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Growth and Instability Performance of Banana Production in India

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Abstract

India is the largest producer of banana in the world producing about 26 per cent of global production. Gujarat, Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka, M.P. Bihar are major banana producing states covering about 75 per cent of production in India. The present study analysed the state wise annual compound growth rate and instability index of banana production in India. The investigation was based on secondary data for the period 1990- 2017. Compound annual growth rate (CAGR) and Instability Index (II) techniques were used to analyse the data. The analysis showed that CAGR of banana production was 5.22 per cent significant at one per cent level in India. The growth in production was due to high growth in area (3.53%) than yield (1.64%). The instability index of banana production was high at 35.35 per cent due to higher instability in area than yield. State wise high variability in growth rates of production and instability in banana production was observed. The states with low growth rate and more instability in banana production needs special attention of policy makers.

Keywords: Banana, Area, Production, Productivity, Growth, Instability

JEL Classification: Q17, R11, O53

Introduction

In India the horticulture sector is one of the most successful sector in agriculture, which provides enough job and opportunities for growers to raise their profits. Horticulture crops occupy an important position in terms of providing more employment, high income, mitigating to some extent the excess demand for cereals and contributing to food and nutritional security (Kondal, 2014).

The fruits are important items in everyday meals, and also have medicinal and aesthetic value. The fruits are considered good to keep the heart healthy and lowering the chances of heart diseases when used regularly and is recommended for patients suffering from high blood pressure, arthritis, ulcer, gastroenteritis and kidney disorders (Arora and Dhawan, 2017). India is the second largest producer of fruits in the world after China with production of 88.98 million tonnes from an area of 7.22 million hectares and contributes 9.78 per cent to the world fruit production during 2018-19 (GoI). Banana is the second major produced fruit after citrus in India. It is grown by small- and large-scale producers, and is produced in more than 130 countries (Dastagiri *et al* 2013). The major producing countries of banana include India, China, Philippines, Brazil and Ecuador which contributed 57 per cent of world banana production in 2015 – 2019, up from 48 per cent registered in the year 2000-04. Banana is the fifth largest agricultural commodity in the global trade after cereals, sugarcane, coffee, and cocoa (Biswas and Kumar, 2010). India, Ecuador, Brazil and China alone produce half of total bananas of the world. The advantage of this fruit is its availability round the year.

India is the largest producer of banana with 30.02 million tonnes from an area of 0.88 million hectares in 2015–2019. The leading banana producing states in India are Gujarat 14.56 per cent, Tamil Nadu 14.28 per cent, Andhra Pradesh 13.39 per cent, Maharashtra 13.07 per cent, Karnataka 8.25 per cent, Madhya Pradesh 6.06 per cent and Bihar 5.09 per cent in 2015-16 to 2017-18. An analysis of instability or fluctuations

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in fruits production is of paramount importance for country's food security and income stability. Instability in production depends upon the nature of production technology, sensitivity to weather, availability of inputs, etc. It is contended that rapid technological changes in agriculture has increased variability in production (Goyal *et al*, 2020). Keeping the above facts in considerations the present study analysed the growth and instability in banana production in major banana producing states of India.

Data Sources and Methodology

The major seven banana producing states were considered for the analysis namely; Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra and Tamil Nadu which encompassed more than 75 per cent of production of banana in India. The investigation was based on secondary time series data. Various sources were explored to collect the required data set to achieve the objective of the research investigation. The data was obtained for the period 1990-2017 or till the latest data was available. The data on area, production and yield of banana for the selected states were collected from Agriculture and Farmers Welfare, Government of India, Ministry Commerce and Industry, Government of India Food and Agriculture Organization (FAO) of the United Nation.

Analytical techniques applied

Compound annual growth rate and Cuddy Della and Valle Index was used to analyse the data.

Compound annual growth rate

Any economic variable's growth indicates its previous performance. The exponential function was used to estimate compound growth rates. The regression equation to estimate growth rates were as follows:

$$Y=ab^t$$

Taking logarithms on both sides

$$\log Y= \log a+ t \log b$$

Where,

Y= Area/ productivity/ production/ of banana from India / States

a & b= parameters to be estimated

t= time period

Then compound annual growth rate was worked out by using following formula:

CAGR= [Antilog (log b) – 1] * 100

The student's *t* test was applied to test the significance of the estimated compound annual growth rates.

