

**IMPACT ASSESSMENT OF CHICKPEA
VARIETY RELEASED BY Dr. PDKV, AKOLA**

THESIS

**Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
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**MASTER OF SCIENCE
IN
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By

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Enrolment Number –QQ/3063

2020

DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled “**IMPACT ASSESSMENT OF CHICKPEA VARIETY RELEASED BY Dr. PDKV, AKOLA**” or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or Scientific Organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

Place: Akola
Date: / / 2020

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CERTIFICATE

This is to certify that the thesis entitled “**IMPACT ASSESSMENT OF CHICKPEA VARIETY RELEASED BY Dr. PDKV, AKOLA**” submitted in partial fulfilment of the requirements for the degree of “**Master of Science in Agriculture (Agricultural Economics)**” of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Kotwal Pooja Nivrutti** under my guidance and supervision.

The subject of thesis has been approved by the Student’s Advisory Committee.

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(C) Abbreviations

%	-	Per cent
/	-	Per
@	-	At the rate
Agril.	-	Agricultural
Dr. PDKV	-	Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
e.g.	-	Exempli gratia (For example)
<i>et al.</i>	-	Et alia (and others)
etc.	-	Et cetra
Ha	-	Hectare
i.e.	-	That is
Kg	-	Kilogram
No.	-	Number (s)
q/ha	-	Quintals per hectare
Qtl	-	Quintal
resp.	-	Respectively
Rs./-	-	Rupees
Sr. No.	-	Serial number
vis-à-vis	-	In relation to
<i>viz;</i>	-	Videlicet (namely)
ECE	-	Electro Chemical Equivalent
dS/m	-	Deci Siemens per meter

(D) Thesis Abstract

- a) Title of the thesis : **IMPACT ASSESSMENT OF CHICKPEA VARIETY RELEASED BY Dr. PDKV, AKOLA**
- b) Full name of student : **Kotwal Pooja Nivrutti**
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Dr. PDKV, Akola

ABSTRACT

The research entitled "Impact Assessment of chickpea variety released by Dr. PDKV, Akola" has been carried out with the aims to work out the region wise growth rate of area, production and productivity of chickpea in Maharashtra, varietal status and economic impact of university released chickpea variety.

In the varietal front the Pulses Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola has made significant progress by releasing 10 excellent Chickpea Varieties for Maharashtra. Chickpea variety JAKI-9218 was released in 2007. The variety is resistant to

wilt disease. Seeds are generally medium in appearance. It is suitable in both rain fed and irrigated condition. Its seed colour is light brown. It is high yielding variety. It gives 18-20 qs/ha yield and crop duration is of 105-110 days. JAKI-9218 variety is mostly adopted in states like Maharashtra, Madhya Pradesh, Gujarat, Rajasthan and Chhattisgarh. Keeping in view of these aspects the present study was a modest alternate to analyze the impact of University released variety JAKI-9218 in Maharashtra with the following specific objectives.

1. To study the growth rates of area, production and productivity of Chickpea.
2. To examine the varietal status of University released Chickpea varieties.
3. To assess the economic impact of University released Chickpea varieties.

The study was based on the secondary data of area, production and productivity of Chickpea in Maharashtra and India was collected from the Annual report, Ministry of Agriculture and Farmers welfare, Government of India for the year 1990-91 to 2018-19 was split into three periods i. e. Period-I (1990-1999), Period-II (2000-2009), Period-III (2010-2018) and overall period (1990 to 2018). The information on expenditure on research, extension, salary, contingency etc. was availed from the office record of Pulses Research Unit, Dr. PDKV, Akola. Data on seed sale of JAKI-9218 was collected from Pulses Research Unit, Dr. PDKV, Akola and Mahabeej office, Akola.

The time series data on costs and returns of Chickpea JAKI-9218 for the year 2008-09 to 2018-19 were compiled from the Chickpea quick estimate reports of Agricultural Price Cost and Scheme, Department of Agril. Economics and Statistics, Dr. PDKV, Akola.

In addition to this project, primary data has been collected from the survey of sampled cultivator through personal interview with help of pre-tested and structured schedule for the year 2019-20.

Partial budget approach was used for estimating the impact of research outcome on income generation. Partial budgeting is a method of organizing experimental data and information about the cost and benefits

from some change in the technologies being used on the farm. The aim is to estimate the change that will occur in farm profit or loss from some change in the farm plan (Boehlje and Eidman, 1984).

Maharashtra state ranks second in area and production of gram in India. Madhya Pradesh ranks first in area and production of gram. The area, production and productivity of Chickpea increased at the rate of 0.41 per cent, 0.51 per cent and 6.89 per cent per annum, respectively, during the entire period. It means clearly indicates that the area, production and productivity of Chickpea was increased due to area expansion, production and productivity improvement for the entire period in the state.

The total economic worthiness of University released Chickpea production technology over other competing varieties of Chickpea in the region was Rs. 14892.60 per hectare. It means the Total Economic Impact to the farming community in Maharashtra state was Rs. 148.82 crores for the year 2019-20.

The area under University released Chickpea varieties for the year 2019-20 was 190343.00 ha.

The gross and net economic impact of University released Chickpea varieties was Rs. 7271.18 Crores and Rs. 931.50 Crores, respectively.

CHAPTER I

INTRODUCTION

India with 1.38 billion population accounts for only about 2.40 per cent of world's geographical area but has to support about 17.7 per cent of the world's human population. Thus, there is a big challenge to feed the ever-growing population even with the current level of population. During 2018-19, there was a record production of food grains to the tune of 283.37 million tonnes in which total pulses production was 23.22 million tonnes and chickpea production was 9.94 million tonnes (www.agricoop.nic.in) the projected demand for chickpea based on FAO estimates for 2050 in India is 16-17.5 million tonnes. The gap between current availability and projected demand for chickpea in 2050 is 7-8 million tonnes which can only be met by systematic research.

The greatest challenge now facing agricultural science is not how to increase production but how to enable resource-poor farmers to produce more. There is a need to evaluate past research and set priorities before carrying out any new research. According to Lockeretz and Anderson (1993), there is a need for rethinking the processes, approaches and institutional structures of agricultural research, because of the range and scale of the consequences that agricultural research is expected to address today. Thus, the national agricultural research system must shift to more rigorous prioritization procedures, systematic evaluation and project-based budgeting mode. These are important for ensuring efficient use of scarce public resources (Pal *et al.* 1996).

This argument makes the ground for importance of impact assessment studies. Impact assessment is a form of research evaluation which involves appraising the worth of research. It is an important component of agricultural research which helps to define priorities of research and facilitate resource allocation among programs, guide researchers and those who involved in technology transfer to have better understanding of the way new technologies are assimilated and diffused into farming communities and show evidence those clients benefits from the

research products (Manyong *et al.* 2001). an impact assessment that is designed and conducted to meet the specific information needs of specific decision makers is more likely to be of use to, and used by, them. The rationale behind conducting impact assessment studies is the expectation that the findings will be used to bring about improvements in policies and programs and thereby contribute to economic and social betterment (Mackay and Horton, 2003).

With a view of the need for stronger accountability in agricultural research in recent years, now there is a great demand not only for demonstrating the actual impacts of research but also for maximizing impacts through targeting research benefits to the society. The agricultural technology is the product of agricultural research; thus, impact assessment of agricultural research means the assessment of impact of agricultural technology. It includes modern crop varieties, plant health management, crop and resource management and post-harvest management. Genetic improvement in seed (planting material) is an important component of agricultural growth for nations and regions in the process of economic development (Smale, 2007).

1.1 Background information

Pulses are the important crops grown in India. The different pulses grown in the country are an integral part of subsistence farming. The different pulses play an important role in sustainable production system and household nutritional security. Pulses are the major source of protein for the vegetarians. India is the premier pulse growing country. India is the world's largest pulse producer, importer and consumer. The pulses are important part of cropping system of most of the farmers, since many years. Pulse crops fit well in the crop rotation that's why farmers all over the country grow pulse crops. Most of the farmers grow pulses in rain fed condition because they have a great drought resistance. Pulse crops add more nitrogen to the soil.

During the various plan periods, there has been a considerable growth in agricultural sector as well as pulses production in terms of increase in volume of output.in spite of this great progress, the country could not

improve the economic position of agriculturists and farmers. This is because of lack of adoption of improved technology and practices, improved varieties. Farmers are using local varieties and traditional techniques of crop production. As a result of this, producer is unable to get better yield, consequently resulting in low income and profit. Also, there are some marketing problems due to which farmers are unable to get fair deal in the market. Hence, keeping the importance of pulse economy in mind particularly chickpea production which is important crop of rabi season in rain fed area, the present study focuses on the study of new released chickpea varieties and how it is better than local varieties by doing impact assessment study.

Chickpeas are one of the earliest known cultivated legumes, tracing their ancestry back at least 7,000 years to the dawn of agriculture. The crop is thought to have originated in southeast Turkey and spread west and south via the Silk Road. Four centers of diversity have been identified – the Mediterranean region, Central Asia, the Near East, and India – with a secondary center of diversity in Ethiopia. There is also evidence from Middle Eastern archaeological sites of chickpeas being grown as far back as the early Bronze Age. Desi chickpeas are thought to be the earliest form of the crop, as they closely resemble seeds found at archaeological sites and those that are produced by the wild ancestor of domesticated chickpeas (*Cicer reticulatum*), which grows solely in southeast Turkey.

Chickpea or chana is a very important pulse crop in the world after peas & beans named *Cicer arietinum* in the *Leguminosae* family. Indian name 'channa' has most probably derived from the Sanskrit word 'chahakam'. Gram is commonly known by various names in different states of India such as, 'chana', 'harbhara', 'chhole', 'Bengal gram' etc. The light brown pulse is considered to be a good source of protein (25 to 29 per cent) and is also called by the name of 'Garbanzo beans' in Latin America, Hommes, Hamaz (Arab World), Nohud, Lablabi (Turkey) and Shimbra (Ethiopia).

