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Research Article

Growth Rate Analysis of Maize Area, Production and Productivity: Special Reference to Karnataka

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ABSTRACT

The global area, production and productivityof maize was registered the positive significant growth rate of 2.37, 3.32 and 1.01 per centsrespectively, during 2004-05 to 2013-14. It indicatesthat the area under maize in Karnataka was increasing at an annual growth rate of 7.08 per cent as compared to national growth rate of 2.67per cent during 1999-2014, respectively. The production trend in Karnataka was also showing increasing trend as the growth rate was registeredat 7.72 per cent as compared to all India level (5.63 %) during 1999-2014. However, the productivity of maize was highest (3.5 tonnes per ha) in Karnataka compared to the national average (2.5 metric tonnes per ha). It was interesting to note that the area, production and productivity during 1999-2014 periods forIndia and Karnataka were found significant at five per cent level, except the productivity of Karnataka which was found non-significant.The area under maize among the major states, Tamil Nadu had registered the growth rate of 9.78 per cent followed by Maharashtra (9.34 %), Karnataka (7.08 %) and Andhra Pradesh (4.95 %) respectively, during the period 1999-2014. Finally the results revealed that the area, production and productivity of maize in NEK region was increased at a growth rate of 8.59, 6.77 and 10.13 per cent respectively during 1998-2014.

Key words: *Zea mays, Wheat, Human food, Animal feed*

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop in the world after wheat and rice. It is known as queen of cereals because of its highest genetic yield potential. Its importance lies in the wide industrial applications besides serving as human food and animal feed. Globally, the area under maize accounting to 177 and 145 million hectares during 2013-14 and 2004-05, respectively which results in the increasing production of 967 and 716 million tonnes in 2013-14 and 2004-05, respectively (3.32 % CAGR). However, the productivity was increased to 5.5 tonnes per hectare (2013-14) from 4.9 tonnes per hectare (2004-05) with a compound growth rate of 1.01 per cent.

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Maize is grown in more than 70 countries of the world. India occupies fourth place after USA (35.48mha), China (35.03 mha) and Brazil (15.28mha) in terms of area by contributing 5.13 per cent, to the world area (9.5 mha). Where as it ranks sixth in terms of production accounting 23.29 million tonnes (2.28%) but the productivity of maize crop was very low about 2.45 tonnes per hectare as compared to the world productivity of 5.50 tonnes per hectare during 2013-14. Maize is cultivated in most of the states in the country. However, maize production is dominated by Andhra Pradesh and Karnataka, producing 38 per cent of India's maize in 2013-14.Nine states viz. Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Maharashtra, Bihar, Uttar Pradesh, Madhya Pradesh and Gujarat accounts for 85 per cent of India's maize production and 80 per cent of area under cultivation. Andhra Pradesh had the highest yield followed by Tamil Nadu due to majority of the area being covered under, single cross hybrids (SCH). In Karnataka area under maize was 1.3 million hectare, with a production of 4.4 million tonnes and yield of 3.5 tonnes per hectare in 2013-14. The productivity of maize was highest (3.5 tonnes per ha) in Karnataka compared to the national average (2.5 metric tonnes per ha). In North Eastern Karnataka, comprising six districts (Ballari, Bidar, Kalaburagi, Koppal, Raichur and Yadgir) occupied 0.16million hectares area under maize (12.3 % of share in Karnataka) with a production of 0.45 million tonnes(10.22 % of share in Karnataka) and productivity of 17.46 tonnes per hectare during 2013-14. Among the North Eastern Karnataka districts, Koppal and Ballari districts contribute area under maize was 0.10million hectare (62%), and 0.05million hectare (31.25 %) and with a production of 0.27 million tonnes (60 %), 0.15 million tonnes (33.33%) respectively. Utilization pattern of Maize as the demand for maize is growing globally due to its multiple uses such as food (9.53 %), feed (49.60 %), industrial use (23.51 %) and ethanol (14.07 %) during 2014-15. Maize consumption in India has increased at an annual growth rate of 2.93 per cent over the last seven years from 16.65 million tonnes in 2007-2008 to 19.1 million tonnes in 2013-14[5].