Instability Index

Degree of variability in area, production and productivity of banana was estimated using instability index given by Cuddy-Della Valle (1978) which is used as the tool to estimate variability in time series data. Whereas coefficient of variation (CV) over estimates the variability in time series data due to presence of trend. The Cuddy-Della Valle corrects this trend and more reliable method than simple coefficient of variation. The following formula was used to calculate the extent of variability around the trend.

$$\text{Cuddy Della Index (\%)} = \text{C.V} \times \sqrt{(1-\overline{\text{R}})^2}$$

$$\text{Coefficient of variation (CV)} = \frac{\sigma}{\bar{x}} \times 100$$

Where:

σ=Standard deviation

$$\sigma = \sqrt{\frac{\sum(\times - \overline{\times})^2}{n}}$$

$\overline{X}$= Arithmetic mean

X = Variable

n = Number of observations

Where:

C.V = Coefficient of variation (%)

$\overline{R}^2$ = Coefficient of determination obtained from a time trend regression adjusted for its degree of freedom.

Cuddy Della Index indicates the real direction of the instability, and is better measure to find out the instability in agricultural production and prices. A low value of this index shows low instability in production and prices (Kumar *et al,* 2013).

Results and Discussion

Bananas are predominantly produced in Asia, Latin America and Africa. The world production of banana during 2000-04 was 78.66 million tonnes which almost doubled to 116.24 million tonnes in 2015-19 (Table 1). While, India's production of banana during 2000-

04 was 14.23 million tonnes. It has increased more than double during the period 2000-04 to 2015-19. The banana production in India for the years 2015-19 was 30.02 million tonnes. India is the largest producer of banana with contribution of around 26 per cent production in the total world production. It was followed by China (9.84%), Philippines (5.15%), Brazil (5.78%) and Ecuador (5.69%) which were the next top banana producing countries in the world. They cumulatively contribute to more than 50 per cent of the world banana production.

Banana production in India in global context

Banana is the most used staple fruit crops in India after mango. For the years 1990-94, average banana production in India was 10.10 million tonne which was about 17.80 per cent of the total world banana production (Table 2). Average banana production for the year 1995-99, 2000-04 and 2005-09, 2010-14 was 13.38, 14.23 22.50 and 28.73 million tonnes, respectively. The share of India in total world banana production increased to around 22 per cent for these years. The average production for the years 2015-19 increased to 30.02 million tonnes and the share in total world production increased to 26.01 per cent."

Trends in area, production and yield of banana in India

Area, production and yield of banana in India for the period 1990-91 to 2017-18 have been presented in Fig. 1. There was an upward trend observed in area, production and productivity. Banana has been a tropical crop which naturally thrives in tropical conditions but its cultivation in arid area has been started successful in recent times

Table 1. Country-wise banana production in the world, 2000-2019

(million tonne)

Country	2000-04	2005-09	2010-14	2015-19
India	14.23	22.50	28.73	30.02
	(18.14)	(22.40)	(22.12)	(26.01)
China	5.75	7.77	11.37	11.44
	(7.32)	(7.67)	(9.97)	(9.84)
Philippines	5.25	7.66	8.37	5.98
	(6.68)	(7.55)	(7.34)	(5.15)
Brazil	6.38	6.91	7.01	6.72
	(8.11)	(6.81)	(6.14)	(5.78)
Ecuador	5.95	6.52	7.02	6.62
	(7.56)	(6.43)	(6.16)	(5.69)
Others	40.87	49.25	51.89	55.45
	(51.96)	(48.58)	(45.49)	(47.71)
World	78.66	101.38	114.07	116.24
	(100.00)	(100.00)	(100.00)	(100.00)

Note: Figures in parentheses are percentage to the world production for respective time period.
Source: Food and Agriculture Organization (FAO)

Table 2. Production of banana in India, 1990-2019

(Million tonne)

Year	India	Total world	Share (%)
1990 -94	10.10	56.73	17.80
1995-99	13.38	66.32	20.17
2000-04	14.23	78.66	18.14
2005-09	22.50	101.38	22.4
2010-14	28.73	114.07	22.12
2015-19	30.02	116.24	26.01

which has resulted in increase in area, production and productivity. Further, it can also be observed that there was year-wise fluctuation in area, production and productivity. The prevailing temperatures in area widely influence the rate of appearance of new leaves which influence yield of banana. Also, the crop is also more sensitive to waterlogging (Chadha *et al*, 2019) and the life span of banana plant is short (about 6 years). "Storms and winds (velocity of 40 to 60 km/hr) can cause damage to leaves and crown while the wind velocity of 95 km/hr cause complete destruction of banana plantation (Chadha *et al*, 2019). All these factors cumulatively contribute to the fluctuation observed in the area, production and productivity.