Chickpea is grown in tropical, sub-tropical and temperate regions. Kabuli type is grown in temperate regions while the desi type

chickpea is grown in the semi-arid tropics. Chickpea is valued for its nutritive seeds with high protein content which is 25.3-28.9 per cent, after de-hulling. Chickpea is also a rich source of vitamin A, C, K and Riboflavin. Chickpea seeds are eaten fresh as green vegetables, fried, parched, boiled and roasted; as snack food, sweet and condiments; seeds are ground and the flour can be used as dal, soup and for preparation of bread; prepared with salt, pepper and lemon it is served as a side dish throughout the globe. Dal is the split chickpea without its seed coat, dried and cooked into a thick soup or ground into flour for snacks namkeens and sweet products. Sprouted seeds are eaten as a vegetable or added to salads. Young plants and green pods are eaten like spinach. A small proportion of canned chickpea is also used in Turkey and Latin America, and to produce fermented food. Animal feed is another use of chickpea in many developing countries. An adhesive may also be prepared; although not water-resistant, it is suitable for plywood. Gram husks, and green or dried stems and leaves are used for stock feed; whole seeds may be milled directly for feed. Leaves are said to yield an indigo like dye. Acid exudates from the leaves can be applied medicinally or used as vinegar. A cooked chickpea-milk (4:1) mixture is good for feeding infants, effectively controlling diarrhoea. Chickpeas yield 21 per cent starch suitable for textile sizing, giving a light finish to wool, silk and cotton cloth. Saponin content in chickpea is high and its inclusion in human diet lowers the plasma cholesterol and reduces the risk of heart disease. Chickpea also enriches the soil by fixing nitrogen through its root nodules.

1.2 Chickpea economy

India ranks first in area under chickpea followed by Pakistan, Iran and Australia and also ranks first in production under chickpea followed by Australia, Myanmar and Ethiopia. Despite of high production, the productivity of chickpea in India is low as compare to other major chickpea producing countries. The global chickpea area is around 139.81 million hectares with production of around 137.31 million tonnes with average global productivity 700-800 kg/ha during 2016-17 (www.faostat.org).

In the domestic scenario, chickpea is the most important pulse crop of India. The share of pulses in total food grain production is around

8.77 per cent and share in area is about 23.12 per cent of the total area under food grains. The share of chickpea in total pulses production is around 50 per cent and share in area is about 37 per cent of the total area under pulses. The area under chickpea during 2017-18 was 105.73 million hectares with a production of 111.58 million tonnes and productivity of 9.82 q/ha. About 94.72 per cent of the chickpea production comes from Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Andhra Pradesh and Karnataka and remaining contributed by rest of the states. (Annual Report 2018-19, Department of Agriculture, Cooperation and Farmer's Welfare).

Madhya Pradesh ranks first among the states with 30 per cent of area and 37 per cent of total rabi pulse production in the country. Maharashtra ranks second among all states with 21 per cent of area and 12 per cent of total rabi pulse production in the country. As usual, Madhya Pradesh has contributed a significant 34 per cent of the total chickpea area and 41 per cent of total gram production in the country, thereby ranking first both in area and production. In Maharashtra, chickpea occupied 20 lakh ha of area which is 18.92 per cent and 17.61 lakh tonnes of chickpea production which is 15.78 per cent of the total chickpea production in the country and holds second rank both in area and production in 2017-18 (Annual Report 2018-19, Department of Agriculture, Cooperation and Farmer's Welfare).

1.3 JAKI-9218: An outline

In the varietal front the Pulses Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola has made significant progress by releasing 10 excellent Chickpea Varieties for Maharashtra. Chickpea variety JAKI-9218 was released in 2007. The variety is resistant to wilt disease. Seeds are generally bold in appearance. It is suitable in both rain fed and irrigated condition. Its seed colour is light brown. It is high yielding variety. It gives 18-20 q/ha yield and crop duration is of 105-110 days. JAKI-9218 variety is mostly adopted in states like Maharashtra, Madhya Pradesh, Gujarat, Rajasthan and Chhattisgarh.

Despite the release of many improved chickpea varieties, JAKI-9218 is still grown by the farmers. In Maharashtra, improved variety JAKI-9218 gave 25-35 per cent higher yield and net returns as compare to

local checks (Reddy et al., 2014). According to Singh et al., 2017, a frontline demonstration carried out in Mandsaur district of Madhya Pradesh with three improved varieties i. e. JAKI-9218, JG-11 and JG-16. The increase in grain yield under demonstration for variety JAKI-9218 is 50 per cent than farmer's local variety.

1.4 Importance of the study

Though global production and yield of chickpea (*Cicer arietinum* L.) has not increased markedly in the past few decades, the world's population has been rising. Consequently, the net availability of chickpea per caput has declined. The increase in future demand due to rising population can be achieved by increasing production which is only possible by improving productivity. There is a large gap between the potential yield and the farm yield. Major factors responsible for this are inappropriate production practices including weed control, inadequate biological nitrogen fixation, damage of crop by several pathogens and pests, and susceptibility of cultivars to abiotic stresses.

The significant increase in chickpea production is possible by improving resource use efficiency, developing better crop management technologies, and focused breeding efforts for development of improved chickpea varieties. The major goals of chickpea breeding are to increase production either by upgrading the genetic potential of cultivars or by eliminating the effect of diseases, insects, drought and cold (Singh, 1997). Breeders produce many varieties of chickpea per year in India and of this, only few varieties are covers maximum area under chickpea. This reflects that despite of bulk presence of new varieties, only few varieties are capable of satisfying the needs of the farmers.

Thus, the popularity of older varieties indicates that probably greater breeding efforts are needed to develop better varieties. This requires a strong linkage between end users and researchers so that breeding efforts are streamlined to on-field requirements. But a large amount of investment required to carry out such a need-based research. In order to attract investment in agricultural research, there is a need for researchers to produce evidence that research and technology dissemination investments

have been competitive to other alternatives. This huge funding on research is justified only when research benefits spill across geographical boundaries. The ex-post impact assessment studies will help to estimate the research benefits.

Keeping in view of these aspects the present study was a modest alternate to analyse the benefits of agricultural technology the impact of University released variety JAKI-9218 in Maharashtra which justify the future investment in chickpea breeding programmes.

1.5 Objectives of the study

The present study is undertaken with the following specific objectives.

1. To study the growth rates of area, production and productivity of Chickpea.
2. To examine the varietal status of University released Chickpea varieties.
3. To assess the economic impact of University released Chickpea varieties.

1.6 Hypothesis

There is positive impact of chickpea variety.

1.7 Scope of the study

The present investigation will help to study the growth rates of area, production and productivity of chickpea in last few years. It will help to increase production of chickpea by area expansion, production and productivity improvement in the state. This study also attempts to analyse impact of university released chickpea variety over other competing variety with a view to increase yield of chickpea.

1.8 Limitations of the study

A well thought and designed research study may not be free from limitations, hence present methodology adopted for analysing data may have inherent limitations. The main limitations of the study are as follows:

1. The present research was conducted in Maharashtra and restricted to chickpea crop.
2. The information which was collected through personal interview which may contain respondent's errors.
3. On farmer side there is not full adoption of these technologies at recommended level and yield obtained are considerably lower than those recorded on the existence of considerable untapped yield potential.
4. Moreover, the study was mostly based on the secondary data collected from various published sources. Often that from various sources may not agree with each other and some efforts to choose better among them are inevitable.

CHAPTER II

REVIEW OF LITERATURE

This chapter is devoted to review the studies closely related to the present research work. In order to have a clear and in-depth understanding of the research investigation to be carried out and to choose the suitable analytical technique, work done by the various researchers pertinent to the present study has been reviewed. The relevant studies have been reviewed in chronological order under the following sub-headings:

1. To study the growth rates of area, production and productivity of Chickpea.
2. To examine the varietal status of University released Chickpea varieties.
3. To assess the economic impact of University released Chickpea varieties.

1. Growth rates of area, production and productivity of Chickpea

Growth rates are generally used to measure the performance of economic variables. They are commonly used as summaries of trends in time series data. They are developed to describe the trends in the variable over time.

Alshi and Joshi (1984) worked out the growth rates of area, production and productivity of pulses in Vidarbha. They revealed that the area, production and productivity of pulses in Vidarbha during the post green revolution period were increased. That was only possible due to adoption of new technology during post green revolution period.

Kaliyas (1985) reported that during the year 1984-85, the productivity of gram in the state of Himachal Pradesh was 6.8q/ha. New technology with adoption of improved variety, soil preparation, time of sowing, fertilizer used P_2O_5 as 40 kg/ha, irrigation, intercultural and weed control and plant protection resulted in increased yield of gram.

Sharma (1988) conducted a study to know the performance of agriculture in Punjab. He observed that the growth rates of area, production

and productivity of gram decreased significantly in Amritsar district of Punjab. However, the decrease in production was due to decline in area under gram.

Singh and Chaudhari (1993) worked out the compound growth rate of area under gram in Bihar state. They observed that the area under gram declined over a period of time except Ranchi district.

Nielsen (2001) studied the Production Functions for Chickpea, Field Pea, and Lentil in the Central Great Plains. This study was conducted to determine the potential of chickpea (*Cicer arietinum* L.), field pea (*Pisum sativum* L.), and lentil (*Lens culinaris* Medik.) as such rotational legumes based on yield responses to water and soil water extraction patterns. The legumes were planted under a line source gradient irrigation system. soil water content, crop water use, seed yield and local historical rainfall were recorded. The result revealed that chickpea exhibited the greatest rate of increase in yield with increases in water use ($10.6 \text{ kg ha}^{-1} \text{ mm}^{-1}$), followed by field pea ($8.0 \text{ kg ha}^{-1} \text{ mm}^{-1}$) and lentil ($3.3 \text{ kg ha}^{-1} \text{ mm}^{-1}$). Yields estimated from the historical rainfall record ranged from 951 to 3782 kg ha^{-1} (mean of 2092 kg ha^{-1}) for chickpea, 523 to 2718 kg ha^{-1} (mean of 1406 kg ha^{-1}) for field pea, and 286 to 1247 kg ha^{-1} (mean of 654 kg ha^{-1}) for lentil. All three legumes have agronomic potential to be used as dry land crops ahead of winter wheat in the central Great Plains.

Raghuwanshi et al. (2001) evaluated study on growth of chickpea in Bundelkhand region of Madhya Pradesh. An attempt has been made to evaluate the growth performance of chickpea production in Bundelkhand region of Madhya Pradesh during 1970-71 to 1994-95. The findings of the study revealed that all the districts of the region experienced positive growth rates of area, production and productivity of chickpea during the reference period. Tikamgarh district showed higher growth rate under area of chickpea while Datia district ranked first in growth of yield. Result of the component analysis showed that yield was the major contributor in production than the area in Datia and Tikamgarh district.

