



Research Article

TREND ANALYSIS OF AREA, PRODUCTION AND PRODUCTIVITY OF MAIZE IN INDIA

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Abstract: In India, maize is emerging as the third most important crop after rice and wheat. Maize is one of the most widely distributed crops in the world and it contributes to food stock in most of the developing nations. It is used directly for human consumption, animal feed, corn starch industry, corn oil production, baby corn and in industrially processing foods. India is the fifth largest producers of maize in the world and contributes 2.5 percent of the global production and has 4.87 percent of the global area. Maize can be cultivated in both *kharif* and *rabi* season. The secondary data of area, production and productivity of maize between the periods 1990-91 to 2018-19 was collected from Ministry of Agriculture & Farmers Welfare, Govt. of India. The collected data was analyzed by using of descriptive statistics and linear growth rates (Compound Annual Growth Rate). The study revealed that area and production of maize has been increasing. The productivity of maize is drastically increasing due to availability of high yielding varieties of seeds and new technologies in cultivation methods.

Keywords: Maize, Area, production and productivity, Compound Annual Growth Rate, Trend analysis

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Introduction

Maize (*Zea mays* L) domesticated in Central America and is widely cultivated as cereal in the world. It is easily adoptable and can be cultivated in dry areas. Maize has highest genetic yield potential and popularly known as queen of cereals. It is the third major crop in India followed by rice and wheat. The contribution of maize is about 9% in total food grain production in India.

According to existing literatures, the utilization pattern of maize at present includes 51 per cent as poultry feed, 20-25 per cent as human food, 10-12 per cent as cattle feed, about 10-12 per cent going towards industrial processing like starch and brewery and 1 percent as seed [1]. Thus, maize has attained an important position as industrial crop because 75% of its produced is used in starch and feed industries. In addition to staple food for human being and quality feed for animals, maize serves as a basic raw material as an ingredient to thousands of industrial products that includes starch, oil, protein, alcoholic beverages, food sweeteners, pharmaceutical, cosmetic, film, textile, gum, package and paper industries etc.

The maize is cultivated throughout the year in all states of the country for various purposes including grain, fodder, green cobs, sweet corn, baby corn, popcorn in peri-urban areas. The predominant maize growing states that contributes more than 80 % of the total maize production are Andhra Pradesh (20.9 %), Karnataka (16.5 %), Rajasthan (9.9 %), Maharashtra (9.1 %), Bihar (8.9 %), Uttar Pradesh (6.1 %), Madhya Pradesh (5.7 %), Himachal Pradesh (4.4 %). Maize is also cultivated in Jammu- Kashmir and North eastern states. It has emerged as important crop in non-traditional regions. Andhra Pradesh which ranks 5th in area (0.79 m ha) has recorded the highest production (4.14 m t) and productivity (5.26 t ha⁻¹) in the country although the productivity in some of the districts of Andhra Pradesh is more or equal to the USA. (Source: Farmers' Portal, GOI)

Maize can be grown successfully in variety of soils ranging from loamy sand to clay loam. The soil contains good organic matter, high water holding capacity and neutral pH are considered good for higher productivity of maize. Being a sensitive crop to moisture stress particularly excess soil moisture and salinity stresses; it is desirable to avoid low lying fields having poor drainage and also the field having higher salinity. Proper drainage in field which is provided to cultivation of maize.

Objective of the study

The specific objective is to study the trend in area, production and productivity of maize in India

Review of Literature

Surendar and Satinder (2014) [2] studied trends in growth in area, production and productivity of sugarcane in Haryana. The data collected from secondary sources and analyzed through compound annual growth rate. The study revealed that the growth rate of area was declined in all districts of Haryana and growth rate of production was positive in only two districts such as Bhiwani and Karnal. The growth of productivity was increased in all districts of Haryana except Gurgaon, Rewari and Sirsa district.

Kumar et al (2014) studied production performance of maize in India approaching an inflection point. For the study, the high frequency data at district level on area, production and yield of maize was collected for the period 1986-87 to 2012-13 from the Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. The study found that phenomenal growth in the production and it's spread across the regions proved maize as a golden grain in India [3-5].

