

GROWTH PATTERN AND TREND ANALYSIS OF MAJOR CROPS OF INDIA

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by

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CERTIFICATE – I

*This is to certify that the thesis entitled “**Growth Pattern and Trend Analysis of Major Crops of India**” submitted in partial fulfillment of the requirements for the Degree of **MASTER OF SCIENCE in AGRICULTURE** in the **Department of Agricultural Economics** of *Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior* is a record of the bona-fide research work carried out by **Ms. VANDANA KUMARI, ID No. 18110907** under my guidance and supervision. The subject of the thesis has been approved by the *Student’s Advisory Committee and the Director of Instructions.**

No part of the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigation has been acknowledged by the scholar.

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Contents

Chapter No.	Title	Page Range
I.	Introduction	1- 3
II.	Review of Literature	4-18
III.	Research Methodology	19-20
IV.	Results	21-90
V.	Discussion	91-95
VI.	Summary, Conclusions and Suggestions for further work	96-105
6.1	Summary	95-100
6.2	Conclusions	101-103
6.3	Suggestions for further work	104-105
	Reference	106-108
	Vita	

List of Tables

Table No.	Title	Page No.
4.1	Compound growth rate of area, production and yield of rice crop of India	23
4.2	Compound growth rate of area, production and yield of wheat crop of India	27
4.3	Compound growth rate of area, production and yield of coarse cereals of India	30
4.4	Compound growth rate of area, production and yield of total pulse crop of India	34
4.5	Compound growth rate of area, production and yield of oilseeds crop of India	37
4.6	Compound growth rate of area, production and yield of sugarcane c of India	41
4.7	Compound growth rate of area, production and yield of cotton crop of India	45
4.8	Target and achievement of rice production of India	49
4.9	Target and achievement of wheat production of India	51
4.10	Target and achievement of coarse cereals production of India	54
4.11	Target and achievement of total pulses production of India	56
4.12	Target and achievement of total oilseeds production of India	59
4.13	Target and achievement of total sugarcane production of India	61
4.14	Target and achievement of cotton production of India	64
4.15	Trend of area, production and productivity of rice crops of West Bengal for next 20 years	66
4.16	Trend of area, production and productivity of wheat crops of Uttar Pradesh for next 20 years	70
4.17	Trend of area, production and productivity of coarse cereals crops of Rajasthan for next 20 years	73
4.18	Trend of area, production and productivity of total pulses crops of Madhya Pradesh for next 20 years	77
4.19	Trend of area, production and productivity of total oilseeds of Madhya Pradesh for next 20 years	80
4.20	Trend of area, production and productivity of sugarcane of Uttar Pradesh for next 20 years	84
4.21	Trend of area, production and productivity of cotton of Gujarat for next 20 years	88

List of Figures

Fig. No.	Title	Page No.
1.	Area and production of rice in India during 1998-99 to 2017-18	24
2.	Productivity of rice in India during 1998-99 to 2017-18	25
3.	Area and production of wheat in India during 1998-99 to 2017-18	28
4.	Productivity of wheat in India during 998-99 to 2017-18	29
5.	Area and production of coarse cereals in India during 1998-99 to 2017-18	31
6.	Productivity of Coarse cereals in India during 1998-99 to 2017-18	32
7.	Area and production of Total pulses in India during 1998-99 to 2017-18	35
8.	Productivity of total pulses in India during 1998-99 to 2017-18	36
9.	Area and production of oilseeds in India during 1998-99 to 2017-18	38
10.	Productivity of oilseeds in India during 1998-99 to 2017-18	39
11.	Area of sugarcane in India during 1998-99 to 2017-18	42
12.	Production of sugarcane in India during 1998-99 to 2017-18	43
13.	Productivity of sugarcane in India during 998-99 to 2017-18	44
14.	Area and production of cotton in India during 1998-99 to 2017-18	46
15.	Productivity of cotton in India during 1998-99 to 2017-18	47
16.	Target and achievement of rice production of India	50
17.	Target and achievement of wheat production of India	52
18.	Target and achievement of coarse cereals production of India	55
19.	Target and achievement of total pulses production of India	57
20.	Target and achievement of oilseeds production of India	60
21.	Target and achievement of sugarcane production of India	62

22.	Target and achievement of cotton production of India	65
23.	Trend of area and production of rice for 2018-19 to 2037-38	67
24.	Trend of Productivity of rice for 2018-19 to 2037-38	68
25.	Trend of area and production of wheat for 2018-19 to 2037-38.	71
26.	Trend of Productivity of wheat for 2018-19 to 2037-38.	72
27.	Trend of area and production of coarse cereals for 2018-19 to 2037-38.	74
28.	Trend of Productivity of coarse cereals for 2018-19 to 2037-38.	75
29.	Trend of area and production of total pulses for 2018-19 to 2037-38.	78
30.	Trend of productivity of total pulses for 2018-19 to 2037-38.	79
31.	Trend of area and production of oilseeds for 2018-19 to 2037-38.	81
32.	Trend of Productivity of oilseeds for 2018-19 to 2037-38.	82
33.	Trend of area of sugarcane for 2018-19 to 2037-38.	85
34.	Trend of production of sugarcane for 2018-19 to 2037-38.	86
35.	Trend of productivity of sugarcane for 2018-19 to 2037-38.	87
36.	Trend of area and production of cotton for 2018-19 to 2037-38	89
37.	Trend of Productivity of cotton for 2018-19 to 2037-38	90

ABBREVIATIONS AND ACRONYMS

Abbreviations/ Acronyms	Meaning
Fig.	Figure
&	And
<i>et al.</i>	And co-workers
@	At the rate of
GDP	Gross domestic production
CD	Critical difference
Cm	Centimeter
MT	Million tones
Mha	Million hectare
CV	Coefficient of Variation
CAGR	Compound annual growth rate
G	Gram
Ha	Hectare
H. I.	Harvest index
i.e.	In reference to; that is
Kg	Kilogram
kg ha ⁻¹	Kilogram per hectare
S.E.	Standard error
TFP	Total food production
ml	Milliliter
Nm	Nanometer
Mm	Milli meter
M	Meter
Mg	Milligram
Min	Minimum
Max.	Maximum
NRs	Net Returns
t ha ⁻¹	Tonnes per hectare
Wt.	Weight
<i>Viz</i>	Used especially to introduce examples, details etc.
No.	Number
N	Nitrogen
K	Potassium
P	Phosphorus
%	Per cent

RH	Relative humidity
Rs.	Rupees
Qtl.	Quintal
S.E.m (d)	Standard error mean of difference
Temp.	Temperature
Gov.	Government
CGR	Compound growth rate
TY	Total Yield
DES	Directorate of economics and statistics
CC	Correlation Coefficient
FAO	Food and agriculture organization
FASAL	Forecasting agricultural output using space, agrometeorological and land based observations
S.E.(m)±	Standard error add mean of difference
g a.i./ha	Grams of active ingredient per hectare
ANOVA	Analysis of Variance

Chapter - I

INTRODUCTION

India is an agriculture based country, where more than 50 per cent of population is depend on agriculture. This structures the main source of income. The dedication of agribusiness in the income in India is all the additional subsequently; it is so that agriculture in India is a backbone for Indian economy. Agriculture is the most important sector of Indian economy. Agriculture sector counts for 18 per cent of India's GDP and provides employment up to 50 per cent of the countries employees. India has the capability to produce the food which can build vast difference in Indian economy. Agriculture is indispensable for the sustenance and growth of the Indian economy. On an average, about 70 per cent of the households and 10 per cent of the urban population is depended on agriculture as their source of livelihood. Total geographical area of India is 328.37 million hectares of which 305.27 million hectare is the reporting area. As of 2018, total sown area of kharif crops in India reached 105.78 million hectares. India ranks second worldwide in farm outputs. Indian yields per hectare of crops are generally low compare to international standards. The major crops of India are Rice, Wheat, Coarse cereals, Pulses, Food grains, Oilseeds, Sugarcane, Cotton, Jute & Mesta etc. The economic contribution of agriculture to India's GDP is regularly declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a very important role in the overall socio-economic fabric of India.

India is one of the largest producers of agricultural production in the world .It is the second largest producer in the wheat and rice. Total cropped area in 2017-18 was 140.1 million hectare, in which total cropped area under rice was 437.891 lakh hectares, followed by wheat (295.76), coarse cereals (242.05), pulses (299.93), food grains (1275.63), oil seeds (246.45), sugarcane (47.32) and cotton (124.29) lakh hectare in 2017-18. Total cereals crops production in 2017-18 was 279.51 million tonnes in which rice production were 112.91 million tonne, followed by wheat (99.70), coarse cereals (46.99), pulses (25.23), food grain (284.83), oilseeds (31.31),

sugarcane (376.90) and cotton 34.89 million tonne in 2017-18. Total yield of rice is 2578 kilogram per hectare in 2017-18 followed by wheat (3371), coarse cereals (1941), pulses (841), food grains (2233), oilseeds (1270) sugarcane (79650) and cotton (477) kilogram per hectare in 2017-18.

All time sequence data is characterized by a unique cycle. Despite its ascertainable uniqueness from conditions that lead to boom times to triggers that result in reversals, historical narratives (Brockwell & Davis, 2009; Lund, Brockwell & Davis, 2002) suggest that most cycles display common features. Boom times are related with periods of credit expansion and persistent increases in asset prices often followed by rapid reversals. These commonalities definite by different observed work (Bordo, Eichengreen, Klingebiel & Martinez-Peria, 2001). Rice and wheat are the staple food for a large percentage of population in India. India is one of the top two producers of rice and wheat. Most of the rice and wheat produced is consumed domestically. In Indian agriculture rice and wheat holds a special place. It is well suited to soil and climate of the country and is intertwined with different religious observations, festivals, customs and traditions. Moreover being a labor intensive crop it absorbs a large section of rural labor force and is a effective source of employment in the country (Ghosh & Neogi, 1995; Ghosh, 2002; Ghosh & RayChaudhury (2007). Above all, several studies have demonstrated India's competitive advantage in rice and under the given conditions the prospect of rice exports. True to this assumption rice has emerged as an important export item with the initiation of economic reforms. Until recently, export in India was a residual in nature so the demand projections will enable us to determine the export potentiality of some commodities (Ghosh, 2002; Ghosh & RayChaudhuri (2007). Research in this direction requires high number of inputs resulting in intensive costs.

Forecasting major crop production (Fansiri, 2004) has been an area of active investigation since past few decades. The major research is generally conducted through statistical techniques. Prominent among these methods of forecasting are based on models that utilize data on crop biometrical characters, weather parameters, farmers' eye estimates, agro meteorological conditions and remotely sensed crop reflectance observations utilized either

separately or in an integrated approach. Consistent and timely forecasts supply important useful effort for proper, foresighted and up to date planning in agriculture which is full of reservations. One of the initial works in rice production was complete by Fisher (1924). His work was concentrated in estimating small number of parameters while taking care of distribution of weather over the crop season. Later on Hendricks et al (Hendricks & Scholl, 1943) modified Fisher's technique by

Therefore, keeping the above facts in view the present investigation has been proposed with the following objective;

Specific objectives

1. To analyse the compound growth rates of area, production & productivity of major crops of India.
2. To find out the gap between target & achievement of production of major crops of India during last 20 years.
3. To examine the state wise trend analysis of area, production and productivity of major crops for next 20 years.

Limitation of the study

1. The most important limitation of this study is that it pertains to the data collected for only 1998-99 to 2017-18. This study was based on time series data of major crops of India.
2. The data was secondary data of major crops of India which is collected from "Agriculture at a glance", Agriculture Department and other Govt. sites.
3. This study is for only research of M. Sc (Ag) not for other future planning making.

Chapter – II

REVIEW OF LITERATURE

To analysis any problem, it is necessary to understand the research work done in past related to different parameters. Their interrelationship inferences drawn and the method used to analysis their relationship etc. This chapter deals with review of research work already done related to problem of study in hand to provide support to the finding of the present study.

Singh *et al.* (2001) conducted study on production and productivity analysis of rice in different states of north-east India revealed that only Mizoram and Tripura states experienced higher growth rate of productivity. Increase in rice production in different states of the region was mainly due to improvement in yield rather than area expansion. The states with higher growth rate witnessed higher instability in rice production. Among the various factors availability of irrigation facilities, adoption of high yielding varieties (HYV) of rice, rate of fertilizer used, farm size and credit availability experienced great impact on rice productivity of the region.

Prajneshu and Chandram (2005) studied on computation of compound growth rates in agriculture, revisited. Growth rates are widely employed in the field of agriculture as these have important policy implications. The usual parametric approach for growth rate analysis is to assume multiplicative error in the underlying nonlinear geometric model and then fit the linearized model by 'method of least squares'. A methodology has been discussed to compute the compound growth rate by using growth models, viz. monomolecular, logistic and gompertz. Further, as an illustration, the total food grain production of our country during the period 1980 to 2001 has been considered and its growth rate has been computed.

Mishra (2007) conducted study on trends in growth of agriculture sector of the Indian economy. Growth in the agriculture sector may well be judged by the increase in agricultural production over time. In economic terms, relative changes in prices of different crops also may affect substitution. In the Indian context, rice, wheat, maize, millets and pulses are the major food crops. Oilseeds, sugarcane, cotton, jute & Mesta, and potatoes are the major cash

crops. We observe that cereals and pulses occupy about 3/4th of the gross area under cultivation. Among the food crops, area under wheat has the highest growth rate followed by maize, rice and pulses in that order. The growth rate of area under millets is negative. Among the food crops, wheat exhibited the highest growth rate of yield per hectare. Maize followed wheat. These two crops experienced over three fold increase in the yield rate. Rice experienced a little less than three fold increase in the yield rate. Millets and pulses also showed about 30-35 per cent increase in the yield rate. The percentage contribution of change (increase) in yield rate (Y) is the most dominant component of agricultural growth.

Ahmad and Haseen (2012) studied about the growth rate in the food grains production and productivity has decelerated when India entered in the era of globalization. The growth of production of food grains is (2.80%) per annum in pre reform period which declined to 1.98 per cent in post reform period. The situation is more worsen in case of growth rate of rice and wheat. The growth rate in productivity of food grains is slightly improved in post reform period but in case of rice and wheat productivity, the result is quite opposite. In this paper we made a modest attempt to analysis this result by considering the change in growth rate of fertilizer consumption, change in cultivated area, change in irrigated area and change in climate conditions.

Sendhil *et al.* (2012) conducted study on the rising trend on area, production and productivity of the crop right from the inception of the coordinated research (1964-65) till 2011-12. Indeed, India produced an historic (93.90 MT) of wheat during 2011-12 owing to the favourable economic and weather factors. This increase in production over previous year (7.03 MT) was due to increase in area (0.83 M ha) and yield (152 kg/ha). The contribution to historic production (8.09%) is attributed to yield growth (5.08%) followed by area (2.87%). Barring few years, rest explicitly indicated the yield growth surpassed the acreage growth. Increase yield is due to the factor like adoption of high yielding genotype through well established coordinated research system coupled with increase in area under irrigation and favourable weather factors during the crop season.

Narwade (2013) studied the state-wise growth performance of coarse cereals like jowar, bajra and maize during the pre- and post-reforms period in India. In the state of Maharashtra bajra output growth has picked up during the period (2001-02 to 2006-07) due to increase in yield per hectare. During the later post-reform period maize recorded significant output growth (4.26%) mainly due to area expansion at all-India level. Andhra Pradesh, Bihar, Karnataka, Maharashtra and Punjab were the states in which output growth in Maize has significantly increased during the post-reform period and later post-reform period. In majority of these states area expansion played an important role in maize output growth.

Ramachandra *et al.* (2013) studied about growth in area, production and productivity of major crops in Karnataka. The growth in the area, production and productivity under different crops were estimated using the compound growth function. Growth rates showed a significant positive growth in area under pulses while cereals showed significant negative growth. The area under jowar, bajra, ragi and minor millets were experiencing a substantial annual decrement. The area under rice has recorded a mild annual increment. The growth in area under oilseeds and commercial crops was negative and insignificant. Similarly, the production of cereals, pulses, vegetables and fruits showed a significant positive growth rate. The production of oilseeds and commercial crops registered insignificant positive growth. The productivity of different crops registered significant growth in the case of cereals, pulses and fruits. Productivity of oilseeds recorded moderately significant positive growth.

Sharma (2013) studied on trends in area, production and productivity of food grain crops, an overview. The study was based on secondary data from 1980-81 to 2011-12. To analyse the trend of area, production and productivity of foodgrains in northeastern states, the linear, quadratic and exponential functional forms were used. To fit the trend, linear functional form was used due to its higher R² value as compared to other two forms. Besides these, compound growth rate, coefficient of variation (CV) and instability indices for area, production and productivity for foodgrain crops in the northeastern states were positive and thereby indicating less risk for growing food grain

crops in the region. The increase in production is due to increase in area as well as interaction of area and productivity of food grain crops in the states.

Chatterjee *et al.* (2014) conducted study on a decadal analysis of pulse production in major states of India. An attempt has been made to evaluate the overall trend in area, production and productivity of kharif, rabi and total pulses as well as their respective growth rates and instability during the period 1986-87 to 2007-08 for the sixteen major pulse growing states of India. The result envisages the fact that there is a tendency to shrink kharif pulses area (-3.89%) more than the rabi pulses (-2.31%) decadally with respective growth in productivity (1.49% and 9.47% respectively). Possible areas under double cropping in the respective states with low and instable acreage for rabi pulse, this may be also increases the productivity per unit of water owing to better solar harvesting and there should be concerted efforts to regain the area under pulses.

Kumar and Singh (2014) studied about the trends in growth rates in area, production and productivity of sugarcane in Haryana. State agriculture has undergone spectacular change after using new agriculture technology during green revolution. The present study initiates and analyzes the trends in area, production and productivity of sugarcane crop in Haryana state at the district and regional levels covering the most recent period from 2000-01 to 2009-10 by using simple descriptive statistics; linear growth rates (compound annual growth rates). The results of this study about the growth rates in the area, production and productivity of sugarcane crop show interesting results in Haryana at the district and regional levels.

Chaudhuri (2015) reported that Year wise gross data and trend in rice cultivation in West Bengal.

Particular/ Year	Area under paddy (lakh ha.)	Production (lakh tonnes)	Productivity (kg/ha.)	Trend Area (year)	Trend Production (year)	Trend Yield (year)
1997 - 98	59	132	2243	00	00	00
1998 - 99	59.04	133.2	2255	0.04	0.8	12
1999 - 00	61.50	138	2237	2.46	4.43	-18
2000 - 01	54.35	124.3	2287	-7.15	-13.3	50
2001 - 02	60.69	152.57	2514	6.34	28.29	227
2002 - 03	58.42	143.89	2463	-2.27	-8.68	-51
2003 - 04	58.57	146.62	2504	0.15	2.73	41
2004 - 05	57.83	148.85	2574	-0.74	2.23	70
2005 - 06	57.83	145.11	2509	00	-3.74	-65

Dhingra (2015) studied on yield of principal crops in India, growth and trends. Present study is an effort to find the growth and trends of yield of principal crops in India and to generate the short term forecasts of yields of rice and wheat (principal crops) in India. The analysis shows that there has not been remarkable growth in the yield per hectare of the principal crops except cotton for the period 2001-2014. The forecasts do not given an optimistic picture about growth of the principal crops in the years to come. An increase in agricultural investments, especially in research and development, is urgently needed to stimulate growth in yield per hectare.

Grewal and Goel (2015) studied on current research status and future challenges to wheat production in India. Wheat is a dominant crop in temperate countries and is being used as human food and livestock feed. The success of wheat depends partly on its adaptability and high yield potential, and also on the gluten protein fraction, which confers the visco-elastic properties that allows its dough to be processed into bread, pasta, noodles and other food products.

Rajan *et al.* (2015) attempted study on forecasting of cotton area, production and productivity using trend analysis in Tamil Nadu. The findings of the study are based on data during the years (1970 to 2012). Three models of trend analysis were applied. The models were linear trend model, quadratic

trend model and cubic trend model. This study was forecasting model for next eight year of area, production and productivity for the cotton were estimated. The exploration of forecasted period from 2013 to 2020 was presented. The best fitted selected model forecasted an area of 1.138(lakh ha) from 2.083 (lakh ha), production is of about 4.404 (lakh bales) from 5.151(lakh bales) and finally productivity of 981(kg/ha) from 1370(kg/ha) respectively were estimated for the years 2013-20. Forecast values are very close to actual values and have positively increased due to availability of cotton crops in Tamil Nadu.

Wali *et al.* (2016) conducted study on dimensions of growth and development of cotton in India, an economic analysis. The study analyzed the growth in area, production and productivity of cotton across different zones in India. The study is based on the time series data analyzed in two sub period's viz, period 1(1992-93 to 2001-02) and period 2 (2002-03 to 2011-12) to know the impact of Bt-cotton on area, production and productivity of cotton in India. To explore the factors determining the growth, the Cobb Douglas production function has been fitted. India is exporting long staple cotton to several countries while importing extra long staple cotton to produce fine quality yarn.

Patil and Yeledhalli (2016) studied compound growth rates and instability indices for area, production and productivity of different crops in Bangalore urban for the period from 1998- 99 to 2013-14. The pulses like Avare, horse gram, and turn witnessed a negative growth rate in area and production expect for productivity of avare and production of avare which showed highest growth rate at extent of (24. 26%) and (24.26%) indicating higher instability index of 67.49 followed by 62.04. Even though area, production and productivity of oilseeds showed a negative growth productivity of castor oil witnessed a lowest instability followed by production of mustard with 1.90. Even though sugarcane was selected under commercial crops it witnessed negative growth in its area production and productivity. It may be attributed due to promoted for shift in cropping pattern and rapid urbanization in this district. In Bengaluru rural ragi being an important crop with an average area of about 116726.67 ha showed negative growth rate and its productivity showed highest instability indices measuring 185.15.09 however area of paddy showed 0.41 which was lowest instability index. Maize being second

important crop showed a positive growth in its area, production and with growth rate at 8.78, 15.04 and 5.75% respectively. Avare productivity was the highest growth rate observed in Bengaluru rural with 22.26% it was significant at one %. In this area flowers like rose, jasmine and marigold was significantly growing positively. Area of rose was growing at rate of 7.45% and its production and productivity had about 16.58% and 8.50% respectively these were significant at one %. Area and production of mango and banana had a positive growth ranges from 2.92% to 1.24% and these instability was also low indicates that fruits are going exponentially because of shift in cultivation. Even though Betel vine has a less area under cultivation its productivity was growing at rate of 20.33% and significant at five % it was because high yielding variety of Betel vine.

Sankar and Naidu (2016) conducted study on growth and instability of cotton crop in major cotton growing states in India. The present study examines the growth and instability of cotton in terms of area, production and productivity of cotton in major cotton growing states of India during the different periods since 1970-71 to 2013-14. For this purpose compound growth rates were estimated by fitting the exponential function and coefficient of variation was worked out to find out instability associated. From the analysis, it was establish that the area under cotton in Andhra Pradesh, Gujarat, Haryana, Maharashtra, Rajasthan and all India witnesses a positive annual growth rate but Karnataka and Tamil Nadu show a negative significant growth considering the production of cotton, Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan and all India noticed a significant positive growth whereas Tamil Nadu shows insignificant negative growth. The instability analysis indicates that Andhra Pradesh witness high instability in area, production and productivity of cotton when compared to major cotton growing states and all-India during the different periods.

Thakur and Rai (2017) compound annual growth rate was calculated on area production and yield of sugarcane for about sixty years in UP. Compound annual growth rate (%) of area increases upto 1990, but there is sharp decrease in the compound annual growth rate (CAGR) to 0.74. This

means that there was not much change in the area after 1990. Overall CAGR in area, production and yield were found to be 1.28%, 2.25% and 0.96%. CAGR in production showed increasing trend till 1990 and after that there was decline per annum. Compound annual growth rate for production was highest (2.95%) in between 1970-90. Yield was having positive sign which indicates, farmer can take up this crop in better way.

Handral and Sethy (2017) studied trends in production and productivity of jowar and bajra in India. Growth patterns and instability in production and productivity of these crops over the time was studied using the compound annual growth rate and coefficient of variation. The analysis shows the changing cropping pattern in the country from coarse grains to high cash crops, which is reflected by decline in area of coarse grains by 15 per cent in 2000's however, the productivity is on the rise in both bajra and jowar due to release of improved hybrids and varieties by public and private sector research in response to their industrial and nutritional value as nutri- cereals. But relation of yield with relative instability in most of the states, growing jowar and bajra has been increasing over the period, which is a matter of serious concern. Hence, the study points out to the significant policy interventions to maintain the stability of coarse grains along with production in the wake of its increasing nutritional and commercial value in suiting to the fragile environmental conditions.

Bhushan (2016) studied TFP growth of wheat and paddy in post-green revolution era in India, parametric and non- parametric analysis for the period 1981- 2010. Both the approaches have revealed that the shift due to technological adoption is a vital source for overall productivity growth. Both the approaches used have produced almost similar results at spatial and temporal directions, showing robustness in TFP estimation, Further, the high-yield states, particularly Punjab, have depicted a decline in the TFP growth for wheat and paddy crops in recent times, which raises an alarm on the long-term sustainability of paddy-wheat production system in this green revolution star state. An obvious extension to this study would be the application of this approach to incorporate more crops and states or at the district level. Another interesting work could be incorporating higher order policy variables such as

subsidies, government investment, variables representing resource endowment, infrastructure, groundwater extraction, etc. in the efficiency equation of SFA.

Tewari *et al.* (2017) conducted study on growth and instability in wheat production, a region wise analysis of Uttar Pradesh, India. The growth was examined by compound annual growth rate and contribution of area and productivity towards output growth by decomposition analysis. The study relates to 1990-91 to 2013-14 which is further divided into five sub-periods. The area under wheat registered positive growth throughout the period in all the regions of the state. While, in case of production and productivity, the positive growth was observed except sub-period 3. The productivity of wheat was found to be highest in western region whereas lowest in the Bundelkhand region. After instability analysis it was observed that there is high instability in production and productivity as compared to area under wheat. Further, the growth in wheat production is decomposed into three components viz. area effect, yield effect and interaction effect. The results of decomposition analysis revealed the dominance of yield effect in the growth of production.

Malik (2017) conducted study on food grains in India, growth, instability and decomposition analysis. Indian economy is an emerging economy but still it is an agricultural economy because here majority of people earn their livelihood from agriculture. The present research work focused on area, production and yield of food grains in India using time series data ranging from 2001-02 to 2015-16. To fulfill the objectives of the study, statistical data has been collected from RBI hand book. Simple statistics tools have been used for examine the data related to trends of area, production and yield. The relative share of area and productivity in the growth of food grains production also estimated. The results revealed that the growth in production was due to the growth in area or both the interaction of area and yield of food grains in India. Future the study concluded that the production of food grains has increased over the time period because of increase in area under food grains also supplemented by the increase in yield of the crops as it is not possible to increase the area in the long run; so there is vital need to adopt the

appropriate / alternate production technologies which will further improve the productivity of food grains.

Reddy and Kingsly (2017) studied on area, production, yield trends and pattern of oilseeds growth in India. India is the fourth largest producer of oilseeds accounting for about 19% of the global area, 2.7% of global production in the world. The oilseeds crops have registered the significant growth in area and production in last 30 years. However, compare to cereals like paddy and wheat, the growth rate of area and production of oilseeds is insignificant and there exists wide variability in their yield in different states of the country. The study has explored the growth performance, and dynamics of major oilseeds in different states of the country. Oilseeds exhibited a dismal picture in their production performance both spatially and temporally.

Mehala and Paul (2018) studied on performance of food grain production in India. The growth rate in the food grains production and productivity has decelerated when India entered in the era of globalization. The growth rate production of food grains is 2.80 per cent per annum in pre reform period which declined to 1.98 per cent in post reform period. The situation is more worsen in case of growth rate of rice and wheat. The growth rate in productivity of food grains is slightly improved in post reform period over the pre reform period but in case of rice and wheat productivity, the result is quite opposite. In the paper we made a modest attempt to analysis this result by considering the change in growth rate of fertilizer consumption, change in cultivated area, change in irrigated area and change in climate conditions.

Seidu *et al.* (2018) studied about growth and Instability in cotton cultivation in northern India. These continuous changes and confrontations invariably affect the trend, growth and stability of the economic performances of cotton. This study based on secondary data from 1966-67 to 2013-14, the study assessed the trends, growth and instability in area, production and yield of cotton in Haryana using semi-log linear function, compound annual growth rate and Cuddy Della Valle Index. The study revealed a positive significant ($P < 0.01$) trends with low annual growth rates of area of harvest (2.00%), production (3.99%) and yield (1.66%). The study, therefore recommended the

development and spread of innovations at an affordable price to farmers. Effective disease and pest control measures should be developed to check the perennial pest infestation of cotton in the state.

Rao *et al.* (2018) studied about sources of growth in rice production in India: state wise component analysis. The present study was taken up to estimate the influence of technology and policy on rice production in India and its major states with objectives; measuring the magnitude of growth, estimating the instability and assessing the influence of technology and policy factors on rice production in different states. Analytical tools like compound growth rate (CGR), Coefficient of Variation (C.V) and component analysis were employed to achieve the objectives. Results reveal that growth and instability in production were more contributed by yield than area.

Kumar and Singh (2018) conducted study on dynamics of area, production, productivity and trade of sugarcane in India, evidences from Uttar Pradesh and Maharashtra, India. A time series data from 1970-71 to 2014-15 (45year) of major sugarcane producing states Uttar Pradesh and Maharashtra in India was used. The compound growth rate as well as trend analysis indicated that the area, production and productivity under sugarcane in Uttar Pradesh and Maharashtra. The area, production under sugarcane in Uttar Pradesh was more than Maharashtra but productivity of sugarcane in Uttar Pradesh was less than Maharashtra. It showed that area, production and productivity of sugarcane was increased over the time period due to more area. The area, production under sugarcane in Uttar Pradesh was more than Maharashtra but productivity of sugarcane in Uttar Pradesh was less than Maharashtra. It is revealed from the results that area, production and productivity of sugarcane is increasing at the rate of 1.20 per cent, 2.27 per cent and 1.20 per cent respectively in Uttar Pradesh and 4.10 per cent, 3.80 per cent and 0.2 per cent respectively in Maharashtra. At India level area, production and productivity grew at the rate of 1.6 per cent, 2.5 per cent and 0.9 per cent respectively. The export and import of sugar gained at the rate of 3.04 per cent and 18.84 per cent respectively.

Jain (2018) analyzed of growth and instability in area, production, yield and price of rice in India. The analysis shows that at all India level compound

annual growth rate of area, production and yield of rice were positive but it had been declining gradually over the periods. In the recent decade (2000-01 to 2011-12) there is increase in instability at all India level in area, production and yield of rice. The possible reasons for increase in instability were low percentage of irrigated area to total cropped area, decline in use of seeds and manure and other inputs necessary for agriculture. In the post reform period (1990-91 to 2016-17) the instability has increased in case of wholesale price of paddy across various states while instability has declined in case of farm harvest price of paddy.