Mathur and Henry (2006) estimated the trends in area, production and productivity of chickpea in arid zone of western Rajasthan, Rajasthan and India. The compound growth rate of area, production and

productivity of chickpea was worked out for different agro-climatic zones of western Rajasthan, Rajasthan and India for two periods viz; long term (1961-1990) and recent years (1991-2002). On long term basis the productivity of the crop increased significantly in arid zone, Rajasthan and in India whereas in recent years it was non-significant. The production indicated a significant positive trend in arid zone as compare to Rajasthan and India on long term basis, whereas it was negative in both arid zone and Rajasthan, low positive in India in recent years. In recent years the area under the crop revealed decreasing trends in arid zone, Rajasthan and India. The chow's test revealed that the production of chickpea increased significantly with area in two periods in zone II of western Rajasthan and in India indicating a positive change due to technological development.

Reddy and Mishra (2009) conducted study on Growth and Instability in Chickpea Production in India: A State Level Analysis. The study is carried out to examine the pattern of growth, variability and the sources of growth and instability in production of chickpea at state level. The time series data for the period 1971-2000 regarding production, area and yield of chickpea has been used to compute compound growth rates, Coefficient of variation, Coppock's Instability Index (CII) and for performing decomposition analysis to attain the objectives. The average production of chickpea increased by 7 per cent from 4.8 MT in 1970/85 to 5.2 MT in 1986/2000, while coefficient of variation increased from 14 per cent to 17 per cent during the same period. As a result, most of the states fall in low growth-high-risk category in chickpea production. Only Madhya Pradesh, Andhra Pradesh and Orissa fall under high growth-low risk category. Yield contributed positively and area contributed negatively to increase in chickpea production between the periods. Madhya Pradesh, Maharashtra and Karnataka contributed to increase in production, while Uttar Pradesh, Punjab and Haryana contributed negatively.

Singh and Renu (2009) studied the growth of production and productivity of different pulses in Jharkhand. The study indicates that there have been positive changes in the area of pulses crops. The annual compound growth rate in the area was estimated to be 8 per cent, 62 per

cent, 0.80 per cent and 0.20 per cent in pea, lentil, chickpea and pigeon pea, respectively. The production growth rate in the same crop was observed to be 9.2 per cent, 6.8 per cent, 3.5 per cent and 3.9 per cent as compound annual rate in the State. The yield growth rate for these crops was further estimated to be 1.20 per cent, 0.05 per cent, 0.20 per cent and 2.20 per cent. The variability in the area was observed to be high in pea followed by lentil and pigeon pea and minimum in chickpea. Similarly, variability in yield was also found to be high in pea followed by chickpea, lentil and minimum in pigeon pea, respectively.

Gajbhiye et al. (2010) evaluated growth and instability of chickpea in Vidarbha region of Maharashtra. The study was based on secondary data pertained to the year 1980-81 to 2007-08. The results revealed that the growth rates for area and production of chickpea were found significant. The production of chickpea over the period has been almost constant.

Acharya et al. (2012) conducted a study on Growth in area, production and productivity of major crops in Karnataka. The growth in the area, production and productivity of different crops in Karnataka was estimated using the compound growth function. The necessary secondary data were collected for a period of 26 years from 1982-83 to 2007-08. Growth rates showed a significant positive growth in area under pulses, vegetables and spices and fruits and nuts while cereals showed significant negative growth. The production of cereals, pulses, vegetables and fruits showed a significant positive growth. The productivity of different crops recorded significant growth in the case of cereals, pulses and fruits.

Neugschwandtner et al. (2013) conducted the study on chickpea performance compared to pea, barley and oat in central Europe: growth analysis and yield. Yield and growth analysis of chickpea were assessed in a two-year field experiment in Central Europe (Raasdorf, Austria) and compared to pea, barley and oat, which are well adapted crops in that region. The result revealed that Chickpea had a lower above-ground biomass and grain yield compared to pea, barley and oat in 2006, whereas only pea was more productive than chickpea in the dry year of 2007. The

relatively good performance of chickpea regarding crop growth rate and relative growth rate compared to pea, barley and oat under severe drought in 2007 indicated that chickpea may be an interesting crop in the Central European production area in the face of possible climate change.

Singh and Prakash (2014) examined the growth and instability analysis of chickpea production in Maharashtra: a district –wise analysis. The district-wise time series data on area, production and productivity pertaining to the period 1980-81 to 2009-10 was taken. The period has been divided decade-wise into three parts. The compound growth rate and coefficient of variance was measured. During the overall period, the growth performance of chickpea in Maharashtra state as a whole showed significant positive growth rate in area (2.33 per cent), production (3.45 per cent) and productivity (2.60 per cent). The highest compound growth rate of chickpea acreage was observed in Yevatmal (97.64 per cent) district. However, in case of productivity, growth rate was found to be highest in Aurangabad (3.78 per cent) district of the state.

Sandeep et al. (2015) conducted the study on the decomposition and acreage response of chickpea in western Vidarbha. The study was based on time series secondary data on the rainfall, farm harvest price and other data, which were obtained from various Government publications. Nerlovian lagged adjustment model (1958) was used in acreage response analysis based on time series data. The study revealed that the compound growth rate for area and production under chickpea was recorded high during period I in all the districts. During period II, the area, production and productivity of chickpea registered mostly negative growth rates in all the districts. During period III, the compound growth rate for area, production and productivity under chickpea has increased in all the districts of western Vidarbha region. During overall period, the co-efficient of variation and Coppock's instability index for area, production were high in Yavatmal district compared to other districts. At overall period, the area effect (37.44%) was most responsible factor for increasing production in Amravati division with positive yield and interaction effect i.e., 6.78 per cent and 55.69 per cent, respectively.

Patil et al. (2016) studied the Performance of Growth and Instability of Chickpea (*Cicer arietinum*) in India. The performance of Chickpea in India was studied with the objectives, to know about growth rates and variability in area, production and productivity. The secondary data on area, production and productivity of Chickpea in India were collected from various government publications of agriculture. Data pertaining to the period of 30 years i.e. from 1985-86 to 2014-15. From study, it was revealed that, the area under Chickpea in period-II (2000-01 to 2014-15) was increased. The growth rates in case of production for period-I (1985-86 to 1999-2000) was 2.02 per cent which is significant at 10 per cent level. In period-II (2000-01 to 2014-15), the growth rate was found 5.35 per cent which is significant at 1 per cent level. It was seen that, the growth rate of productivity of Chickpea for the period-I (1985-86 to 1999-2000) was 1.49 per cent which was significant at 1 per cent level. In period-II (2000-01 to 2014-15), it was found non-significant. India exhibited low variation in period-I (1985-86 to 1999-2000) in area under Chickpea. India exhibited low variation of production in period-I (1985-86 to 1999-2000) and high variation in overall period. It means that, area and production of gram in India was constant for period-I (1985-86 to 1999-2000) & period-II (2000-01 to 2014-15).

Gupta and Gupta (2016) conducted study on dynamics of gram production in major gram producing Districts of Madhya Pradesh. The study was conducted during the year 1992-93 to 2012-13. The result lead to conclude that the higher and significant linear growth (3.19 %) in production of Gram in these districts, was due to significantly higher growth (7.64 %) of area followed by better growth in productivity. The overall compound growth of Gram production in these districts was 3.28 per cent. During the study period acreage of Gram was found negative growth in Narsinghpur and Gunn districts. All other districts have positive compound growth rate and significant in most of the districts. Production of Gram increased in all the districts but it was significantly in Jabalpur, Sager, Damoh, Panna, Dewas, Guna, Sehore, Raisen, Vidisha and Rajgarh districts. The compound growth rates measure in different districts between 0.67 to 6.23 per cent. The productivity of Gram is static around 1 tonnes/ha.

Bhokare et al. (2017) examined the Performance of chickpea production in Amravati district of Maharashtra. The present study is an attempt to evaluate the growth and instability of such important crop i.e. chickpea. For the present study, Amravati district from Maharashtra state was chosen purposively as area under chickpea is reported highest in this district. The study was based on secondary data pertained to the year i.e. 1994-95 to 2014-15. The result revealed that Chickpea is the most important pulse crop in Amravati district, the growth rate for area of production of chickpea was found significant. Instability studied in chickpea indicate, that productivity under chickpea exhibited more yield. It means that production of chickpea over the period has been almost high.

Maurya and Kumar (2018) conducted a study on growth of chickpea production in India. The chickpea production in the country has gone up from 3.65 to 9.53 million tonnes between 1950-51 and 2013-14, registering a modest growth. During the period while the area has also gone up from 7.57 to 9.93 million ha, the yield has steadily increased from 482 kg/ha to 960. The compound growth rates of production and yield of chickpea were found positive and negative for area. However, growth in yield was estimated positive after eighties. Overall, there was positive growth rate of production and yield, and marginal negative growth in area. Overall, the production is increased mainly due to area effect.

From the above study, it can be concluded that the growth rates of area, production and productivity of chickpea was increasing.

2. Varietal status of University released Chickpea varieties

Shivakumar (2001) evaluated performance of chickpea (*Cicer arietinum*) varieties as influenced by sulphur with and without phosphorus. A two year field experiment was conducted at New Delhi during 1993-95 with three varieties of chickpea (*Cicer arietinum* L.) ('Biogreen', 'BG 256' and 'BG 209') and 5 levels of S and P (0, 40, 80 kg S/ha, 40 kg S + 40 kg P₂O₅ and 80 kg S+40 kg P₂O₅/ha). It concluded that 'Biogreen' recorded significantly higher seed yield than the other varieties, while 'BG 209' recorded the least seed yield. Application of S with or without P recorded significantly higher seed yield up to 40 kg S/ha only. Addition of P with S showed significantly

higher seed yield than S alone. Most of the growth and yield attributes too showed similar trend except seeds/pod, test weight and harvest index.

Katerji et al. (2001) evaluated the response to soil salinity of two chickpea varieties differing in drought tolerance. Two chickpea varieties namely Variety ILC 3279 and Filip 87-59C, differing in drought tolerance, were grown in lysimeters filled with clay, and were irrigated with waters of three different salinity levels. The result revealed that salinity had a slight effect on the leaf water potential and the osmotic adjustment. The drought sensitive variety, however, showed under slightly saline conditions ($EC_e = 2.5$ dS/m) from 135 days after sowing onwards a different behaviour by the growth of new leaves and flowers, a delay in senescence, leading to the same yield as under non-saline conditions. Under saline conditions ($EC_e = 3.8$ dS/m) the drought sensitive variety showed the same yield reduction of about 70 per cent as the drought tolerant variety. The nitrogen balances of both varieties (van Hoorn et al., 2001) indicate that ILC 3279 maintained its nitrogen fixation under slightly saline conditions at the same level as under non-saline conditions, and two times higher than Filip 87-59C.