Data base and Research Methods

The data was collected from secondary sources like various publications for this study. The area, production and productivity of minor millets (1990 to 2018) collected from Ministry of Agriculture and Farmers Welfare and India stat. Two methodologies were used such as descriptive statistics and compound annual growth rate. By using linear functions on time series data on area, production and productivity of maize, the exponential compound annual growth rate was estimated. To analyze the trend in growth rate, semi exponential function used which is one of the appropriate function forms to estimate the growth rate.

That is, the growth rate was estimated by using the following semi log functional form:

$$\log Y_t = a + bt \quad (1)$$

Table-1 Growth rate of area, production and productivity of Maize in India

SN	Year	Area (In 000 Hectare)	Production (In 000 Hectare)	Productivity (In Kg. / Hectare)
1	1990	5904	8962	1518
2	1991	5859	8064	1376
3	1992	5963	9994	1676
4	1993	5995	9601	1602
5	1994	6136	8884	1448
6	1995	5979	9534	1595
7	1996	6260	10770	1720
8	1997	6321	10819	1712
9	1998	6204	11148	1797
10	1999	6422	11510	1792
11	2000	6611	12043	1822
12	2001	6582	13160	2000
13	2002	6635	11152	1681
14	2003	7343	14984	2041
15	2004	7430	14172	1907
16	2005	7588	14709	1938
17	2006	7894	15097	1912
18	2007	8118	18955	2335
19	2008	8174	19731	2414
20	2009	8262	16720	2024
21	2010	8553	21726	2540
22	2011	8782	21759	2478
23	2012	8677	22258	2565
24	2013	9066	24260	2676
25	2014	9185	24172	2632
26	2015	8806	22567	2563
27	2016	9633	25900	2689
28	2017	9380	28753	3065
29	2018	9027	27715	3070
	Total	216789	469119	60588
	Mean	7475.483	16176.52	2089.241
	Std	1272.437	6373.403	484.5747
	CAGR %	1.97**	4.62**	2.59**

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India

Note: Std: Standard deviation, CAGR: Compound annual growth rate, ** Significant at 1 percentage, * Significant at 5 percentage

This equation (1) can be elaborated in details as:

$$Y_t = Y_0 (1+r)^t \quad (i)$$

Taking log on both sides,

$$\text{We get } \log Y_t = \log Y_0 + t \log (1+r) \quad (ii)$$

Equation (ii) can be rewrite as

$$Y = a + bt \quad (iii)$$

Where,

$$Y = \log Y_t ; a = \log Y_0 ; b = \log (1+r),$$

In equation (iii)

Y_t = area/production/ productivity, as the case may be, of minor millets as discussed above

a = constant

t = Time variable in year (1, 2...n)

b = Regression Coefficient that shows the rate of change or growth rates in a series. The annual compound growth rate (s) can be worked out by using:

Antilog (b) = Antilog (log (1+r)).

Antilog (b) = 1+r

and

$r = \text{Antilog } b - 1$

When multiplied by 100, it gives the percentage growth rate in area, production and productivity of sugarcane. That is, Compound Annual Growth Rate (CAGR) (%) = $r = (\text{Antilog } b - 1) \times 100$.

Results and Discussion

To study the trend analysis in area, production and productivity of Maize, secondary data of 29 year (1990-91 to 2018-19) was considered. Compound annual growth rate was calculated separately for area, production and productivity of maize for whole India. Area, production and productivity of maize is mentioned in [Table-1]. To determine the results in area, production and productivity of Maize in India, the index numbers were constructed by using 1990 as the base year. The indices of area, production and productivity are presented in [Table-1].

It is evident from the table that, increasing trend under the maize was observed in area with fluctuating condition at national level.