CAGR in area, production and yield of banana

The Compound Annual Growth Rate (CAGR) of area, production and yield of banana in India has been presented in Table 3 for the period 1990 to 2017. The growth rate was specified for decadal periods and the overall period. CAGR for area, production and productivity for the overall period 1990-2017 was found to be 3.53, 5.22 and 1.64 per cent respectively, significant at one per cent level. During the first period (1990- 1999), the CAGR of area, production and yield of banana in India was 1.89 per cent, 7.74 per cent, and 5.75 per cent. The growth in area, production and productivity was the highest in the period 2000-2009. The CAGR in this period for area, production and productivity was 5.48, 8.36 and 2.73 per cent, respectively. Thereafter, in the period 2000-2009 there was no significant increase in production and productivity but area under banana cultivation increased significantly (CAGR 3.31%).

Instability Index of area, production and yield of banana

The instability index of area, production and yield for banana in India has been presented in table 4. The analysis has been conducted for the time period 1990-2017. Mean area under banana cultivation in India was 567.45 thousand hectares with standard deviation

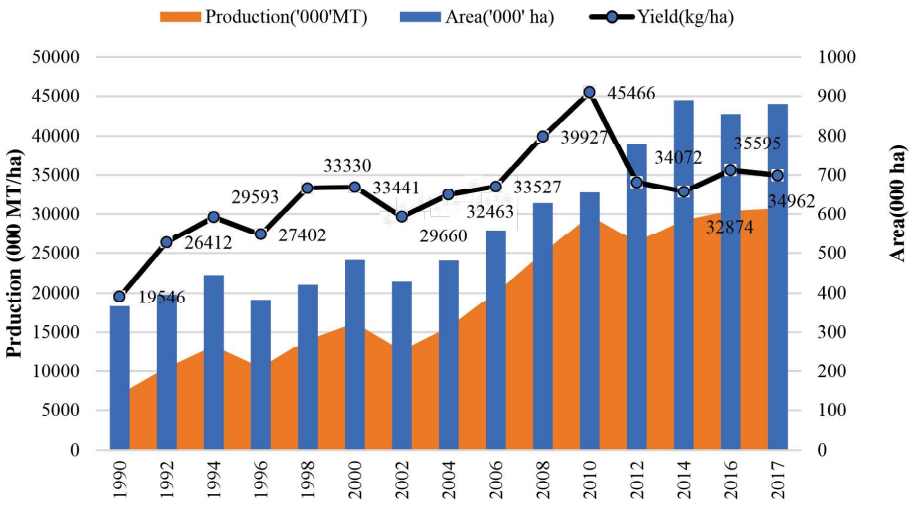

Figure 1: Area, Production and Yield of banana in India, 1990-2017

Table 3. CAGR in area, production and yield of banana in India, 1990 -2017

Periods	Area	Production	Yield
1990 to 1999	1.89** (0.03)	7.74***(0.00)	5.75*** (0.00)
2000 to 2009	5.48*** (0.00)	8.36***(0.00)	2.73*** (0.00)
2010 to 2017	3.31*** (0.01)	0.99 (0.17)	-2.24 (0.14)
Overall (1990 to 2017)	3.53*** (0.00)	5.22*** (0.00)	1.64*** (0.00)

Note : Area in thousand hectare; Production in thousand tonnes and; Yield in tonne per hectare
*Figures in parentheses depicted P-value of respective values. *** and **, denotes significant at 1, and 10 per cent level of significance, respectively, ns denotes non-significant results.*