Shiyani et al. (2005) attempted a study to assess the adoption of different chickpea varieties in Gujarat and identify farmers' preferences for different varietal traits. ICCV 1 was released as ICC 4 in the early 1980s, and its adoption pattern is yet to be examined. The study revealed that farmers in Gujarat prefer bold, yellow coloured, round, desi - type grains. Wilt-and insect-resistant, drought-escaping varieties were also preferred by a majority of them. It is suggested that large scale on-farm demonstrations supported by seed production by public sector companies will accelerate the rate of adoption of improved chickpea varieties in Gujarat.

Ravi et al. (2006) reported that a field experiment was conducted during 1998-99 to 2000-01 at the Indian Institute of Pulses Research, Kanpur, Uttar Pradesh, India, to study the genotypic compatibility in *kabuli* chickpea (*Cicer arietinum* cultivars L 550, BG 1003 and KAK 2) and Indian mustard (*Brassica juncea* cultivars Varuna and Vardan) in chickpea + Indian mustard intercropping system. The sole crop of chickpea cv. BG1003 recorded significantly highest growth and yield attributes than the other

genotypes of chickpea. Among the various intercropping system, BG 1003 chickpea + Vardan Indian mustard recorded significantly highest growth and yield attributes of chickpea and Indian mustard than the other intercropping systems. However, the highest 100-seed weight of chickpea was recorded in chickpea KAK 2 in the chickpea + Vardan Indian mustard intercropping system at 6:2 row ratio. Yield reduction of chickpea was recorded higher in Indian mustard genotypes of Varuna than Vardan. Significantly higher chickpea-equivalent yield, land-equivalent ratio (LER), net returns and benefit: cost ratio (B: C ratio) were recorded in BG 1003 + Vardan intercropping system than the other intercropping system.

Bhuiyan et al. (2009) assessed the effect of Rhizobium inoculation on four cultivars of chickpea. Field experiments were carried out at a Regional Agricultural Research Station (RARS), Rahmatpur, Barisal, Bangladesh for two consecutive rabi seasons in 2002-03 and 2003-04. Four chickpea cultivars, namely BARI Chola-3, BARI Chola-4, BARI Chola-5 and BARI Chola-6, were used in these trials. There were eight treatments and four replications. The Rhizobium strain used was BARI RCa-220. The result revealed that the variety BARI Chola-3 produced significantly higher nodule numbers and nodule weights, and BARI Chola-5 produced significantly higher seed yields. The seed yields of the BARI Chola-5 variety (1.80 t/ha and 1.85 t/ha) were increased by 20.0 per cent and 19.4 per cent over uninoculated treatments for two consecutive rabi seasons in 2002-03 and 2003-04. Uninoculated BARI Chola-3 recorded the lowest yields in both these years.

Khatun et al. (2009) studied the effect of seed collected from different parts of chickpea varieties on growth, yield and yield attributes of chickpea. Field experiments were carried out between 2004-2006 at the Bangladesh Agricultural Research Institute Farm in Grey Terrace Soils, Joydebpur, Gazipur, Bangladesh. Chickpea seeds of three varieties (BARI Chola-5, BARI Chola-6 and BARI Chola-8) were collected from different sites i.e., B1: collection of pods from primary branches of chickpea plants, B2: collection of pods from secondary branches of chickpea plants and B3: collection of pods from tertiary branches of chickpea plants prior to

harvesting. The result revealed that maximum pods plant⁻¹, seeds pod⁻¹ and seed yield were observed in BARI Chola-5 and the lowest in BARI Chola-8, though 1000-seed weight was recorded from BARI Chola-8. Seeds were collected from primary branches of chickpea plants (B1) recorded the highest pods plant⁻¹, seeds pod⁻¹, 1000-seed weight and seed yield. Overall maximum seed yield was recorded from BARI Chola-5 when seeds were collected from primary branches.

Meena and Dudi (2012) studied the comparative performance of newly released as well as conventionally grown popular early, timely and late sown chickpea varieties. Ten 'On Farm Assessment Trials (OFAT)' were conducted during Rabi 2008–09, 2009–10 and 2010–11 at various locations in arid region Pali district of Rajasthan. Results of 'OFAT' revealed that chickpea varieties viz; RSG-888 as well as RSG-991 were equally good performers under early sown conditions with respective average grain yields of 16.9 and 15.5 q/ha under rainfed. Timely sown chickpea grown under rainfed conditions of Sumerpur, Raipur and Sojat blocks, RSG-896, GNG-1488, GNG-1292 and RSG-902 recorded grain yield ranging between 16.9 to 19.7 q/ha, while under irrigated conditions of Jaitaran and Sumerpur blocks, RSG-895, CSZD-884, Pratap-1 and RSG-807 performed better in terms of productivity and profitability with average grain yield ranging between 16.5 to 18.2 q/ha with highest yield in CSZD-884. The results under late sown rainfed chickpea indicated that GNG-469, GNG-663 and GNG-1958 recorded higher productivity over *deshi chana*, while new cultivars GNG-1969 was low performers under irrigated late sown conditions in terms of productivity and profitability over conventionally grown popular varieties GNG-469 and GNG-1958, respectively.

Sharma et al. (2013) evaluated Nutritional and anti-nutritional profile of newly developed chickpea (*Cicer arietinum* L) varieties. In this study the variability in nutritional composition, mineral profile, anti-nutritional factors and in vitro starch digestibility of five desi and four kabuli chickpea cultivars were studied. Proximate composition varied significantly ($p < 0.05$) among different types of chickpea cultivars. The crude protein content is higher in kabuli chickpea cultivars which is 18-31 per cent than desi

chickpea. Iron was present in all the cultivars of chickpea (4.6-10.5%). Among anti-nutritional factors tannin concentration ranged from 0.07-0.22 per cent and trypsin content ranges from 9-31 mg/gm. in both the cultivars of chickpea. In vitro starch digestibility of chickpea was found significantly ($p < 0.05$) higher in kabuli chickpea than desi chickpea cultivars. It concluded that chickpea cultivars K850 in desi and PUSA 1108, PUSA 1088 and PUSA 1053 in kabuli cultivars had good potential as a food crop.

Ghosh et al. (2014) conducted a study on participatory varietal selection of chickpea in rainfed rice fallow lands of Chhattisgarh and Madhya Pradesh in India for sustainable crop production. There is a great scope for expanding chickpea production with or without limited irrigation in rainfed rice fallow lands (RRFL) in the states of Chhattisgarh and Madhya Pradesh. Nineteen chickpea genotypes were tested using participatory varietal selection (PVS) trials on farmers' fields in each of the four districts of Chhattisgarh and Madhya Pradesh. Among the several traits of the introduced chickpea varieties, grain yield was the most preferred trait by farmers, followed by resistance to diseases and early maturity. Yield potential of PVS genotypes averaged up to 50 per cent greater than the local cultivar. Farmer's participation in the selection process of genotypes laid the foundation of better and sustainable yields of chickpea and thereby providing better economic returns suitable to small farmers of RRFL of Chhattisgarh and Madhya Pradesh. The results of this study can be replicated in the similar environments in Asia and Africa.

Khan and Khan (2015) studied the Varietal Response of Chickpea (*Cicer arietinum* L.) Towards the Allelopathy of Different Weeds. Three chickpea varieties viz, Karak-I, Karak-III and Shenghar in a laboratory trial were tested against the phytotoxicity of five weed species: *Parthenium hysterophorus* L., *Phragmites australis* (Cav.) Trin., *Datura alba* L., *Cyperus rotundus* L. and *Convolvulus arvensis* L. in January 2013. The weed extracts were prepared at the rate of 120 g/L (w/v) after shade dry. The result revealed that highly significant inhibitory effect of all the tested weed species occurs on the chickpea varieties. The chickpea variety Karak-III was more susceptible to the phytotoxicity of the tested weed extracts. The effect of P.

australis extract was found a little stimulator by speeding the seed germination in all varieties and giving a low (2.21) mean germination time (MGT) value. From the current results it can be concluded that the infestation of *C. arvensis* can pollute the soil by accumulating toxic chemicals that leads to the germination failure and growth suppression in chickpea. Therefore, the prevention and removal of *C. arvensis* in the chickpea growing areas could be recommended. Chickpea varieties withstand against phytotoxicity of *P. australis*, so that it can be popularized as bio-herbicide in chickpea if it gave promising results in controlling chickpea weeds.

Patil et al. (2016) evaluated Compartmental bunding (CB) and improved chickpea varieties in ten farmers' fields during rainy-winter (kharif-rabi) seasons of 2012-13 in Vertisols at Bellary, India. Adopting improved chickpea varieties of BGD103 and JG11 during winter season increased the grain yields from 12.5 to 15.9 per cent, respectively over locally cultivated A1 variety. During July (rainy season) CB conserved rainwater in-situ and further increased the grain yield of chickpea up to 36.7 per cent in BGD103 and 43.9 per cent in JG-11. The increase in grain yield from 24.2 per cent (JG-11) to 27.8 per cent (BGD103) indicates that CB is effective for in-situ rainwater conservation and improving profile soil moisture in Vertisols. Technology index was higher in this study and varied from 48.3 per cent (Cultivation of BGD103 variety with CB) to 60.6 per cent (Cultivation of JG11 variety without CB) indicating that technology index can be reduced and chickpea yields can be increased and sustained with adoption of improved chickpea production technologies including in-situ rainwater conservation practices at farmers' fields. Higher gross and net returns with greater B:C ratio were observed with layout of farmers' fields with CB and cultivation of JG11 variety.

Rani and Krishna (2016) were conducted an experiment on response of chickpea (*Cicer arietinum* L.) varieties to nitrogen on a calcareous vertisols during rabi season of 2010-12. The experiment carried out with four varieties i.e., NBeG-3, NBeG-28, JG-11 and KAK-2 and with four nitrogen levels i.e., 0, 20, 30 and 40 kg/ha laid out in factorial randomized block design with three replications. Among the varieties

significantly higher dry matter production at harvest was recorded with JG-11 while it was lowest with KAK-2. More number of pods per plant and seed yield was recorded with JG-11 followed by NBeG-3 and NBeG-28, while lowest with KAK-2. Interaction effect among the different varieties and nitrogen levels was non-significant with yield attributes. Significantly higher seed yield was recorded with JG-11 @ 40 kg of N/ha but was at par with N @ 20 and 30 kg /ha, followed by NBeG-3 and NBeG-28.

