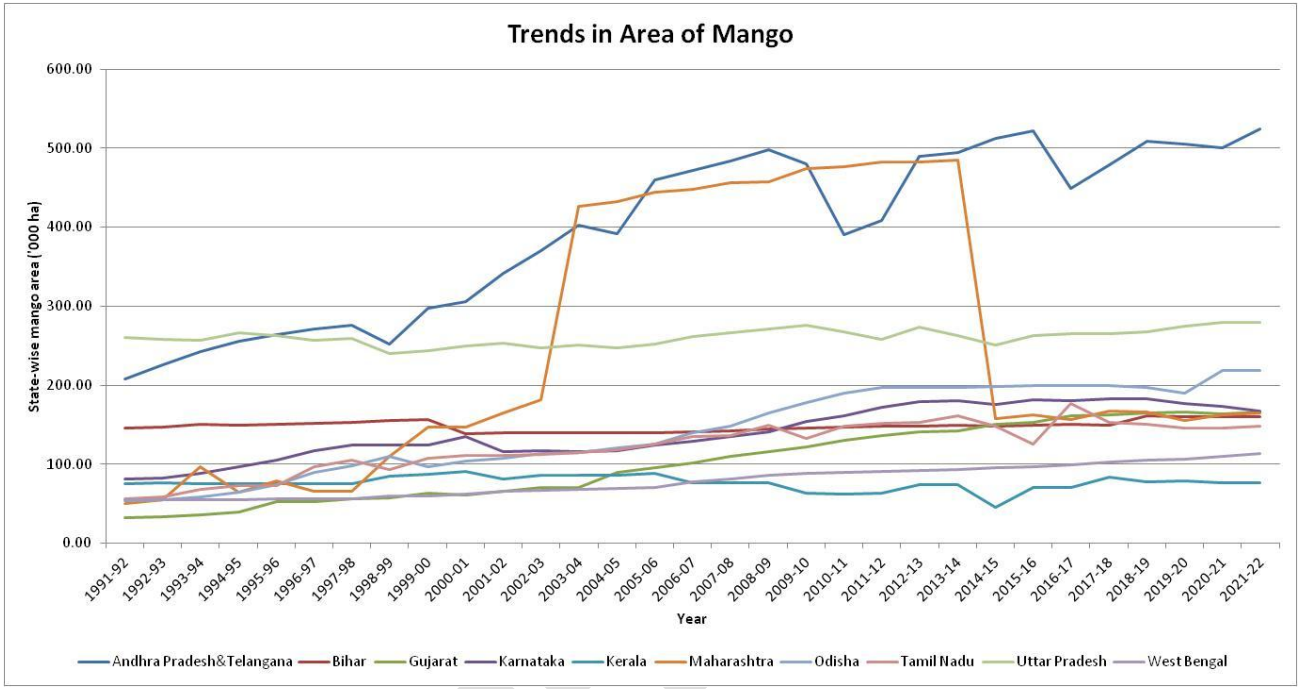

Figure 2 Trends in area of mango across different states in India (1991-92 to 2021-22)