of 178.47. The coefficient of variation and instability index was 31.45 and 5.85 per cent, respectively. The time period was divided into three sub-periods i.e., 1990-1999, 2000-2009 and 2010-2017. The average area for these periods was 414.30, 525.30 and 811.57 thousand hectares respectively. The coefficient of variation was found to be the highest for the time period 2000-2009. It was 9.20 per cent during 2010-2017 and 8.67 per cent during 1990-1999. The instability index was 5.47, 10.55 and 7.11 per cent between 1990-1999, 2000-2009 and 2010-2017, respectively. The overall mean production between 1990-2017 was 19112.39 thousand tonnes with standard deviation 7910.09 and coefficient of variation 41.39 per cent. The instability index for production of banana cultivation between 1990-2017 was found to be 35.35 per cent. For different time periods i.e., 1990-1999, 2000-2009 and 2010-2017, the mean production was found to be 117338.40, 18384.20 and 29240.12 thousand tonnes, respectively with standard deviation of 2890.88, 5078.97 and 1330.70, respectively and coefficient of variation 24.62. 27.63 and 4.55, respectively. The instability index of production for these time periods was 6.94, 16.82 and 4.49, respectively. Average productivity of banana crop in India for the time period 1990-2017 was 32.71 million tonnes per hectare with standard deviation of 5.46 and coefficient of variation of 16.69. The instability index was found to be 14.26. The mean productivity for 1990-1999, 2000-2009 and 2010-2017 was 28.03, 34.51 and 36.30 million tonnes per hectare, respectively. The coefficient of variation was found to be highest for the time period 1990-1999 i.e., 17.55. It was 10.83 and 11.73 between 2000-2009 and 2010-2017, respectively. The instability index was 3.40, 9.13 and 10.73 between 1990-1999, 2000-2009 and 2010-2017, respectively. Overall the high instability in banana production was due to both area and yield.

State-wise production of banana in India

"Banana crop is extensively grown in India and has great socio-economic as well as religious importance. Banana is the fourth food ingredient in terms of gross value exceeded only by rice, wheat and milk product (Biswas and Kumar, 2010). In India for the years 2015-16 to 2017-18, banana occupied 13.6 per cent of area under total fruit crops (304.8 lakh ha out of 973.58 lakh ha) and shared about 26.01 per cent total fruit production of the country. The information of the state wise production of banana has been presented in table 5 also see figures 2 to 8. The major banana producing states are Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Madhya Pradesh and Bihar with around 75 per cent production of the country. During the period of study, the production of banana has increased

Table 4. Instability in area, production, and yield of banana in India, 1990 -2017

Particulars	Mean	Standard Deviation	CV (%)	Instability Index
Area				
1990 to 1999	414.30	35.92	8.67	5.47
2000 to 2009	525.30	94.47	17.98	10.55
2010 to 2017	811.57	74.66	9.20	7.11
Overall (1990 to 2017)	567.45	178.47	31.45	15.85
Production				
1990 to 1999	117338.40	2890.88	24.62	6.94
2000 to 2009	18384.20	5078.97	27.63	16.82
2010 to 2017	29240.12	1330.70	4.55	4.49
Overall (1990 to 2017)	19112.39	7910.09	41.39	35.35
Yield				
1990 to 1999	28.03	4.92	17.55	3.40
2000 to 2009	34.51	3.74	10.83	9.13
2010 to 2017	36.30	3.90	11.73	10.73
Overall (1990 to 2017)	32.71	5.46	16.69	14.26

Note: Area in thousand hectare; Production in thousand tonnes and; Yield in tonne per hectare

about three folds. The average production of banana was 100.95 lakh tonnes during 1990-91 to 1994-95 which increased to 296.44 lakh tonnes among 2015-16 to 2017-18. Average banana production was the highest in Gujarat for the years 2015-16 to 2017-18. It was around 14.50 per cent of the total production of the country. It was followed by the Tamil Nadu (14.28%), Andhra Pradesh (13.39%), Maharashtra (13.07%), Karnataka (8.25%), Madhya Pradesh (6.06%) and Bihar (5.09%). There was lot of variation in production of banana over selected time span. For the years 2010-11 to 2014-15, the highest producer was Tamil Nadu (20.83%), followed by Gujarat (14.69%), Maharashtra (14.67%), Andhra Pradesh (10.84%) and Karnataka (8.66%). The main reason of fluctuation in banana production is that the average life of a banana tree is six years, therefore, the area under banana cultivation change overtime.

CAGR of banana among different states

Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Madhya Pradesh and Bihar are the major banana producing states occupying 488.62 thousand area and producing 22448.81 thousand tonnes of banana in India during 2017 -18. State wise analysis of growth and instability of area, production and yield of banana were discussed for these selected states.