MATERIAL AND METHODS

Designing of proper methodology is very important to carry out a systematic analysis of any research problem. In this paper the methodology followed in the present study, which includes the nature and sources of data, techniques employed and statistical procedures followed. For the evaluation of objective the secondary data related to area, production and productivity was collected from the Directorate of Economics and Statistics, Govt. of India, Department of Agriculture, Govt. of Karnataka, Food and Agricultural Organization (FAO) and other published sources. The present study focused on trends in the area, production and productivity of maize crop in north eastern Karnataka districts. For the purpose of achieving the objectives of the study, the data collected were subjected to the statistical analysis. Based on the nature and extent of availability of data, the following analytical tools and techniques had been adopted. Here in this study we employed the compound growth rate analysis, the methodological procedure is given below.

Growth rate analysis

Growth rate in area, production and productivity of maize were computed for a period of 30 years from 1984 to 2013 for India, Karnataka and North Eastern Karnataka region depending upon the availability of data. In order to know what happened to the trends in area, production and productivity before implementation of AMDP (Accelerated maize development programmer) and after implementation of AMDP (1998) in India, the study period is divided in to two phases, period I (1984-1998) and Period II (1999-2013). The linear, log-linear, exponential and power functions are some of the important functional forms employed to study the growth rates. Different functional forms were tried in the past for working out the growth rates in area, yield and production by Hasan *et al.*[1], Saraswathi *et al.*[3] and Ranjitkumar *et al.*.

Some of the important forms tried were the linear growth model (Y=a+bt), exponential form ($Y=ab^t$) and quadratic function ($Y=a+bt+ct^2$). However, it was found that the exponential form of the function $Y_t=ab^t$ is the better and most frequently used one. In the present study, compound growth rates in area, production and productivity of maize were estimated by exponential function as it has the advantage of taking all the date points into consideration, hence the name compound growth rate it would be realistic oneVeena[6].

The compound growth function is specified in the following form.

$y_t = ab^te^u$ ...(1)

Where,

y_t= area/ production /productivity in the year t

t = time period

a = intercept value (value of y when t = 0)

b = (1+r), 'r' being the growth rate

e = error term

Equation (3.1) was converted into the logarithmic form in order to facilitate the use of linear regression. Taking logarithms on both sides we obtain,

$$\text{Ln } y_t = \text{Ln } a + t \text{ Ln } b + u \quad \ldots (2)$$

Ln a and Ln b are obtained by application of ordinary least squares (OLS) procedure to equation (3.2) and the growth rate 'r' is computed as below:

$$r = (\text{Anti Ln of } b - 1) \times 100 \quad \ldots (3)$$

RESULTS AND DISCUSSION

Table 1: Global trends in area, production and productivity of maize during 2004-2014

Years	Area (mha)	Production (mt)	Yield (t/ha)
2004-05	145	717	4.9
2005-06	145	700	4.8
2006-07	150	716	4.8
2007-08	160	795	5.0
2008-09	159	800	5.0
2009-10	159	825	5.2
2010-11	164	834	5.1
2011-12	171	886	5.2
2012-13	176	863	4.9
2013-14	177	967	5.5
CAGR (%)	**2.37***	**3.32***	**1.01***

Source**:** Food and Agriculture Organization (FAO)

Note: * Significant at five percent level

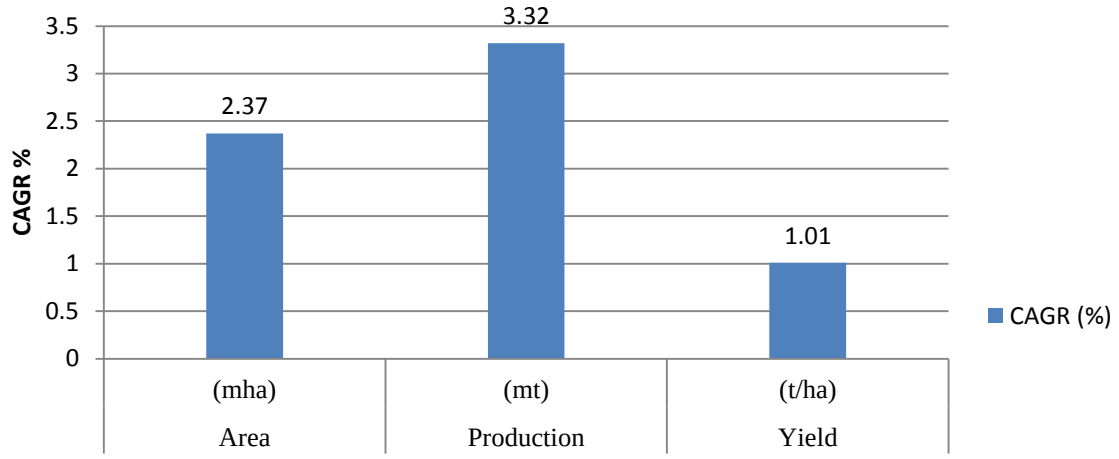

Figure1: Global trends in area, production and productivity of maize during 2004-2014

It was revealed from the Table 4.1, that the global area, production and productivity of maize was registered the positive significant growth rate of 2.37, 3.32 and 1.01 per cent respectively, during 2004-05 to 2013-14.