Samal *et al.* (2018) conducted study on state-wise analysis of growth in production and profitability of rice in India. The paper evaluates the growth experience of production and profitability in rice using secondary data for the period 1970-71 to 2015-16. The decadal growth in an area, production and yield of rice in India and for different states were computed and compared for the above period. It was found that area growth in most of the states has either exhausted or declined. The production growth was mainly from the growth in productivity. Therefore, future growth in rice production has to come from yield growth through technological improvement. This requires more investment in rice research to increase the yield the trends in costs and profits were computed for the period 1980-81 to 2014-15.

Kumari *et al.* (2018) studied about trend analysis of area, production and productivity of jute in India. Overall period divided into three sub periods as period 1(1990-00), period 2 (2000-10), period 3 (2010-16) based on decade. Negative growth of area 0.2, 0.9 and 1.6 per cent observed for the overall period, second period and third period respectively whereas first period showed positive growth of 1.5 per cent for area, production showed growth rate of 2.3, 1.4 and 1.3 for first, second and overall period respectively while third period showed negligible growth for production. Decomposition calculated area effect and both effect for period 2 and period 3 and overall period but area effect, productivity effect and both effect are positive in the first period.

Korem *et al.* (2018) reported that Linear growth rate and Compound growth rate of area, production and productivity of rice. For the area, period-I

and period-II both linear growth rate and compound growth rate were non-significant. In combined period growth rates showed significant at 5 per cent level. Period-II was showing more growth rate than the period-I. In production case Period-I, period-II and Combined Period of growth rates showed significantly at 5 per cent level. In these case also Period-II was more growth rate compare with the Period-I. As well as in productivity case all periods were showing significant results at 1 per cent level. In these period-I growth rates were more than the period-II growth rates. Growth rates of all periods reveal positive growth. As a whole, the growth rates of production were higher than growth rates of area and productivity. This implies relatively slow growth in area, moderately growth in productivity and high growth rate were observed in production. The results were agreed with the work has done by other places on the same line.

Ahmad et.al (2015) Examined on the trend of area, production and productivity of major cereals: India and Nigeria scenario from period 1982 - 2012. Compound growth rate for cereals in India was negative and significant for area. Production and productivity compound growth rate was positive and significant.

Kumar and Sisodia (2018) Attempted study on trends in growth of area, production and productivity have been found almost linear with little bit fluctuations in certain years. The growth rates of area, production and productivity during the last four decade have been found to be 1.13, 3.17 and 2.28 per cent annually (based on linear growth function). However, the maximum growth rates in area and production, i.e. 2.71 and 4.99 per cent respectively have been observed in the first decade, while the productivity was 2.27 per cent. Almost similar growth rate in area, production and productivity have been obtained on the basis of growth function like compound and semi-log functions. Since trends in area, production and productivity were found to be linear in nature, the linear growth function was found to be best fitted. Thus, the results based on linear growth function were more reliable as compared to compound growth function.

Rajpoot *et al.* (2019) conducted study on jute crop production estimation in major states of India. The correlation coefficient (r) over the

years between DES and FASAL estimates ranging between 0.995 to 1.00 and 0.996 to 1.00 in acreage and production estimates respectively. At district level, the correlation coefficient (r) values for the area and production were 0.967 and 0.962 respectively. On the basis of statistical criteria used in this study, FASAL estimates were close to DES estimates and improved over the years.

Swamy *et al.* (2019) study the global area, production and productivity of maize were registered the positive significant growth rate of 2.37, 3.32 and 1.01 per cents respectively, during 2004-05 to 2013-14. It indicates that 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 2.67 per cent during 1999-2014, respectively. The production trend in Karnataka was also showing increasing trend as the growth rate was registered at 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) 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.

Nisha *et al.* (2019) Attempted study on positive trends in area, production and yield of wheat for both Haryana and India. The contributions of area and yield in the production of wheat crop were comparable for both Haryana and India. Similar results were obtained on triennium bases. All the three aspects (i.e. area, production and yield) have shown positive growth rates in Haryana while in case of India, positive growth rates were observed for both area and production except in Period- IV from 1996-97 to 2005-06. For the entire period under study the trend of area under wheat crop revealed a highly significant growth of 2.25 per cent and for its production and productivity it was 4.77 and 2.46 per cent respectively in Haryana. For India the trend coefficient for wheat crop have shown positive growth rates of 1.25, 3.68 and 2.40 per cent respectively during this period. Hence area, production and productivity of wheat have increased with highly significant growth in both Haryana and India. Trend of yield in India was similar to that of Haryana.

Similar results were observed for coefficient of variation and stability indices in production and yield of wheat in Haryana as well as India.

Kasula (2019) studied that the compound growth rate of the area under Paddy during 1991-92 to 1999-2000 is 0.77 per cent and the t value is significant at 1 per cent level. But the compound growth rate of area under Paddy during 2000-01 to 2009-10 decreased to 0.51 per cent and the t value is significant at 5 per cent level and ever since the compound growth in the area under food grains drastically declined and the t value is not significant.

Chapter - III

RESEARCH METHODOLOGY

The study was based on secondary data. The secondary data were collected from the website of Ministry of Agriculture and Farmers' Welfare Government of India (agriculture. gov. in) and Agricultural Statistics at a Glance, Directorate of Economics and Statistics, and Food and Agriculture Organization (FAO).

The secondary data on area, production and productivity from 1998-99 to 2017-18 was used for analysis. The secondary time series data on area, production and productivity of major crops of India were used to analysis.

Analysis of data:

The collected data was tabulated in the view of the cited objectives and was interrelated by using suitable statistical measures. Followings statistical measures were used for present study.

Compound Growth Rate (CGR):

By taking time as the independent variable and the area, production and productivity of the major crops of India, as the dependent variable, the compound growth rates was estimated by using the formula:

$$Y_t = a (1 + r)^t$$

Where,

Y_t = Dependent Variable like area, production and productivity of major crops of India in the year's' for which growth rate was estimated.

a = Constant

r = rate of annual increment

t = time element which takes the value of 1, 2, 3...n

The above exponential equation can be expressed in terms of log forms as follows:

$$\text{Log } Y_t = \text{Log } a + t \text{ Log } (1 + r)$$

$$\text{Log } Y_t = \text{log } a + t \text{ log } b, \text{ where, } b = 1 + r$$

By putting $\text{log } Y_t = y$, $\text{log } a = A$ and $\text{log } b = B$, the model becomes linear between y and t , as $y = A + Bt$,

Now,

CGR per cent can be expressed as:

$$\text{CGR in per cent} = (\text{Antilog } b - 1) \times 100$$

To test the significance of compound growth rate t test was used as follows:

$$t = r / \text{S.E. } (r) \text{ with } (n - 2) \text{ degrees of freedom}$$

Where,

$$\text{S.E. } (r) = 100 \times b \times \text{S.E. } (\text{log } b) / 0.4343$$

$$r = \text{CGR per cent};$$

$$n = \text{number of year}$$

Trend Analysis

Linear Model: - The linear trend model that is suggested by finger (2007) and Boken *et al.* (2000) was used in this study for analysis. The trends in area, production and productivity of major crops have been worked out by fitting the following functions:

$$Y_t = \beta_0 + \beta_1 t + e_t$$

Where, Y = Expected value, β_0 = intercept, β_1 = Trend value

Chapter - IV

RESULTS

The chapter of result is the key manuscript of research may be called research report findings. This chapter deals with the results is based on time series data collected and analyzed in the light of the objective stated in chapter first. The whole chapter deals with analysis, interpretation of time series data for facts and findings. The data has been processed and tabulated in the light of the objectives of the study. The chapter also focuses on the results of the study found after analysis. The study was intended with the compound growth rate analysis of major crops such as Rice, Wheat, Coarse cereals, Oilseed, Pulses, Sugarcane and cotton of India during 1998-99 to 2017-18. In next, as per objective of the study was also analyze the gap between target and achievement of area, production and productivity of major crops (Rice, Wheat, Coarse cereals, Oilseed, Pulses, Sugarcane and Cotton) of India during last 20 years (1998-99 to 2017-18) and state wise trend analysis of area, production and productivity of major crops such as rice for West Bengal, Wheat for Uttar Pradesh, Coarse cereals for Rajasthan, Oilseeds & Total pulses for Madhya Pradesh, Sugarcane for Uttar Pradesh and Cotton for Gujarat for next 20 years (2018-19-2037-38).

The chapter was finding for used to future production of major crops because in future Indian population will be increase significantly that population would be need more food so researcher is want to how to growth rate of production of major crops which fulfillment of food for population for future of India. Therefore second objective was finding can be used for solve the problem of target and achievement gap of different major crops such as Rice, Wheat, Coarse cereals, Oilseed, Pulses, Sugarcane and Cotton in past era of India .While the third objective was finding can be used for how to increase production of major crops of various states of India.

The study based on secondary data and secondary data collected from agriculture statistics at a glance and Ministry of agriculture and farmers welfare government of India, Directorate of Economics and Statistics and Food and Agriculture Organization.

For the easy of presented of facts and findings as per the stated objectives.

- 4.1 Compound growth rates of area, production & productivity of major crops (Rice, Wheat, Coarse Cereals, Oil Seed, Pulses and Sugarcane & Cotton) of India during last 20 years (1998-99 to 2017-18).
- 4.2 Gap between target & achievement of production of major crops of India during last 20 years (1998-99 to 2017-18).
- 4.3 State wise trend analysis of area, production and productivity of major crops for next 20 years.

4.1: Compound growth rates of area, production & productivity of major crops (Rice, Wheat, Coarse Cereals, Oil Seed, Pulses and Sugarcane & Cotton) of India during last 20 years (1998-99 to 2017-18)

4.1.1. Compound growth rate (%) of area, production and productivity of rice:

Compound growth rate (%) of area, production and productivity of rice are presented in table 4.1. For rice crop, the area was decreased from 44.80 to 43.79 million hectares i.e. 1.01 million hectares while the production and productivity for India were increase 86.08 to 112.91 million tonnes and 1921 to 2578 kg/ ha respectively for India during the last 20 years (1998-2018). Under rice crop compound growth rates of area -0.043 per cent was observed in India for 1998-99 to 2017-18 period, while the compound growth rates were 1.585 per cent and 1.628 per cent for production and productivity respectively in case of India. Compound growth rate of area sign is negative that means area of rice crop was decreased and also compound growth rate was found to be negatively but not significant, while production and productivity were increased and compound growth rate are positive and non significant. The values of "t" calculation found to be -0.41, 6.24 and 9.47 for area, production and productivity respectively.

Table 4.1: Compound growth rate of area, production and yield of rice of India

Year	Area (mha)	Production (MT)	Yield (kg/ha)
1998-1999	44.80	86.08	1921
1999-2000	45.16	89.96	1986
2000-2001	44.71	84.98	1901
2001-2002	44.90	93.34	2079
2002-2003	41.18	71.82	1744
2003-2004	42.59	88.53	2079
2004-2005	41.91	83.13	1984
2005-2006	43.66	91.79	2102
2006-2007	43.81	93.35	2131
2007-2008	43.91	96.69	2202
2008-2009	45.54	99.18	2178
2009-2010	41.92	89.09	2125
2010-2011	42.86	95.98	2239
2011-2012	44.01	105.30	2393
2012-2013	42.75	105.24	2461
2013-2014	44.14	106.65	2416
2014-2015	44.11	105.48	2391
2015-2016	43.50	104.41	2400
2016-2017	43.99	109.70	2494
2017-2018*	43.79	112.91	2578
Compound growth rate (%)	-0.043	1.585	1.628
“t” value calculated	-0.41	6.24	9.47

Compound growth rate *is Significant at 5% and ** is highly significant at 1% level

Fig 1: Area and production of rice in India in 1998-99 to 2017-18

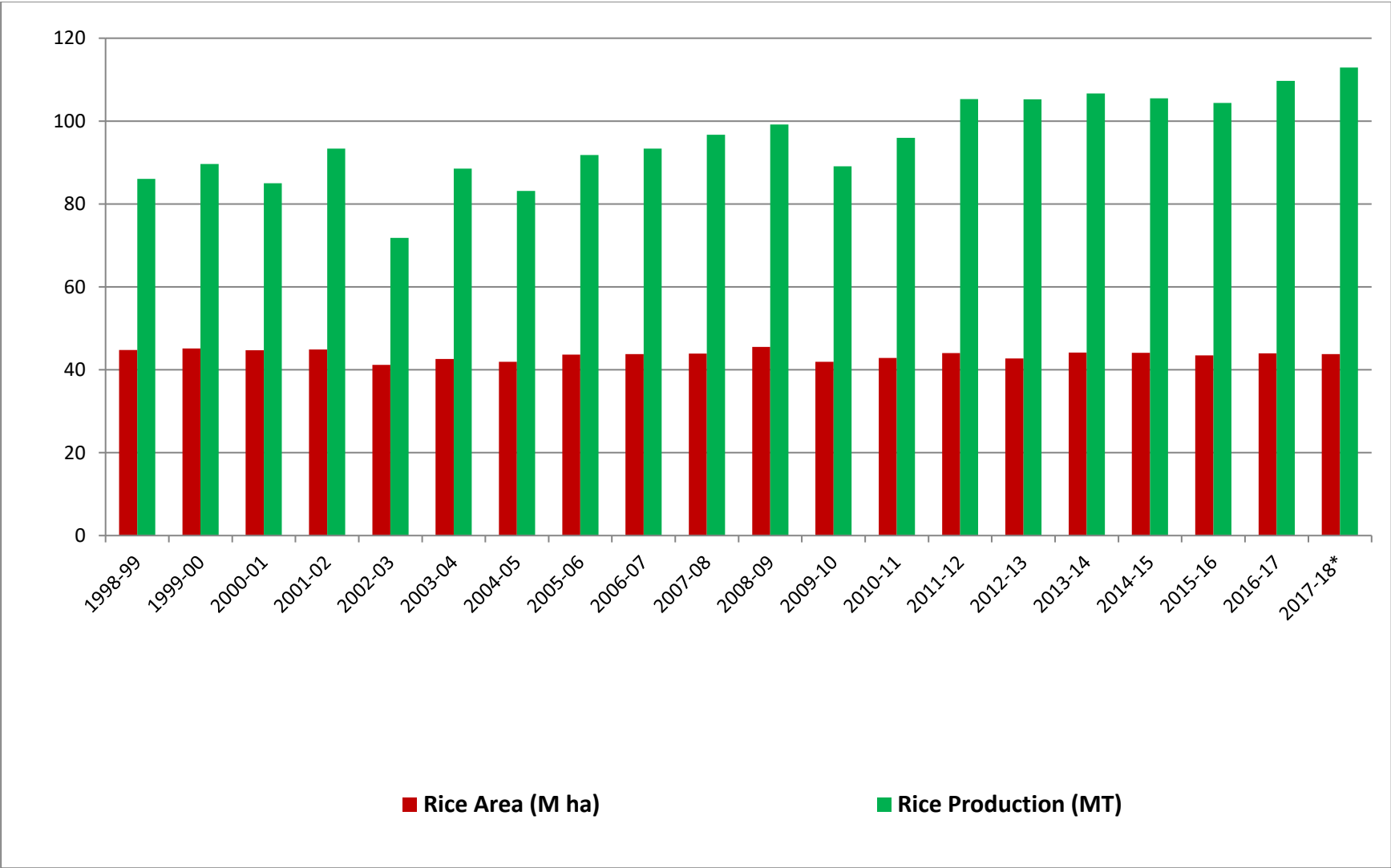
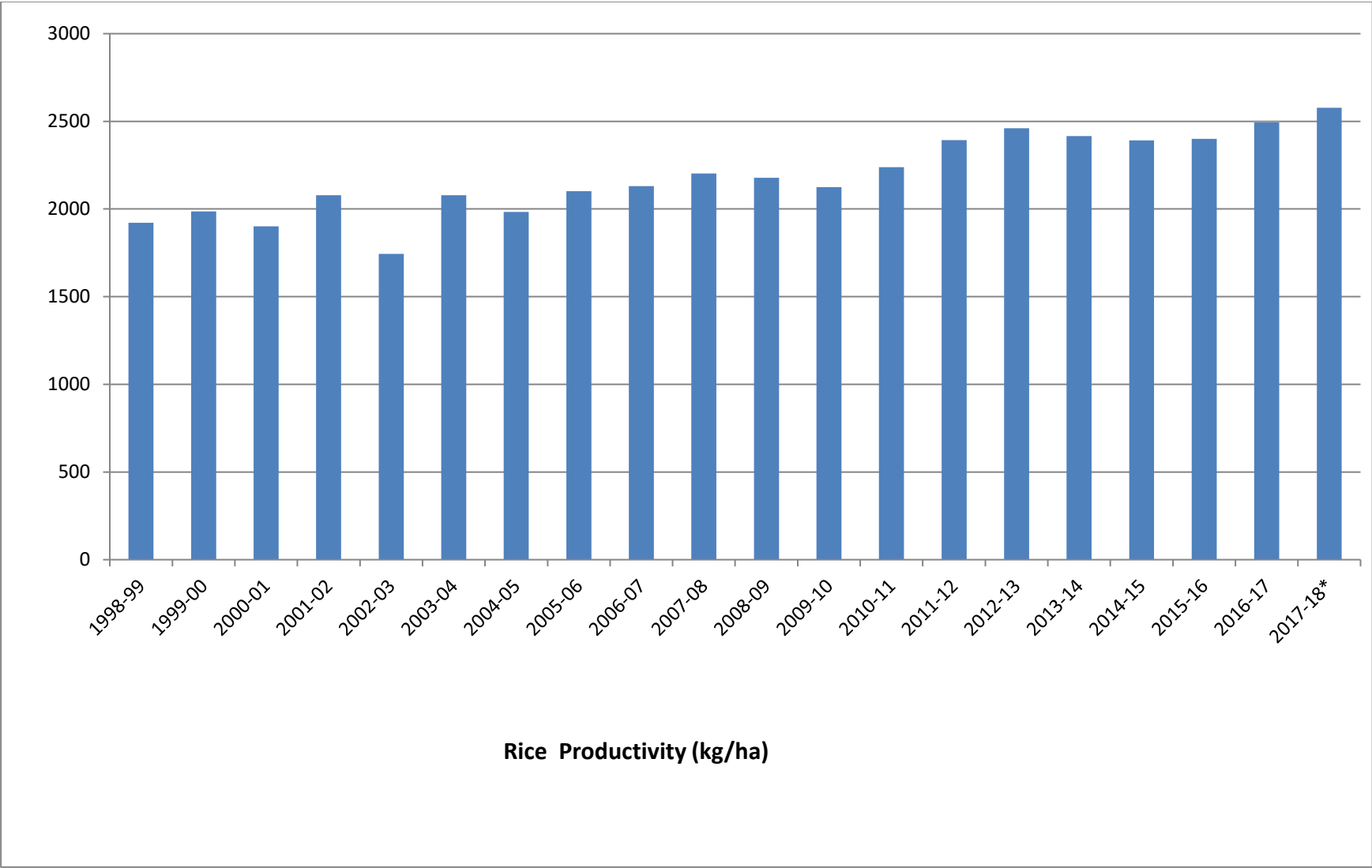


Fig 2: Productivity of rice in India in 1998-99 to 2017-18



4.1.2: Compound growth rate of area, production and productivity of wheat of India

Compound growth rate (%) of area, production and productivity of wheat are presented in table 4.2. For wheat crop, the area was increases from 27.52 to 29.58 million hectares i.e. 2.06 million hectares while the production and productivity were increase 71.29 to 99.70 million tonnes and 2590 to 3371 kg/ ha respectively for India during the last 20 years (1998-2018). For wheat crop compound growth rates of area 0.957 per cent was observed in India for 1998-99 to 2017-18 period, while the compound growth rates were found to be 2.070 per cent and 1.103 per cent for production and productivity respectively in case of India. Area, production and productivity were increased and compound growth rate are positive and non significant. The values of “t” calculation found to be 7.22, 8.39 and 5.94 for area, production and productivity respectively.

4.1.3 Compound growth rate (%) of area, production and productivity of coarse cereals

Compound growth rate (%) of area, production and productivity of coarse cereals are presented in table 4.3. it was observed coarse cereals crop, the area was decreases from 29.34 to 24.21 million hectares i.e. 5.13 million hectares while increase in production and productivity were 31.34 to 46.99 million tonne and 1068 to 1941 kg/ha respectively for India during the last 20 years (1998-2018). For coarse cereals crop compound growth rates of area -1.145 per cent was observed in India for 1998-99 to 2017-18 period, while the compound growth rates were found to be 2.227 per cent and 3.411 per cent for production and productivity respectively in case of India. CGR of area was negative and non significant that area of coarse cereals crop was decreased, while production and productivity were increased and compound growth rate of production was positive and significant, compound growth rate of productivity of coarse cereals was positive and highly significant for India. The values of “t” calculation found to be -8.00, 6.40 and 11.39 for area, production and productivity respectively.

Table 4.2: Compound growth rate of area, production and yield of wheat of India

Year	Area (mha)	Production (MT)	Yield (kg/ha)
1998-1999	27.52	71.29	2590
1999-2000	27.49	76.37	2778
2000-2001	25.73	69.68	2708
2001-2002	26.34	72.77	2762
2002-2003	25.20	65.76	2610
2003-2004	26.59	72.16	2713
2004-2005	26.38	68.64	2602
2005-2006	26.48	69.35	2619
2006-2007	27.99	75.81	2708
2007-2008	28.04	78.57	2802
2008-2009	27.75	80.68	2907
2009-2010	28.46	80.80	2839
2010-2011	29.07	86.87	2988
2011-2012	29.86	94.88	3177
2012-2013	30.00	93.51	3117
2013-2014	30.47	95.85	3146
2014-2015	31.47	86.53	2750
2015-2016	30.42	92.29	3034
2016-2017	30.79	98.51	3200
2017-2018	29.58	99.70	3371
Compound growth rate (%)	0.957	2.070	1.103
“t” value calculated	7.22	8.39	5.94

Compound growth rate *is Significant at 5% and ** is highly significant at 1% level

Fig 3: Area and production of wheat in India in 1998-99 to 2017-18

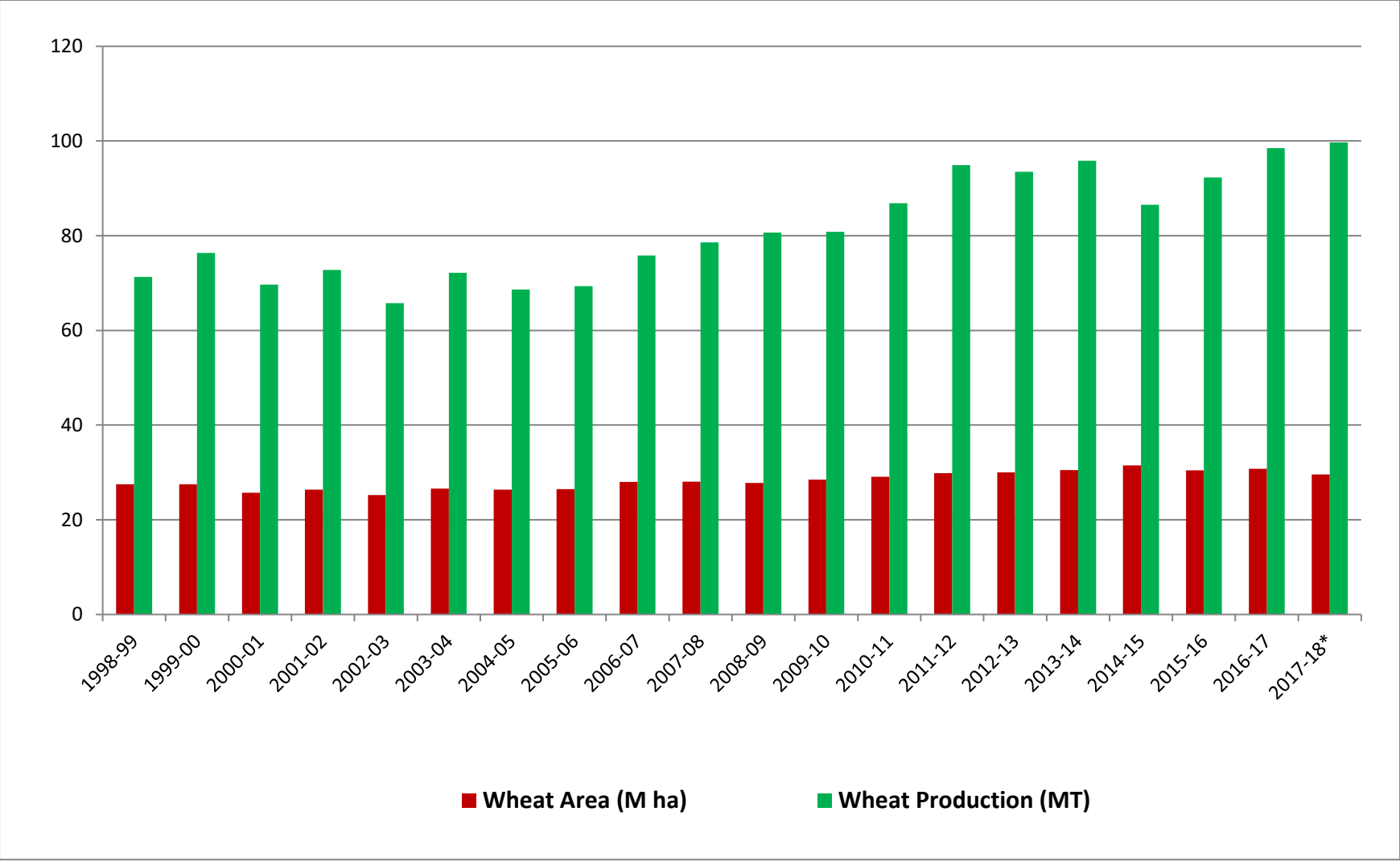


Fig 4: Productivity of wheat in India in 1998-99 to 2017-18

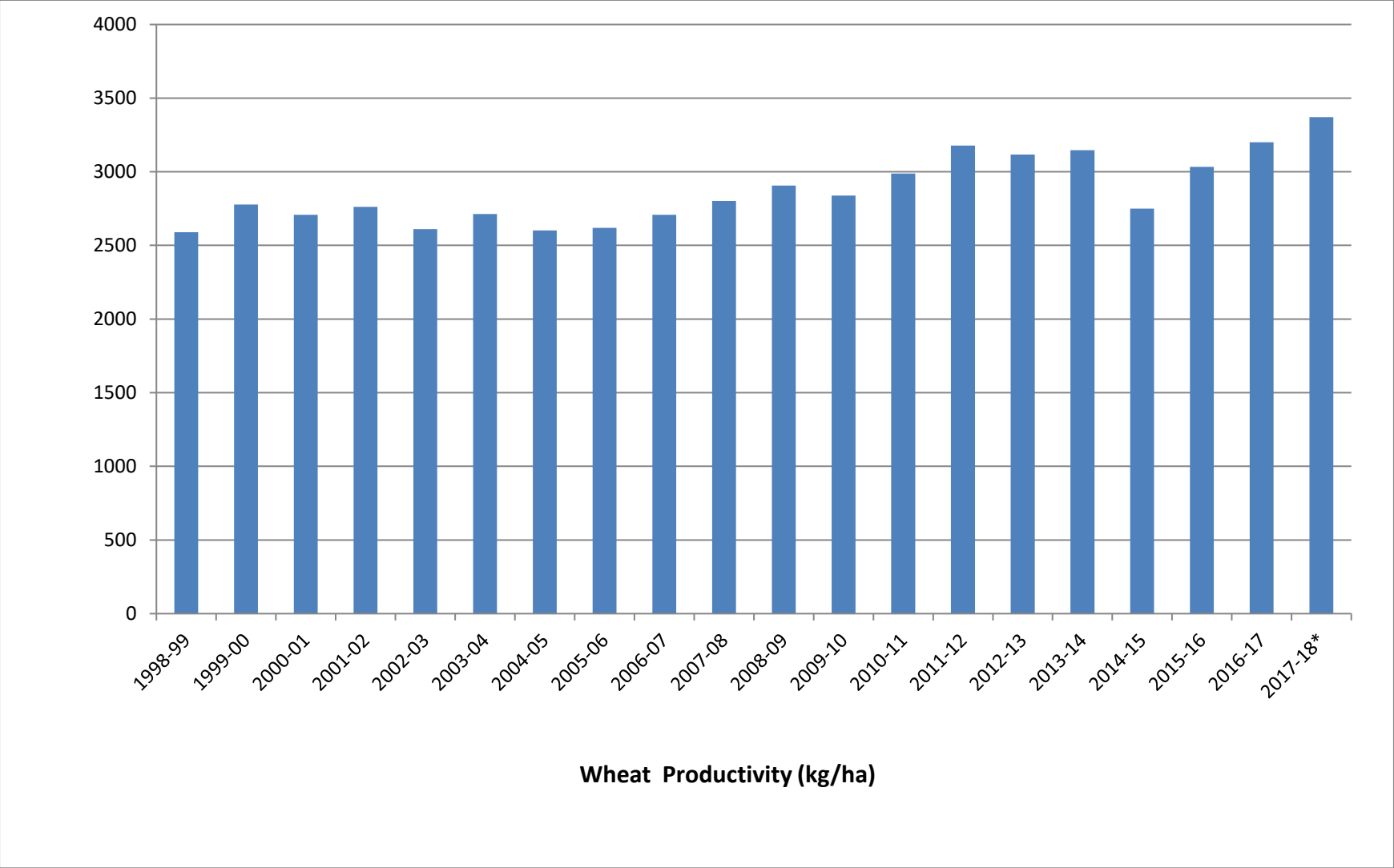


Table 4.3: Compound growth rate of area, production and yield of coarse cereals of India

Year	Area (M ha)	Production (MT)	Yield (kg/ha)
1998-1999	29.34	31.34	1068
1999-2000	29.34	30.33	1034
2000-2001	30.26	31.08	1027
2001-2002	29.52	33.38	1131
2002-2003	26.99	26.07	966
2003-2004	30.80	37.60	1221
2004-2005	29.03	33.46	1153
2005-2006	29.06	34.07	1172
2006-2007	28.71	33.92	1182
2007-2008	28.48	40.75	1431
2008-2009	27.45	40.04	1459
2009-2010	27.68	33.55	1212
2010-2011	28.34	43.40	1531
2011-2012	26.42	42.01	1590
2012-2013	24.76	40.04	1617
2013-2014	25.22	43.29	1717
2014-2015	25.17	42.86	1703
2015-2016	24.39	38.52	1579
2016-2017	25.01	43.77	1750
2017-2018	24.21	46.99	1941
Compound growth rate (%)	-1.145	2.227*	3.411**
“t” value calculated	-8.00	6.40	11.39

Compound growth rate *is Significant at 5% and ** is highly significant at 1% level