The CAGR for area, production and yield of banana in the major states for the time period 1990-2017 have been presented in table 6. All the states depicted different growth pattern in production across different time periods. The CAGR of production varied between 7.95 to 2.30 per cent for the overall period of study (1990-2017). It was the highest in Andhra Pradesh (7.95%) followed by Bihar (7.76%) and closely followed by Gujarat (7.53%). The CAGR of area and yield was significant in all the state with different magnitude. In the second decade of 2000s the production of banana have either positive but non-significant or negative growth rate in all states except Andhra Pradesh and Madhya Pradesh. The production of banana increased at 17.32 per cent in Gujarat 2000-2009 with almost equal growth in area and production. Thus overall the pattern of growth in banana production depicted high growth scenario with difference in magnitude and period

Table 5. State-wise production of banana in India, 1990-91 to 2017-18

(lakh tonnes)

States	1990-91 to 1994-95	1995-96 to 1999-02	2000-01 to 2004-05	2005-06 to 2009-10	2010-11 to 2014-15	2015-16 to 2017-18
Gujarat	10.68 (10.58)	10.59 (7.91)	13.88 (9.76)	31.84 (14.12)	42.20 (14.69)	42.99 (14.50)
Tamil Nadu	23.34 (23.12)	38.43 (28.72)	34.91 (24.54)	54.86 (24.34)	59.84 (20.83)	42.34 (14.28)
Andhra Pradesh	7.43 (7.36)	8.60 (6.43)	10.96 (7.70)	23.91 (10.61)	31.14 (10.84)	39.70 (13.39)
Maharashtra	24.62 (24.39)	33.06 (24.70)	42.73 (30.04)	48.71 (21.61)	42.16 (14.67)	38.74 (13.07)
Karnataka	9.80 (9.71)	19.11 (14.28)	12.66 (8.90)	17.60 (7.81)	24.87 (8.66)	24.45 (8.25)
Madhya Pradesh	6.24 (6.18)	3.10 (2.32)	7.67 (5.39)	10.92 (4.84)	16.74 (5.83)	17.96 (6.06)
Bihar	3.57 (3.54)	5.53 (4.13)	5.78 (4.06)	12.44 (5.52)	15.54 (5.41)	15.10 (5.09)
Others	15.27 (15.13)	15.39 (11.50)	14.66 (10.31)	26.12 (11.59)	54.82 (19.08)	75.17 (25.36)
Total	100.95 (100.00)	133.82 (100.00)	142.26 (100.00)	225.42 (100.00)	287.31 (100.00)	296.44 (100.00)

Source: Ministry of Agriculture and Farmers' Welfare, Govt. of India
Note: Figures in parentheses are percentage to the total for respective time period.