Table 2: Area, production and productivity of maize in India and Karnataka, (1984-2014)

Year	India			Karnataka		
	Area (mha)	Production (mt)	Yield (Kg/ha)	Area ('000 ha)	Production ('000 tonnes)	Yield (Kg/ha)
1984-85	5.8	8.44	1456	188	477	2670
1985-86	5.8	6.64	1146	167	398	2508
1986-87	5.92	7.59	1282	227	576	2677
1987-88	5.56	5.72	1029	205	510	2618
1988-89	5.9	8.23	1395	255	677	2794
1989-90	5.92	9.65	1632	253	709	2953
1990-91	5.9	8.96	1518	250	630	2659
1991-92	5.86	8.06	1376	283	855	3178
1992-93	5.96	9.99	1676	315	977	3263
1993-94	6.12	9.6	1602	318	947	3141
1994-95	6.14	8.88	1446	343	988	3020
1995-96	5.98	9.53	1595	365	1142	3294
1996-97	6.26	10.77	1720	445	1385	3272
1997-98	6.32	10.82	1712	561	1511	2833
1998-99	6.21	11.15	1797	512	1672	3434
CAGR (%)	**0.61* -5.31**	**3.26* -4.44**	**2.63* -3.94**	**7.99* -14**	**9.94* -15.85**	**1.79* -4.66**
1999-00	6.42	11.51	1792	606	1603	2783
2000-01	6.61	12.04	1822	669	2136	3361
2001-02	6.58	13.16	2000	580	1513	2747
2002-03	6.64	11.15	1681	650	1343	2176
2003-04	7.34	14.98	2041	618	2512	1957
2004-05	7.43	14.17	1907	850	2728	2955
2005-06	7.59	14.71	1938	936	2719	2915
2006-07	7.89	15.09	1912	961	3254	2829

2007-08	8.12	18.96	2335	1113	3029	2924
2008-09	8.17	19.73	2414	1069	3013	2833
2009-10	8.26	16.72	2024	1240	4444	2430
2010-11	8.55	21.73	2542	1288	4085	3450
2011-12	8.78	21.76	2478	1331	3247	3018
2012-13	8.67	22.26	2566	1315	3823	3259
2013-14	9.43	24.35	2583	1300	4400	3500
CAGR (%)	**2.67*** **-18.77**	**5.63*** **-11.18**	**2.88*** **-6.32**	**7.08*** **-11.36**	**7.72*** **-6.53**	**1.54 NS** **-1.67**

Source: Ministry of Agriculture, Govt. of India and Directorate of Economics and Statistics, Govt. of Karnataka
Note: Figures in the parenthesis indicates't' value
* Significant at five percent level
NS: Non-significance

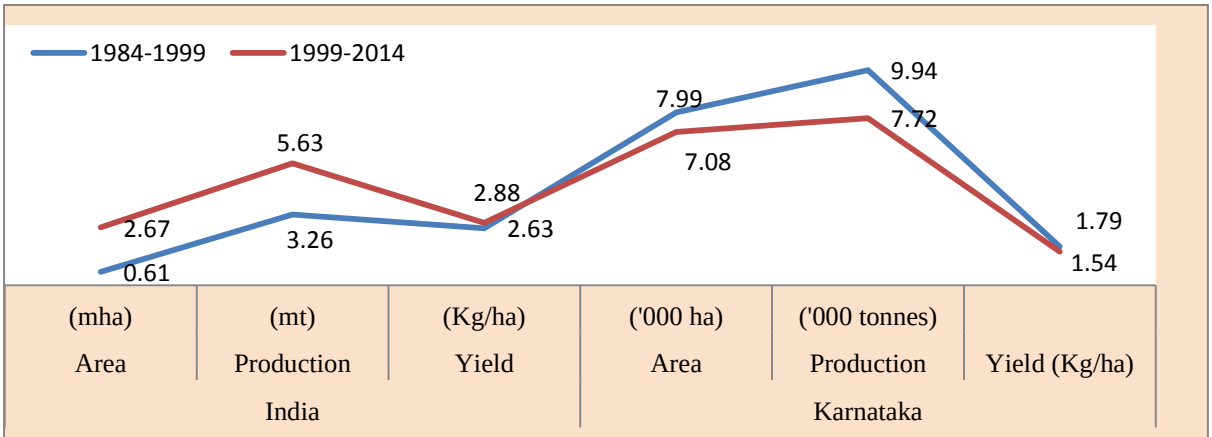

Figure 2: Area, production and productivity of maize in India and Karnataka (1984-2014)