Fig 5: Area and production of coarse cereals in India in 1998-99 to 2017-18

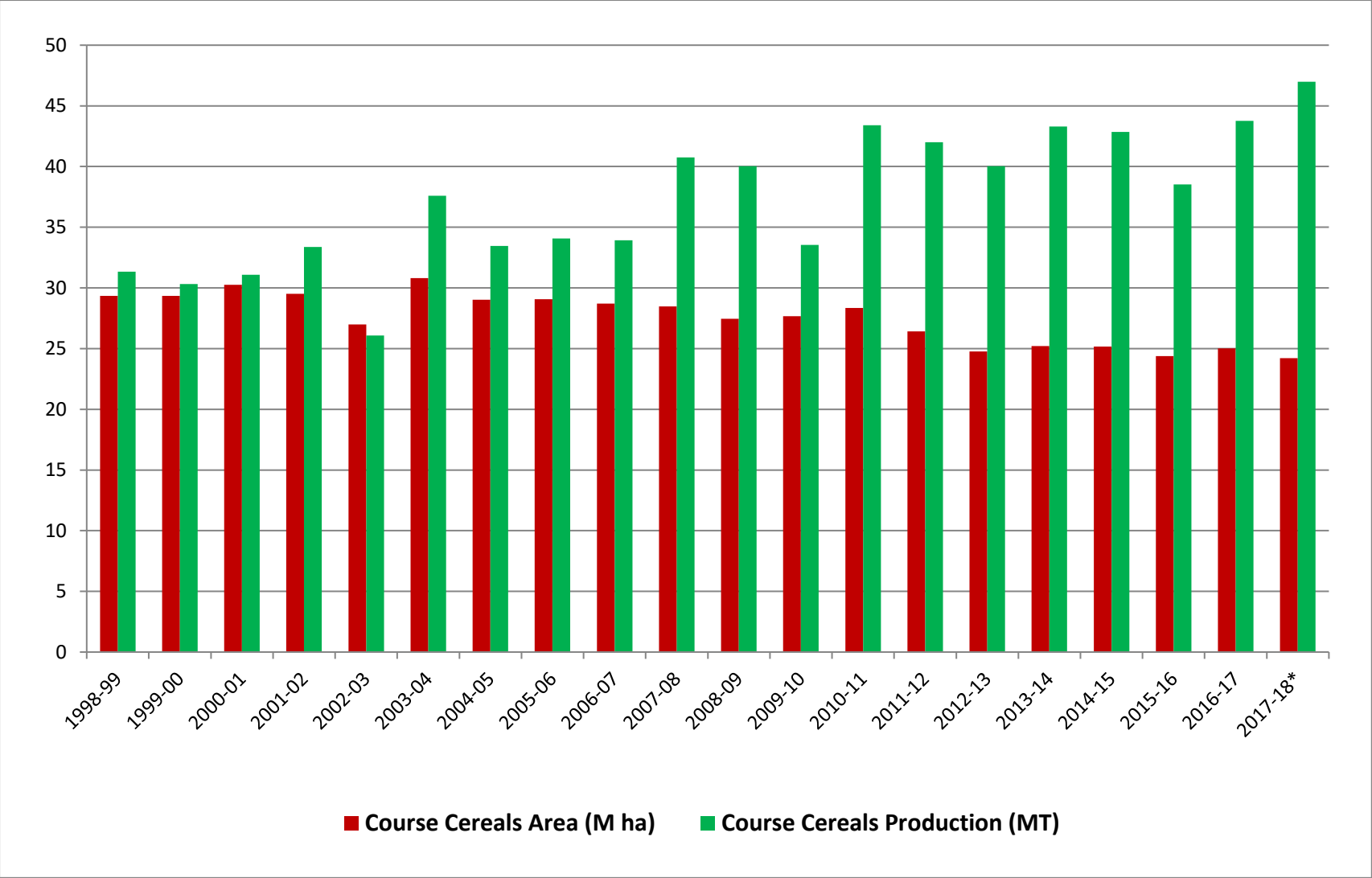
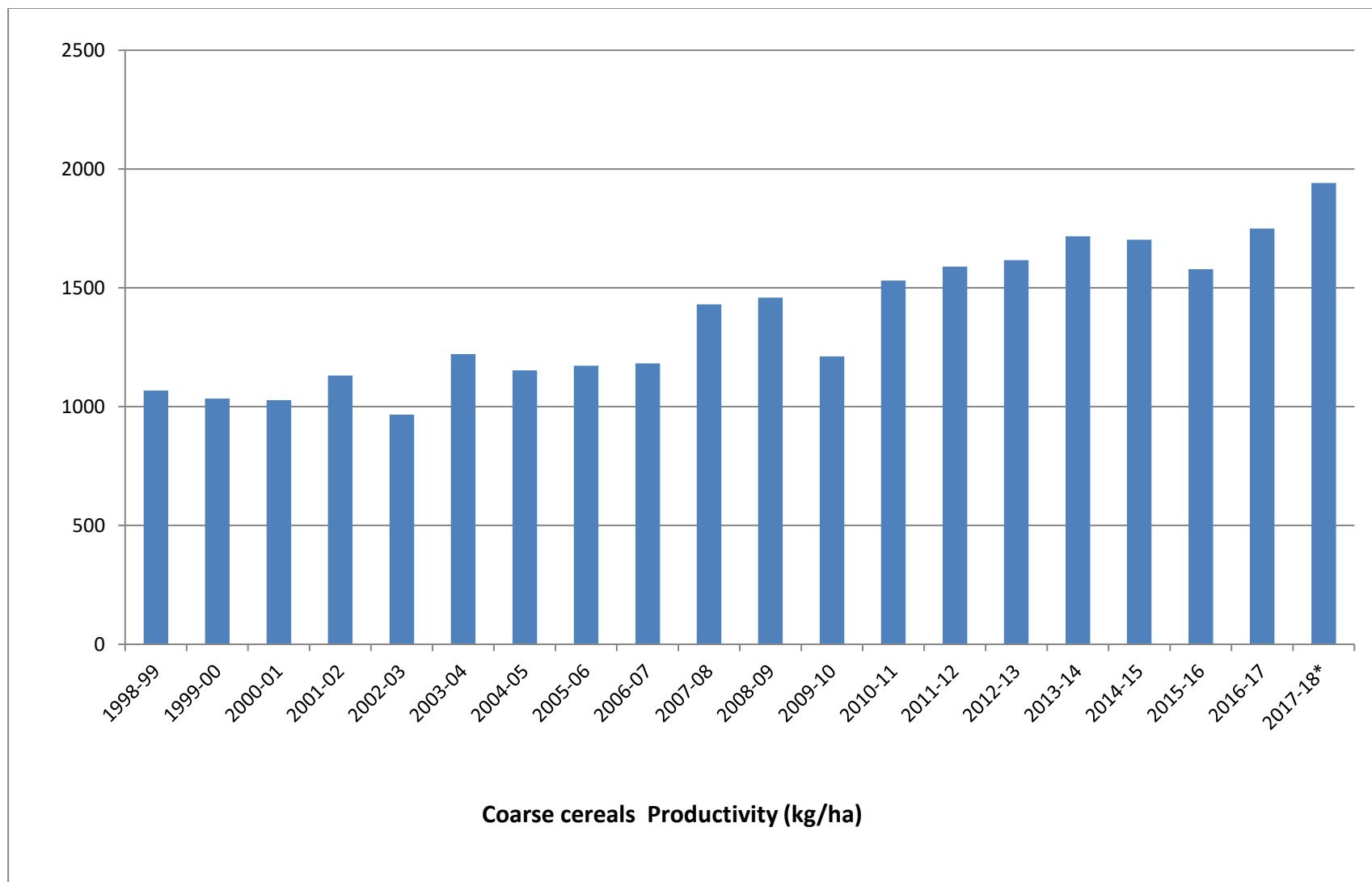


Fig 6: Productivity of Coarse cereals in India in 1998-99 to 2017-18



4.1.4 Compound growth rate (%) of area, production and productivity of total pulses

Compound growth rate (%) of area, production and productivity of total Pulses are presented in table 4.4. For total pulses crop, the area was increases from 23.50 to 29.99 million hectares i.e. 6.49 million hectares while the annual increase in production and productivity were 14.91 to 25.23 million tonne and 634 to 841 kg/ha respectively for India during the last 20 years (1998-2018). For total pulses crop compound growth rates of area 1.337 per cent was observed in India for 1998-99 to 2017-18 period, while the Compound growth rates were found to be 6.027 and 1.672 for production and productivity respectively in case of India. Compound growth rate of area was positive and non significant that area of total pulses crop was increased, while production was found to be positive and highly significant and productivity was found to be increased positive but non significant for India. The values of “t” calculation found to be 5.16, 6.25 and 5.69 for area, production and productivity respectively.

4.1.5 Compound growth rate of area, production and productivity of oilseeds in India

Compound growth rate (%) of area, production and productivity of oil seeds in are presented in table 4.5. For oilseeds crop, the area was decreases from 26.20 to 24.65 million hectares i.e. 1.55 million hectares while the annual increase in production and productivity were found to be 24.75 to 31.31 million tonne and 945 to 1270 kg/ha respectively for India during the last 20 years(1998-2018). For oilseeds crop compound growth rates of area 0.547 per cent was observed in India for 1998-99 to 2017-18 period, while the compound growth rates were 2.483 per cent and 1.925 per cent for production and productivity respectively. Compound growth rate of area was found to be positive and non significant, while production was found to be positive and significant and productivity was increased and their compound growth rate was found to be positive and non significant. The values “t” calculation found to be 2.02, 4.18, and 4.56 for area, production and productivity respectively.

Table 4.4: Compound growth rate of area, production and yield of total pulses of India

Year	Area (mha)	Production (MT)	Yield (kg/ha)
1998-1999	23.50	14.91	634
1999-2000	21.12	13.42	635
2000-2001	20.35	11.08	544
2001-2002	22.01	13.37	607
2002-2003	20.50	11.13	543
2003-2004	23.46	14.91	635
2004-2005	22.76	13.13	577
2005-2006	22.39	13.38	598
2006-2007	23.19	14.20	612
2007-2008	23.63	14.76	625
2008-2009	22.09	14.57	659
2009-2010	23.28	14.66	630
2010-2011	26.40	18.24	691
2011-2012	24.46	17.09	699
2012-2013	23.26	18.34	789
2013-2014	25.21	19.25	764
2014-2015	23.55	17.15	728
2015-2016	24.91	16.32	655
2016-2017	29.45	23.13	786
2017-2018	29.99	25.23	841
Compound growth rate (%)	1.337	6.027**	1.672
“t” value calculated	5.16	6.25	5.69

Compound growth rate *is Significant at 5% and ** is highly significant at 1% level

Fig 7: Area and production of Total pulses in India in 1998-99 to 2017-18

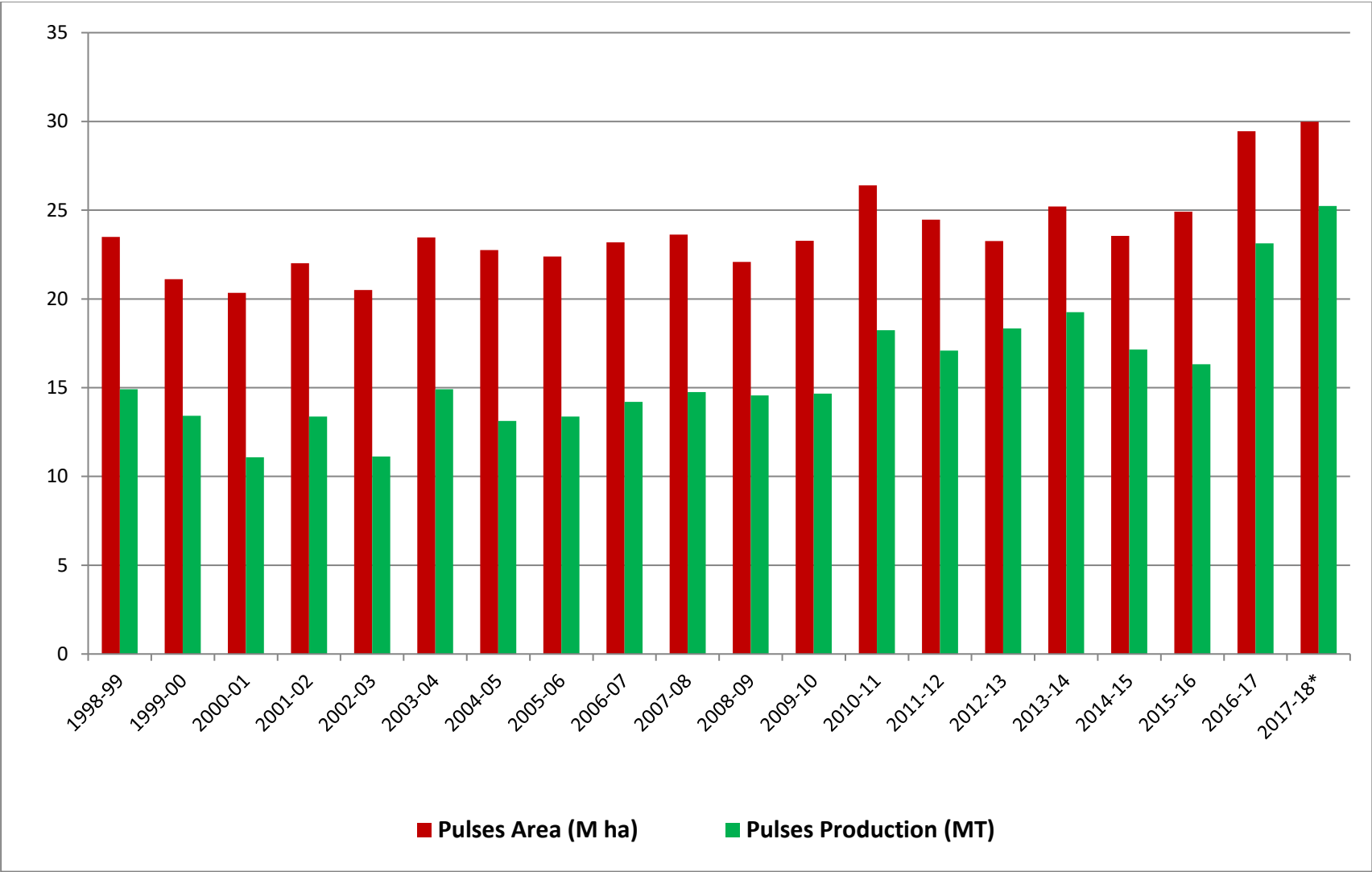


Fig 8: Productivity of total pulses in India in 1998-99 to 2017-18

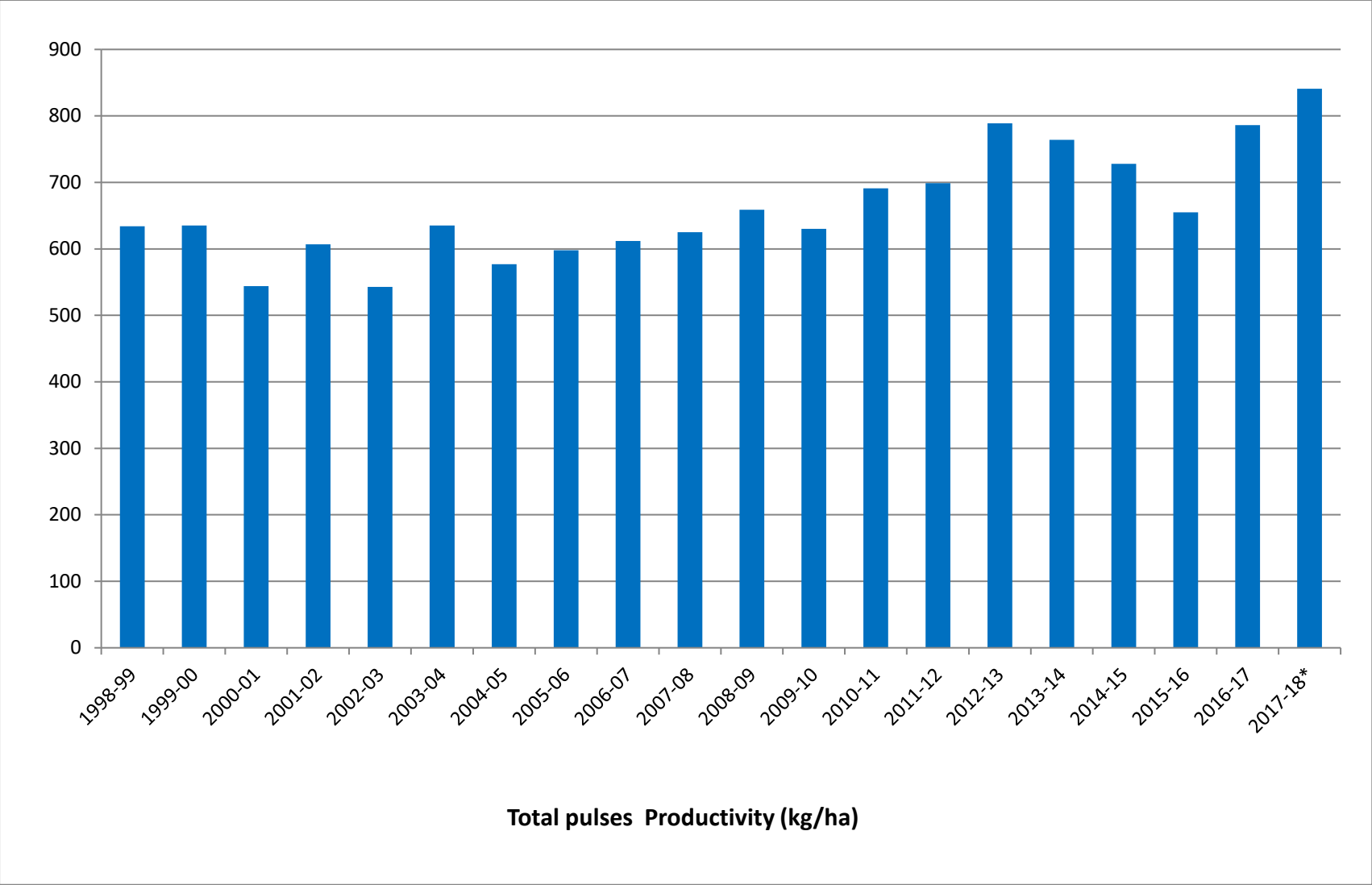


Table 4.5: Compound growth rate of area, production and yield of oilseeds of India

Year	Area (mha)	Production (MT)	Yield (kg/ha)
1998-1999	26.20	24.75	945
1999-2000	24.26	20.71	854
2000-2001	22.77	18.44	810
2001-2002	22.64	20.66	913
2002-2003	21.49	14.84	691
2003-2004	23.66	25.19	1064
2004-2005	27.52	24.35	885
2005-2006	27.86	27.98	1004
2006-2007	26.51	24.29	916
2007-2008	26.69	29.76	1115
2008-2009	27.56	27.72	1006
2009-2010	25.96	24.88	958
2010-2011	27.22	32.48	1193
2011-2012	26.31	29.80	1133
2012-2013	26.48	30.94	1168
2013-2014	28.05	32.75	1168
2014-2015	25.60	27.51	1075
2015-2016	26.09	25.25	968
2016-2017	26.18	31.28	1195
2017-2018	24.65	31.31	1270
Compound growth rate (%)	0.547	2.483*	1.925
“t” value calculated	2.02	4.18	4.56

Compound growth rate *is Significant at 5% and ** is highly significant at 1% level

Fig 9: Area and production of oilseeds in India in 1998-99 to 2017-18

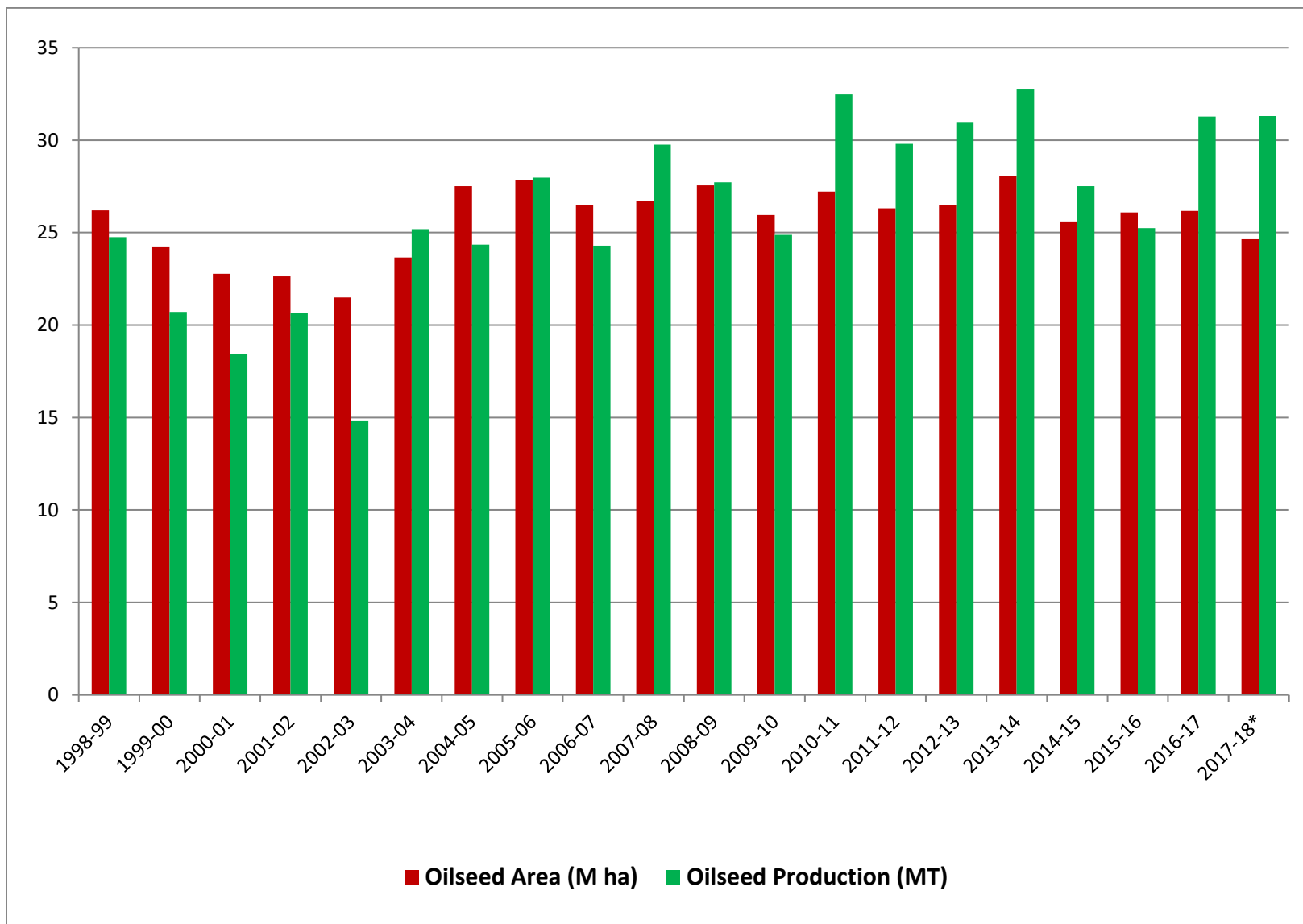
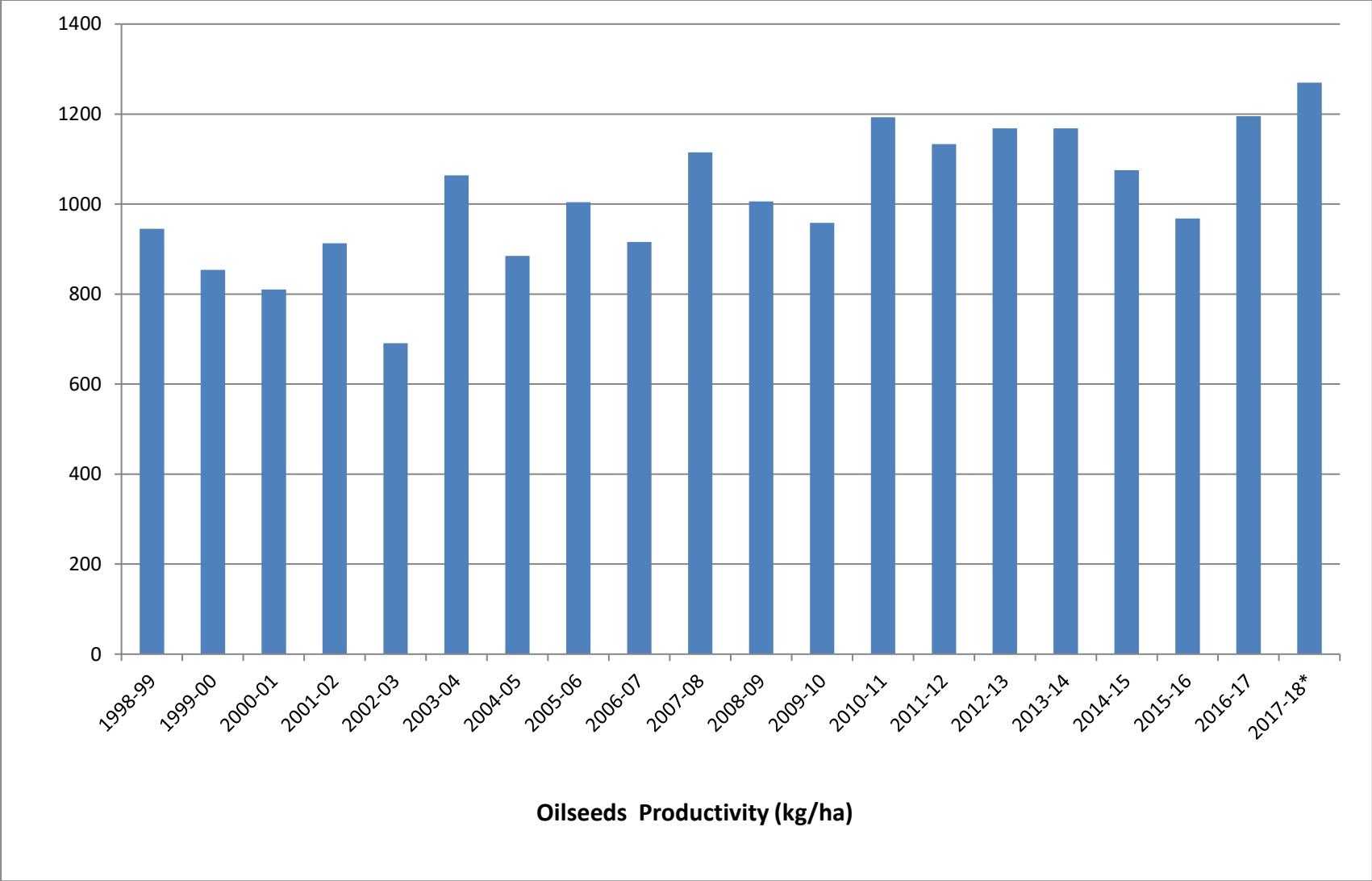


Fig 10: Productivity of oilseeds in India in 1998-99 to 2017-18



4.1.6 Compound growth rate (%) of area, production and productivity of sugarcane in India

Compound growth rate (%) of area, production and productivity of sugarcane are presented in table 4.6. For sugarcane crop, the area was increases from 4.05 to 4.73 million hectares i.e. 0.68 million hectares as well as increase in production and productivity were 288.72 to 376.90 million tonne and 71203 to 79650 kg/ha respectively for India during the last 20 years (1998-2018). For sugarcane crop compound growth rates of area 0.988 per cent was observed in India for 1998-99 to 2017-18 period, while the compound growth rates were 1.457 per cent and 0.468 per cent for production and productivity respectively. Compound growth rate of area, production and productivity found to be positively and non significant. The values of “t” calculation found to be 3.07, 3.39 and 2.25 for area, production and productivity respectively.

4.1.7 Compound growth rate (%) of area, production and productivity of cotton

Compound growth rate (%) of area, production and productivity of cotton are presented in table 4.7. For cotton crop, the area was increases from 9.34 to 12.43 million hectares i.e. 3.09 million hectares while the increase in production and productivity were 12.29 to 34.89 million tonne and 224 to 477 kg/ha respectively for India during the last 20 years (1998-2018). For cotton crop compound growth rates of area was observed 2.427 per cent in India for 1998-99 to 2017-18 period, while the compound growth rates were found to be 8.059 per cent and 5.498 per cent for production and productivity respectively. Compound growth rate of area was found to be positive and significant, while production and productivity were found to be positively and highly significantly. The values of “t” calculation found to be 6.74, 9.25 and 7.11 per cent for area, production and productivity respectively.