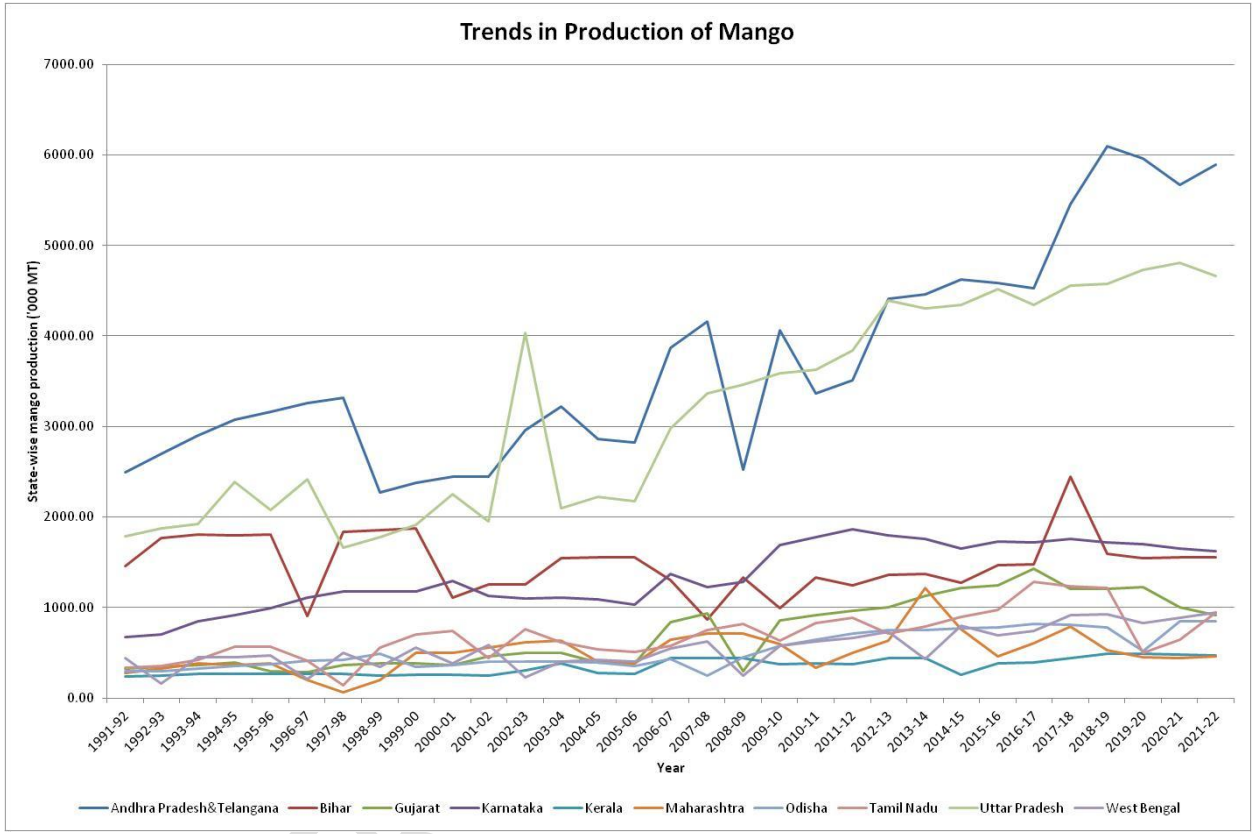

Figure 3 Trends in production of mango across different states in India (1991-92 to 2021-22)

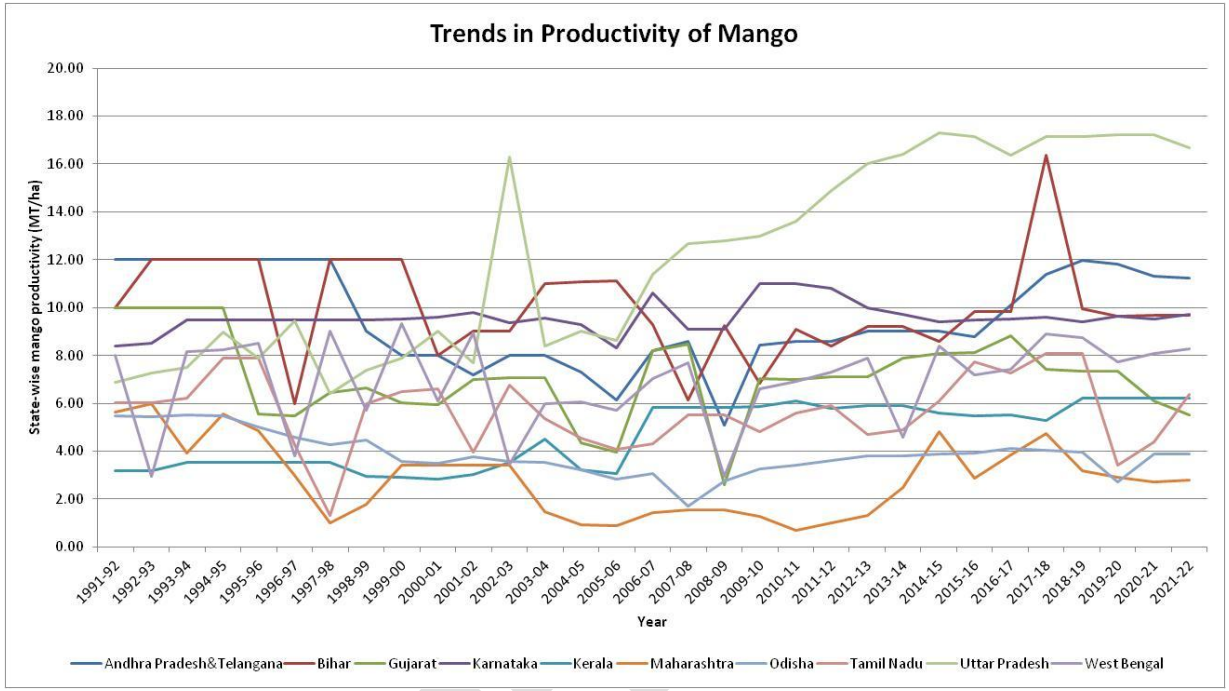

Figure 4 Trends in productivity of mango across different states in India (1991-92 to 2021-22)

Conclusions:

Mango is the most important fruit crop in Indian economy. India is the leading mango producing country in the world and contributes more than 40 per cent of global mango production. The present study is an attempt to analyse the production performance of mango in India. The increasing trend and positive growth rate were noticed in area and production of mango in India as a whole which is a good sign. However, declining trend, negative growth rate and higher instability in productivity over the years should be matter of concern. Development like high density planting in mango cultivating areas, replacing old orchards having less productivity trees by high yielding mango varieties with high market demand, control of pests and diseases, solving physiological disorder, improving water table, solving of climate problems can be implemented to improve productivity. Proper infrastructure facilities like storage facilities, processing units lead to good quality mangoes for export which enhance farmers' income. Hence, there should be more focus on productivity to improve its growth rate and reduce instability which will eventually improve the mango production since area showed high positive growth rate and low instability. Likewise, states whichever showed increasing trend, positive growth rate and low instability in area, production and productivity are favorable for mango cultivation. However, states having declining trend, negative growth rate and high instability in area, production and productivity need to be concerned and for which researchers deserve deeds.

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