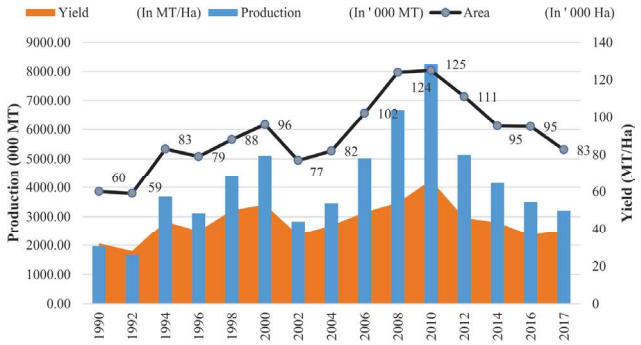

Figure 2. Area, production and yield of banana in Tamil Nadu, 1990 to 2017

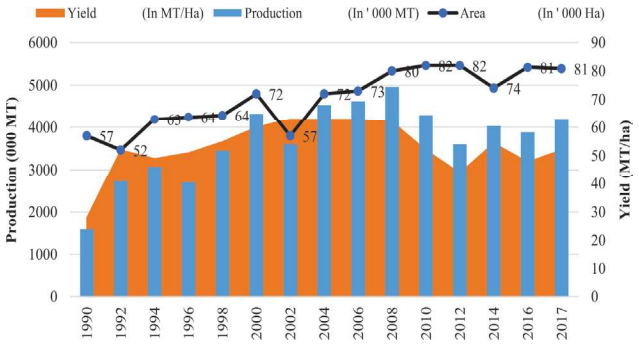

Figure 3. Area, production and yield of banana in Maharashtra, 1990-2017

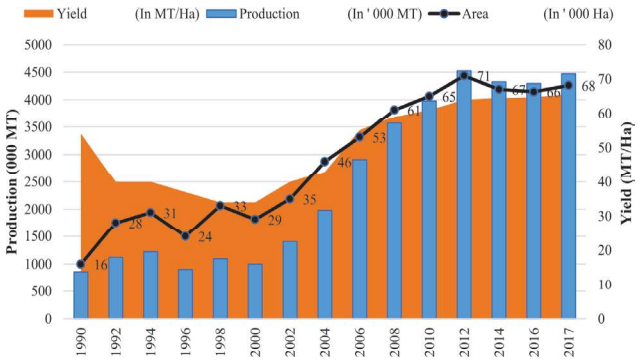

Figure 4. Area, production and yield of banana in Gujarat, 1990-2017

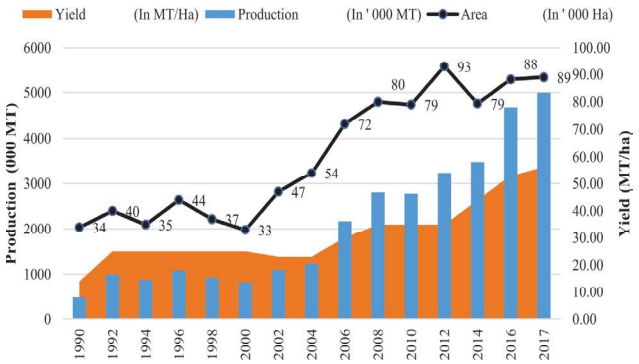

Figure 5. Area, production and yield of banana in Andhra Pardesh, 1990-2017

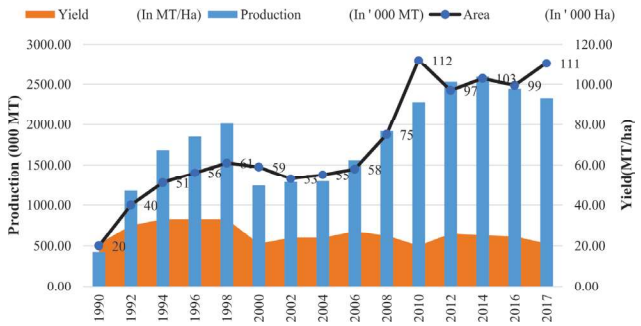

Figure 6. Area, production and yield of banana in Karnataka, 1990-2017

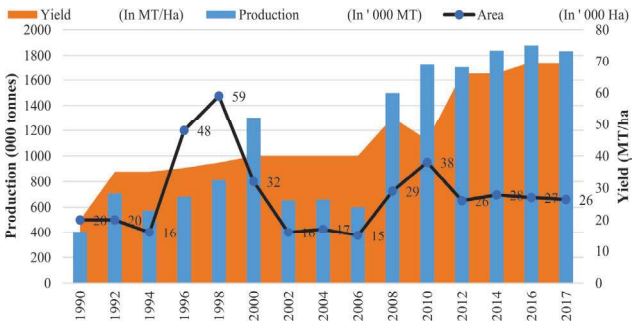

Figure 7. Area, production and yield of banana in MadhyaPradesh, 1990-2017

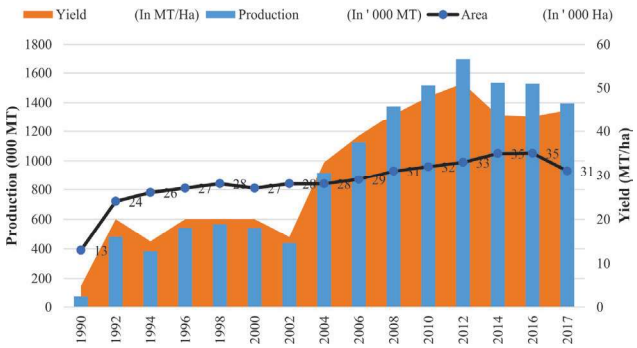

Figure 8. Area, production and yield of banana in Bihar, 1990-2017

Table 6. CGR in area, production and yield of banana in major states, India, 1990 -2017

(Percentage per annum)