Table 4.6: Compound growth rate of area, production and yield of sugarcane of India

Year	Area (mha)	Production(MT)	Yield (kg/ha)
1998-99	4.05	288.72	71203
1999-2000	4.22	299.32	70934
2000-01	4.32	295.96	68578
2001-02	4.41	297.21	67370
2002-03	4.52	287.38	63576
2003-04	3.93	233.86	59380
2004-05	3.66	237.09	64752
2005-06	4.20	281.17	66919
2006-07	5.15	355.52	69022
2007-08	5.06	348.19	68877
2008-09	4.42	285.03	64553
2009-10	4.17	292.30	70020
2010-11	4.88	342.38	70091
2011-12	5.04	361.04	71668
2012-13	5.00	341.20	68254
2013-14	4.99	352.14	70522
2014-15	5.07	362.33	71511
2015-16	4.93	348.45	70720
2016-17	4.44	306.07	69001
2017-18	4.73	376.90	79650
Compound growth rate (%)	0.988	1.457	0.468
“t” value calculated	3.07	3.39	2.25

Compound growth rate *is Significant at 5% and ** is highly significant at 1% level

Fig 11: Area of sugarcane in India in 1998-99 to 2017-18

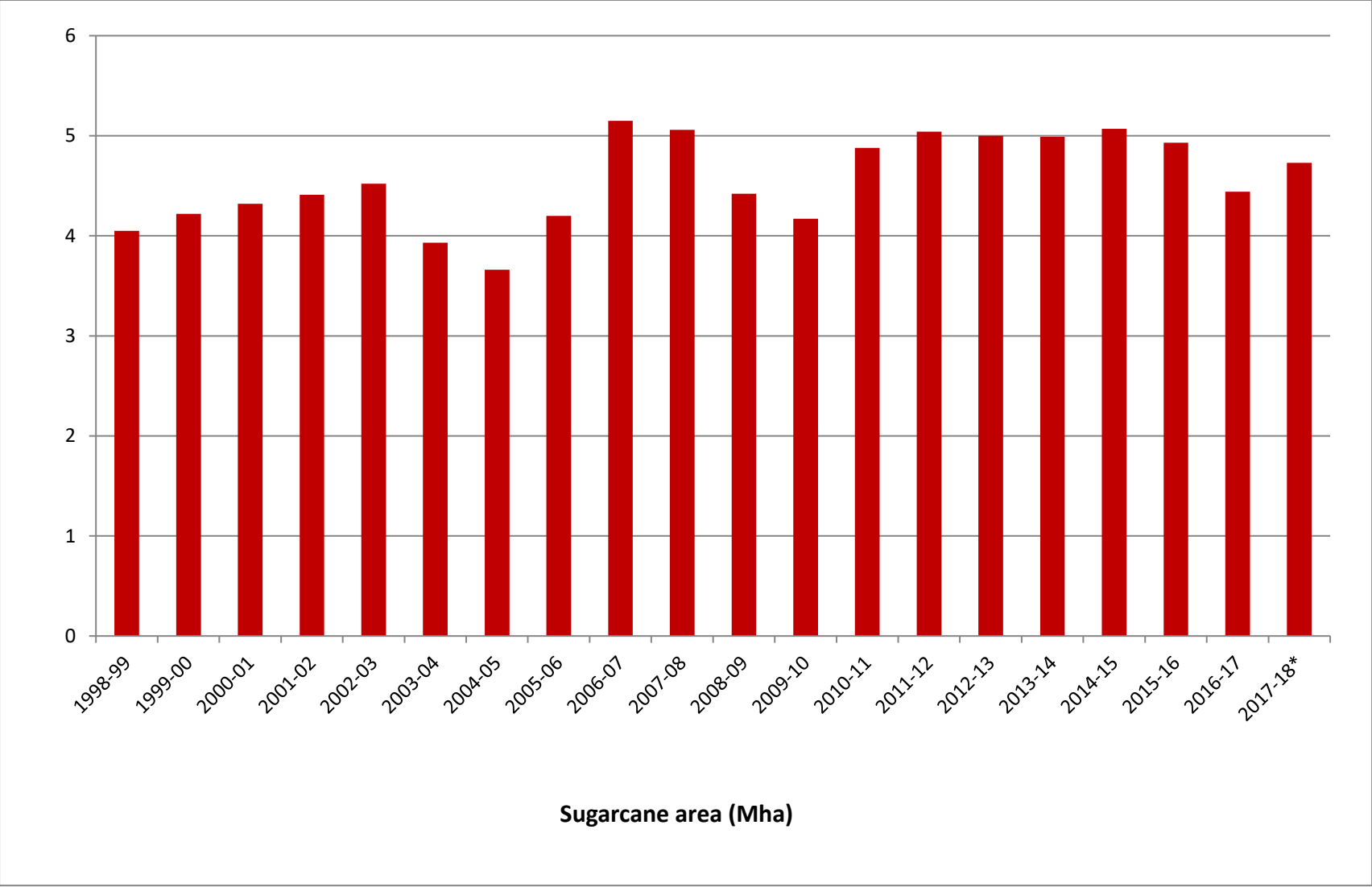


Fig 12: Production of sugarcane in India in 1998-99 to 2017-18

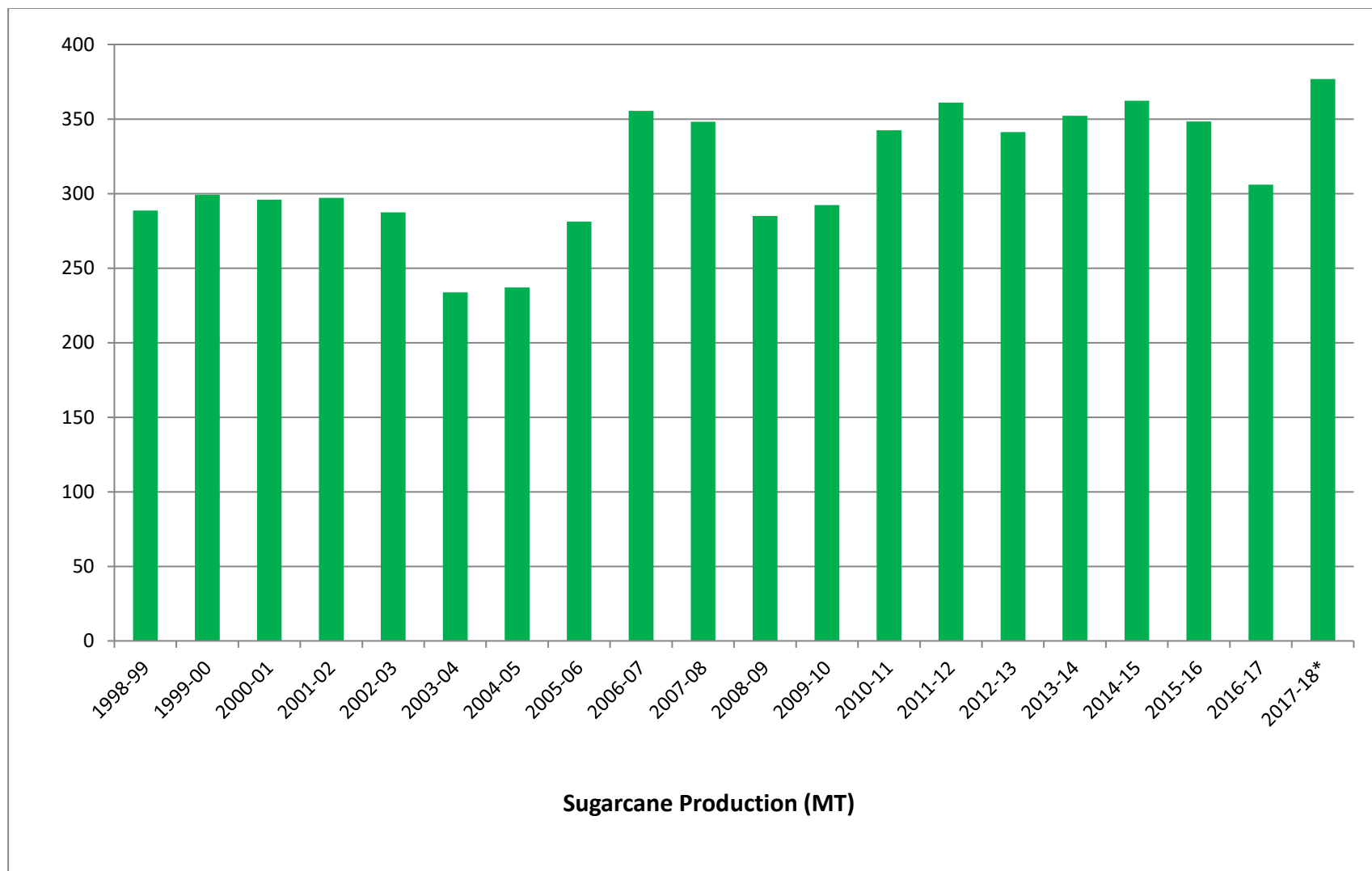


Fig 13: Productivity of sugarcane in India in 1998-99 to 2017-18

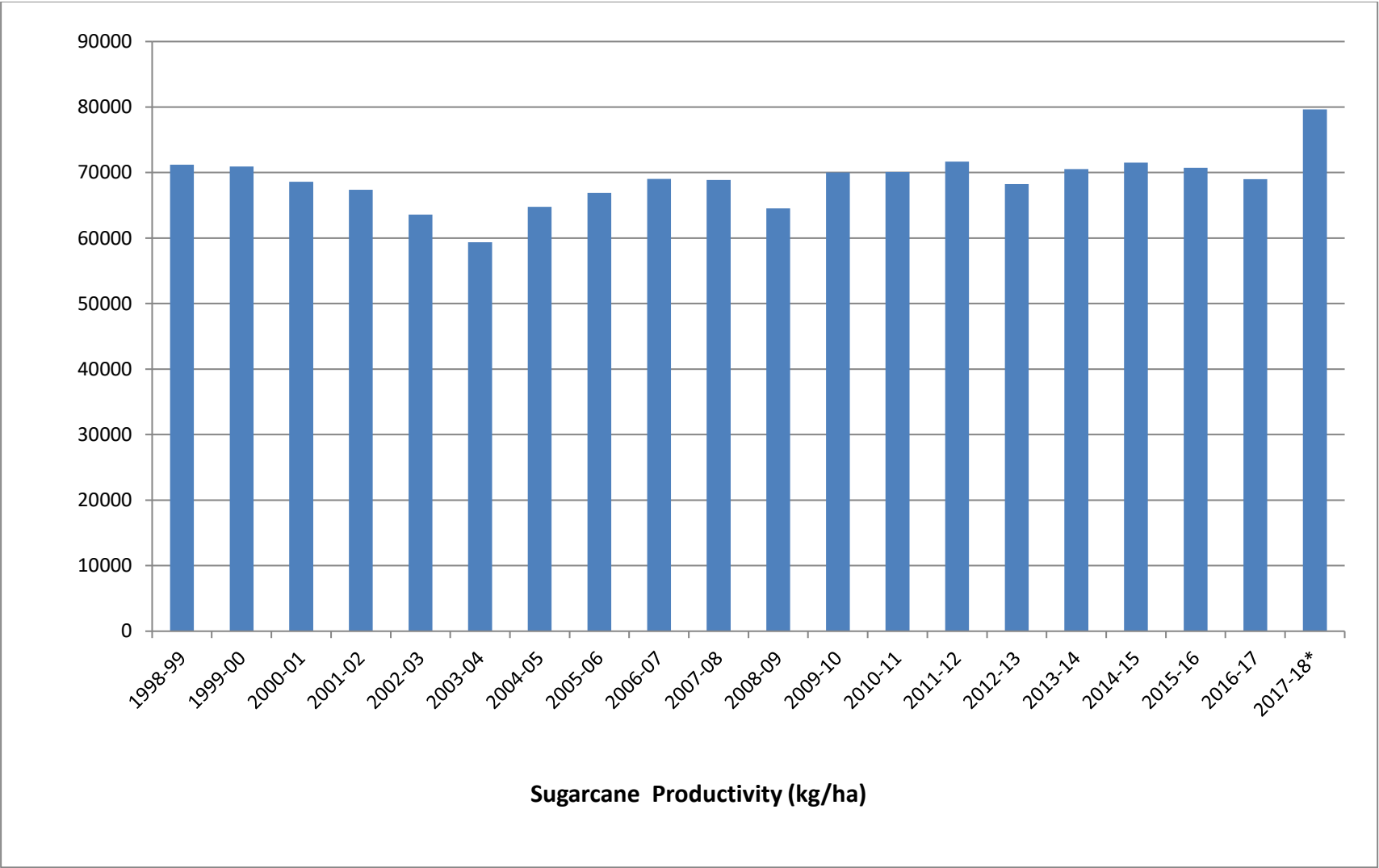


Table 4.7: Compound growth rate of area, production and yield of cotton of India .

Year	Area (mha)	Production(MT)	Yield (kg/ha)
1998-99	9.34	12.29	224
1999-2000	8.71	11.53	225
2000-01	8.53	9.52	190
2001-02	9.13	10.00	186
2002-03	7.67	8.62	191
2003-04	7.60	13.73	307
2004-05	8.79	16.43	318
2005-06	8.68	18.50	362
2006-07	9.14	22.63	421
2007-08	9.41	25.88	467
2008-09	9.41	22.28	403
2009-10	10.13	24.02	403
2010-11	11.24	33.00	499
2011-12	12.18	35.20	491
2012-13	11.98	34.22	486
2013-14	11.96	35.90	510
2014-15	12.82	34.80	462
2015-16	12.29	30.01	415
2016-17	10.83	32.58	512
2017-18	12.43	34.89	477
Compound growth rate (%)	2.427*	8.059**	5.498**
“t” value calculated	6.74**	9.25**	7.11**

Compound growth rate *is Significant at and ** is highly significant at 5% level

Fig 14: Area and production of cotton in India in 1998-99 to 2017-18

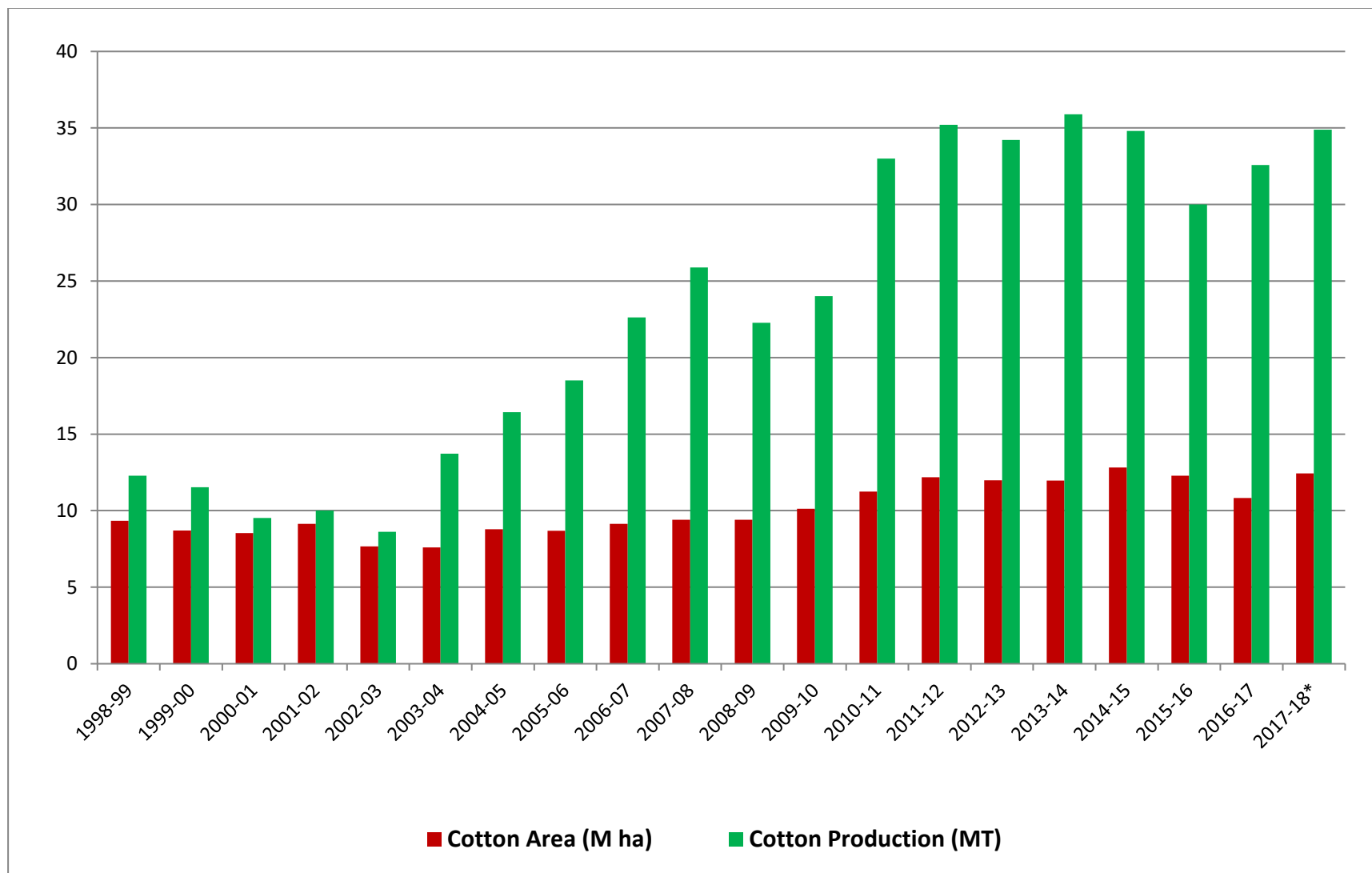
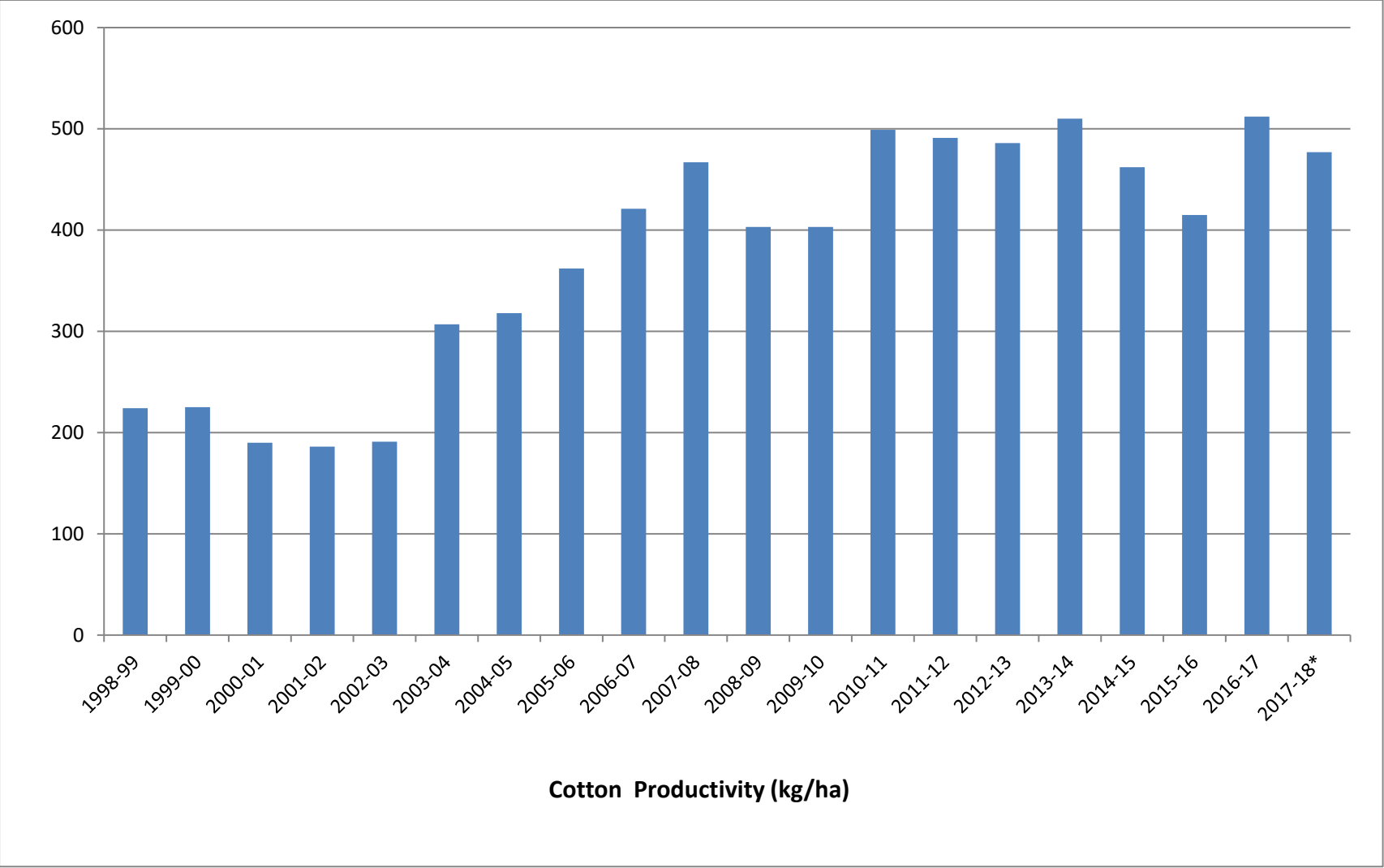


Fig 15: Productivity of cotton in India in 1998-99 to 2017-18



4.2: Gap between target & achievement of production of major crops of India during last 20 years (1998-99 to 2017-18).

4.2.1 Target and achievement of rice production in India

The target and achievement of production of rice in India during 1998-99 to 2017-18 are presented in table 4.8. Where in production target was decide minimum 86 MT and achievement was got 86.08 MT in 1998-99 while maximum production target was decide to 108.50 MT and achievement was got 112.91 MT. The under achievement target year of production of rice were find to be in 2000-01, 2002-03, 2003-04, 2004-05, 2009-10, 2010-11, 2014-15 and 2015-16 while other side more achievement were find to be in 1998-99, 1999-2000, 2001-02, 2005-06, 2006-07, 2007-08, 2008-09, 2011-12, 2013-14, 2014-15, 2016-17 and 2017-18. The target was under achievement (minimum) 77.23% in 2002-03 while the achievement was 104.60% more than target of production of rice in 1999-2000.

4.2.2 Target and achievement of wheat production of India

The target and achievement of production of wheat in India during 1998-99 to 2017-18 are presented in table 4.9. After green revaluation wheat production was increase significantly, where minimum production target was decide minimum 74 MT and achievement was got 71.29 MT in 1998-99 while maximum production target was decide to 97.50 MT and achievement was got 99.70 MT in 2017-18. The under achievement target year of production of wheat were find to be in 1998-99, 2000-01, 2001-02, 2002-03, 2004-05, 2005-06, 2014-15 and 2015-16 while other side more achievement were find to be in 1999-2000, 2003-04, 2006-07, 2007-08, 2008-09, 2010-11, 2011-12, 2013-14, 2014-15, 2016-17 and 2017-18. The target was under achievement (minimum) 84.31% in 2002-03 while the achievement was 112.95% more than target of production of wheat in 2011-12.

Table 4.8: Target and achievement of rice production of India (million tonnes)

Year	Target	Achievement	Achievement % to target
1998-99	86	86.08	100.09
1999-2000	86	89.96	104.60
2000-01	90	84.98	94.42
2001-02	92	93.34	101.46
2002-03	93	71.82	77.23
2003-04	93	88.53	95.19
2004-05	93.50	83.13	88.91
2005-06	87.80	91.79	104.54
2006-07	92.80	93.35	100.59
2007-08	93	96.69	103.97
2008-09	97	99.18	102.25
2009-10	100.50	89.09	88.65
2010-11	102	95.98	94.10
2011-12	102	105.30	103.24
2012-13	104	105.24	101.19
2013-14	105	106.65	101.57
2014-15	106	105.48	99.51
2015-16	106.10	104.41	98.41
2016-17	108.50	109.70	101.11
2017-18	108.50	112.91	104.06

Fig 16: Target and achievement of rice production of India

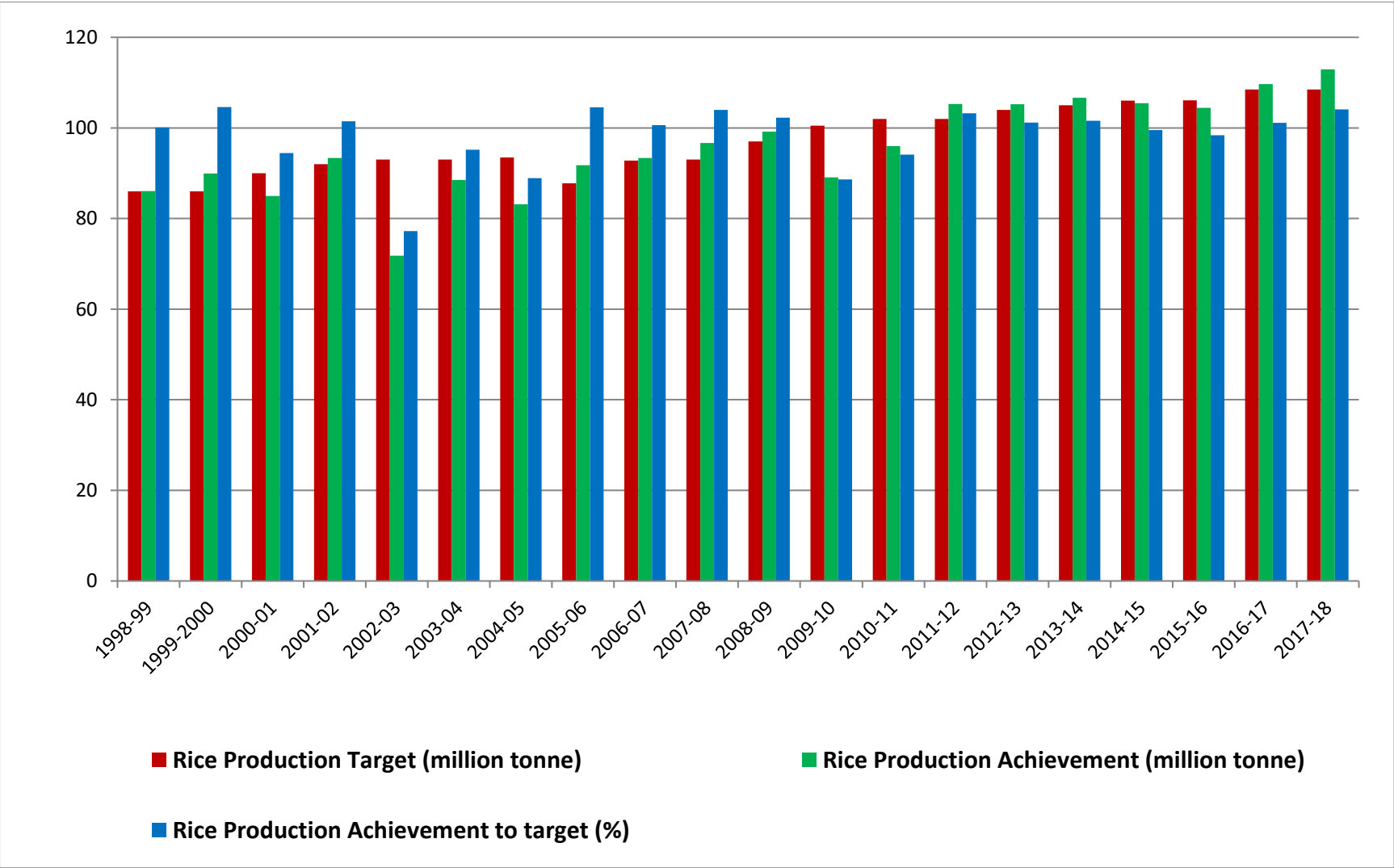
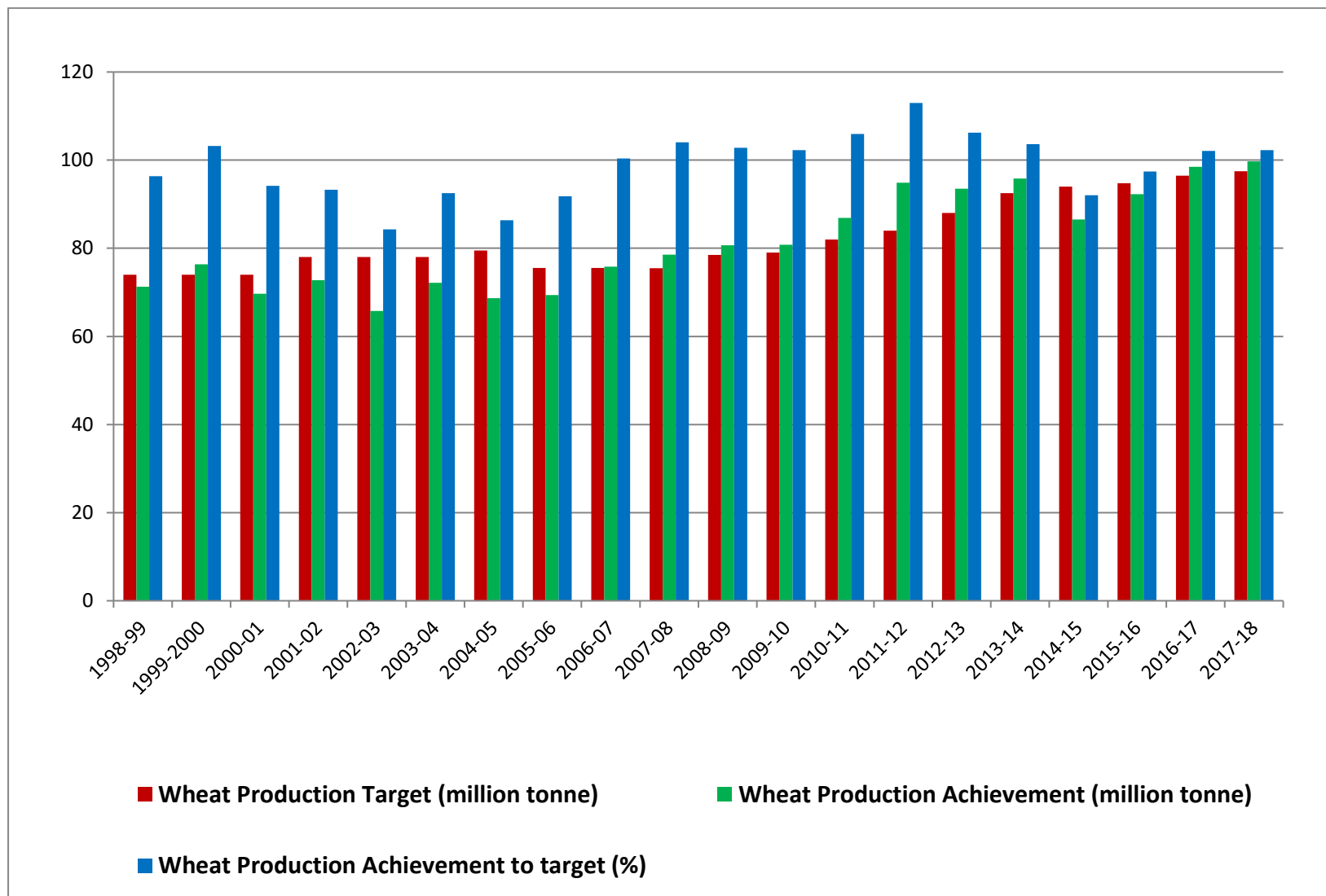


Table 4.9: Target and achievement of wheat production of India (million tonnes)

Year	Target	Achievement	Achievement % to target
1998-99	74	71.29	96.34
1999-2000	74	76.37	103.20
2000-01	74	69.68	94.16
2001-02	78	72.77	93.29
2002-03	78	65.76	84.31
2003-04	78	72.15	92.50
2004-05	79.50	68.64	86.34
2005-06	75.53	69.35	91.82
2006-07	75.53	75.81	100.37
2007-08	75.50	78.57	104.07
2008-09	78.50	80.68	102.78
2009-10	79	80.80	102.28
2010-11	82	86.87	105.94
2011-12	84	94.88	112.95
2012-13	88	93.51	106.26
2013-14	92.50	95.85	103.62
2014-15	94	86.53	92.05
2015-16	94.75	92.29	97.40
2016-17	96.50	98.51	102.08
2017-18	97.50	99.70	102.26

Fig 17: Target and achievement of wheat production of India



4.2.3 Target and achievement of coarse cereals production of India

The target and achievement of production of coarse cereals in India during 1998-99 to 2017-18 are presented in table 10. Coarse cereals production target was decide minimum 34.50 MT for both 1998-99 and 1999-2000 and achievement was got respectively 31.33 and 30.34 MT in 1998-99 while maximum production target was decide to 45.65 MT and achievement was got 46.99 MT in 2017-18. The under achievement target year of production of coarse cereals were find to be in 1998-99, 1999-2000, 2000-2001, 2002-03, 2004-05, 2005-06, 2006-07, 2008-09, 2009-10, 2010-11, 2012-12, 2015-16 and 2016-17 while other side more achievement were find to be in 2001-02, 2003-04, 2007-08, 2011-12, 2013-14, 2014-15 and 2017-18. The target was under achievement (minimum) 77.84% in 2009-10 while the achievement was 110.59% more than target of production of coarse cereals in 2003-04.