Trends in area, production and productivity of maize were estimated for two periods (1984-1999 and 199-2014) by compound annual growth rate for India and Karnataka. The results are presented in Table 4.2 and it indicates that the area under maize in Karnataka was increasing at an annual growth rate of 7.99 and 7.08 per cent as compared to India accounting for 0.61 and 2.67 per cent during 1984-99 and 1999-2014, respectively. The production trend in Karnataka was also showing increasing trend as growth rate was registered9.94 and 7.72 per cent as compared to India (3.26 % and 5.63 %) during 1984-1999 and 1999-2014, respectively. However, the productivity of maize in India was registered positive and significant (2.88 %) as compared to Karnataka (1.54 %) during 1999-2014. It was interesting to note that the area, production and productivity for all periods of India and Karnataka were found significant at five per cent level, except the productivity of Karnataka during 1999-2014 as it was found non-significant.

Table 3: Trends in area, production and productivity of maize in major states of India (1984-2014)

Major states	Area		Production		Yield	
	CAGR %	't' Value	CAGR %	't' Value	CAGR %	't' Value
1984-1999						
Andhra Pradesh	1.86*	5.16	5.65*	3.96	6.69*	12.21
Karnataka	7.99*	14.1	9.94*	15.85	1.79*	4.66
Tamil Nadu	7.85*	7.31	4.5*	21.71	-0.56 NS	-0.84
Rajasthan	0.21 NS	0.69	5.69*	5.41	2.26 NS	1.03
Maharashtra	14.41*	10.41	5.98*	3.29	2.3*	2.49

Uttar Pradesh	-0.87*	-6.32	4.92*	4.45	0.66	0.65
India	**0.61***	**5.31**	**3.26***	**4.44**	**2.63***	**3.94**
1999-2014						
Andhra Pradesh	4.95*	5.91	8.86*	8.02	2.7*	3.75
Karnataka	7.08*	11.36	7.72*	6.53	1.54 NS	1.67
Tamil Nadu	9.78*	6.42	13.88*	11.41	9.29*	5.73
Rajasthan	0.98*	3.71	3.24*	2.07	1.98 NS	1.14
Maharashtra	9.34*	3.56	14.74*	9.76	4.44*	3.97
Uttar Pradesh	0.20*	5.92	-1.04 NS	-1.10	0.06 NS	0.1
India	**2.67***	**18.77**	**5.63***	**11.18**	**2.88**	**6.32**