Khoiwal et al. (2017) studied the Evaluation of Chickpea Varieties under Different Moisture Stress Condition on Growth and Yield of Chickpea (*Cicer arietinum* L.). The experiment was conducted in split-plot design replicated 3 times, keeping 3 moisture stress situation viz; S0 – Water withheld after germination, S6L – Water withheld from 6 leaf stage and SFL – Water withheld from flowering in main-plots and 9 chickpea cultivars viz; V1–Ujjain 21, V2–JAKI- 9218, V3 –IG 593, V4 –JG 6, V5 –JG 16, V6 –JG 130, V7 –JG 412, V8 –JG 11 and V9 –KAK 2 in sub-plots. Among the chickpea varieties, V5 –JG 16 produced highest seed yield followed by V6–JG 130 followed by V8–JG 11. Under various treatment combinations, the seed yield of chickpea was recorded highest under SFLX V5. B:C ratio was noted highest with SFL due to moisture stress situations while in case of chickpea varieties, maximum values were estimated under V5– JG 16. It may be concluded from that the combination of moisture stress situation SFL– Water withheld from flowering and the chickpea variety V5–JG 16 was found most suitable in terms of productivity and profitability.

Parmar et al. (2018) studied the Adoption of Improved Varieties of Chickpea in Sehore District of Madhya Pradesh. It was conducted in the Sehore district of Madhya Pradesh in the Department of Agriculture Extension & Communication, R.A.K. Agriculture College Sehore M.P., in year 2017-18. The result revealed that the majority of chickpea growers (45.83%) adopted overall technology in chickpea cultivation by medium level followed by (27.50%) adopted overall technology in chickpea cultivation by low level and (26.67%) adopted overall technology in chickpea cultivation by high level, respectively.

The above reviews clearly indicate that all the different varieties which were released are high yielding and profitable to farmers.

3. To assess the economic impact of University released Chickpea varieties

Nanjareddy et al. (1990) studied the economics of producing hybrid and local tomato varieties for 1988-89, in Bangalore district. They found that most of the inputs used in the cultivation of hybrid tomatoes were higher than those of local varieties except seeds and bullock labour. Their average total variable cost per acre in the case of hybrid tomato (Rs.14006.55) was about 250 per cent higher than that of local varieties (Rs.4109.63). The average labour required per acre in the case of hybrid tomato (313.21 man days).

Shiyani et al. (1996) conducted a study to assess the role of the Krishak Bharti Cooperative (KRIBHCO) project in disseminating improved chickpea varieties, the direct and indirect on-farm benefits of improved chickpea varieties, and factor influencing adoption of improved chickpea varieties. Data were collected for the period 1994-96 from 48 adopters of improved chickpea varieties and 48 non-adopters drawn from four villages in Panchamahhal district, Gujarat, India. The higher yield of the improved varieties reduced per unit production cost and increased profitability.

Joshi et al. (1998) studied the spread of adoption of chickpea varieties and their economics in India and measures returns to investments on chickpea research at ICRISAT. Survey data relating to the period 1992-95 were collected from 1150 chickpea growers drawn from four states (Andhra Pradesh, Gujarat, Madhya Pradesh and Maharashtra). To on-farm benefits of improved chickpea varieties over traditional varieties are shown in terms of yield, income, unit cost, employment and price premium. The internal rate of return and net present value of benefits from research were calculated as 21 per cent and \$1.44 million for ICCV 2 and 25 per cent and \$2.87 million for ICCV 37.

Shiyani et al. (2000) examined the factors influencing adoption of recently developed improved gram varieties in few and backward tribal villages of Gujarat state in India. The data for the study were collected from 96 farmers from selected Limkhera block of Panchmahal district. Farmers were divided into two groups 1) Adopters and 2) Non-adopters of improved varieties. The study concluded that, there was substantial increase in yield level, income and labour productivity of these varieties. They further observed that the use of improved varieties helped in reduction of cost of production as compared to local varieties.

Shiferaw et al. (2005) conducted a study on assessment of the adoption and impact of improved pigeon pea varieties in Tanzania. During the study data collected from both adopting and non-adopting households so that the impact of the interventions can be estimated by comparing sample households with and without the technology. The study revealed that yields varied significantly across villages and also between improved varieties and local landraces. The average yield from the local varieties is about 425 kg/ha, but the comparative data for improved varieties is about 709 kg/ha. Improved pigeon pea varieties were grown by 25 per cent of surveyed farmers and 98 per cent of these adopting farmers marketed some of the grain they harvested, indicating a positive impact of adoption on market participation and generating marketable surplus.

Chaitanya and Chandrika (2006) studied the performance of chickpea varieties under varied dates of sowing in Chittoor district of Andhra Pradesh. A field experiment was conducted during rabi 2001-02 on sandy loam soils of Tirupati with three chickpea varieties (ICCV-10, ICCV-2 AND Annegiri-1) sown on four different dates (October 15, November 1, November 15 and December 1). The chickpea variety ICCV-10 recorded higher yield (475 kg/ha) and yield attributes. Among the four dates of sowing, November 1 sown crop recorded higher yield attributes and yield (579 kg/ha).

Macharia et al. (2012) assessed the potential economic and poverty impact of 11 improved chickpea varieties released by the National Agricultural Research Organization of Ethiopia in collaboration with the

International Crops Research Institute for the Semi-Arid Tropics. The economic surplus model applied estimated a total benefit of US\$ 111 million for 30 years. Consumers are estimated to get benefit up to 39 per cent and producers 61 per cent. The benefit cost ratio was estimated at 5:1 and an internal rate of return of 55 per cent, indicating that the investment is profitable. The generated benefit is expected to lift more than 0.7 million people (both producers and consumers) out of poverty. Thus, further investments in the chickpea and other legume research in Ethiopia is justified as a means of poverty alleviation.

Reddy et al. (2014) conducted a study for response of varieties to climate vulnerabilities like floods and droughts in selected villages of 13 districts in Andhra Pradesh and Maharashtra. The demonstrations on improved cultivars along with the respective local checks were compared with the participating farmers. The result showed that, in Maharashtra, improved varieties of chickpea (Digvijay) in Ahmednagar, Aurangabad and Nandurbar districts and JAKI-9218 in Amravati and Gondia districts gave 25-35 per cent higher yield and net returns compared to respective local checks.

Ambulkar and Dixit (2014) assessed the impact of gram for enhancing production for food nutritional security and livelihood of remote tribal community under pulses. The demonstration of gram varieties JAKI-9218 and JG-11 was conducted on farmer's field in Samnapur block of district Dindori (MP) in rabi 2011-12. The result revealed that the data shows on grain yield were found significant in different demonstration of gram. Average maximum yield (1650 kg/ha) was recorded under the variety JAKI-9218 which was significantly superior to farmers practice (700 kg/ha). The percentage changes of yield in variety of gram JAKI- 9218 were recorded 85.71 per cent.

Gulpadia and Chhonkar (2014) were studied the effect of phosphorus on growth and productivity of chickpea varieties during rabi Season of 2011-12 at Research farm, Raja Balwant Singh College, Bichpuri, Agra (U.P.). The experiment comprised of four levels of phosphorus (0, 30, 60 and 90 kg P₂O₅ ha⁻¹) and three chickpea varieties viz; Haryana-1, BG-7 and PBG-7. Result revealed that the taller plants root growth and yield and

yield attributes were obtained with higher Haryana-1 variety. Most of the growth parameters and yield attributes were increased significantly with every increase in levels of phosphorus up to 60 kg P₂O₅ ha⁻¹ which were statistically at par with 90 kg P₂O₅ ha⁻¹ but significantly higher than other levels of phosphorus. Maximum net returns (Rs.32875 ha⁻¹) along with a B:C ratio of 2.41 was obtained in Haryana-1. Phosphorus use efficiency decreased with the increase in P level. Net returns (Rs.30334.8 ha⁻¹) and benefit cost (2.40) ratio were the highest with 60 kg P₂O₅ ha⁻¹.

Rimal et al. (2015) studied the adoption pattern of improved varieties of chickpea (*Cicer arietinum* L.) and their impact on farm income in Madhya Pradesh with 100 chickpea growing households spread over Vindhyan, Malwa and Bhagelkhand regions for the survey period of 2012-13 which provided insight into the incidence and intensity/ penetration power of varieties in seed supply chain and increase in overall chickpea production in the state. Farmers of Vindhyan and Bhagelkhand regions mostly preferred desi varieties as they adopted JG 315 followed by JG 335, Ujjan 21 and JG 11, while Dollar and KAK 2 were dominant kabuli varieties in Malwa region. The result revealed that the adoption of improved varieties the seed replacement rate of pulses has increased from 2.15 per cent in 2002 to 11 per cent in 2012. The average price of kabuli chickpea was 31.17 per cent higher than desi chickpea. In case of kabuli chickpea, the net revenue from Dollar variety was about 10 per cent more than that obtained from KAK2. The physical and financial performance of JG-315 and Ujjain 21 were also better compared to other varieties in Vindhyan and Bhagelkhand regions. It also provides deep insight to stakeholders of chickpea not only to penetrate in seed markets but also help in deciding how to design R&D program as well.

Verkaart et al. (2017) analysed the impact of improved chickpea adoption on welfare in Ethiopia using three rounds of panel data. First, they estimated the determinants of improved chickpea adoption using a double hurdle model. Second, they estimated the impact of area under improved chickpea cultivation on household income and poverty. The result revealed that improved chickpea adoption significantly increases house-hold income while also reducing household poverty. Finally, results

disaggregated by landholding to explore whether the impact of adoption has heterogeneous effects. Adoption favoured all but the largest landholders, for who the new technology did not have a significant impact on income. Overall, increasing access to improved chickpea appears a promising pathway for rural development in Ethiopia's chickpea growing regions.

Mathur and Dhaka (2017) conducted a study on impact assessment of chickpea (Chana) price forecast advice on economic status of the farmers. The study was commenced to investigate and apprehension the impact of pre sowing price forecast of chickpea released during September, 2015. Monthly time series data on average prices of chickpea for the period from 2006 to 2015 were collected from APMC, Bikaner. ARIMA (1, 1, 1) was used and forecasted prices were calculated. The impact assessment of price forecast was done on 20 adopter farmers of Bikaner. Thus, the significant acreage increases and an incremental income realized to the extent of 17001.6 per hectare by the farmers.