Time periods	Area	Production	Yield
	Tamil Nadu		
1990 to 1999	5.21***(0.00)	12.15*** (0.00)	6.65*** (0.00)
2000 to 2009	4.58 ***(0.01)	6.52** (0.06)	1.92** (0.03)
2010 to 2017	-5.96*** (0.00)	-11.98*** (0.00)	-6.40 *** (0.00)
Overall 1990 to 2017	**1.88*** (0.00)**	**3.07***(0.00)**	**1.21*** (0.00)**
	Maharashtra		
1990 to 1999	1.38 (0.17)	8.19***(0.00)	6.71***(0.00)
2000 to 2009	3.26*** (0.00)	3.17*** (0.00)	0.18 (0.46)
2010 to 2017	-0.88 (0.40)	-1.63 (0.49)	-0.72 (0.68)
Overall 1990 to 2017	**1.49*** (0.00)**	**2.30***(0.00)**	**0.68 (0.12)**
	Gujarat		
1990 to 1999	5.33***(0.01)	1.29 (0.34)	-3.94*** (0.00)
2000 to 2009	9.50 *** (0.00)	17.32*** (0.00)	7.31 *** (0.00)
2010 to 2017	0.18 (0.75)	1.08 (0.13)	0.92*** (0.00)
Overall 1990 to 2017	**4.94*** (0.00)**	**7.53*** (0.00)**	**2.46 ***(0.00)**
	Andhra Pradesh		
1990 to 1999	2.38 **(0.02)	7.47**(0.02)	5.19** (0.02)
2000 to 2009	9.26***(0.00)	15.59***(0.00)	5.77***(0.00)
2010 to 2017	0.47 (0.71)	8.56***(0.00)	8.07***(0.00)
Overall 1990 to 2017	**4.27***(0.00)**	**7.95***(0.00)**	**3.52***(0.00)**
	Karnataka		
1990 to 1999	9.86***(0.00)	12.25***(0.00)	3.21***(0.00)
2000 to 2009	5.78***(0.01)	6.36***(0.00)	0.27 (0.75)
2010 to 2017	0.34 (0.80)	0.13 (0.91)	-0.14 (0.89)
Overall 1990 to 2017	**4.33***(0.00)**	**4.87***(0.00)**	**-1.09 *** (0.00)**
	Madhya Pradesh		
1990 to 1999	10.7**(0.06)	3.37 (0.23)	-6.62 (0.43)
2000 to 2009	1.82 (0.61)	4.66 (0.30)	3.00**(0.07)
2010 to 2017	-2.18 (0.28)	2.59** (0.07)	4.81**(0.02)
Overall 1990 to 2017	**0.58 (0.90)**	**4.78***(0.00)**	**3.17***(0.00)**
	Bihar		
1990 to 1999	5.99***(0.00)	15.44***(0.01)	9.37**(0.04)
2000 to 2009	1.90***(0.00)	15.40***(0.00)	13.42***(0.00)
2010 to 2017	0.53 (0.50)	-1.17 (0.23)	-1.70**(0.10)
Overall 1990 to 2017	**1.84***(0.00)**	**7.76***(0.00)**	**5.89***(0.00)**

*Note: Figure in parentheses depicted P-value of respective values *** and **, denotes significant level of significance at 1, and 10 per cent, respectively.*

High insability was observed in area under and yield of banana in all the states with difference in magniyude and pattern. This indicate that the high instability in banana production leads to risk in income of banana growers. Similar observation was shared by Ahmed and Joshi (2013) in cotton crop, Kumar *et al* (2013) in banana production and Joshi and Singh (2015) in Indian spices.

Table 7. Instability index in area, production, and yield of banana for major states in India, 1990 -2017.

(per cent)

Time periods	Area	Production	Yield
	Tamil Nadu		
1990 to 1999	4.74	8.47	6.69
2000 to 2009	8.72	21.35	14.77
2010 to 2017	2.38	4.33	5.22
Overall (1990 to 2017)	**11.39**	**24.89**	**16.01**
	Maharashtra		
1990 to 1999	8.27	5.99	5.12
2000 to 2009	4.67	3.31	2.1
2010 to 2017	6.29	14.37	11.37
Overall (1990 to 2017)	**4.23**	**13.99**	**1.48**
	Gujarat		
1990 to 1999	4.74	8.47	6.69
2000 to 2009	0.94	1.31	0.78
2010 to 2017	8.24	10.43	5.1
Overall (1990 to 2017)	**1.48**	**0.09**	**8.48**
	Andhra Pradesh		
1990 to 1999	7.25	16.97	10.56
2000 to 2009	1.78	4.53	5.47
2010 to 2017	8.38	3.8	2.98
Overall (1990 to 2017)	**4.33**	**9.22**	**22.37**
	Karnataka		
1990 to 1999	4.53	10.93	7.05
2000 to 2009	12.47	2.17	9.4
2010 to 2017	7.83	6.65	11.27
Overall (1990 to 2017)	**36.37**	**36.05**	**11.84**
	Madhya Pradesh		
1990 to 1999	39.12	22.62	18.35
2000 to 2009	39.72	42.56	11.07
2010 to 2017	13.93	5.78	5.66
Overall (1990 to 2017)	**25.32**	**8.35**	**6.39**
	Bihar		
1990 to 1999	6.74	13.95	17.6
2000 to 2009	0.92	5.66	6.48
2010 to 2017	5.03	5.4	4.86
Overall (1990 to 2017)	4.04	8.18	9.19

of growth. All the states showed increase in area and yield which ultimately resulted in high production of banana in almost all the states under study.