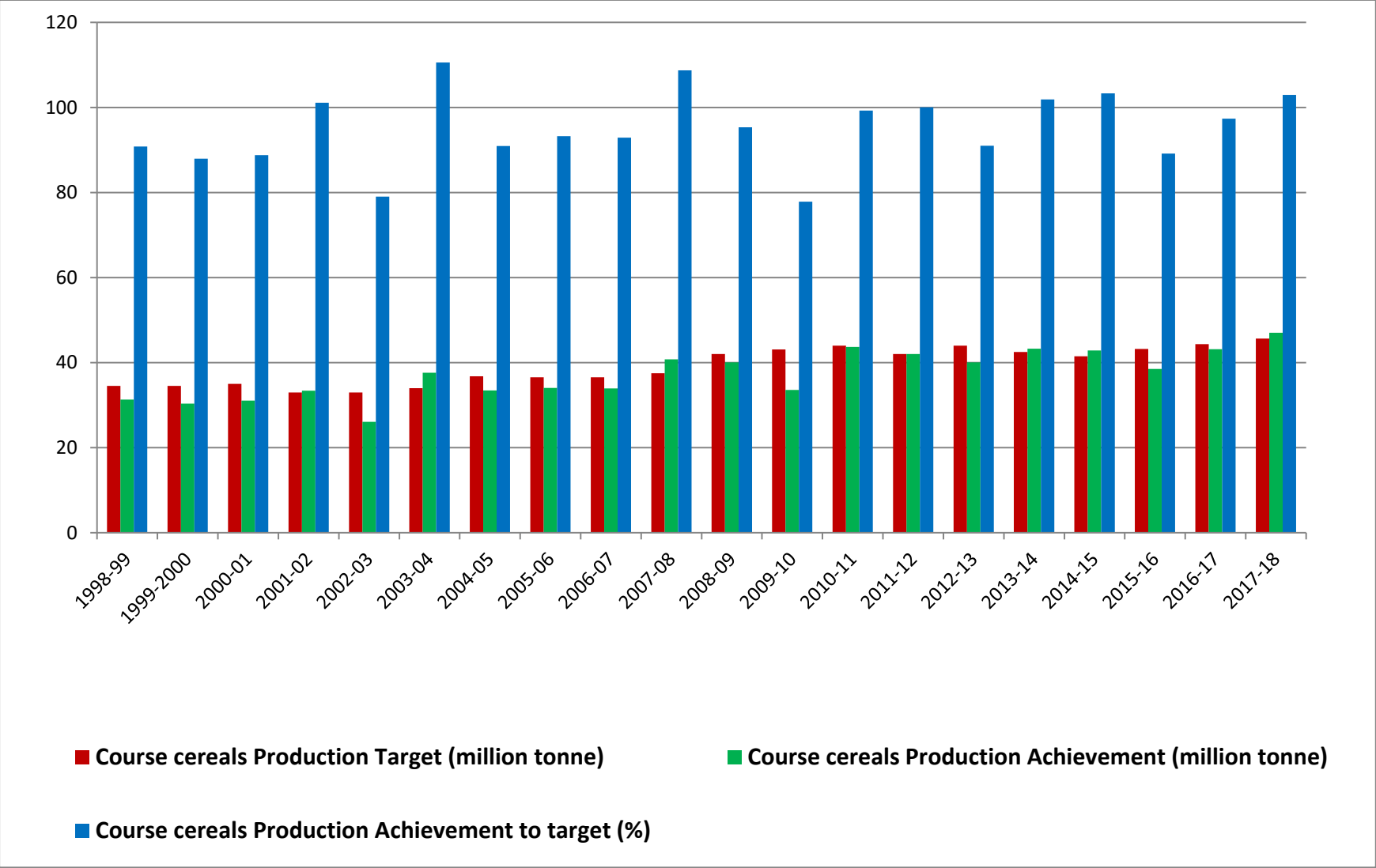
4.2.4 Target and achievement of total pulses production of India

The target and achievement of production of total pulses in India during 1998-99 to 2017-18 are presented in table 4.11. Total pulses production target was decide minimum 15 MT for both 2000-01 and 2003-04 and achievement was got respectively 11.07 and 14.91 MT while maximum production target was decide to 22.90 MT and achievement was got 25.23 MT in 2017-18. The under achievement target year of production of total pulses were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05, 2005-06, 2006-07, 2007-08, 2008-09, 2009-10, 2014-15 and 2015-16 while other side more achievement were find to be in 2010-11, 2011-12, 2012-13, 2013-14, 2016-17 and 2017-18. The target was under achievement (minimum) 69.56% in 2002-03 while the achievement was 110.55% more than target of production of total pulses in 2010-11.

**Table 4.10: Target and achievement of coarse cereals production of India
(million tonnes)**

Year	Target	Achievement	Achievement % to target
1998-99	34.50	31.33	90.81
1999-2000	34.50	30.34	87.94
2000-01	35	31.08	88.80
2001-02	33	33.37	101.12
2002-03	33	26.07	79.00
2003-04	34	37.60	110.59
2004-05	36.80	33.46	90.92
2005-06	36.52	34.06	93.26
2006-07	36.52	33.92	92.88
2007-08	37.50	40.76	108.69
2008-09	42	40.03	95.31
2009-10	43.10	33.55	77.84
2010-11	44	43.68	99.27
2011-12	42	42.01	100.02
2012-13	44	40.04	91.00
2013-14	42.50	43.29	101.86
2014-15	41.50	42.86	103.28
2015-16	43.20	38.52	89.17
2016-17	44.35	43.17	97.34
2017-18	45.65	46.99	102.94

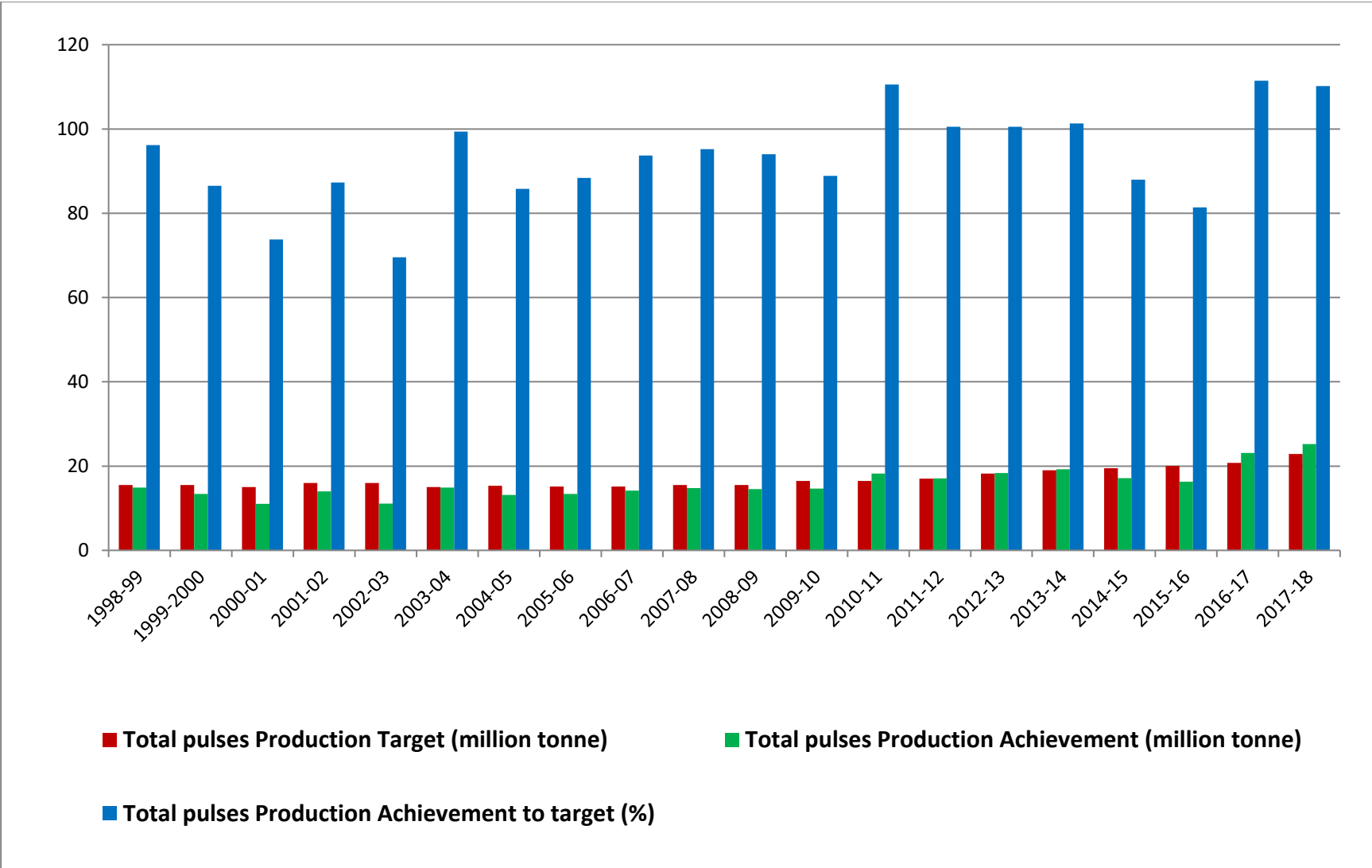
Fig 18: Target and achievement of coarse cereals production of India I



**Table 4.11: Target and achievement of total pulses production of India
(million tonnes)**

Year	Target	Achievement	Achievement % to target
1998-99	15.50	14.91	96.19
1999-2000	15.50	13.41	86.52
2000-01	15	11.07	73.80
2001-02	16	13.97	87.31
2002-03	16	11.13	69.56
2003-04	15	14.91	99.40
2004-05	15.30	13.13	85.82
2005-06	15.15	13.39	88.38
2006-07	15.15	14.20	93.73
2007-08	15.50	14.76	95.23
2008-09	15.50	14.57	94.00
2009-10	16.50	14.66	88.85
2010-11	16.50	18.24	110.55
2011-12	17	17.09	100.53
2012-13	18.24	18.34	100.55
2013-14	19	19.25	101.32
2014-15	19.50	17.15	87.95
2015-16	20.05	16.32	81.40
2016-17	20.75	23.13	111.47
2017-18	22.90	25.23	110.17

Fig 19: Target and achievement of total pulses production of India



4.2.5 Target and achievement of total oilseeds production of India

The target and achievement of production of oil seeds in India during 1998-99 to 2017-18 are presented in table 4.12. Oil seeds production target was decide minimum 27 MT for 1998-99, 1999-2000 and 2002-03 and while maximum production target was decide to 35.50 MT in 2017-18. The under achievement target year of production of oil seed were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2004-05, 2006-07, 2007-08, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2014-15, 2015-16, 2016-17 and 2017-18 while other side more achievement were find to be in 2003-04, 2005-06 and 2013-14. The target was under achievement (minimum) 65.86% in 2000-01 while the achievement was 105.65% more than target of production of oil seed in 2013-14.

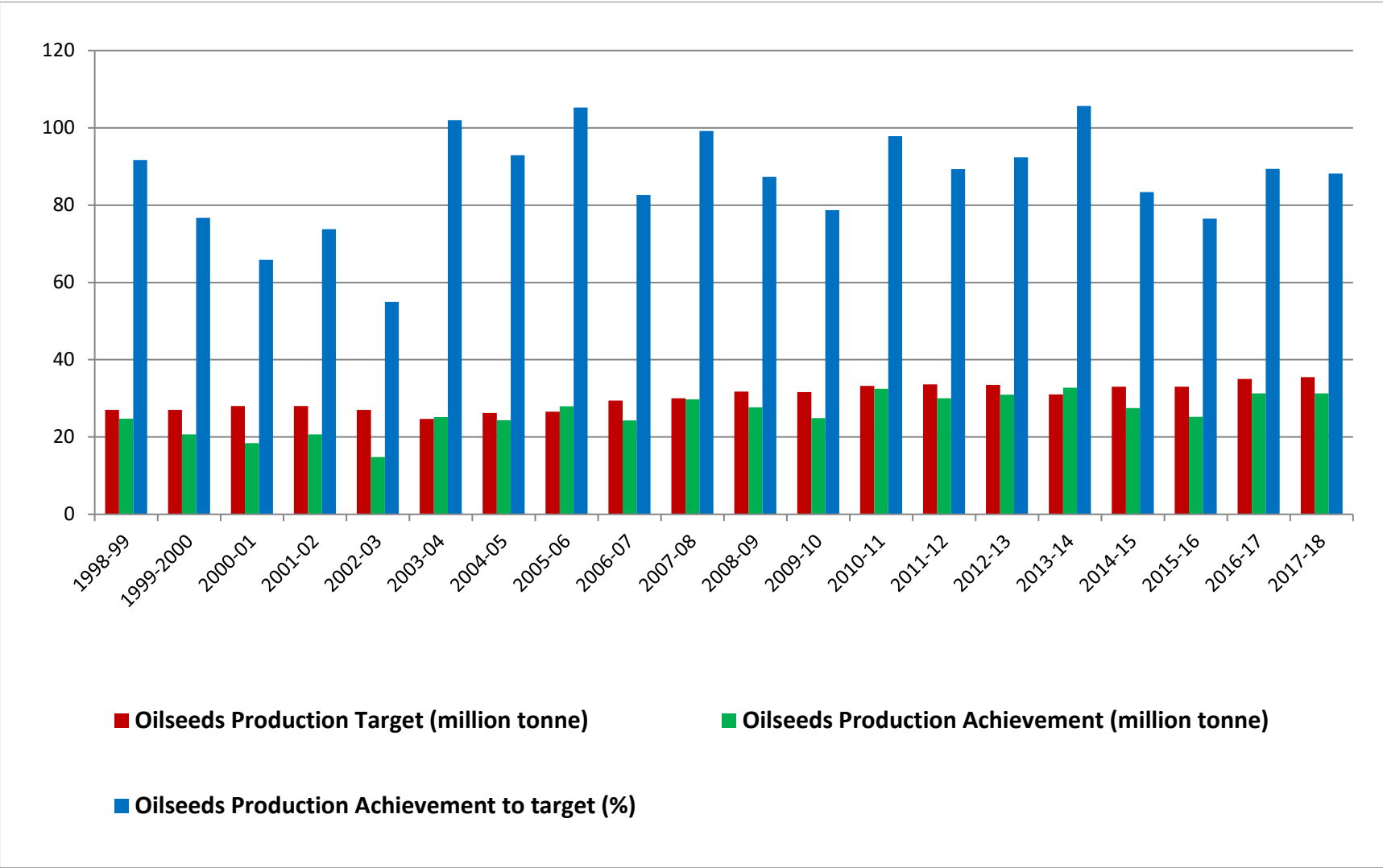
4.2.6 Target and achievement of sugarcane production of India

The target and achievement of production of sugarcane in India during 1998-99 to 2017-18 are presented in table 4.13. Sugarcane production target was decide minimum 237.50 MT for 2005-06 and while maximum production target was decide to 355 MT for 2015-16, 2016-17 and 2017-18. The under achievement target year of production of sugarcane were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05, 2008-09, 2009-10, 2012-13, 2015-16 and 2016-17 while other side more achievement were find to be in 2005-06 2006-07, 2007-08, 2010-11, 2011-12, 2013-14, 2014-15 and 2017-18. The target (minimum) was under achievement 73.08% in 2003-04 while the achievement was 131.67% more that target of production of sugarcane in 2006-07.

**Table 4.12: Target and achievement of total oilseeds production of India
(million tonnes)**

Year	Target	Achievement	Achievement % to target
1998-99	27	24.75	91.67
1999-2000	27	20.71	76.70
2000-01	28	18.44	65.86
2001-02	28	20.66	73.79
2002-03	27	14.84	54.96
2003-04	24.70	25.19	101.98
2004-05	26.20	24.35	92.94
2005-06	26.58	27.98	105.27
2006-07	29.40	24.29	82.62
2007-08	30	29.76	99.20
2008-09	31.75	27.72	87.31
2009-10	31.60	24.88	78.73
2010-11	33.20	32.48	97.83
2011-12	33.60	30.01	89.32
2012-13	33.50	30.94	92.36
2013-14	31	32.75	105.65
2014-15	33	27.51	83.36
2015-16	33	25.25	76.52
2016-17	35	31.28	89.37
2017-18	35.50	31.31	88.20

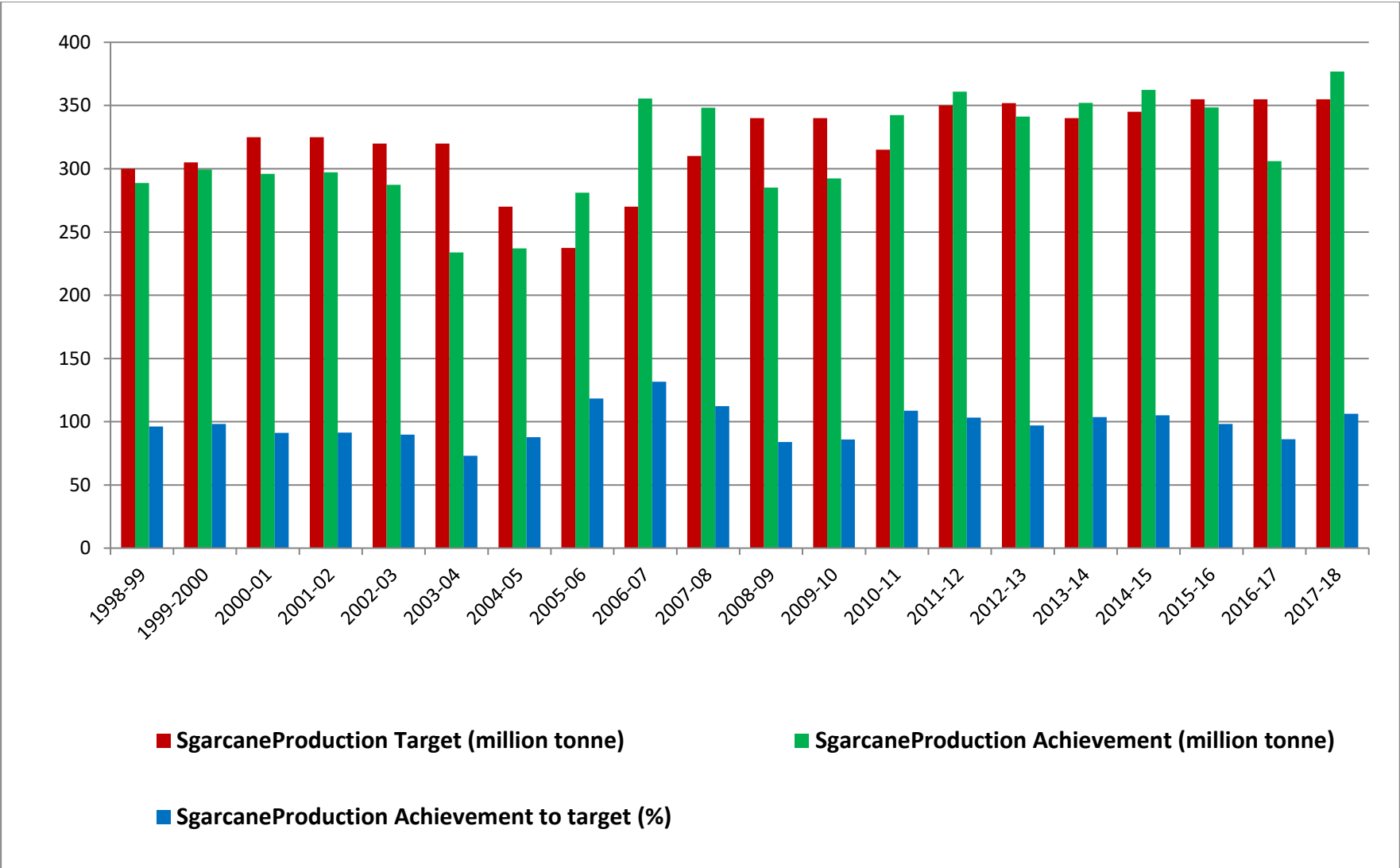
Fig 20: Target and achievement of oilseeds production of India



**Table 4.13: Target and achievement of sugarcane production of India
(million tonnes)**

Year	Target	Achievement	Achievement % to target
1998-99	300	288.72	96.24
1999-2000	305	299.32	98.14
2000-01	325	295.96	91.06
2001-02	325	297.20	91.45
2002-03	320	287.38	89.81
2003-04	320	233.86	73.08
2004-05	270	237.09	87.81
2005-06	237.50	281.17	118.39
2006-07	270	355.52	131.67
2007-08	310	348.19	112.32
2008-09	340	285.03	83.83
2009-10	340	292.30	85.97
2010-11	315	342.38	108.69
2011-12	350	361.04	103.15
2012-13	352	341.20	96.93
2013-14	340	352.14	103.57
2014-15	345	362.33	105.02
2015-16	355	348.45	98.15
2016-17	355	306.07	86.22
2017-18	355	376.90	106.17

Fig 21: Target and achievement of sugarcane production of India



4.2.7 Target and achievement of cotton production of India

The target and achievement of production of cotton in India during 1998-99 to 2017-18 are presented in table 4.14. Cotton production target was decided minimum 14.50 MT in 2000-01 and 2001-02 while maximum production target was decided to 35.50 million tonnes in 2017-18. The under achievement target year of production of cotton were found to be in 1998-99, 1999-2000, 2000-01, 2001-02, 2002-03, 2003-04, 2008-09, 2009-10, 2014-15, 2015-16, 2016-17 and 2017-18. While other side more achievement were found to be in 2004-05, 2005-06, 2006-07, 2007-08, 2010-11, 2011-12, and 2013-14. The target was under achievement (minimum) 57.47% in 2002-03 while the highest achievement was 126.92 per cent more than target of production of cotton in 2010-11.

4.3 State wise trend analysis of area, production and productivity of major crops for next 20 years

4.3.1 Trend of area, production and productivity of rice crops of West Bengal for next 20 years

The trends of area, production and productivity of rice crop for next twenty year (2017-18 to 2037-38) of West Bengal are showing the table 4.15. The area trend of rice is expected to small increases 6.73 (2018-19) to 7.37 million hectare (2037-38) while production trend is expected to increase 50.69 (2017-18) to 91.30 million tonnes (2037-38). The productivity trend of rice is expected to increase from 2940 (2018-19) to 3550 kg per hectare (2037-38). The value of regression of area was found to be negative (-0.0392) that mean area of rice be decrease while the value of regression of production was found to be 2.1375 which is positive and significant that mean production be increases for next 20 years. The value of regression of productivity was found to be 32.1413 which is positive and significant that mean productivity be increases for next 20 years.

Table 4.14: Target and achievement of cotton production of India (million tonnes)

Year	Target	Achievement	Achievement % to target
1998-99	14.80	12.29	83.04
1999-2000	15	11.53	76.87
2000-01	14.50	9.52	65.66
2001-02	14.50	10	68.97
2002-03	15	8.62	57.47
2003-04	15	13.73	91.53
2004-05	15	16.43	109.53
2005-06	16.50	18.50	112.12
2006-07	18.50	22.63	122.32
2007-08	22	25.88	117.64
2008-09	26	22.28	85.69
2009-10	26	24.02	92.38
2010-11	26	33	126.92
2011-12	34	35.20	103.53
2012-13	35	34.22	97.77
2013-14	35	35.90	102.57
2014-15	35	34.81	99.46
2015-16	35.15	30.01	85.38
2016-17	36	32.58	90.50
2017-18	35.50	34.89	98.28

Fig 22: Target and achievement of cotton production of India

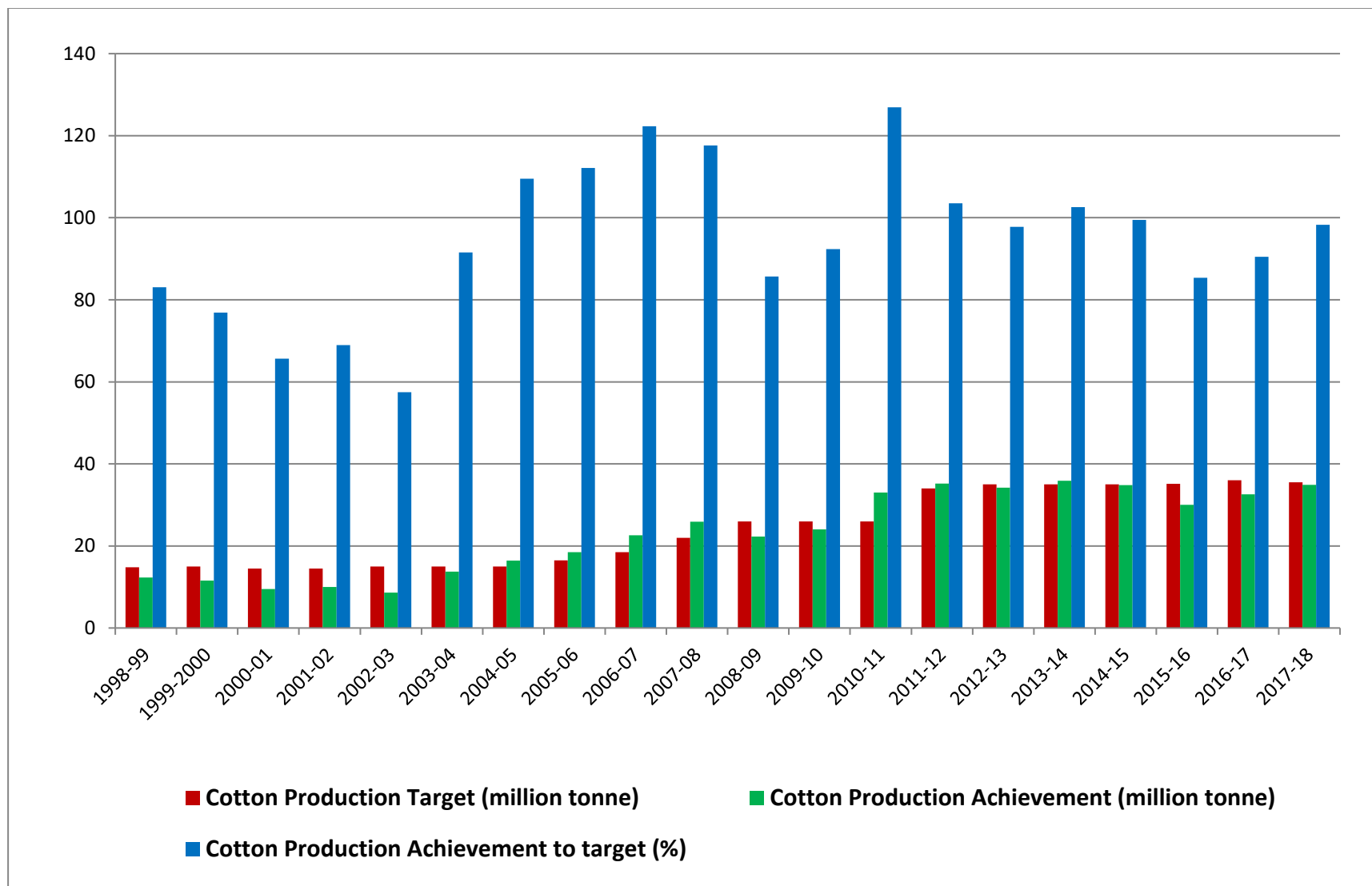


Table 4.15: Trend of area, production and productivity of rice crops of West Bengal for next 20 years (Area- million hectares, Production- million tonnes and Productivity- kg/ha)

Year	Estimated area	Estimated production	Estimated productivity	
2018-19	6.73	50.69	2940	
2019-20	6.76	52.82	2972	
2020-21	6.80	54.96	3004	
2021-22	6.83	57.10	3036	
2022-23	6.86	59.24	3068	
2023-24	6.90	61.37	3100	
2024-25	6.93	63.51	3132	
2025-26	6.97	65.65	3165	
2026-27	7.00	67.79	3197	
2027-28	7.03	69.92	3229	
2028-29	7.07	72.06	3261	
2029-30	7.10	74.20	3293	
2030-31	7.14	76.34	3325	
2031-32	7.17	78.47	3357	
2032-33	7.20	80.61	3390	
2033-34	7.24	82.75	3422	
2034-35	7.27	84.89	3454	
2035-36	7.31	87.02	3486	
2036-37	7.34	89.16	3518	
2037-38	7.37	91.30	3550	
Based on 1998-99 to 2017-18	“b”	-0.0392	2.1375	32.1413
	“a”	6.0160	5.5987	2264.616
	“t”	-4.6560	1.3282	11.8067