Above study concluded that the use of improved varieties helped in reduction of cost of production as compared to local varieties.

CHAPTER III

METHODOLOGY

Study of agricultural development has assumed very importance as an area of research in Agricultural Economics. Many research workers directed their efforts towards evaluating the pace, pattern and impact of agricultural development either at the micro or macro level. Yet, there is a dearth of information to assess the impact of technology on agricultural production.

The present study was undertaken with the aim to study an impact assessment of chickpea variety released by Dr. PDKV, Akola. The importance and utility of study depends upon the reliability of the collected data, materials and methods. This chapter deals with the methodology adopted for undertaking the study viz; selection of pulses research unit, methods of data collection, analysis of data by applying appropriate

statistical tools to obtain the results as per the objectives of the study and interpretation of the data.

3.1 Selection of area

Chickpea crop is grown in entire Maharashtra state consisting four regions viz; Western Maharashtra, Marathwada, Vidarbha and Konkan. But, the collected data of area, production and productivity of Western Maharashtra and Khandesh region were compiled for analysis purpose.

3.2 Selection of Pulses Research Unit

The Pulses Research Station, Dr. P. D. K. V., Akola was selected for estimating the economic impact of JAKI-9218 variety of Chickpea in Maharashtra.

3.3 Selection of Variety :

JAKI-9218 variety was selected for the present study because this variety was widely used under cultivation of Chickpea and the local variety used as a check.

3.4 Period of study

The present study was conducted for Maharashtra state. The data were collected on area, production and productivity of chickpea in Maharashtra pertaining to the period from 1990-91 to 2017-18. For the analysis of growth rate, the entire study period was split into three sub-periods and overall, as follows.

Period I : 1990-91 to 1999-2000

Period II : 2000-01 to 2009-10

Period III : 2010-11 to 2017-18

Overall : 1990-91 to 2017-18

3.5 Collection of data

The data on area, production and productivity of Chickpea for Maharashtra and India was collected from the Annual report, Ministry of Agriculture and Farmers welfare, Government of India for the year 1990-91 to 2018-19. The information on expenditure on research, extension, salary,

contingency etc. was availed from the office record of Pulses Research Unit, Dr. PDKV, Akola. Data on seed sale of JAKI- 9218 was collected from Pulses Research Unit, Dr. PDKV, Akola and Mahabeej office, Akola.

As the farmers retained the seed for next year also distribute among the other farmers as per demand. So, the area under seed spread was considered 25 per cent increase on over total seed.

The time series data on costs and returns of Chickpea JAKI- 9218 for the year 2008-09 to 2018-19 were compiled from the Chickpea quick estimate reports of Agricultural Price Cost and Scheme, Department of Agril. Economics and Statistics, Dr. PDKV, Akola.

In addition to this project, primary data has been collected from the survey of sampled cultivator through personal interview with help of pre-tested and structured schedules for the year 2019-20.

3.6 Analytical techniques

The present analysis was based on time series secondary data of chickpea in Maharashtra. It was conducted on following aspects.

3.6.1) Compound growth rate

3.6.2) Return to Investment (Partial Budgeting Method)

3.6.3) Up scaling of economic impact

3.6.1) Compound growth rate

The compound growth rates were computed based on time series data on area, production and productivity of Chickpea for Maharashtra for study period viz; 1990-91 to 2017-18 using log-linear function. The period 1990-91 to 2017-18 was subdivided into four sub-periods viz; Period-I (1990-1999), Period-II (2000-2009), Period-III (2010-2018) and overall period (1990 to 2018).

Compound growth rates were estimated to study the percentage increase or decrease in the selected parameter. The following exponential growth function was used.

$$Y = a.b^t \dots\dots\dots (1)$$

Where,

Y = Dependent variable for which growth was estimated
(i.e. area, production and productivity)

a = Intercept or constant

b = Regression/trend coefficient

t = Periods in years (1, 2, 3...n)

This equation was estimated after transforming (1) as follows

$$\text{Log } Y = \log a + t \log b \dots\dots\dots (2)$$

Then the per cent compound growth rate was computed as follows

$$\text{CAGR (\%)} = [\text{Antilog}(\log b) - 1] \times 100 \dots\dots\dots(3)$$

Where, CAGR= Compound Annual Growth Rate

The significance of the regression coefficient was tested using the students' t test. The 't' test was applied to test of significance of 'b'. This test was performed as under following formula.

$$t = \frac{b^n}{\text{S.E.of } b}$$

3.6.2) Return to Investment

Return to investment is a ratio between net profit over a period and cost of investment resulting from an investment of some resources at a point in a time. As a performance measure, it is use to evaluate the efficiency of an investment. Economically, it is one way of relating profits to capital invested. In this study, it was use to evaluate the impact of JAKI- 9218 variety.

There are three techniques which popularly used to study the impact analysis viz;

- (i) Log linear production function
- (ii) Total factor productivity
- (iii) Partial budgeting technique

For the present study Partial Budget technique was used.

Partial budgeting

Partial budgeting is used to find the economic viability of partial change in the farm such as use of new variety or new technology or new innovation or new practice or new equipment or new service. Partial budget approach was used for estimating the impact of research outcome on income generation. Partial budgeting is a method of organizing experimental data and information about the cost and benefits from some change in the technologies being used on the farm. The aim is to estimate the change that will occur in farm profit or loss from some change in the farm plan (Boehlje and Eidman, 1984).

In this study the four components of partial budgeting were considered viz; i) Added expenditure due to cultivation of improved Chickpea variety ii) Reduced returns due to cultivation of improved Chickpea variety iii) Reduced cost due to cultivation of improved gram variety and iv) Added returns due to cultivation of improved Chickpea variety. The partial budget can be divided into three main sections viz; (i) cost, (ii) returns and (iii) analysis. The analysis section includes net change in profits. Net change in profit is the factor that determines whether the change can be profitable over the other. If the benefits are better than the cost, the change will have a positive net benefit. If costs related to a proposed change are greater than benefits, then the proposed change should not be considered, as it will cost more than it will return.

A partial budget can be arranged into the following format in Table 3.1.

Table 3.1 Partial Budgeting Format

Section I- Costs (Debit Side)	Section II- Returns (Credit Side)
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Additional Costs (Added expenditure due to cultivation of improved Chickpea variety)	Additional Returns (Added returns due to cultivation of improved Chickpea variety)
Reduced Returns (Reduced returns due to cultivation of improved Chickpea variety)	Reduced Costs (Reduced cost due to cultivation of improved gram variety)
Total Costs (A+ B)	Total Returns (D+ E)
Section III- Analysis	
G. Net change in Profits (F- C)	

3.6.3) Up scaling the economic impact

For up scaling the economic impact the probability performance of the technology, rate of adoption of technology and depreciation of the technology was considered.

The gross and net gain from University released variety over check variety has been deflated on the basis of Consumer Price Index (CPI).

CHAPTER IV

SOCIO-ECONOMIC STATUS OF MAHARASHTRA STATE

Maharashtra is the largest and populous state in India. Maharashtra share in India's GDP is 14.4 per cent and the growth rate of GDP is 6 per cent in the state. Share of agriculture and allied sectors in the state income is 13 per cent. Agriculture is most dynamic sector, which influence not only agriculture economy, but also secondary and tertiary sectors. Geographical and climatic factors such as soil type, topography and

weather conditions are mostly responsible for changes in agriculture. Purpose of this chapter is to study climatic, geographical and economic factors in the state.

1. Geographical factors

Maharashtra is the third-largest state by area in India. Its area is around 307.58 lakh hectares. Maharashtra contributed nearly 10 per cent of geographical area of the Indian union; it extended over 800 Km. from east to west and around 700 Km. north to south and lies between 16.4 and 22.1 north latitudes and between 72.6° and 80.9° east longitudes. Maharashtra state has been divided into 4 broad regions on the basis of climatic situations. These are Konkan (30 lakh hectares), Western Maharashtra (117 lakh hectares), Marathwada (64 lakh hectares) and Vidarbha (97 lakh hectares).

State is flanked by Arabian Sea on the west. Gujarat surrounds it on western side, Madhya Pradesh on Northern side, Chhattisgarh on eastern side, Andhra Pradesh, Karnataka and Goa on southern side. The western ghat run from north to south separating the coastal district Mumbai, Thane, Raigad, Ratnagiri and Sindhudurga from the rest Maharashtra, as the ridge runs across at the right angle to the monsoon stream, it forms an important climatic divide.

2. Physical features

Geographically the state can be divided into three main regions based on its physical features viz; Maharashtra Plateau, the Sahyadri Range and the Konkan Coastal Strip as explained below.



Location of Maharashtra state in India

N





Fig 4.1 Map of Maharashtra

i. Maharashtra Plateau

The major physical characteristics of the state include many small plateau and river valleys. In the north the plateau is flanked by Satpuda ranges, which run in the East-West direction in Maharashtra. The river Narmada flows along the north boundary of Maharashtra, and other major rivers like Krishna, Godavari, Bhima, Penganga, Wardha, and Tapi, Purna have carved the plateau in alternating broad river valleys and intervening highlands.

ii. The Sahyadri Range

The Western Ghats of Maharashtra known as the 'Sahyadri' mountain ranges have an average elevation of 1000-1200 m above the MSL. The Sahyadri hills run parallel to the seacoast, with many offshoots branching eastwards from the main ranges (Satmala, Ajanta, Harishchandra, Balaghat and Mahadeo). The special features are the hills of Trimbakeshwar, Matheran and the Mahabaleshwar plateau. Its highest peak is Kalsubai at an altitude of 1650 m. Most of the rivers in Maharashtra originate in the Sahyadri.

iii. The Konkan Coastal Strip

The narrow strip of coastal land between the Sahyadri and the Arabian Sea is called the Konkan coastal strip. It is barely 50 km in width; it is wider in the north and narrows down in the south. River creeks and branches of the Sahyadri, which reach right up to the coast, dissect this coastline. The important creeks in Konkan are Terekhol, Vijaydurg, Rajapuri, Raigad, Dabhol, Daramthar, Thane and Vasai. Some important rivers are Ulhas, Savitri, Vashishthi and Shastri.