In case of area maximum increasing trend was observed 2016 over the 29 years followed by in the year 2003, 2015 and 2018, respectively. The maximum declined in area was observed in the year 2015 over the last 29 years. It shows that area has fluctuated from 5904 thousand hectares to 9027 thousand hectares (1990-91 to 2018-19) with average of 7475.483 thousand hectares. The increase of 52 percent cultivation area has occurred due to high yielding variety of maize. The cultivation area of maize has increase 8 percent during the period 1990-91 to 1999-00. In the second decade from 2000-01 to 2009-10, area has increased another 25 percent. In 2010-11 to 2018-19 has increased 5 percent. The result of CAGR showed that the overall area of maize was significantly increased and productivity increased 1.97 per cent annually. In case of production maximum increasing trend was observed in 2010 followed by 2007, 2016 and 2017, respectively. Maximum declined in the year 2009. Production increased from 8962 thousand tonne to 27715 thousand tonne (1990-91 to 2018-19) with average of 16176.51 thousand tonne. Production increase of 209 percent has occurred during the period 1990-91 to 2018-19 due to high yielding variety of maize. The production of maize has increased 28 percent during the period 1990-91 to 1999-00. In the second decade from 2000-01 to 2009-10, production has increased another 38 percent. In 2010-11 to 2018-19 has increased 27 percent. The result of CAGR showed that the overall production of maize was highly significant and production increased 4.62 per cent annually. In case of productivity maximum increasing trend was observed in 2010 followed by 2007, 2017 and 2003, respectively. Maximum declined in the year 2009. The trend in the area, production and productivity were observed irregular. The productivity of maize increased from 1518 kg per hectare to 3070 kg per hectare (1990-91 to 2018-19) with average of 2089.24 kg per hectare. Productivity increase of 102 percent has occurred during the period 1990-91 to 2018-19 due to availability of high yielding varieties of seeds and new technologies in cultivation methods. The productivity of maize has increased 18 percent during the period 1990-91 to 1999-00.

In the second decade from 2000-01 to 2009-10, yield has increased another 11 percent. In 2010-11 to 2018-19 has increased 20 percent. The result of CAGR showed that the overall productivity of maize was highly significant and productivity increased 2.59 per cent annually.

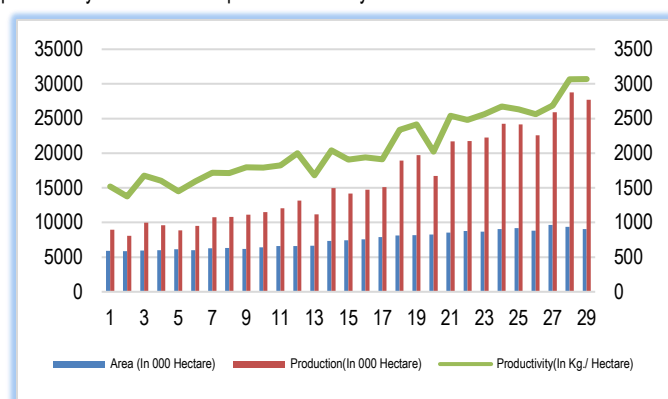


Fig-1 Growth rate of area, production and productivity of Maize

[Table-2] shows the percentage changes in area production and productivity of maize in India from 1990-91 to 2018-19 and additionally calculated 10-year intervals. The coefficient of area and production has calculated by considering area as independent variable x and production as dependent variable y. It clearly showed that overall area and production positively related with each other. The overall period (1990-91 to 2018-19) shows 4.86 units changed in area leads to 1 unit changed in production. The positive relationship between area and production has occurred 4.96 in the year 1990-91 to 1999-00 which means 4.96 units changed in area led to 1 unit in production. In the last nine years 2010-11 to 2018-19 changes occurred and 5.62 units in area led to 1-unit change in production.

Table-2 Percentage changes and coefficient of area, production and productivity of Maize

Year	Percentage			Coefficient Area(x)- Production (y)
	Area	Production	Productivity	
1990-91-2019-20	52	209	102	4.86
1990-91-1999-00	8	28	18	4.96
2000-01-2009-10	25	38	11	3.69
2010-11-2018-19	5	27	20	5.62

Conclusion

This study set out to analyze the growth rate in area, production and productivity of the maize crop in India. Specifically, the study seeks to investigate the existence of acceleration, stagnation or deceleration in growth rates of maize area, production and productivity over the study period (1991-2018). It has been argued that analysis of the growth rate trends helps us to identify the changing pattern of crops and land use pattern under different crop and rate of change in area production and productivity of the crop and further help in designing the appropriate agricultural policy for a region or state. Trend in area of maize shows significant increase in all over India. Similarly, production and productivity of maize show highly significant growth and it increases year on year in India.

Application of research: Study the growth rate of area, production and productivity of maize in India.

Research Category: Agri-Business Management and Agricultural Economics

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Study area / Sample Collection: International Agri-Business Management Institute, Anand Agricultural University, Anand, 388110

Cultivar / Variety / Breed name: Maize (*Zea mays* L)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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