Significant at the 0.05 level of probability

Fig 23: Trend of area and production of rice for 2018-19 to 2037-38

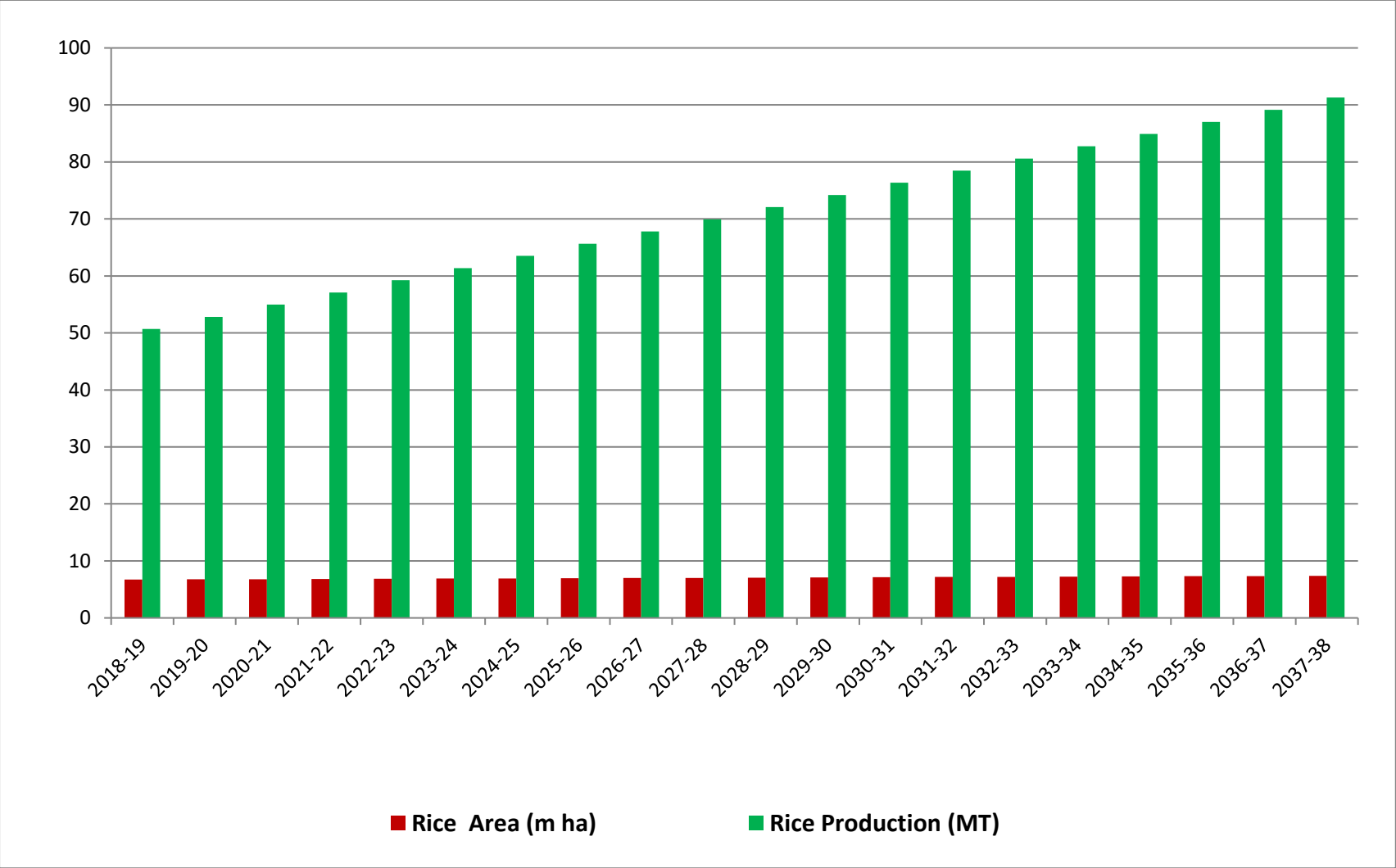
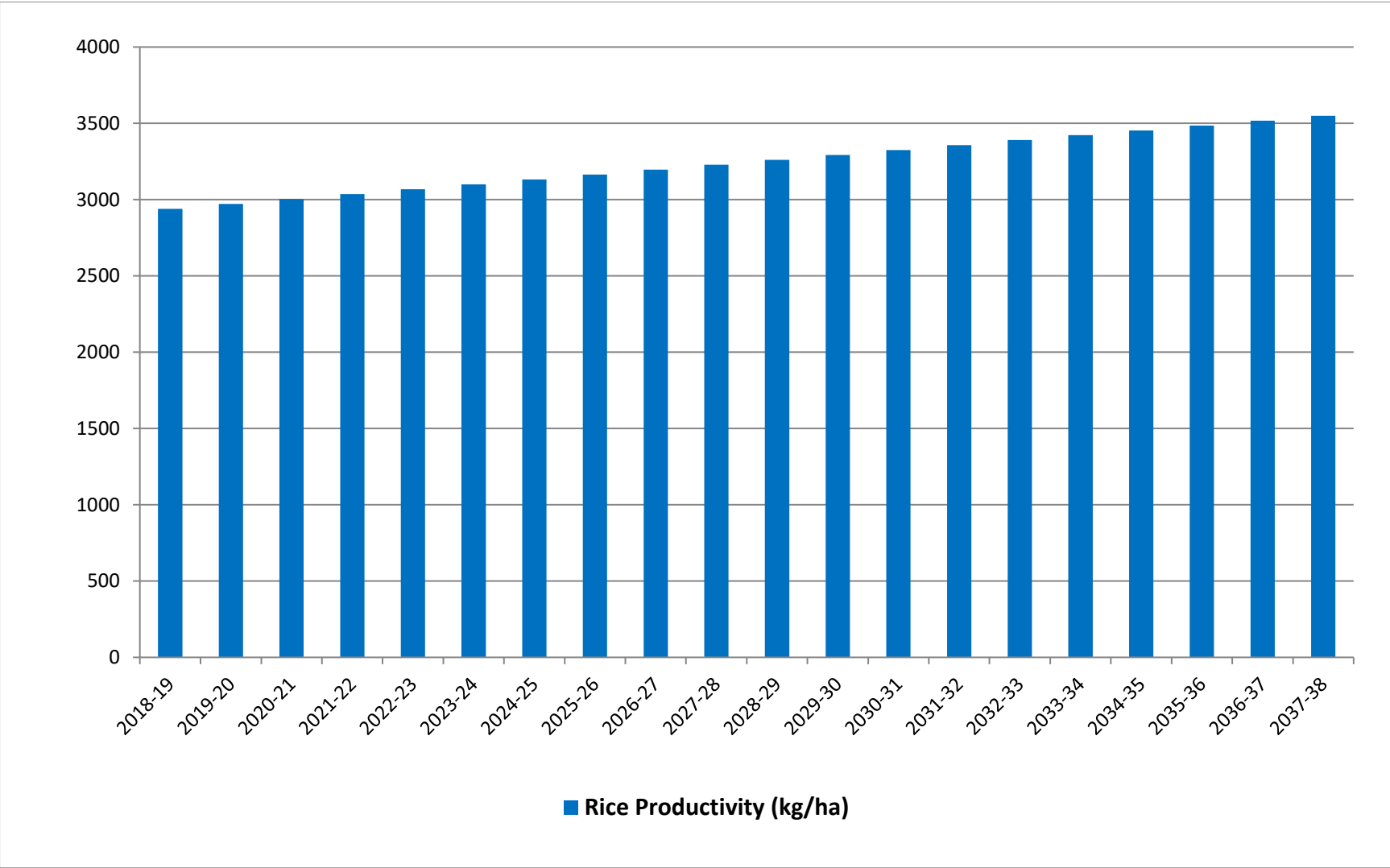


Fig 24: Trend of Productivity of rice for 2018-19 to 2036-37



4.3.2 Trend of area, production and productivity of wheat crops of Uttar Pradesh for next 20 years

The trends of area, production and productivity of wheat crop for next twenty year (2017-18 to 2037-38) of Uttar Pradesh are shown the table 4.16. The area trend of wheat is expected to increase 9.84 (2018-19) to 10.53 million hectare (2037-38) while production trend is expected to be increases 29.81 (2017-18) to 35.47 million tonnes (2037-38). The productivity trend of wheat is expected to be increase from 3047 (2018-19) to 3449 kilogram per hectare (2037-38). The value of regression of area was found to be positive (0.0363) that mean area of wheat be increase while the value of regression of production was found to be 0.2977 which is positive and significant that mean production be increases for next 20 years. The value of regression of productivity of wheat was found to be 21.1609 which are positive and significant that means productivity be increases for next 20 years.

4.3.3 Trend of area, production and productivity of coarse cereals crops of Rajasthan for next 20 years

The trends of area, production and productivity of coarse cereals crop for next twenty year (2017-18 to 2037-38) of Rajasthan are show the table 4.17. The area trend of coarse cereals is expected to small decreases 0.15 million hectare from 6.40 (2018-19) to 6.25 million hectare (2037-38) while production trend is expected to increases 7.80 (2017-18) to 12.10 million tonne (2037-38). The productivity trend of coarse cereals is expected to increase from 1244 (2018-19) to 1985 kilogram per hectare (2037-38). The value of regression of area was found to be negative (-0.0078) and not significant that mean area of coarse cereals be decrease while the value of regression of production was found to be 0.2262 which is positive and non significant that mean production be increases for next 20 years. The value of regression of productivity was found to be 38.9729 which are positive and significant that means productivity be increases for next 20 years.

Table 4.16: Trend of area, production and productivity of wheat crops of Uttar Pradesh for next 20 years (Area- million hectares, Production- million tonnes and Productivity- kg/ha)

Year	Estimated area	Estimated production	Estimated productivity	
2018-19	9.84	29.81	3047	
2019-20	9.88	30.11	3068	
2020-21	9.91	30.41	3089	
2021-22	9.95	30.71	3111	
2022-23	9.98	31.00	3132	
2023-24	10.02	31.30	3153	
2024-25	10.06	31.60	3174	
2025-26	10.09	31.90	3195	
2026-27	10.13	32.19	3216	
2027-28	10.17	32.49	3238	
2028-29	10.20	32.79	3259	
2029-30	10.24	33.09	3280	
2030-31	10.28	33.39	3301	
2031-32	10.31	33.68	3322	
2032-33	10.35	33.98	3343	
2033-34	10.38	34.28	3365	
2034-35	10.42	34.58	3386	
2035-36	10.46	34.87	3407	
2036-37	10.49	35.17	3428	
2037-38	10.53	35.47	3449	
Based on 1998-99 to 2017-18	“b”	0.0363	0.2977	21.1609
	“a”	9.0746	23.5585	2602.711
	“t”	5.1111	3.2147	2.3197

Significant at the 0.05 level of probability

Fig 25: Trend of area and production of wheat for 2018-19 to 2037-38

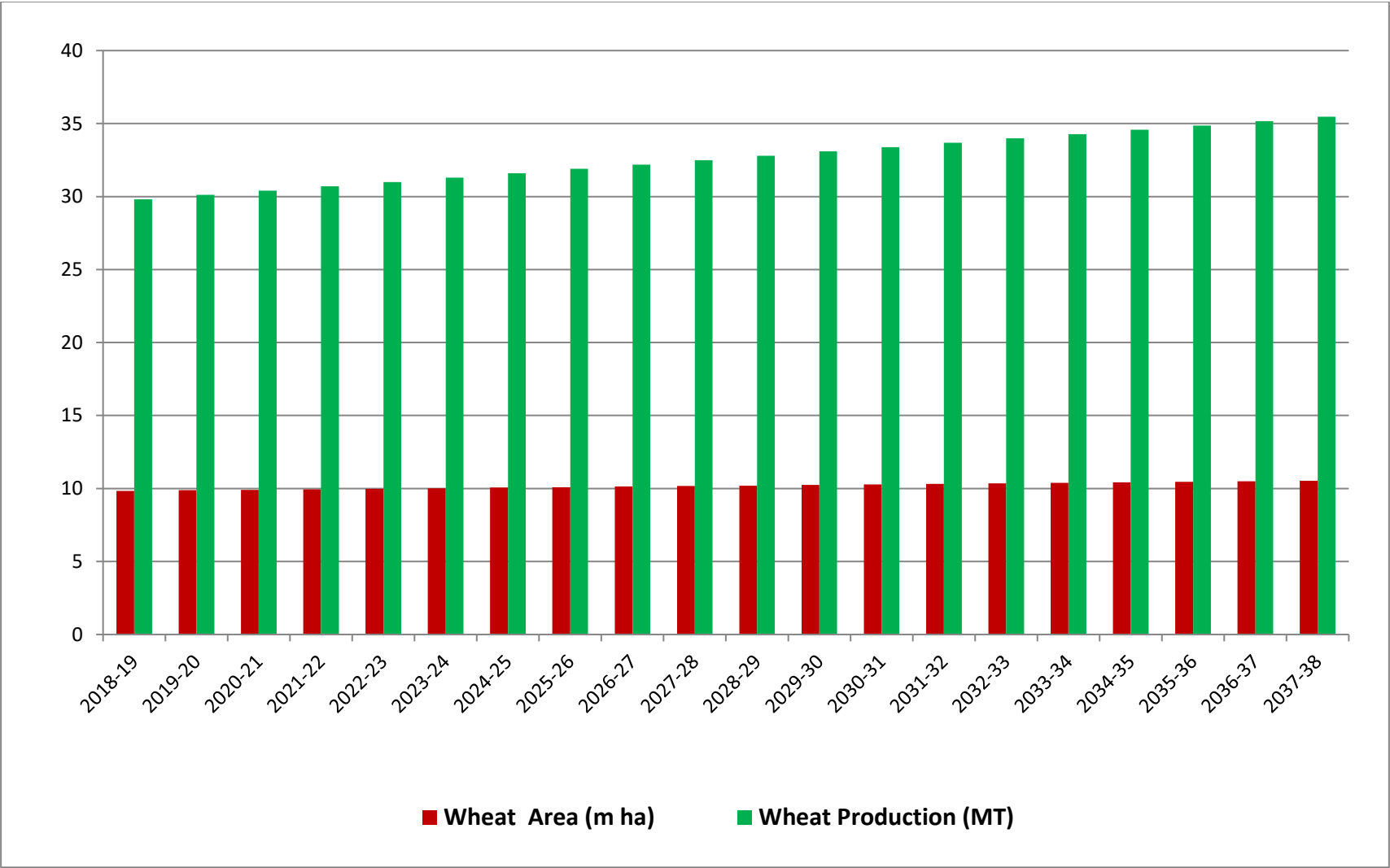


Fig 26: Trend of Productivity of wheat for 2018-19 to 2036-37

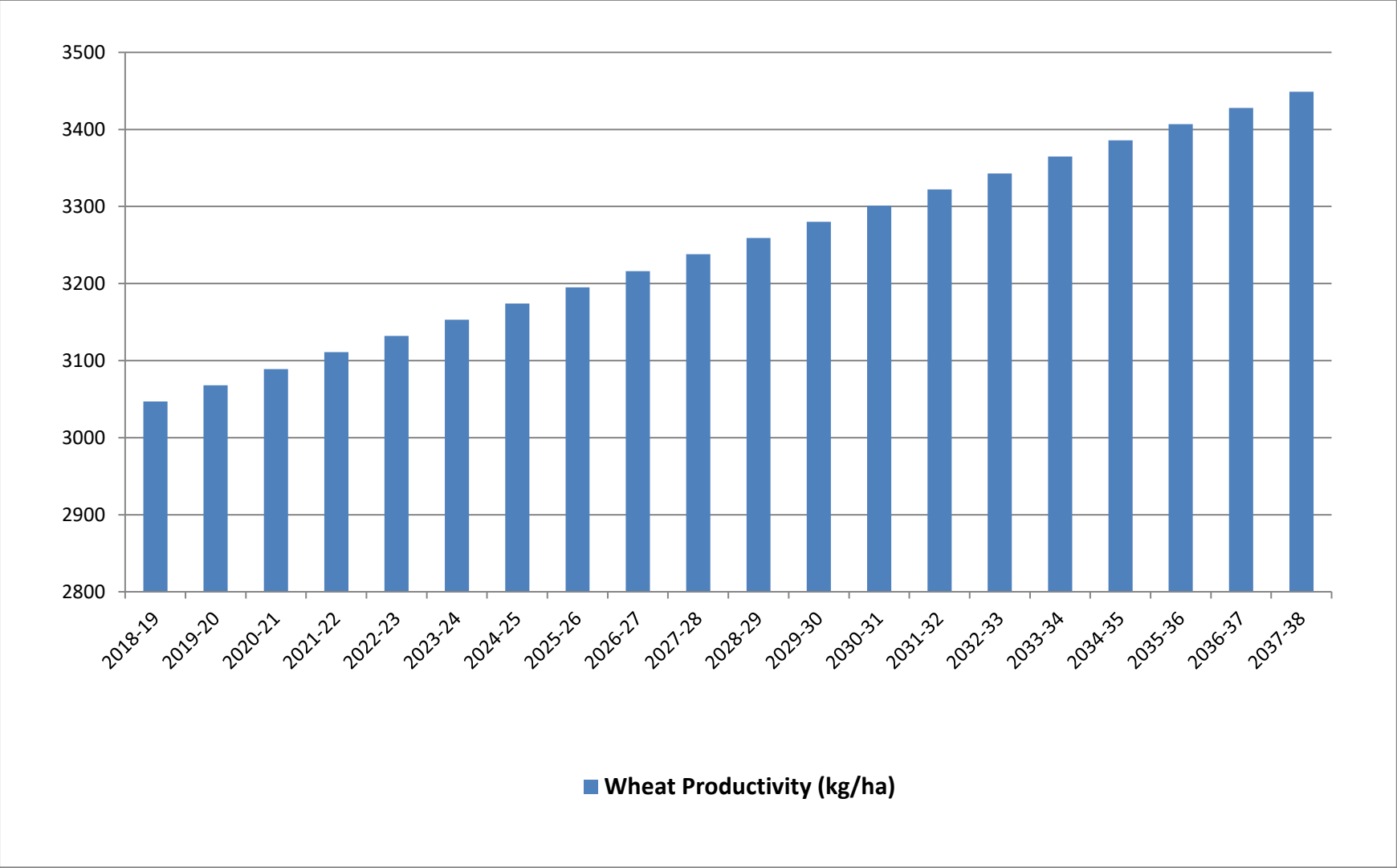


Table 4.17: Trend of area, production and productivity of coarse cereals crops of Rajasthan for next 20 years (Area- million hectares, Production- million tonne and Productivity- kg/ha)

Year		Estimated area	Estimated production	Estimated productivity
2018-19		6.40	7.80	1244
2019-20		6.40	8.02	1283
2020-21		6.39	8.25	1322
2021-22		6.38	8.48	1361
2022-23		6.37	8.70	1400
2023-24		6.36	8.93	1439
2024-25		6.36	9.15	1478
2025-26		6.35	9.38	1517
2026-27		6.34	9.61	1556
2027-28		6.33	9.83	1595
2028-29		6.33	10.06	1634
2029-30		6.32	10.29	1673
2030-31		6.31	10.51	1712
2031-32		6.30	10.74	1751
2032-33		6.29	10.96	1790
2033-34		6.29	11.19	1829
2034-35		6.28	11.42	1868
2035-36		6.27	11.64	1907
2036-37		6.26	11.87	1946
2037-38		6.25	12.10	1985
Based on 1998-99 to 2017-18	“b”	-0.0078	0.2262	38.9729
	“a”	6.5674	3.0453	425.5842
	“t”	-0.2656	4.1030	5.0076

Significant at the 0.05 level of probability

Fig 27: Trend of area and production of coarse cereals for 2018-19 to 2037-38

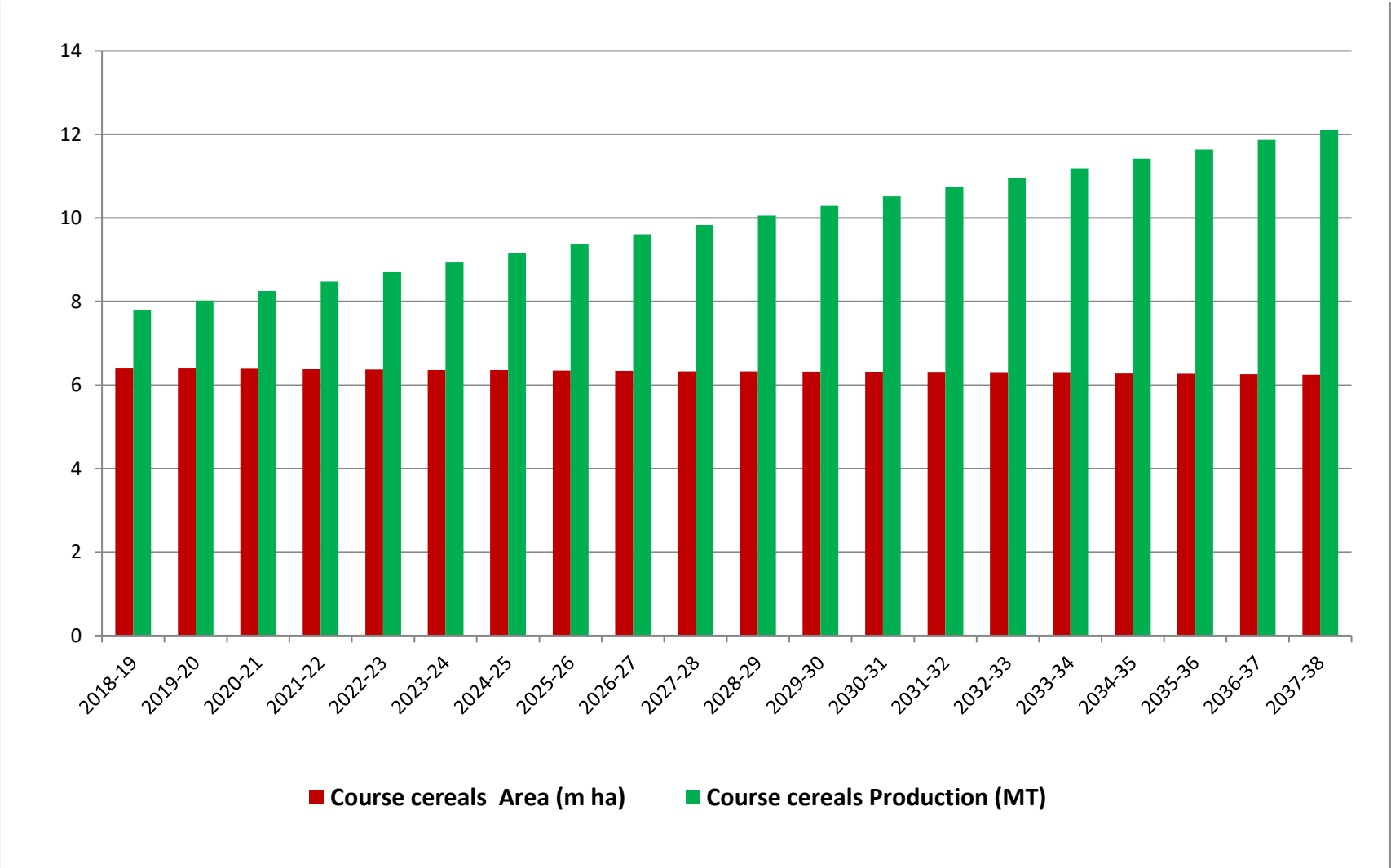
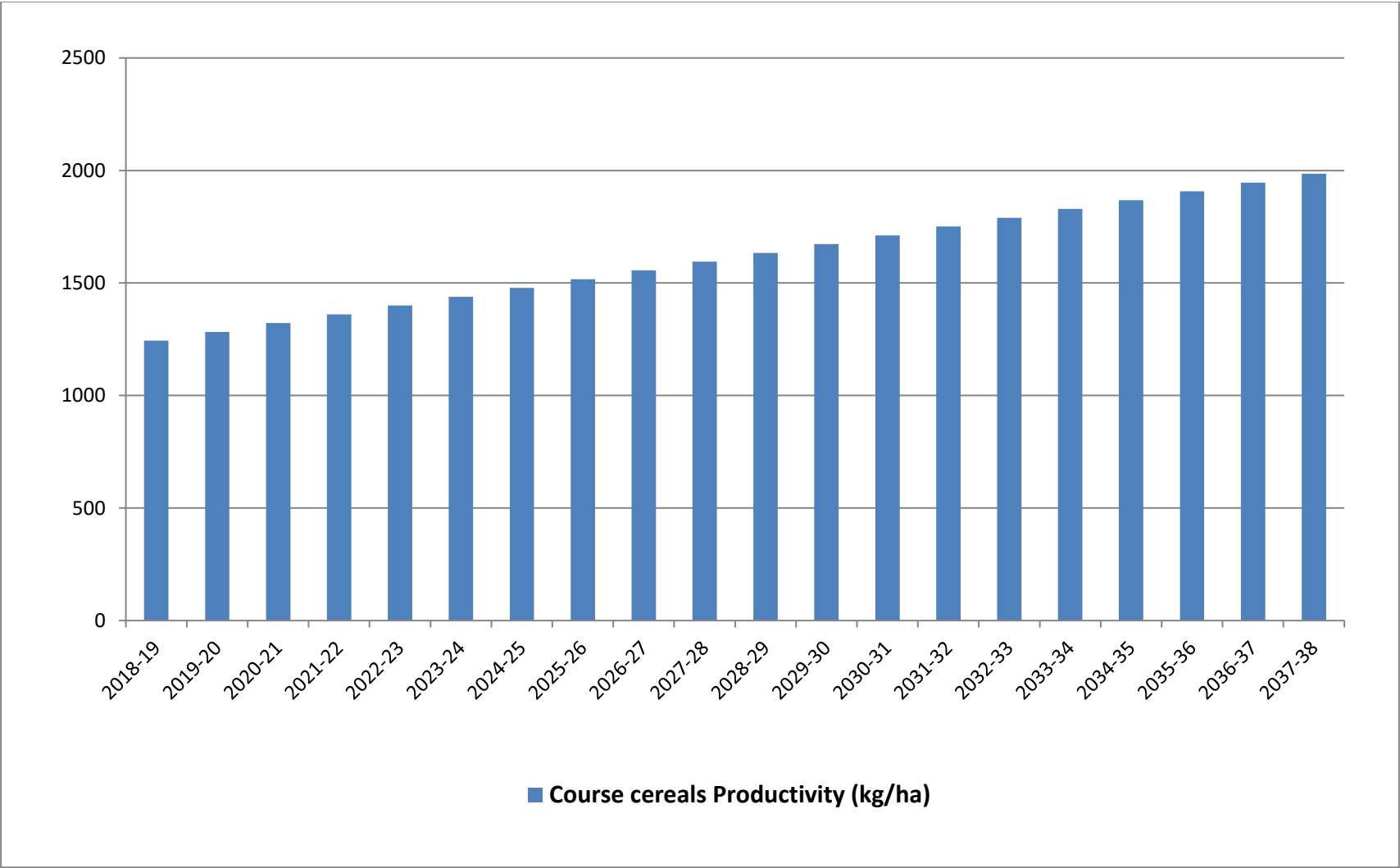


Fig 28: Trend of Productivity of coarse cereals for 2018-19 to 2036-37



4.3.4 Trend of area, production and productivity of total pulses of Madhya Pradesh for next 20 years

The trends of area, production and productivity of total pulses crop for next twenty year (2017-18 to 2037--38) of Madhya Pradesh are show the table 4.18. The area trend of total pulses is expected to be increase 6.11 (2018-19) to 8.44 million hectare (2037-38) while production trend is expected to be decreases 14.32 (2017-18) to 4.37 million tonne (2037-38). The productivity trend of total pulses is expected to be increase from 955 (2018-19) to 1245 kilogram per hectare (2037-38). The value of regression of area was found to be 0.1228 which is positive and not significant that mean area of total pulses will be increase while the value of regression of production was found to be -0.5237 which is negative and non significant that mean production be decreases for next 20 years. The value of regression of productivity was found to be 15.2804 which are positive and significant that means productivity will be increases for next 20 years.

4.3.5 Trend of area, production and productivity of total oilseeds of Madhya Pradesh for next 20 years

The trends of area, production and productivity of total oilseeds crop for next twenty year (2018-19 to 2037-38) of Madhya Pradesh are shown the table 4.19. The area trend of total oilseeds is expected to be increase 7.89 (2018-19) to 9.24 million hectare (2037-38) while production trend is expected to be increases 64.15 (2018-19) to 79.98 million tonnes (2037-38). The productivity trend of total oilseeds is expected to be increases from 830.22 (2018-19) to 830.35 kilogram per hectare (2037-38). The value of regression of area was found to be 0.071 which is positive and not significant that mean area of total oilseeds will be increase while the value of regression of production was found to be 0.832 which is positive and non significant that mean production be increases for next 20 years. The value of regression of productivity was found to be 0.0069 which are positive and non significant that means productivity will be increases for next 20 years.

Table 4.18: Trend of area, production and productivity of total pulses of Madhya Pradesh for next 20 years (Area- million hectares, Production- million tonnes and Productivity- kg/ha)

Year		Estimated area	Estimated production	Estimated productivity
2018-19		6.11	14.32	955
2019-20		6.23	13.80	970
2020-21		6.36	13.27	985
2021-22		6.48	12.75	1001
2022-23		6.60	12.23	1016
2023-24		6.72	11.70	1031
2024-25		6.85	11.18	1047
2025-26		6.97	10.66	1062
2026-27		7.09	10.13	1077
2027-28		7.21	9.61	1092
2028-29		7.34	9.08	1108
2029-30		7.46	8.56	1123
2030-31		7.58	8.04	1138
2031-32		7.71	7.51	1154
2032-33		7.83	6.99	1169
2033-34		7.95	6.47	1184
2034-35		8.07	5.94	1199
2035-36		8.20	5.42	1215
2036-37		8.32	4.90	1230
2037-38		8.44	4.37	1245
Based on 1998-99 to 2017-18	“b”	0.1228	-0.5237	15.2804
	“a”	3.5304	25.3197	634.0053
	“t”	0.0085	-0.1862	0.0002

Significant at the 0.5 level of probability

Fig 29: Trend of area and production of total pulses for 2018-19 to 2037-38.