Source: Ministry of Agriculture, Govt. of India

Note: * Significant at five percent level, NS: Non-significance

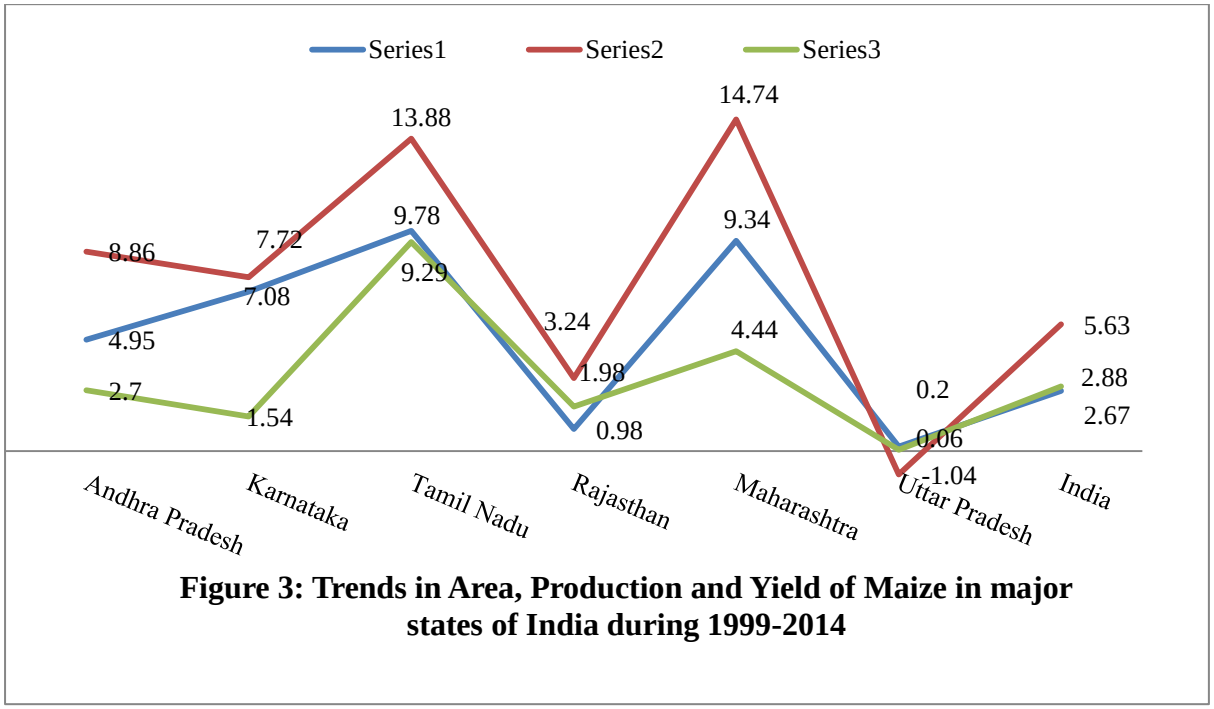

Figure 3: Trends in Area, Production and Yield of Maize in major states of India during 1999-2014

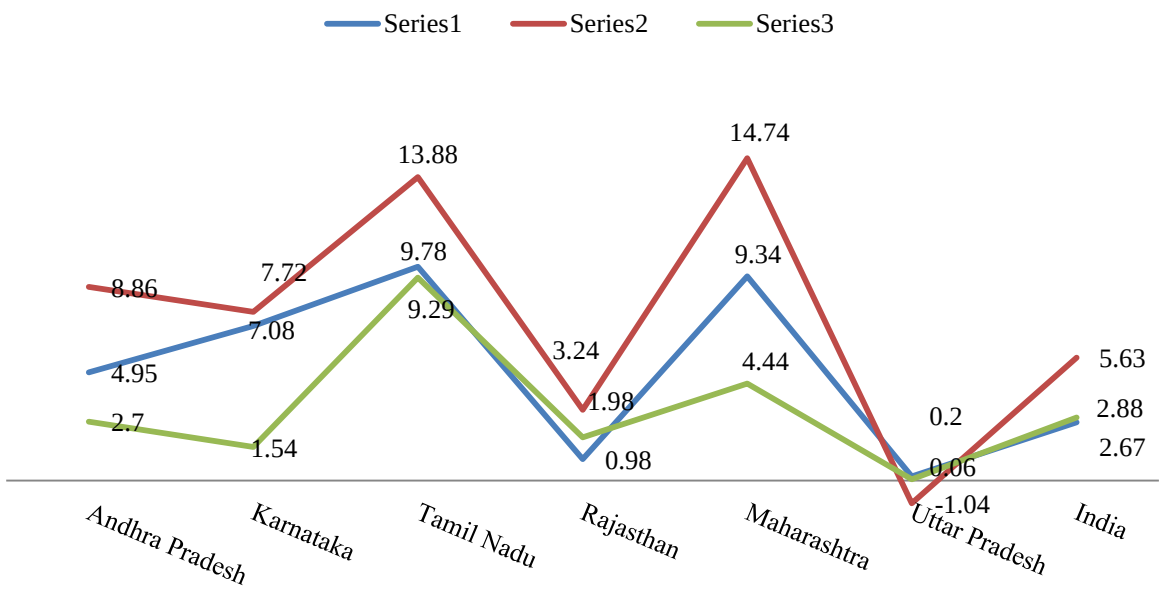

Figure 4: Trends in Area, Production and Yield of Maize in major states of India during 1999-2014

The growth in area, production and productivity of maize for the periods 1984-1999 and 1999-2014 were presented in Table 4.3 and it was clearly indicated that the area under maize among the major states, Maharashtra showing increasing trend by registering the growth rate of 14.41 per cent followed by Tamil Nadu (7.85 %), Karnataka (7.99 %) and Andhra Pradesh (1.86 %) during 1984-1999 respectively. During the period 1999-2014, Tamil Nadu had registered the growth rate of 9.78 per cent followed by Maharashtra (9.34 %), Karnataka (7.08 %) and Andhra Pradesh (4.95 %) respectively.