3. Population

Population plays an important role in development of agriculture. As per the population census 2011, population of Maharashtra is 11.24 crore, which is 9.3 per cent of the all India population. The state is second largest populous state in India after Uttar Pradesh. The state has a density of population 365 per sq. km. which is bellow all-India average of 382 per sq. km. Growth rate of population is 16.01 per cent. Share of urban and rural sector in total population of state is 45 and 55 per cent, respectively. The sex ratio is 929 females per thousand males. Working population of the state is 42.50 per cent. The percentage share of agriculture workers in total workers is 54.96 per cent and percentage of female workers is 34.78 per cent. Contribution of agriculture worker in total population is decreasing over a period of time. It indicates that development of non-agricultural sector is in increasing state. Demographic particulars of Maharashtra are given in Table 4.1.

Table 4. 1. Demographic particulars of Maharashtra

year	Population (crore)					Sex Ratio No of female/ 1000 male			Literacy Rate (%)
	Rural	Urban	Total	Male	Female				
1991	4.84	3.05	7.89	4.08	3.81	934	972	875	64.9
2001	5.58	4.11	9.69	5.04	4.65	922	960	873	76.9
2011	6.16	5.08	11.24	5.82	5.81	929	952	903	82.3

Source - Commissionerate of Agriculture, GoM

4. Climates and Rainfall

Maharashtra has a tropical climate, with three distinct seasons: Summer (March–May), Monsoon (June– September), and winter (October–February). However, dew and hail also occur sometimes, depending upon the seasonal weather. Summers (March, April and May) are extremely hot, the temperature rises from 22 °C to as high as 47 °C during the summer. The rainfall starts normally in the first week of June. July is the wettest month in Maharashtra, while August also gets substantial rain. The rainy season starts its retreat with the coming of September to the state. Rainfall in Maharashtra differs from region to region. In winter, a cool dry spell occurs, with clear skies, gentle air breeze, and pleasant weather prevails from October to February. But the eastern part of Maharashtra sometimes receives some rainfall. Temperature rise from 12 °C to 34°C during this season.

The state with 36 districts is divided into four regions by IMD: Konkan (7 Districts), Western Maharashtra (10 Districts), Marathwada (8 Districts) and Vidarbha (11 Districts). Among the four regions of Maharashtra, the first region comprises of coastal districts of Konkan, which have low variation in annual temperature. The winter in this region is very mild and humidity is relatively high. The second comprising the districts of western Maharashtra, is characterized by relatively hot summer, rainy season and moderately cold winter. The third and fourth region comprising the districts of Marathwada and Vidarbha region, respectively differ from each other only in degree is so far as temperatures are concern. The

temperature of Vidarbha is relatively higher than Marathwada region. In both the regions, the winter temperature is rather low.

During 2019 SW Monsoon, the state had 1328.5 mm rainfall, which was 32 per cent above Long Period Average. In that, Konkan region had maximum rainfall above 4000 mm which is about 35 to 57 per cent above normal rainfall with the highest rainfall of 4945.6 mm (57% above normal) being in Raigarh district. Western Maharashtra had 1166.9 mm rainfall during the monsoon, 55 per cent above normal. Kolhapur with 2927.5 mm (69% above normal) rainfall had the highest rainfall and Solapur with 299.6 mm (38% below normal, the only district of this region having below normal rainfall). Marathwada is the only region in the Central and South India where the region had below normal rainfall, deficit being 12 per cent. Bid (-27%) and Latur (-22%) were in Deficit rainfall category districts, Nanded with 814.4 mm had the highest rainfall of this region. Vidarbha too had above 1000 mm rainfall (1054.6 mm, 12% above normal) during SW Monsoon 2019. Five (Gadchiroli (1850.5 mm, 48% above normal), Chandrapur (1269, 17% above normal), Bhandara (1222.9, 6% above normal), Gondiya (1183.9 mm, 3% above normal), Nagpur (1169.8, 27% above normal)) of the districts had above 1000 mm rainfall. Yavatmal (30% below normal) and Washim (20% below normal) are the two deficit districts in this region. Yavatmal, with 563.8 mm, had the lowest rainfall of this region.

5. Soils

Maharashtra state has variety of soils on account of its geographical situation. Soils of Maharashtra can be classified into following six groups.

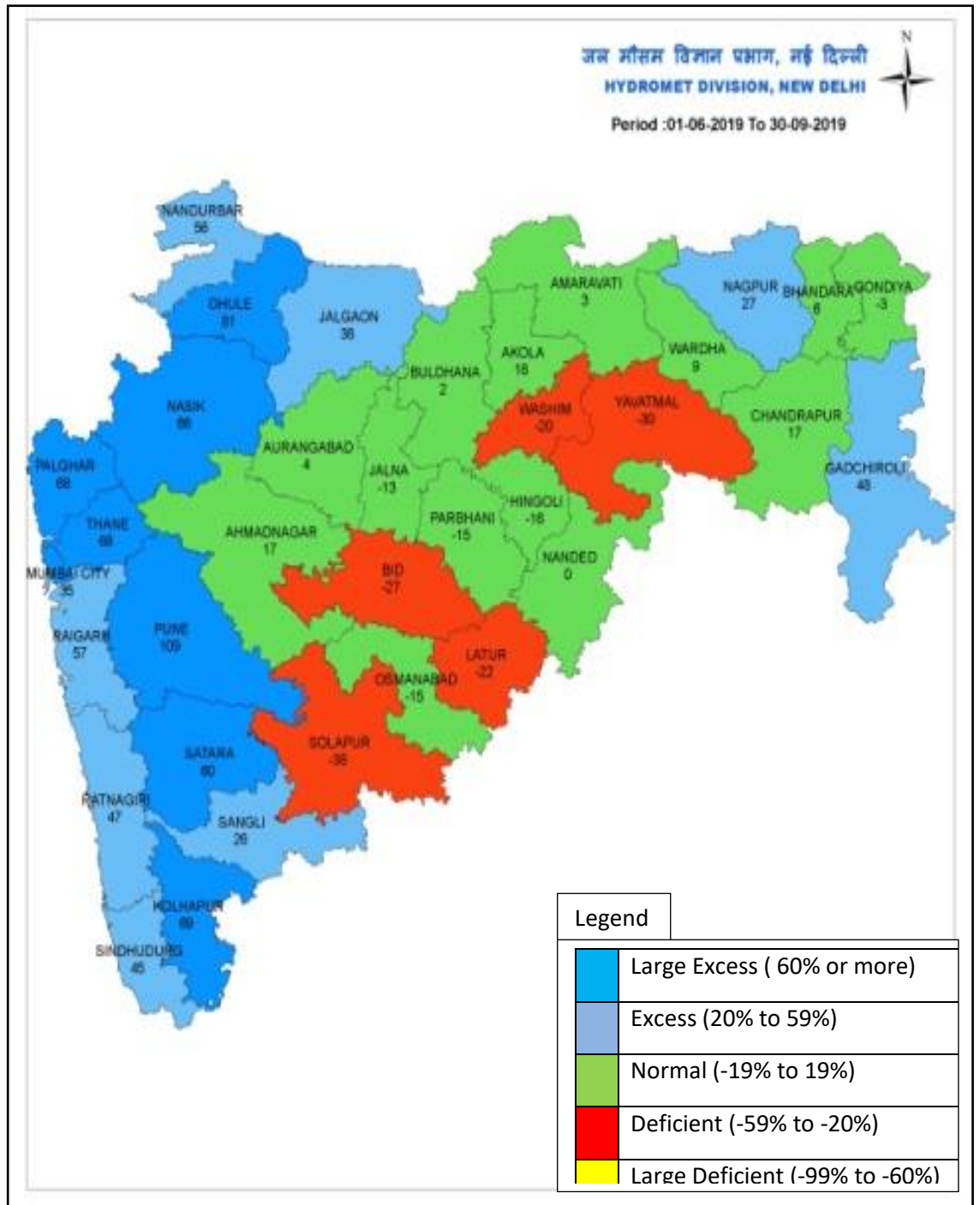


Fig 4.2 District rainfall departure map- Maharashtra

a) Deep black soils of clay nature

These soils are known as regur or black cotton soils. In general, these soils are more fertile and produce excellent yield of cotton, sugarcane, groundnut, jowar, wheat, banana, citrus and other crops.

b) Clay loam and medium black soils of black colour derived from trap

These soils cover the largest area in Maharashtra extending over the whole of the Deccan plateau. They also occur in wide area in the districts of Marathwada and Vidarbha. All kinds of soils are grown on these soils depending upon availability of water.

c) Soils of laterite origin

These soils are occurring mainly in Ratnagiri and Sindhudurg districts and in northern and western parts of Satara district and western part of Kolhapur district. The texture of these soils varies from loam to clay loam.

d) Coastal alluvial soils

These soils are of coastal track and are covered with coastal alluvial. These are trap in origin in the North and lateritic in the northern end of this long coastal strip.

e) Coastal saline and saline alkali soils

Large track of land has become saline due to the grass of sea water along the western sea coast. These soils are also known as khar and khajan land.

f) Yellowish brown and red soils

These soils are found in the eastern part of Chandrapur, Gadchiroli and Bhandara districts. These soils are formed from mixed parent material, under influence of warm humid climate and forest vegetation. Paddy and rabi jowar are main crops grown on these soils.

5. Agro climatic zones of Maharashtra state

Agro climatic condition of Maharashtra varied with respect to soil types, temperature, rainfall, humidity etc. across the state. Randhwa et al. (1968) divided Maharashtra state into six regions on the basis of flowing rivers in the state and their drainage areas viz; Konkan, Krishna basin, Vainganga basin, Godavari basin, Tapi basin and Purna basin. In this classification, however, the major commodity yields contributing factors such as rainfall, topography, soil type and cropping pattern etc. have not been

considered. Vaidya and Sahastrabudhe (1970) have attempted to divide Maharashtra state into nine agro climatic zones by considering rainfall, topography, soil type, other climatic conditions and cropping pattern. These are given below.

1. Very high rainfall zone with lateritic soil
2. Very high rainfall zone with non-lateritic soil
3. Western ghat zone
4. Transition zone (or sub-montance zone) with red to reddish brown soil
5. Transition zone (or plain zone) with grayish soil
6. Scarcity zone
7. Assured rainfall zone with mainly kharif cropping
8. Moderate to moderately high rainfall zone with soils formed from trap
9. High rainfall zone with soils formed from mixed rocks.

6. Land holding in Maharashtra state

As per the first Agriculture Census (1970-71) number of operational holdings and area of operational holdings in the State was 0.50 crore and 2.12 crore ha, respectively. As per the tenth Agriculture Census (2015-16) number of operational holdings increased to 1.53 crore and area of operational holdings decreased to 2.05 crore ha. The average size of holding decreased from 4.28 ha in the first census to 1.34 ha as per tenth census. The average size of land holding for SC and ST was 1.24 ha and 1.76 ha, respectively. The share of female operational holders was 14.1 per cent with 1.22 ha of average size of land holding. It is explained in Table. 4.2.