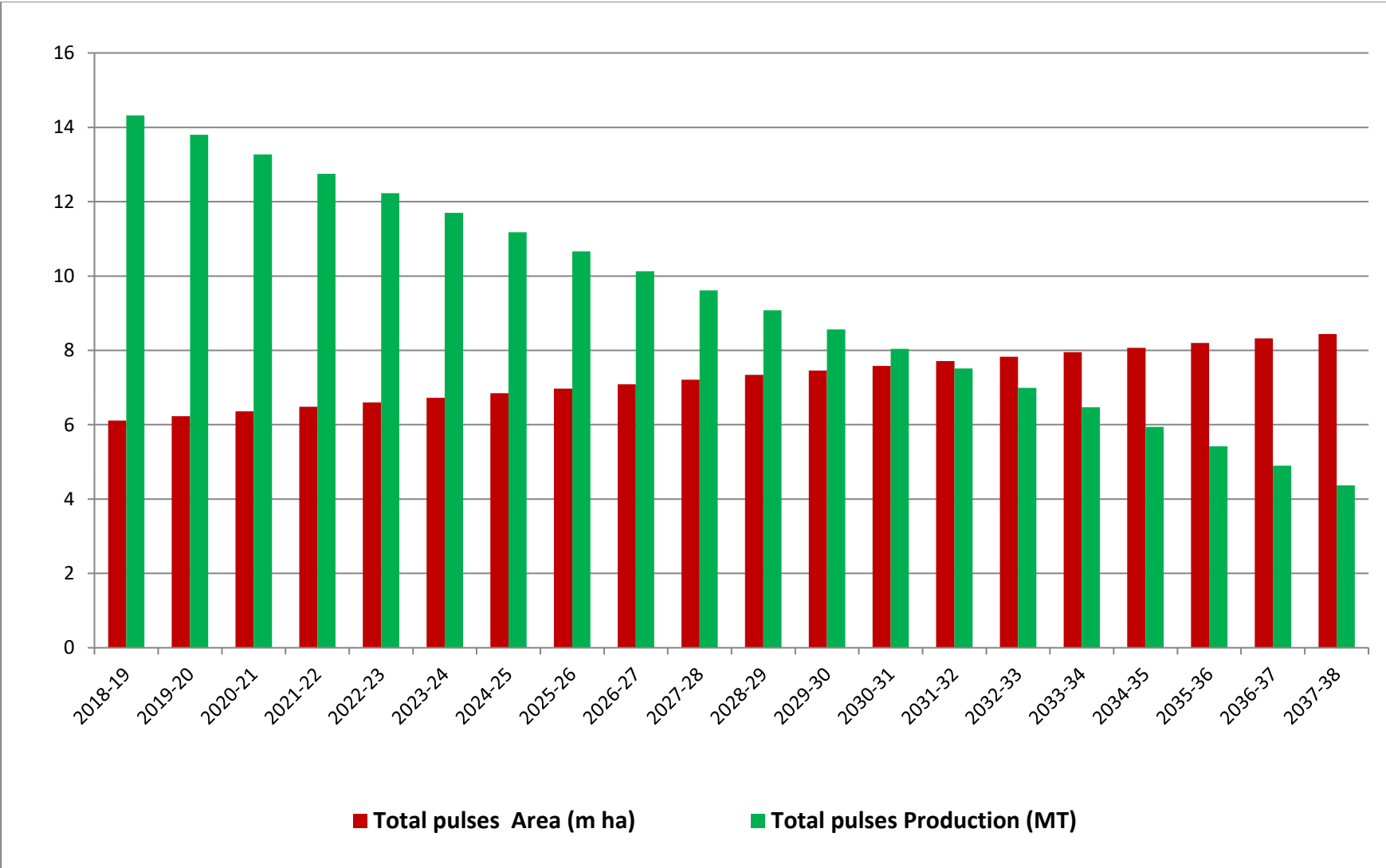


Fig 30: Trend of Productivity of total pulses for 2018-19 to 2037-38

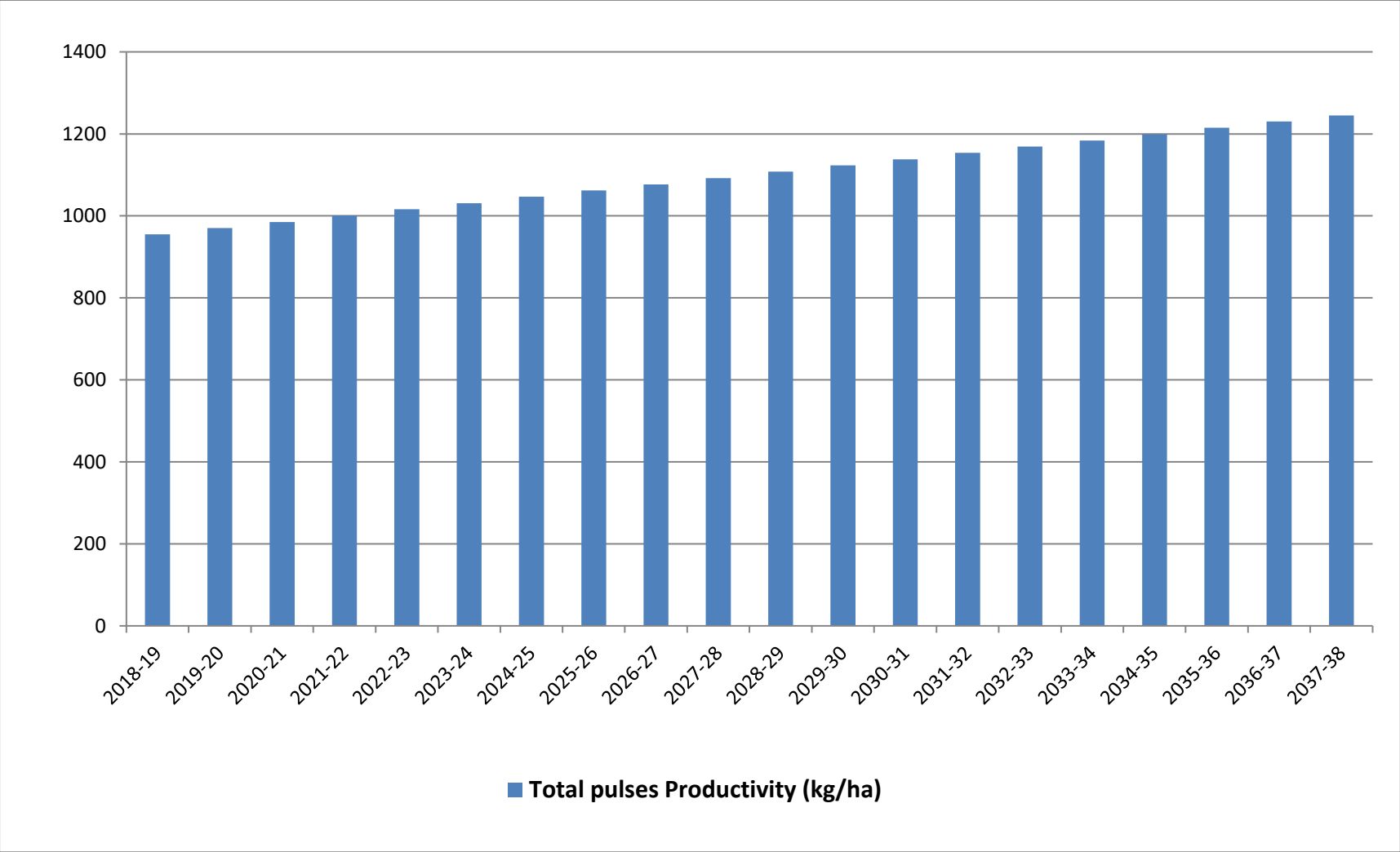


Table 4.19: Trend of area, production and productivity of total oilseeds of Madhya Pradesh for next 20 years (Area- million hectares, Production- million tonnes and Productivity- kg/ha)

Year	Estimated area	Estimated production	Estimated productivity	
2018-19	7.89	64.15	830.22	
2019-20	7.96	64.99	830.23	
2020-21	8.03	65.82	830.23	
2021-22	8.10	66.65	830.24	
2022-23	8.18	67.49	830.25	
2023-24	8.25	68.32	830.25	
2024-25	8.32	69.15	830.26	
2025-26	8.39	69.98	830.27	
2026-27	8.46	70.82	830.28	
2027-28	8.53	71.65	830.28	
2028-29	8.60	72.48	830.29	
2029-30	8.67	73.32	830.30	
2030-31	8.74	74.15	830.30	
2031-32	8.81	74.98	830.31	
2032-33	8.89	75.82	830.32	
2033-34	8.96	76.65	830.32	
2034-35	9.03	77.48	830.33	
2035-36	9.10	78.31	830.34	
2036-37	9.17	79.15	830.34	
2037-38	9.24	79.98	830.35	
Based on 1998-99 to 2017-18	“b”	0.071	0.832	0.0069
	“a”	6.40	46.66	380.0717
	“t”	2.34	-0.2140	3.04

Significant at the 0.05 level of probability

Fig 31: Trend of area and production of oilseeds for 2018-19 to 2037-38

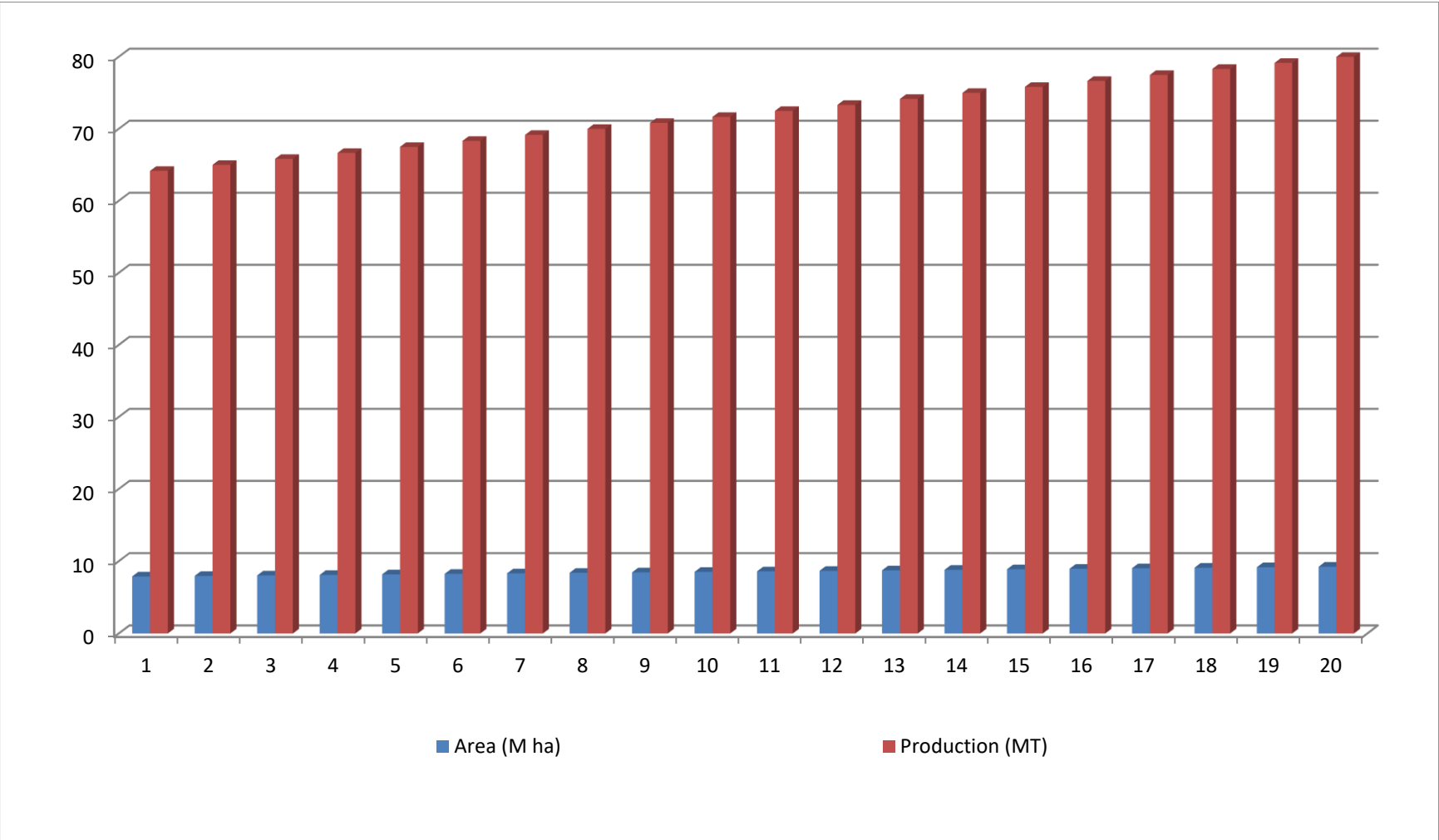
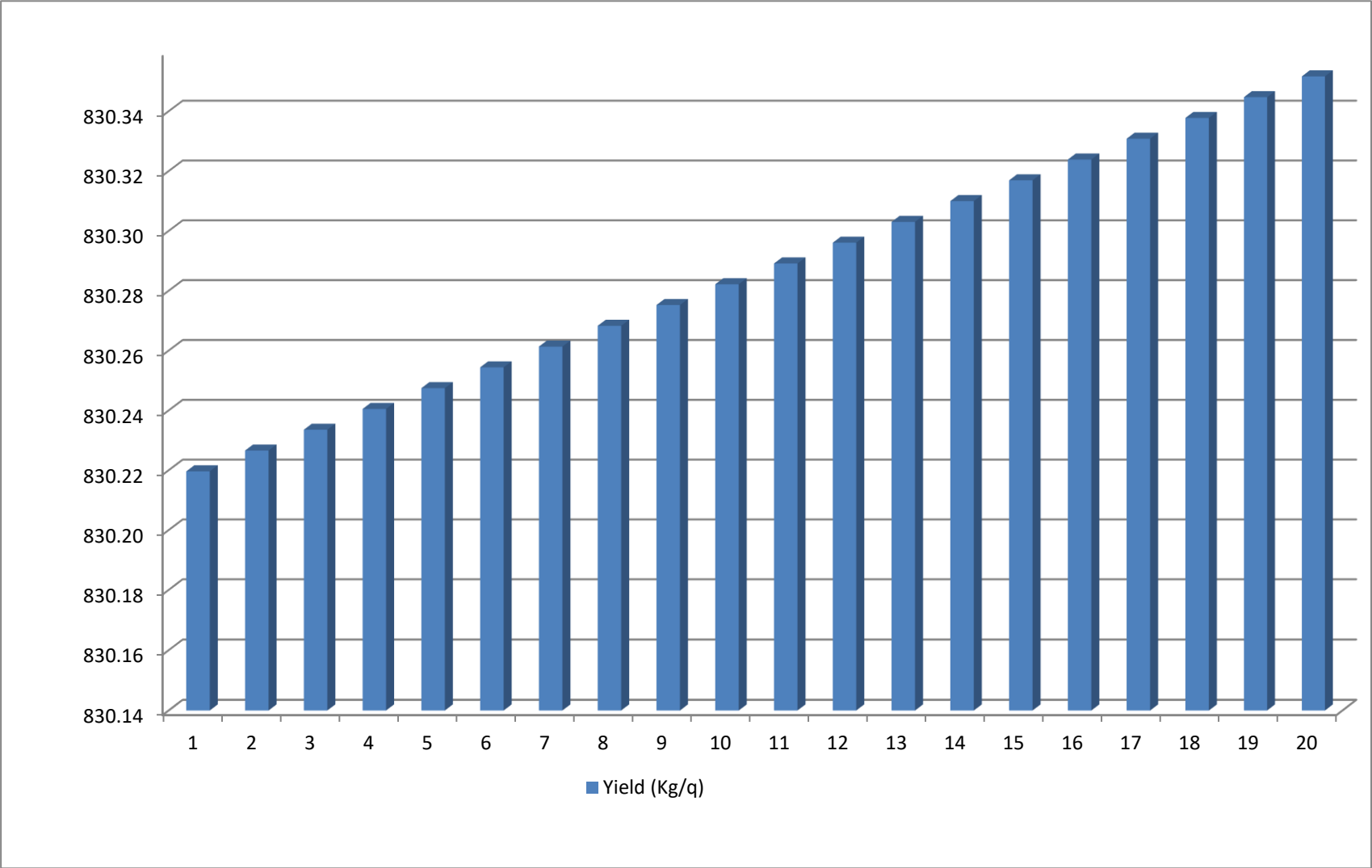


Fig 32: Trend of Productivity of oilseeds for 2018-19 to 2037-38



4.3.6 Trend of area, production and productivity of sugarcane of Uttar Pradesh for next 20 years

The trends of area, production and productivity of sugarcane crop for next twenty year (2017-18 to 2037-38) of Uttar Pradesh are showing the table 4.20. The area trend of sugarcane is expected to be increase 2.23 (2018-19) to 2.44 million hectare (2037-38) while production trend is expected to increases 148.73 (2017-18) to 188.24 million tonnes (2037-38). The productivity trend of sugarcane is expected to increase from 68413 (2018-19) to 82473 kg per hectare (2037-38). The value of regression of area was found to be 0.0113 which is positive and not significant that mean area of sugarcane is increase, while the value of regression of production was found to be 2.0796 which are positive and significant that means production be increases for next 20 years. The value of regression of productivity was found to be 740.0188 which are positive and significant that means productivity be increases for next 20 years.

4.3.7 Trend of area, production and productivity of cotton of Gujarat for next 20 years

The trends of area, production and productivity of cotton crop for next twenty year (2017-18 to 2036-37) of Gujarat are showing the table 4.21. The area trend of cotton is expected to be increase 6.05 (2018-19) to 10.92 million hectare (2037-38) while production trend is expected to be increases 24.47 (2017-18) to 46.46 million tonne (2037-38). The productivity trend of cotton is expected to increase from 790 (2018-19) to 1303 kilogram per hectare (2037-38). The value of regression of area was found to be 0.2563 which is positive and significant that mean area of cotton will be increase while the value of regression of production was found to be 1.1577 which is positive and significant that means production be increases for next 20 years. The value of regression of productivity was found to be 26.9651 which are positive and significant that means productivity be increases for next 20 years.

Table 20: Trend of area, production and productivity of sugarcane of Uttar Pradesh for next 20 years (Area- million hectares, Production- million tonnes and Productivity- kg/ha)

Year		Estimated area	Estimated production	Estimated productivity
2018-19		2.23	148.73	68413
2019-20		2.24	150.81	69153
2020-21		2.25	152.89	69893
2021-22		2.26	154.97	70633
2022-23		2.27	157.05	71373
2023-24		2.28	159.13	72113
2024-25		2.30	161.21	72853
2025-26		2.31	163.29	73593
2026-27		2.32	165.37	74333
2027-28		2.33	167.45	75073
2028-29		2.34	169.53	75813
2029-30		2.35	171.61	76553
2030-31		2.36	173.69	77293
2031-32		2.38	175.77	78033
2032-33		2.39	177.85	78773
2033-34		2.40	179.92	79513
2034-35		2.41	182.00	80253
2035-36		2.42	184.08	80993
2036-37		2.43	186.16	81733
2037-38		2.44	188.24	82473
Based on 1998-99 to 2017-18	“b”	0.0113	2.0796	740.0188
	“a”	1.9888	105.056	52872.55
	“t”	3.8632	0.0450	4.4454

Significant at the 0.05 level of probability

Fig 33: Trend of area of sugarcane for 2018-19 to 2037-38

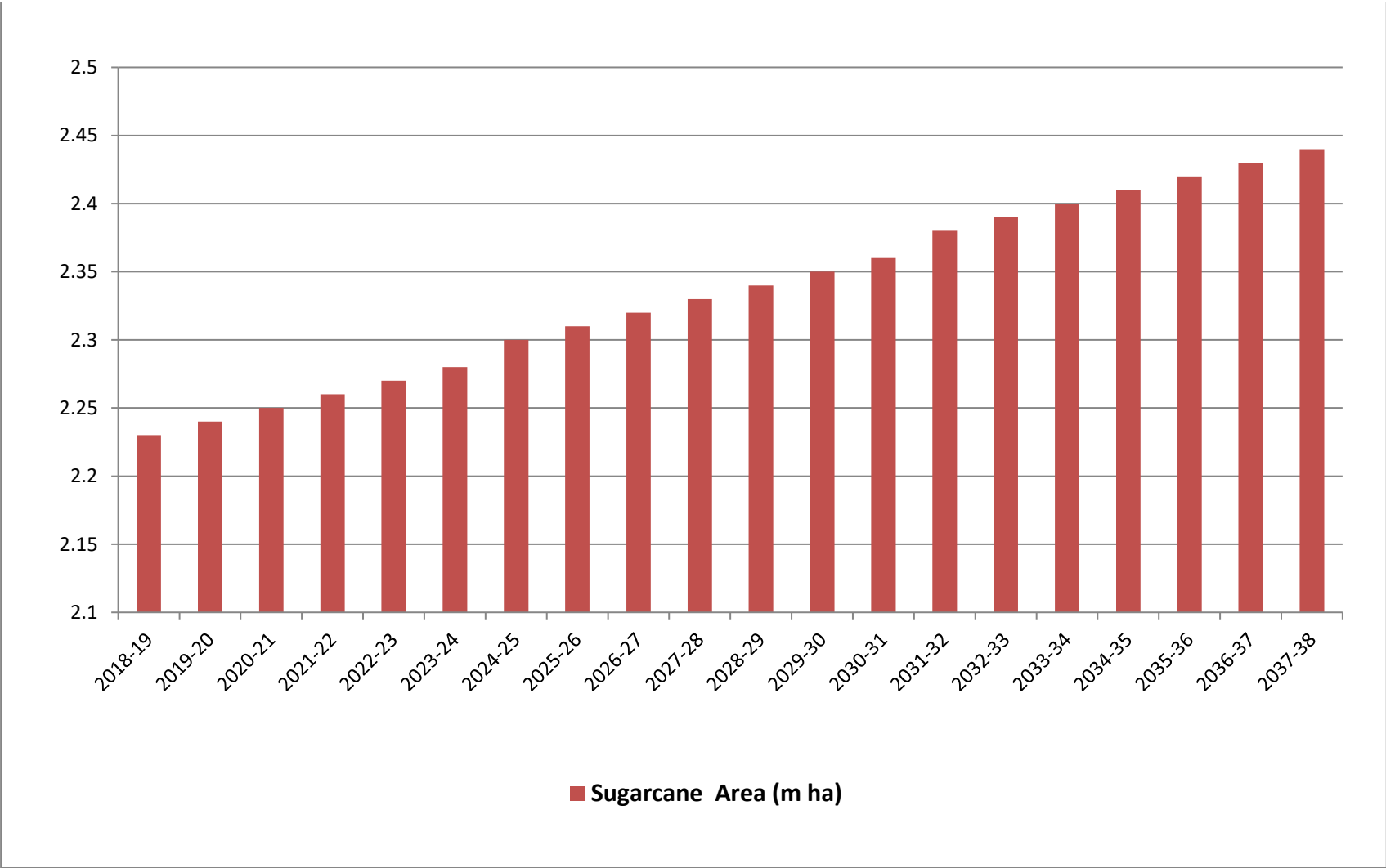


Fig 34: Trend of production of sugarcane for 2018-19 to 2036-37

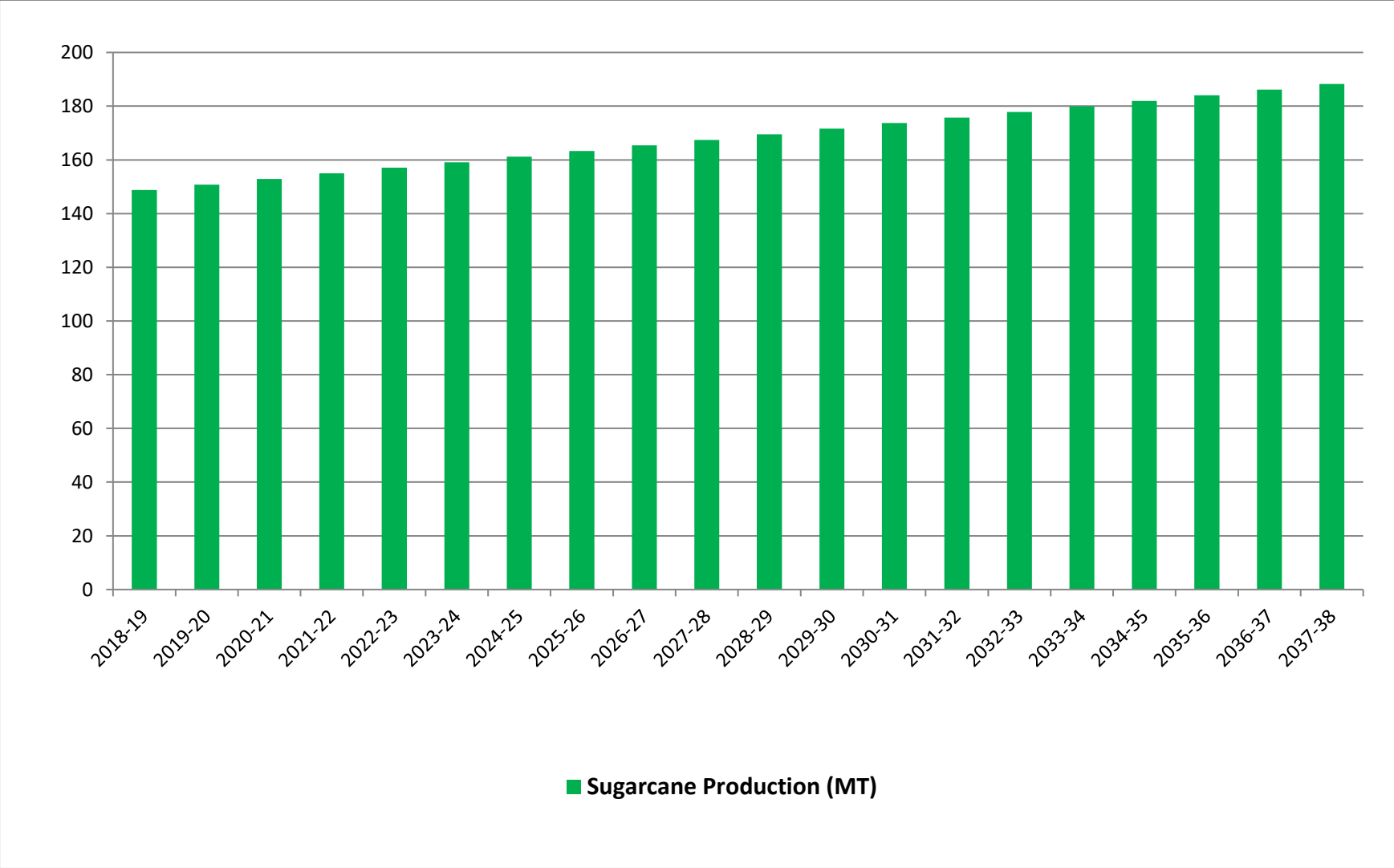


Fig 35: Trend of Productivity of sugarcane for 2018-19 to 2037-38

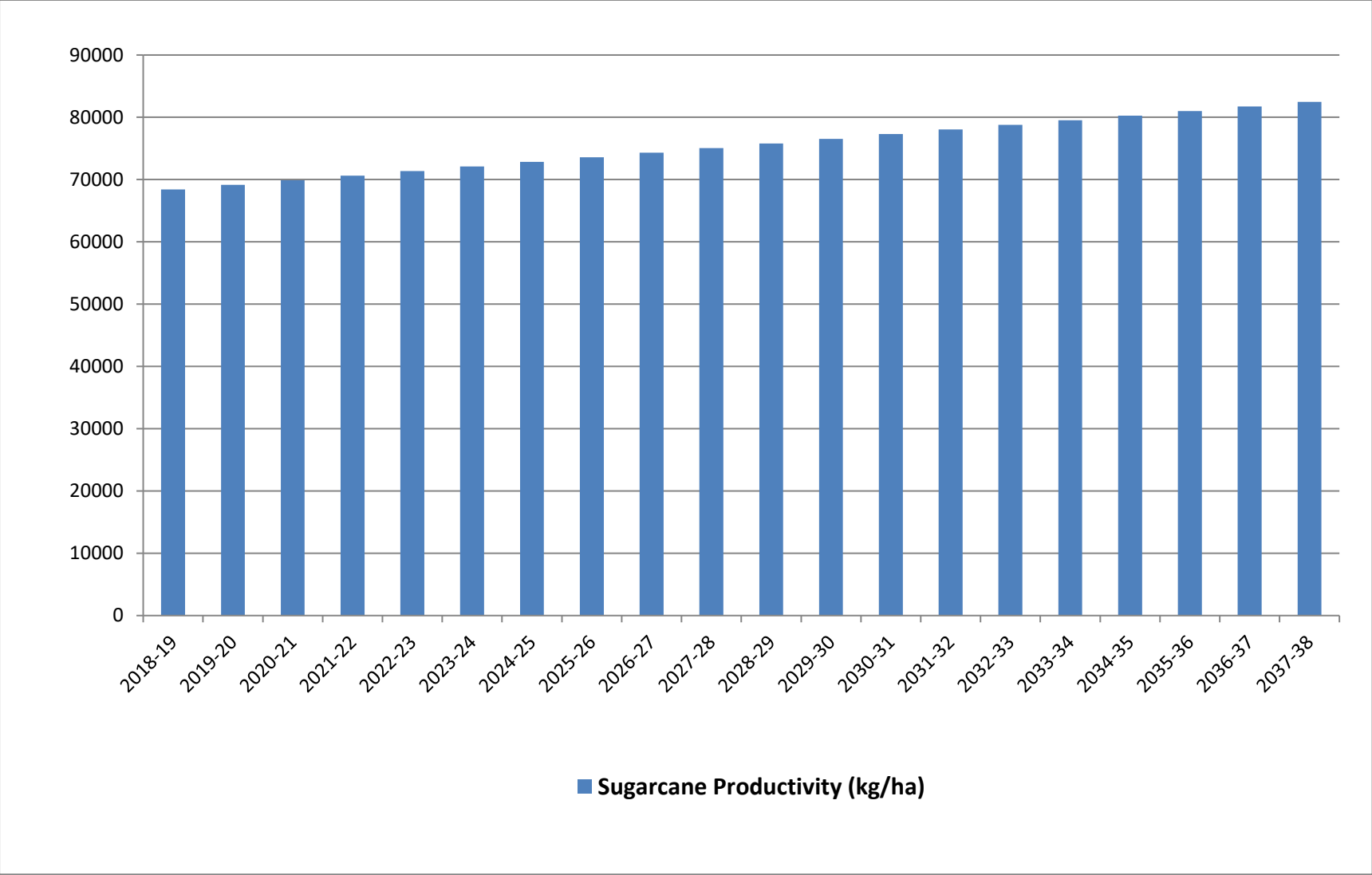


Table 4.21: Trend of area, production and productivity of cotton of Gujarat for next 20 years (Area- million hectares, Production- million tonnes and Productivity- kg/ha)

Year	Estimated area	Estimated production	Estimated productivity	
2018-19	6.05	24.47	790	
2019-20	6.30	25.62	817	
2020-21	6.56	26.78	844	
2021-22	6.81	27.94	871	
2022-23	7.07	29.10	898	
2023-24	7.33	30.26	925	
2024-25	7.58	31.41	952	
2025-26	7.84	32.57	979	
2026-27	8.10	33.73	1006	
2027-28	8.35	34.89	1033	
2028-29	8.61	36.04	1060	
2029-30	8.86	37.20	1087	
2030-31	9.12	38.36	1114	
2031-32	9.38	39.52	1141	
2032-33	9.63	40.68	1168	
2033-34	9.89	41.83	1195	
2034-35	10.15	42.99	1222	
2035-36	10.40	44.15	1249	
2036-37	10.66	45.31	1276	
2037-38	10.92	46.46	1303	
Based on 1998-99 to 2017-18	“b”	0.2563	1.1577	26.9651
	“a”	0.6626	0.1548	224.0587
	“t”	1.3044	1.4483	5.9266