Instability Index of area, production and yield of banana across different states has been depicted in table 7. It is revealed from the table the instability index of banana production is high in different states, which ranged between 36.05 per cent in Karnataka to less than one per cent in Gujarat during 1990-2017. The instability index was 24.89 in Tamil Nadu followed by 13.99 in Maharashtra. It ranged between 8 to 10 per cent for Andhra Pradesh, Madhya Pradesh and Bihar.

Conclusion and Policy Implications

Overall, it is concluded that India is the largest producer of banana in the world and its share increased over time making it about 26 per cent of global production during 2015-19. The production of banana increased significantly in India during 1990-2017 at 5.46 per cent due to significant increase in area (3.53%) and yield (1.64%). State-wise the highest growth rate of banana production was observed in Andhra Pradesh (7.95%) closely followed by Bihar (7.76%). Overall growth rate of banana production ranged between 2.30 per cent to 7.95 per cent. In Karnataka the growth rate of yield of banana was negative whereas in Bihar it was the highest at 5.89 per cent. Instability index also varied among different banana producing states. High instability was observed in Madhya Pradesh and Karnatakawith respect to area area and in Andhra Pradesh and Tamil Nadu in the context of Yield. Bihar was the most stable state in production, area and productivity of banana with the highest significant growth in production. Thus high instability in banana production is observed in different states. The excessive instability in area, production and productivity causes demand and supply gaps, which leads to unstable income of farmers. These fluctuations in production induce price instability and inefficiency in production, employment and income distribution. Thus appropriate policy measures should be devised to minimise the risk in fruit cultivation in general and banana production in particular.

References

Ahmed S I and Joshi M B 2013. Analysis of instability and growth rate of cotton in three districts of Marathwada. *International Journal of Statisitcs and Mathematics* **6**: 121-124. https://statperson.com/Journal/StatisticsAndMathematics/Article/Volume6Issue3/IJSAM_6_3_5.pdf

Arora K and Dhawan V 2017. A study on production and trade performance of fruits in India. *Agricultural Research Journal* **54**: 108-115. DOI: 10.5958/2395-146X.2017.00019.9

Biswas B C and Kumar L 2010. High density planting: Success stories of banana farmers. *Fertiliser Marketing News* **41***:* 3-10. https://www.yumpu.com/en/document/read/36113603/high-density-planting-success-stories-of-banana-farmers

Chadha K L, Singh S K, Prakash J and Patel V B 2019. *Shaping the future of horticulture*. Kruger Brentt Publishers, U.K. 171-200. http://krugerbrentt.com/book/bookDetail/9781787150331

Cuddy J D A and Valle P A D 1978. Measuring the instability of time series data. *Oxford Bulletin of Economics and Statistics* **40**: 79:85. https://doi.org/10.1111/j.1468-0084.1978.mp40001006.x

Dastagiri M B, Chand R, Immanuerlraj T K, HanumanthaiahC V, Paramsivam P, Sidhu R S, Sudha M, Mandal S,Singh B, Chand K and Kumar G B 2013. Indian vegetable: production trends, marketing efficiency and export competitiveness. *American Journal of Agriculture and Forestry* **1:** 1-11. https://krishi.icar.gov.in/jspui/handle/123456789/28282

Government of India 2019. *Horticulture statistics at a glance*. National Horticulture Board, Department of Agriculture Cooperation and Farmers Welfare, Government of India, New Delhi. https://agricoop.nic.in/en/statistics/horticulture

Goyal S K, Goyal N, Agarwal S and Goyal M 2020. Growth and instability in production ofmajor fruits grown in India. *International Journal of Education and Management Studies* **10**: 50-52. http://www.i-scholar.in/index.php/injems/article/ view/208723

Joshi D and Singh H P 2015. An empirical analysis of growth and instability in major spices in India. *International Journal of Agricultural Sciences* **7**: 440-444. https://74.220.219.42/files/articles/7_2_3_IJAS.pdf

Kondal K 2014. Trends in area and production of horticulture sector in India. *Anvesak* 44: 57-65. https://scholar.google.co.in/citations?view_op=view_citation&hl=en&user=VtKSyHUAAAAJ&citation_for_view=VtKSyHUAAAAJ:2osOgNQ5qMEC

Kumar M K, Muralidhara B M, Rani M U and Gowda J A 2013. A figuration of banana production in India. *Environment and Ecology* **31**: 1860-1862. www.environmentalandecology.com.

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