It was worth to mention that there was no much variation in growth rate of maize production among major growing states except Tamil Nadu (4.5 %) and Uttar Pradesh (4.92 %) during 1984-1999 and in the period 1999-2014, the growth rate in production of maize in Karnataka was 7.72 per cent and it stood after Maharashtra (14.74 %), Tamil Nadu (13.88 %) and Andhra Pradesh (8.86 %) respectively. However, the growth rate of productivity of maize in Andhra Pradesh indicated the increased trend of 6.69 per cent followed by Karnataka (1.79 %) and Maharashtra (2.3 %). Whereas, the other states are showing non-significance growth rate of productivity during 1984-1999. During the 1999-2014 periods, Tamil Nadu had registered positive significance growth rate of 9.29 percent in productivity followed by Maharashtra (4.44 %) and Andhra Pradesh (2.7 %) while other states are shown non-significance growth rates. The results are on par with Tripathy[4].

Table 4: Trends in area, production and productivity of maize in NEK region 1998-99 to 2013-14

Years	Area (ha)	Production (t)	Yield (qtl/ha)
1998-99	50330	162937	32.37
1999- 00	59564	182735	30.67
2000-01	68002	218320	32.1
2001-02	57983	182389	31.45
2002-03	64024	167446	26.15

2003-04	80667	212608	26.35
2004-05	73403	216752	29.52
2005-06	93569	165724	20.69
2006-07	102353	225802	22.06
2007-08	127719	118152	9.25
2008-09	122366	176965	8.74
2009-10	144808	100315	18.66
2010-11	151990	464983	30.59
2011-12	165939	453212	27.31
2012-13	166701	468541	28.1
2013-14	160000	450000	28.12
CAGR (%)	**8.59*** **-3.57**	**6.77*** **-3.15**	**10.13*** **-3.24**

Note: Figures in the parenthesis indicates "t" value
* Significant at five percent level
NS: Non-significance

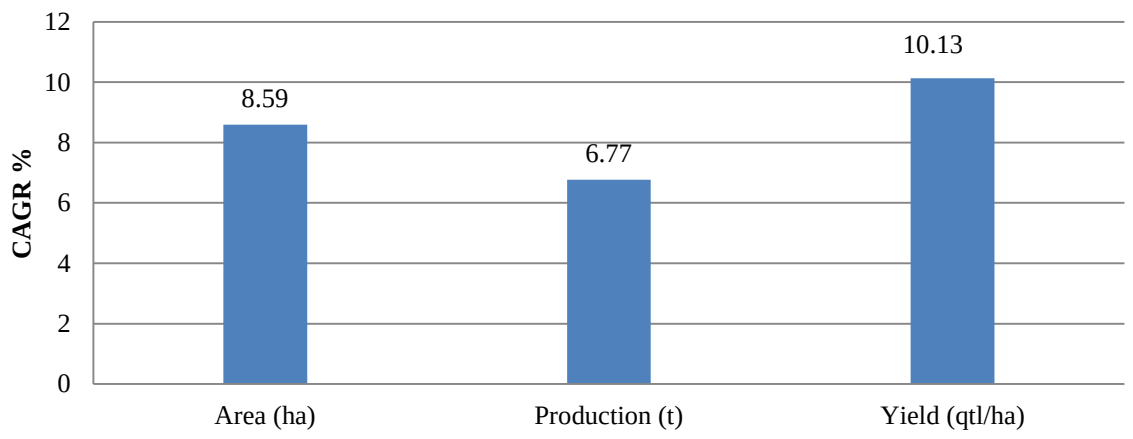

Figure 5: Trends in area, production and productivity of maize in NEK region 1998-99 to 2013-14

Growth rate of area, production and productivity of maize in North Eastern Karnataka (NEK) region for the period ranges from 1998 to 2014 presented in the Table 4.4. The results revealed that the area, production and productivity of maize in NEK region was increased at a growth rate of 8.59, 6.77 and 10.13 per cent respectively during 1998-2014.

CONCLUSION

The area, production and productivity of maize in NEK region was increased at a growth rate of 8.59, 6.77 and 10.13 per cent respectively during 1984-2014.Maize is used for various purposes such as poultry feed , livestock, industrial (starch) products and other purposes therefore, there is a huge potential for expansion of area under maize in the region.

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