Significant at the 0.05 level of probability

Fig 36: Trend of area and production of cotton for 2018-19 to 2037-38

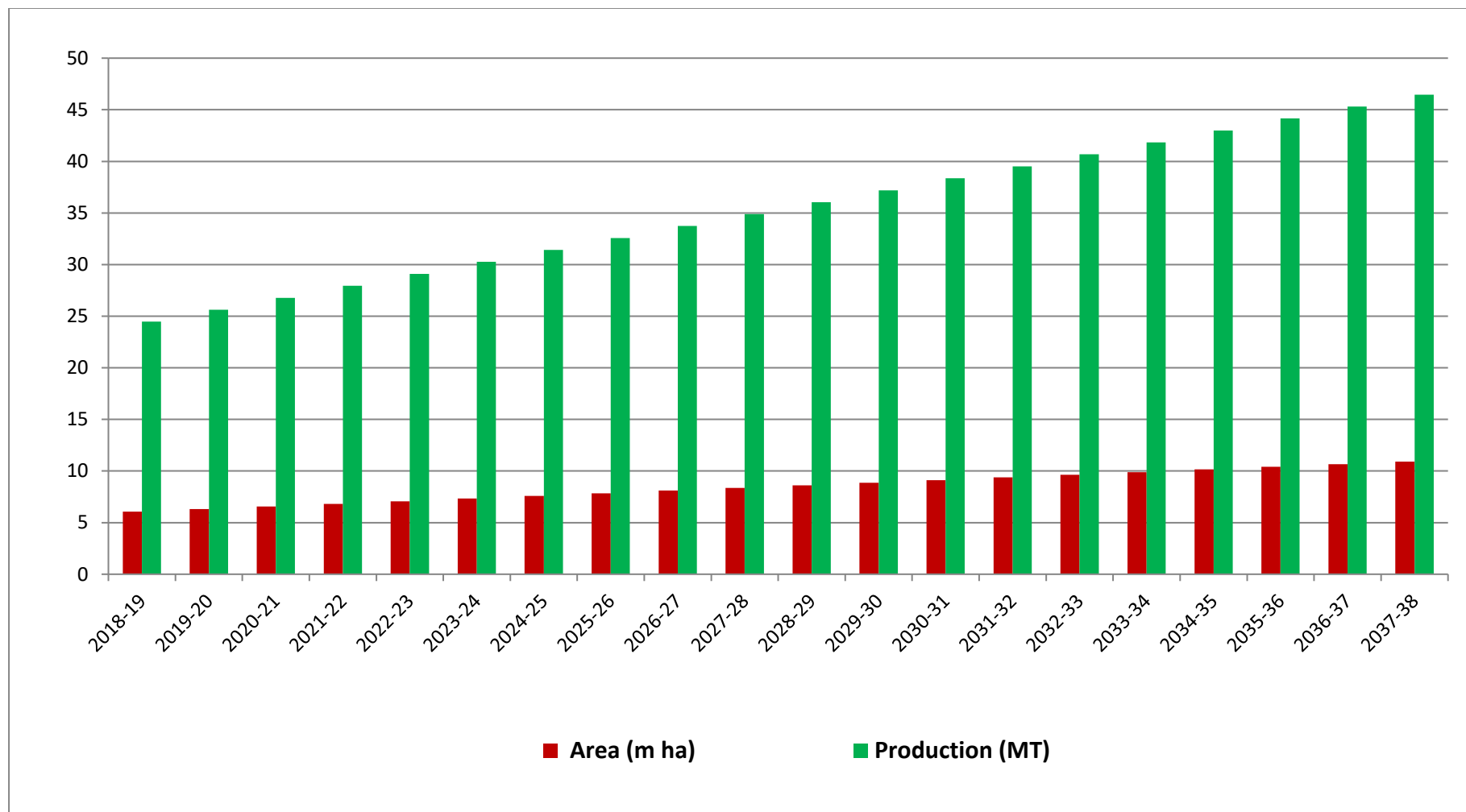
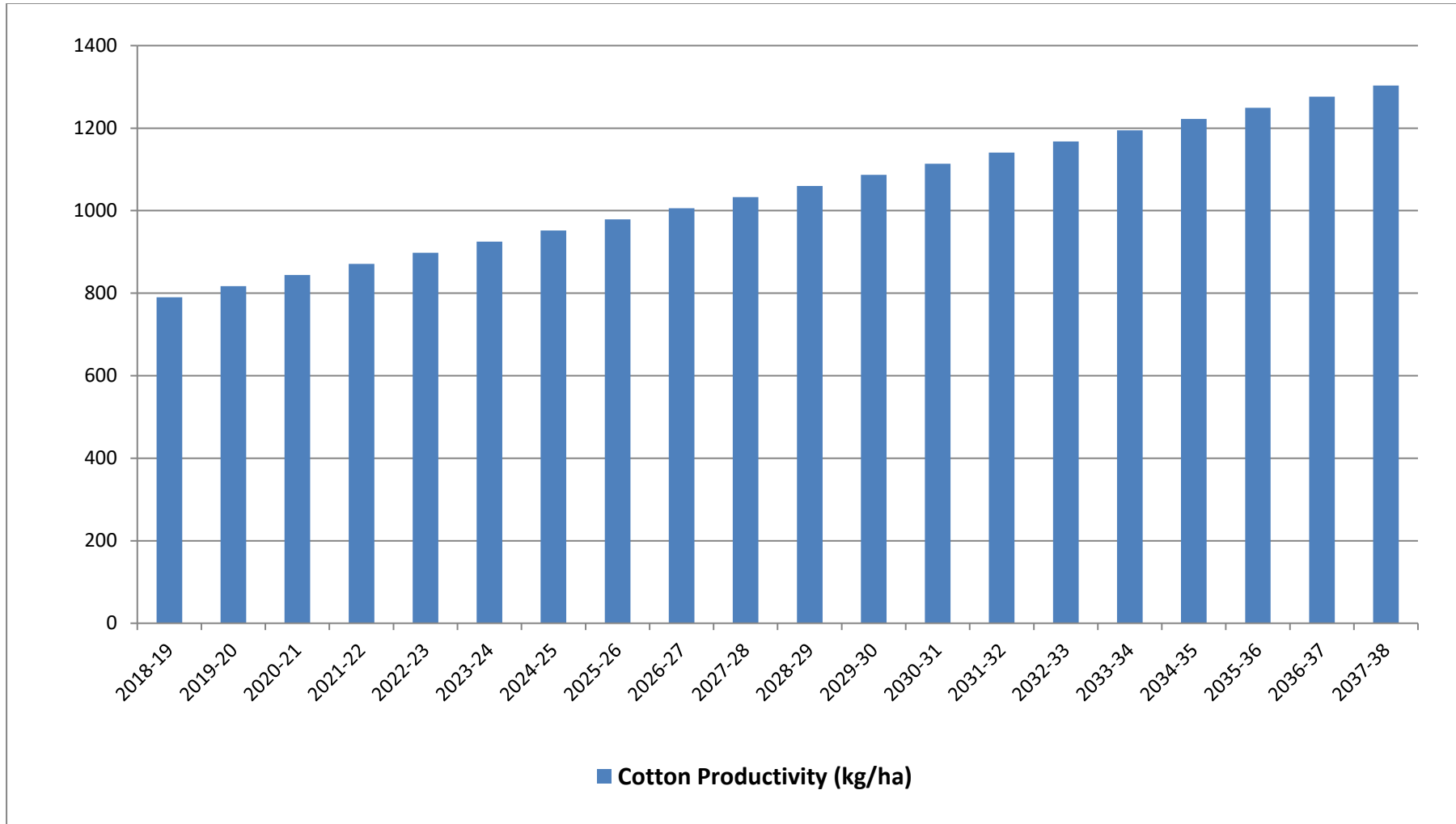


Fig 37: Trend of Productivity of cotton for 2018-19 to 2037-38



Chapter - V

DISCUSSION

5.1 Compound growth rate of area, production and productivity of major crops of India:

Compound growth rate of rice crop compound growth rates of area was found to be -0.043 per cent in India for 1998-99 to 2017-18 period, while the compound growth rates were found to be 1.585 per cent and 1.628 per cent for production and productivity respectively in case of India. Compound growth rate of area sign is negative that area of rice crop was decreased and CGR was found to be negatively non significant, while production and productivity were increased and compound growth rate was positive and non significant for India. The 't' value calculated for CGR were -0.41, 6.24 and 9.47 as area, production and productivity of rice respectively. Crop compound growth rates of wheat area was found to be 0.957 per cent in India for 1998-99 to 2017-18 period, while the compound growth rates were 2.070 per cent and 1.103 per cent for production and productivity respectively in case of India. Area, production and productivity were increased and compound growth rate are positive and non significant. The 't' value calculated for CGR were 7.22, 8.39 and 5.94 for area, production and productivity of wheat crop respectively.

For coarse cereals crop compound growth rates of area was found to be -1.145 per cent while the compound growth rates were 2.227 per cent and 3.411 per cent for production and productivity respectively. Compound growth rate of area sign is negative that means area of coarse cereals crop was decreased negatively but non-significant, while production and productivity were increased and compound growth rate of production was positive and significant, productivity of coarse cereals was positive and highly significant for India. The 't' value calculated for CGR were -8.00, 6.40 and 11.39 as area, production and productivity of wheat crop respectively.

Total pulses crop compound growth rates of area was found to be 1.337 per cent while the compound growth rates were 6.027 per cent and 1.672 per cent for production and productivity respectively. Compound growth

rate of area was positive that area of total pulses crop was increased and CGR was found to be positive but non significant, while production and productivity were increased and compound growth rate of production was found to be positive and highly significant for India and productivity was found to be positive and non significant for India. The 't' value calculated for CGR were 5.16, 6.25 and 5.69 as area, production and productivity of total pulses crop respectively.

Oilseeds crop compound growth rates of area was found to be 0.547 per cent while the compound growth rates were 2.483 per cent and 1.925 per cent for production and productivity respectively. Compound growth rate of area of oilseeds crop was decreased and CGR was found to be positive and non significant, while production was found to be positive and significant and productivity was increased and their compound growth rate was found to be positive and non significant. The 't' value calculated for CGR were 2.02, 4.18 and 4.56 for area, production and productivity of oilseeds crop respectively.

Sugarcane crop compound growth rates of area was found to be 0.988 per cent was observed in India for 1998-99 to 2017-18 period, while the compound growth rates were 1.457 per cent and 0.468 per cent for production and productivity respectively. Compound growth rate of area, production and productivity were found to be positively but non significant. The 't' value calculated for CGR were 3.07, 3.39 and 2.25 area, production and productivity of sugarcane crop respectively.

A Cotton crop compound growth rate of area was observed 2.427 per cent while the compound growth rates were 8.059 per cent and 5.498 per cent for production and productivity respectively. Compound growth rate of area was found to be positive and significant, while production and productivity were found to be positive and highly significantly. During this period 1998-99 to 2017-18. The 't' value calculated for CGR were 6.74, 9.25 and 7.11 area, production and productivity of cotton crop respectively.

5.2 Target and achievement of major crops production in India:

The under achievement target year of production of rice were find to be in 2000-01, 2002-03, 2003-04, 2004-05, 2009-10, 2010-11, 2014-15 and

2015-16 while other side More achievement were find to be in 1998-99, 1999-2000, 2001-02, 2005-06, 2006-07, 2007-08,2008-09, 2011-12, 2013-14. 2014-15, 2016-17 and 2017-18. The target was under achievement (minimum) 77.23 per cent in 2002-03 while the achievement was 104.60 per cent more than target of production of rice in 1999-2000.

The under achievement target year of production of wheat were find to be in 1998-99, 2000-01, 2001-02, 2002-03, 2004-05,2005-06, 2014-15 and 2015-16 while other side More achievement were find to be in 1999-2000, 2003-04, 2006-07, 2007-08,2008-09, 2009-10, 2010-11, 2011-12, 2013-14. 2014-15, 2016-17 and 2017-18. The target was under achievement (minimum) 84.31 per cent in 2002-03 while the achievement was 112.95 per cent more than target of production of wheat in 2011-12.

The under achievement target year of production of coarse cereals were find to be in 1998-99, 1999-2000, 2000-2001, 2002-03, 2004-05,2005-06, 2006-07, 2008-09, 2009-10, 2010-11, 2012-12, 2015-16 and 2016-17 while other side More achievement were find to be in 2001-02, 2003-04, 2007-08, 2011-12, 2013-14. 2014-15 and 2017-18. The target was under achievement (minimum) 77.84 per cent in 2009-10 while the achievement was 110.59 per cent more than target of production of coarse cereals in 2003-04.

The under achievement target year of production of total pulses were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05,2005-06, 2006-07,2007-08, 2008-09, 2009-10, 2014-15 and 2015-16 while other side More achievement were find to be in 2010-11, 2011-12, 2012-13, 2013-14. 2016-17 and 2017-18. The target was under achievement (minimum) 69.56 per cent in 2002-03 while the achievement was 110.55 per cent more than target of production of total pulses in 2010-11.

The under achievement target year of production of oil seed were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2004-05, 2006-07,2007-08, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2014-15, 2015-16, 2016-17 and 2017-18while other side More achievement were find to be in 2003-04, 2005-06 and 2013-14. The target was under achievement

(minimum) 65.86 per cent in 2000-01 while the achievement was 105.65 per cent more than target of production of oil seed in 2013-14.

The under achievement target year of production of sugarcane were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05, 2008-09, 2009-10, 2012-13, 2015-16 and 2016-17 while other side More achievement were find to be in 2005-06 2006-07,2007-08, 2010-11, 2011-12, 2013-14, 2014-15 and 2017-18. The target (minimum) was under achievement 73.08 per cent in 2003-04 while the achievement was 131.67 per cent more that target of production of sugarcane in 2006-07.

The under achievement target year of production of cotton were find to be in 1998-99, 1999-2000, 2000-01, 2001-02, 2002-03, 2003-04, 2008-09, 2009-10, 2014-15, 2015-16, 2016-17 and 2017-18. while other side More achievement were find to be in 2004-05,2005-06, 2006-07, 2007-08, 2010-11, 2011-12, and 2013-14. The target was under achievement (minimum) 57.47 per cent in 2002-03 while the achievement was 126.92 per cent more than target of production of cotton in 2010-11.

5.3 Trend of area, production and productivity of major crops for next 20 years:

In case of rice crop in West Bengal, the value of regression of rice area was found to be negative (-0.0392) that mean area of rice be small increases While the value of regression of production and productivity were found to be 2.1375 and 32.1413 which is both positive and significant that mean production be increases for next 20 years.

In case of wheat crop in Uttar Pradesh, the value of regression of area was found to be positive (0.0363) that mean area of wheat be increase While the value of regression of production was found to be 0.2977 which is positive and not significant that mean production be increases. The value of regression of productivity of wheat was found to be 21.1609 which are positive and significant that means productivity be increases for next 20 years.

In case of coarse cereals in Rajasthan, the value of regression of area was found to be negative (-0.0078) and not significant that mean area of coarse cereals be decrease While the value of regression of production was

found to be 0.2262 which is positive and not significant that mean production be increases. The value of regression of productivity was found to be 38.9729 which are positive and significant that means productivity be increases for next 20 years.

In case of total pulses for Madhya Pradesh, the value of regression of area was found to be 0.1228 which is positive and not significant that mean area of total pulses will be increase while the value of regression of production was found to be -0.5237 which is negative and non significant that mean production be decreases. The value of regression of productivity was found to be 15.2804 which are positive and significant that means productivity will be increases for next 20 years.

In case of total oilseeds for Madhya Pradesh, the value of regression of area was found to be 0.071 which is positive and not significant that mean area of total oilseeds will be increase while the value of regression of production was found to be 0.832 which is positive and non significant that mean production be increases. The value of regression of productivity was found to be 0.0069 which are positive and non significant that means productivity will be increases for next 20 years.

In case of sugarcane for Uttar Pradesh, the value of regression of area was found to be 0.0113 which is positive and not significant that mean area of sugarcane be increase while the value of regression of production and productivity were found to be 2.0796 and 740.0188 both which are positive and significant that mean production and productivity be increases for next 20 years.

In case of cotton for Gujarat, the value of regression of area was found to be 0.2563 which is positive and significant that mean area of cotton will be increase while the value of regression of production was found to be 1.1577 which is positive and not significant that means production be increases. The value of regression of productivity was found to be 26.9651 which are positive and significant that means productivity be increases for next 20 years.

Chapter - VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

6.1 Summary:

The major crops of India are Rice, Wheat, Coarse cereals, Pulses, Food grains, Oilseeds, Sugarcane, Cotton, Jute & Mesta etc. Total cropped area in 2017-18 is 140.1million hectare, in which rice was grown 437.891 lakhs hectare out of total cropped area, followed by wheat (295.76), coarse cereals (242.05), total pulses (299.93), total food grains (1275.63), oil seeds (246.45), sugarcane (47.32), cotton (124.29) and total cropped area of jute & Mesta (7.35) lakhs hectare respectively in 2017-18. Total production in 2017-18 was 279.51 (million tonnes) in which rice production was 112.91 million tonnes, followed by wheat (99.70), coarse cereals (46.99), total pulses (25.23), total food grain (284.83), oilseeds (31.31), sugarcane (376.90), cotton (34.89) and total production of jute and Mesta (10.14) million tonnes respectively in 2017-18. Total yield of rice was 2578 kilogram per hectare in 2017-18 followed by wheat (3371), coarse cereals (1941), total pulses (841), total food grains (2233), oilseeds (1270), sugarcane (79650), cotton (477) and total yield of jute and Mesta (2481) kilogram per hectare in 2017-18 informed by Ministry of Agriculture. **The study was intended with the “Growth pattern and trend analysis of major crops of India”.** The results have been discussed under the following sub-heads.

Specific objectives

1. To analyse the compound growth rates of area, production & productivity of major crops (Rice, Wheat, Coarse Cereals, Oil Seed, Pulses, Sugarcane & Cotton) of India during last 20 years (1998-99 to 2017-18).
2. To find out the gap between target & achievement of production of major crops of India during last 20 years (1998-99 to 2017-18).
3. To examine the state wise trend analysis of area, production and productivity of major crops for next 20 years.

The study was based on secondary data. The secondary data on area, production and productivity from 1998-99 to 2017-18 were used for analysis. The secondary time series data on area, production and productivity of major crops of India were used to analysis. The secondary data was collected from the website of Ministry of Agriculture and Farmers' Welfare Government of India (agriculture.govt.in) and Agricultural Statistics at a Glance, Directorate of Economics and Statistics, and Food and Agriculture Organization (FAO).

Compound Growth Rate (CGR):- By taking time as the independent variable and the area, production and productivity of the major crops of India, as the dependent variable, the compound growth rates was estimated by using the formula: $Y_t = a (1 + r)^t$ & CGR in per cent = $(\text{Antilog } b - 1) \times 100$ and trend analysis calculated by linear model. The linear trend model that is suggested by finger (2007) and Boken *et al.* (2000) was used in this study for analysis and expressed as: $Y_t = \beta_0 + \beta_1 t + e_t$. Results: Compound growth rate of rice crop area was found to be -0.043 per cent while the compound growth rates were found to be 1.585 per cent and 1.628 per cent for production and productivity respectively. Compound growth rate of area sign is negative that means area of rice crop was decreased and CGR was found to be negatively non significant, while production and productivity were increased and their Compound growth rate was found to be positive and non significant for India. A compound growth rate of wheat area was found to be 0.957 per cent while the compound growth rates were 2.070 per cent and 1.103 per cent for production and productivity respectively in case of India. Area, production and productivity were increased and compound growth rates are positive but non significantly. For coarse cereals crop compound growth rates of area was found to be -1.145 per cent while the compound growth rates were 2.227 per cent and 3.411 per cent for production and productivity respectively. Compound growth rate of area sign is negative that area of coarse cereals crop was decreased and negative non significant, while production and productivity were increased and compound growth rate of production are positive and significant, productivity are positive highly significant for India. Total pulses crop compound growth rates of area was found to be 1.337 per cent while the compound growth rates were 6.027 per cent and 1.672 per cent

for production and productivity respectively. Compound growth rate of area was found to be positive but non significant that area of total pulses crop was increased, while production and productivity were increased and compound growth rate of production was positive and highly significant, productivity was found to be positive and non significant for India. Oilseeds crop compound growth rates of area was found to be 0.547 per cent while the compound growth rates were 2.483 per cent and 1.925 per cent for production and productivity respectively. Compound growth rate of area of oilseeds crop was decreased and CGR was found to be positive and non significant, while production was found to be positive and significant, productivity increased positively but non-significant. A sugarcane crop compound growth rate of area was found to be 0.988 per cent while the compound growth rates were 1.457 per cent and 0.468 per cent for production and productivity respectively. Compound growth rate of area, production and productivity were found to be positive but non-significantly. Cotton crop compound growth rates of area was observed 2.427 per cent while the compound growth rates were 8.059* per cent and 5.498* per cent for production and productivity respectively. Compound growth rate of area was found to be positive and significant, while production and productivity were found to be positively and highly significantly.

Target and achievement of major crops production in India: The under achievement target year of production of rice were find to be in 2000-01, 2002-03, 2003-04, 2004-05, 2009-10, 2010-11, 2014-15 and 2015-16 while other side More achievement were find to be in 1998-99, 1999-2000, 2001-02, 2005-06, 2006-07, 2007-08,2008-09, 2011-12, 2013-14. 2014-15, 2016-17 and 2017-18. The target was under achievement (minimum) 77.23 per cent in 2002-03 while the achievement was 104.60 per cent more than target of production of rice in 1999-2000. The under achievement target year of production of wheat were find to be in 1998-99, 2000-01, 2001-02, 2002-03, 2004-05,2005-06, 2014-15 and 2015-16 while other side more achievement were find to be in 1999-2000, 2003-04, 2006-07, 2007-08,2008-09, 2009-10, 2010-11, 2011-12, 2013-14. 2014-15, 2016-17 and 2017-18. The target was under achievement (minimum) 84.31 per cent in 2002-03 while the

achievement was 112.95 per cent more than target of production of wheat in 2011-12. The under achievement target year of production of coarse cereals were find to be in 1998-99, 1999-2000, 2000-2001, 2002-03, 2004-05, 2005-06, 2006-07, 2008-09, 2009-10, 2010-11, 2012-12, 2015-16 and 2016-17 while other side More achievement were find to be in 2001-02, 2003-04, 2007-08, 2011-12, 2013-14. 2014-15 and 2017-18. The target was under achievement (minimum) 77.84 per cent in 2009-10 while the achievement was 110.59 per cent more than target of production of coarse cereals in 2003-04. The under achievement target year of production of total pulses were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05, 2005-06, 2006-07, 2007-08, 2008-09, 2009-10, 2014-15 and 2015-16 while other side More achievement were find to be in 2010-11, 2011-12, 2012-13, 2013-14. 2016-17 and 2017-18. The target was under achievement (minimum) 69.56 per cent in 2002-03 while the achievement was 110.55 per cent more than target of production of coarse cereals in 2010-11. The under achievement target year of production of oil seed were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2004-05, 2006-07, 2007-08, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2014-15, 2015-16, 2016-17 and 2017-18 while other side More achievement were find to be in 2003-04, 2005-06 and 2013-14. The target was under achievement (minimum) 65.86 per cent in 2000-01 while the achievement was 105.65 per cent more than target of production of oil seed in 2013-14. The under achievement target year of production of sugarcane were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05, 2008-09, 2009-10, 2012-13, 2015-16 and 2016-17 while other side More achievement were find to be in 2005-06, 2006-07, 2007-08, 2010-11, 2011-12, 2013-14, 2014-15 and 2017-18. The target (minimum) was under achievement 73.08 per cent in 2003-04 while the achievement was 131.67 per cent more that target of production of sugarcane in 2006-07. The under achievement target year of production of cotton were find to be in 1998-99, 1999-2000, 2000-01, 2001-02, 2002-03, 2003-04, 2008-09, 2009-10, 2014-15, 2015-16, 2016-17 and 2017-18. while other side more achievement were find to be in 2004-05, 2005-06, 2006-07, 2007-08, 2010-11, 2011-12, and 2013-14. The target was under achievement

(minimum) 57.47 per cent in 2002-03 while the achievement was 126.92 per cent more than target of production of cotton in 2010-11.

Trend of area, production and productivity of major crops for next 20 years: In case of rice crop in West Bengal, the value of regression of rice area was found to be negative (-0.0392) that mean area of rice be small increases While the value of regression of production and productivity were found to be 2.1375 and 32.1413 which is both positive and significant that mean production be increases for next 20 years. In case of wheat crop in Uttar Pradesh, the value of regression of area was found to be positive (0.0363) that mean area of wheat be increase While the value of regression of production was found to be 0.2977 which is positive and not significant that mean production be increases. The value of regression of productivity of wheat was found to be 21.1609 which are positive and significant that means productivity be increases for next 20 years. In case of coarse cereals in Rajasthan, the value of regression of area was found to be negative (-0.0078) and not significant that mean area of coarse cereals be decrease while the value of regression of production was found to be 0.2262 which is positive and not significant that mean production be increases. The value of regression of productivity was found to be 38.9729 which are positive and significant that means productivity be increases for next 20 years. In case of total pulses for Madhya Pradesh, the value of regression of area was found to be 0.1228 which is positive and not significant that mean area of total pulses will be increase While the value of regression of production was found to be -0.5237 which is negative and non significant that mean production be decreases. The value of regression of productivity was found to be 15.2804 which are positive and significant that means productivity will be increases for next 20 years. In case of total oilseeds for Madhya Pradesh, the value of regression of area was found to be 0.071 which is positive and not significant that mean area of total oilseeds will be increase while the value of regression of production was found to be 0.832 which is positive and non significant that mean production be increases. The value of regression of productivity was found to be 0.0069 which are positive and non significant that means productivity will be increases for next 20 years. In case of sugarcane for Uttar

Pradesh, the value of regression of area was found to be 0.0113 which is positive and not significant that mean area of sugarcane be increase While the value of regression of production and productivity were found to be 2.0796 and 740.0188 both which are positive and significant that mean production and productivity be increases for next 20 years. In case of cotton for Gujarat, the value of regression of area was found to be 0.2563 which is positive and significant that mean area of cotton will be increase while the value of regression of production was found to be 1.1577 which is positive and not significant that means production be increases. The value of regression of productivity was found to be 26.9651 which are positive and significant that means productivity be increases for next 20 years.

6.2 Conclusion:

The study was based on time series data of area, production and productivity from 1998-99 to 2017-18 was used for analysis. The compound growth rates was estimated by using the formula: $Y_t = a (1 + r)^t$ & CGR in per cent = $(\text{Antilog } b - 1) \times 100$ and trend analysis calculated by linear model expressed as: $Y_t = \beta_0 + \beta_1 t + e_t$.

Compound growth rate of area sign is negative that area of rice crop was decreased and CGR was found to be negative non significant, while production and productivity were increased and Compound growth rate are positive and non significant for India. Crop compound growth rates of wheat area, production and productivity were increased and compound growth rate are positive but non significantly. For coarse cereals crop compound growth rates of area was found to be negative that area of coarse cereals crop was decreased and negative non significant, while production was found to be positive and significant and productivity was found to be increased and compound growth rate are positive and highly significant for India. Total pulses crop compound growth rates of area was found to be positive but non-significant that means area of total pulses crop was increased, while production and productivity were increased and production was found to be positive and highly significant, compound growth rate of total pulses productivity was found to be positive but non-significant for India. Oilseeds

crop compound growth rates of area was found to be positive but non-significant, while production was found to be positive significant and productivity was found to be positive but non-significant. Sugarcane crop compound growth rates of area, production and productivity were found to be positive but non-significantly. Cotton crop compound growth rates of area was found to be positive significant, production and productivity were found to be positive and highly significantly.

Target and achievement of major crops production in India: The under achievement target year of production of rice were find to be in 2000-01, 2002-03, 2003-04, 2004-05, 2009-10, 2010-11, 2014-15 and 2015-16 while other side More achievement were find to be in 1998-99, 1999-2000, 2001-02, 2005-06, 2006-07, 2007-08,2008-09, 2011-12, 2013-14. 2014-15, 2016-17 and 2017-18. The under achievement target year of production of wheat were find to be in 1998-99, 2000-01, 2001-02, 2002-03, 2004-05,2005-06, 2014-15 and 2015-16 while other side More achievement were find to be in 1999-2000, 2003-04, 2006-07, 2007-08,2008-09, 2009-10, 2010-11, 2011-12, 2013-14. 2014-15, 2016-17 and 2017-18. The under achievement target year of production of coarse cereals were find to be in 1998-99, 1999-2000, 2000-2001, 2002-03, 2004-05,2005-06, 2006-07, 2008-09, 2009-10, 2010-11, 2012-12, 2015-16 and 2016-17 while other side More achievement were find to be in 2001-02, 2003-04, 2007-08, 2011-12, 2013-14. 2014-15 and 2017-18. The under achievement target year of production of total pulses were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05,2005-06, 2006-07,2007-08, 2008-09, 2009-10, 2014-15 and 2015-16 while other side More achievement were find to be in 2010-11, 2011-12, 2012-13, 2013-14. 2016-17 and 2017-18. The under achievement target year of production of oil seed were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2004-05, 2006-07,2007-08, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2014-15, 2015-16, 2016-17 and 2017-18while other side More achievement were find to be in 2003-04, 2005-06 and 2013-14. The under achievement target year of production of sugarcane were find to be in 1998-99, 1999-2000, 2000-2001, 2001-02, 2002-03, 2003-04, 2004-05, 2008-09, 2009-10, 2012-13, 2015-16 and 2016-17 while other side More

achievement were find to be in 2005-06 2006-07,2007-08, 2010-11, 2011-12, 2013-14, 2014-15 and 2017-18. The under achievement target year of production of cotton were find to be in 1998-99, 1999-2000, 2000-01, 2001-02, 2002-03, 2003-04, 2008-09, 2009-10, 2014-15, 2015-16, 2016-17 and 2017-18. while other side More achievement were find to be in 2004-05,2005-06, 2006-07, 2007-08, 2010-11, 2011-12, and 2013-14.

Trend of area, production and productivity of major crops for next 20 years: In case of rice crop in West Bengal, the value of regression of rice area was found to be negative (-0.0392) that mean area of small increase While the value of regression of production and productivity were found to be 2.1375 and 32.1413 which is both positive and significant that mean production be increases for next 20 years. In case of wheat crop in Uttar Pradesh, the value of regression of area was found to be positive (0.0363) that mean area of wheat be increase While the value of regression of production was found to be 0.2977 which is positive and not significant that mean production be increases. The value of regression of productivity of wheat was found to be 21.1609 which are positive and significant that means productivity be increases for next 20 years. In case of coarse cereals in Rajasthan, the value of regression of area was found to be negative (-0.0078) and not significant that mean area of coarse cereals be decrease While the value of regression of production was found to be 0.2262 which is positive and not significant that mean production be increases. The value of regression of productivity was found to be 38.9729 which are positive and significant that means productivity be increases for next 20 years. In case of total pulses for Madhya Pradesh, the value of regression of area was found to be 0.1228 which is positive and not significant that mean area of total pulses will be increase While the value of regression of production was found to be -0.5237 which is negative and non significant that mean production be decreases. The value of regression of productivity was found to be 15.2804 which are positive and significant that means productivity will be increases for next 20 years. In case of total oilseeds for Madhya Pradesh, the value of regression of area was found to be 0.1071 which is positive and not significant that mean area of total oilseeds will be increase while the value of regression of production was found to be -

1.0941 which is negative and non significant that mean production be decreases. The value of regression of productivity was found to be 15.8691 which are positive and significant that means productivity will be increases for next 20 years. In case of sugarcane for Uttar Pradesh, the value of regression of area was found to be 0.0113 which is positive and not significant that mean area of sugarcane be increase While the value of regression of production and productivity were found to be 2.0796 and 740.0188 both which are positive and significant that mean production and productivity be increases for next 20 years. In case of cotton for Gujarat, the value of regression of area was found to be 0.2563 which is positive and significant that mean area of cotton will be increase while the value of regression of production was found to be 1.1577 which is positive and not significant that means production be increases. The value of regression of productivity was found to be 26.9651 which are positive and significant that means productivity be increases for next 20 years.

6.3 Suggestions:

On the basis of above findings, the following major suggestions can be made.

1. In case of rice, the compound growth rate of rice area is negative so area of this crop can be decrease in future but CGR of production and yield are positive that mean production of rice will be increase in future that overall total production of rice would be increase which is fulfill of our requirement of food problem in future. Rice is main food of our daily life, 80 percent people are consuming the rice. The main problem is decreasing of area because various reason such as farmers are sifting of other crops, increases cost of cultivation and decreasing the net return etc.
2. In case of wheat, CGR of area, production and yield are positive so production is increases in future which is also fulfillment in our food problem. Wheat is second main consuming food after rice in India. So positive value of CGR, this is good sign for India.
3. In case of coarse cereals, CGR of production and yield are positive so increases of production in future while CGR of area is negative that is not good sign of India because coarse cereal is cultivated in drought region

and unproductive land. If we want to area of coarse cereals increases that good package and practice is used in cultivation and high price declared of coarse cereals crops.

4. In case of total pulses, CGR of area, production and yield are positive so production is increases in future that are also fulfillment in our food problem. Pulse is good source of protein for vegetarian people. India is fighting again pulse production after green revaluation but recently area of pulse crops is increasing significantly.
5. In case of oilseed, CGR of area, production and yield are positive so production is increases in future that are fulfillment in our food problem. Oilseed is good source of fat for vegetarian people. India is fighting again oilseed production lost one decade but recently area of oilseeds crops is increasing significantly.
6. In case of sugarcane, CGR of area, production and yield are positive so production of sugarcane is increases in future that are fulfillment in sugar, jury and ethanol problems.
7. In case of cotton, CGR of area, production and yield are positive so production of cotton is increases. Cotton is main commercial crop of India. Textile industry depend on cotton that this crop is more employment and income generating crop for India.

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