Table 4.2. Total number, area and average size of operational holdings in the state according to agricultural censuses

Sr. No.	Size class (ha)	Number of operational holdings ('00)		Area of operational holdings ('00 ha)		Average size of holdings (ha)	
		2010-11	2015-16	2010-11	2015-16	2010-11	2015-16
1	Below 0.5	36,457	43,722	9,180	10,278	0.25	0.24
2	0.5-1.0	30,633	34,436	22,680	24,209	0.74	0.70
3	1.0-2.0	40,523	43,393	57,391	57,711	1.42	1.33
4	2.0-3.0	15,463	16,964	36,681	38,844	2.37	2.29
5	3.0-4.0	6,128	6,306	20,974	21,412	3.42	3.40
6	4.0-5.0	3,142	3,353	13,901	14,778	4.42	4.41
7	5.0-10.0	3,964	3,983	26,027	26,216	6.57	6.58
8	10.0-20.0	590	576	7,524	7,251	12.75	12.59
9	20.0 and above	89	121	3,314	4,365	37.24	36.07
	Total	1,36,989	1,52,854	1,97,672	2,05,064	1.44	1.34

Source - Commissionerate of Agriculture, GoM

7. Land use pattern

The land utilization statistics for 2017-18 depicts that out of the total 307.58 lakh ha geographical area of the state, the gross cropped area was 232.68 lakh ha while the net sown area was 169.42 lakh ha (55.08 per cent). The area under forest was 52.19 lakh ha (16.96 per cent), land not available for cultivation was 34.84 lakh ha (11.32 per cent), other uncultivated land was 24.66 lakh ha (8.02 per cent) and fallow land was 26.27 lakh ha (8.54 per cent). During the period of last five years i.e. from 2013-14 to 2017-18, land put to non-agricultural uses has increased.

The details of land use pattern of Maharashtra for last 13 years (2005 to 2018) are presented in Table.4.3.

year	Geographical area	Area under forest	Land not available for cultivation		Other uncultivated land			Fallow lands		Cropped area		Gross Cropped area
			Barren and uncultivable land	Land put to non-Agricultural uses	Cultivable waste land	Permanent pasture and grazing land	Land under miscellaneous tree crop and groves	Current fallows	Other fallows	Net area sown	Area sown more than once	
2005-06	30,758	5212	1720	1407	914	1252	249	1327	1204	17,473	5083	22,556
2006-07	30,758	5213	1719	1412	915	1252	249	1324	1196	17,478	5079	22,557
2007-08	30,758	5213	1718	1427	916	1248	248	1327	1188	17,473	5182	22,655
2008-09	30,758	5213	1718	1433	918	1240	248	1372	1188	17,422	5032	22,454
2009-10	30,758	5214	1729	1443	917	1242	250	1373	1189	17,401	5211	22,612
2010-11	30,758	5210	1731	1449	919	1242	250	1366	1179	17,406	5709	23,175
2011-12	30,758	5211	1728	1451	919	1244	250	1378	1192	17,386	5720	23,106
2012-13	30,758	5207	1722	1455	916	1245	251	1418	1200	17,344	5772	23,116
2013-14	30,758	5205	1723	1460	915	1242	249	1401	1192	17368	6012	23,380

2014-15	30,758	5201	1727	1482	919	1249	249	1399	1188	17344	5929	23,273
2015-16	30,758	5194	1731	1521	887	1249	251	1477	1255	17191	5671	22,863
2016-17	30,758	5194	1822	1642	924	1351	253	1401	1257	16910	6314	23,224
2017-18	30,758	5219	1834	1650	923	1287	256	1365	1262	16942	6326	23,268

Table 4. 3. Land Use Pattern of Maharashtra

(Area '000 ha)

Source: Economic survey of Maharashtra 2019-20

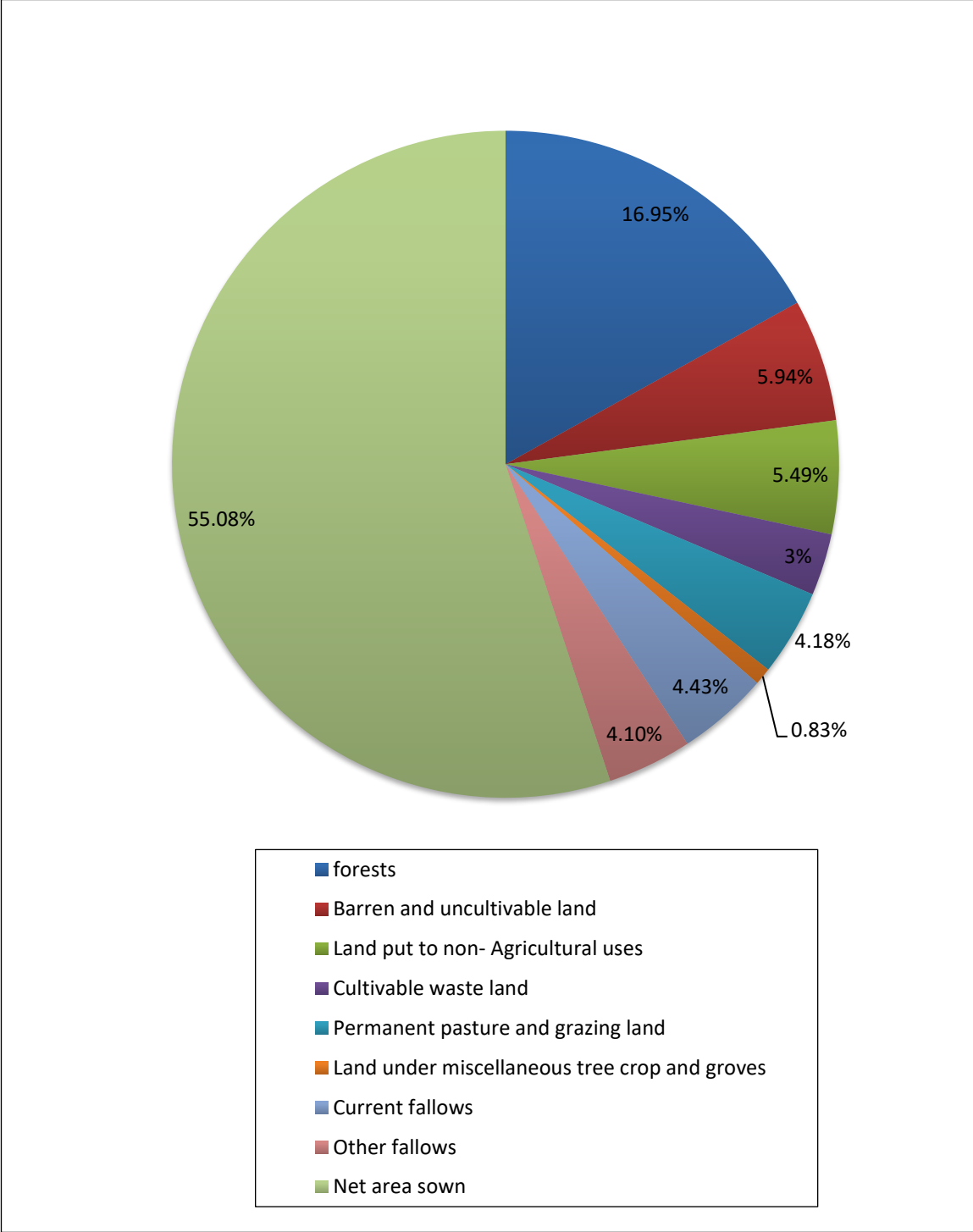


Fig 4.3 land use pattern of Maharashtra

8. Cropping pattern

The usual cropping pattern is determined by large number of factors. The most important factors are climate, topography, soil, customs and distance of the market. Rice, wheat, jowar, bajra etc. commodities were grown in the Maharashtra followed by pulses, oilseeds, cotton, sugarcane, vegetables, flowers, fruits, spices and plantation commodity. The area under different commodity grown in Maharashtra was given below in the Table 4.4.

Table 4. 4. Cropping pattern of Maharashtra (2017-2018)

Sr. No	Commodity	Area ('000 ha)	Percentage to total
1	Rice	1451	6.10
2	Wheat	1138	4.79
3	Jowar	3464	14.58
4	Bajra	788	3.32
5	Ragi	86.4	3.64
6	Maize	913.8	3.84
7	Other cereals	221.8	0.93
	Total cereals	8063	33.95
8	Tur	1375	5.79
9	Gram	2234	9.40
10	Udid	351	1.48
11	Moong	432	1.90
12	Other pulses	185	0.78
	Total pulses	4577	19.27
	Total food grains	12640	53.22
13	Groundnut	291	1.22
14	Soybean	3694	15.55
15	Safflower	39	0.16
16	Sunflower	15.2	0.06
17	Niger seed	18.1	0.07
18	Sesame	18	0.07
19	Linseed	10.2	0.04
20	Other oilseeds	53.5	0.22
	Total oilseeds	4133	17.40

21	Sugarcane	902	3.78
22	Cotton	4351	18.32
23	Fruits	735.18	3.09
24	Vegetables	726.20	3.05
25	Spices and condiments	34.37	0.14
26	Plantation crops	220.72	0.93
27	Flowers	5.49	0.02
	Gross cropped area	23747.96	100

Source: Commissionerate of Agriculture, GoM

9. Improved Seeds

Maharashtra State Seeds Corporation (MSSC) and National Seeds Corporation (NSC) are major public sector organisations in production and distribution of quality seeds. Private seed producers are also involved in supply of seeds of various crops. GoI has fixed the seed replacement targets of 35 per cent for self-pollinated crops (paddy, wheat, tur, moong, urid, etc.), 50 per cent for cross pollinated crops (maize, jowar, bajra, sunflower, etc.) and 100 per cent for hybrid crops. The quantity of improved seeds distributed for kharif and rabi seasons is given in Table 4.5.

Table 4.5 Quantity of improved seeds distributed for kharif & rabi seasons
(‘000 quintal)

Distribution agency	Season	2017	2018
Public	Kharif	501	555
	Rabi	274	345
	Total	775	900
Private	Kharif	907	1031
	Rabi	532	193
	Total	1439	1224
Total	Kharif	1408	1586
	Rabi	806	538
	Total	2214	2124

Source: Commissionerate of Agriculture, GoM

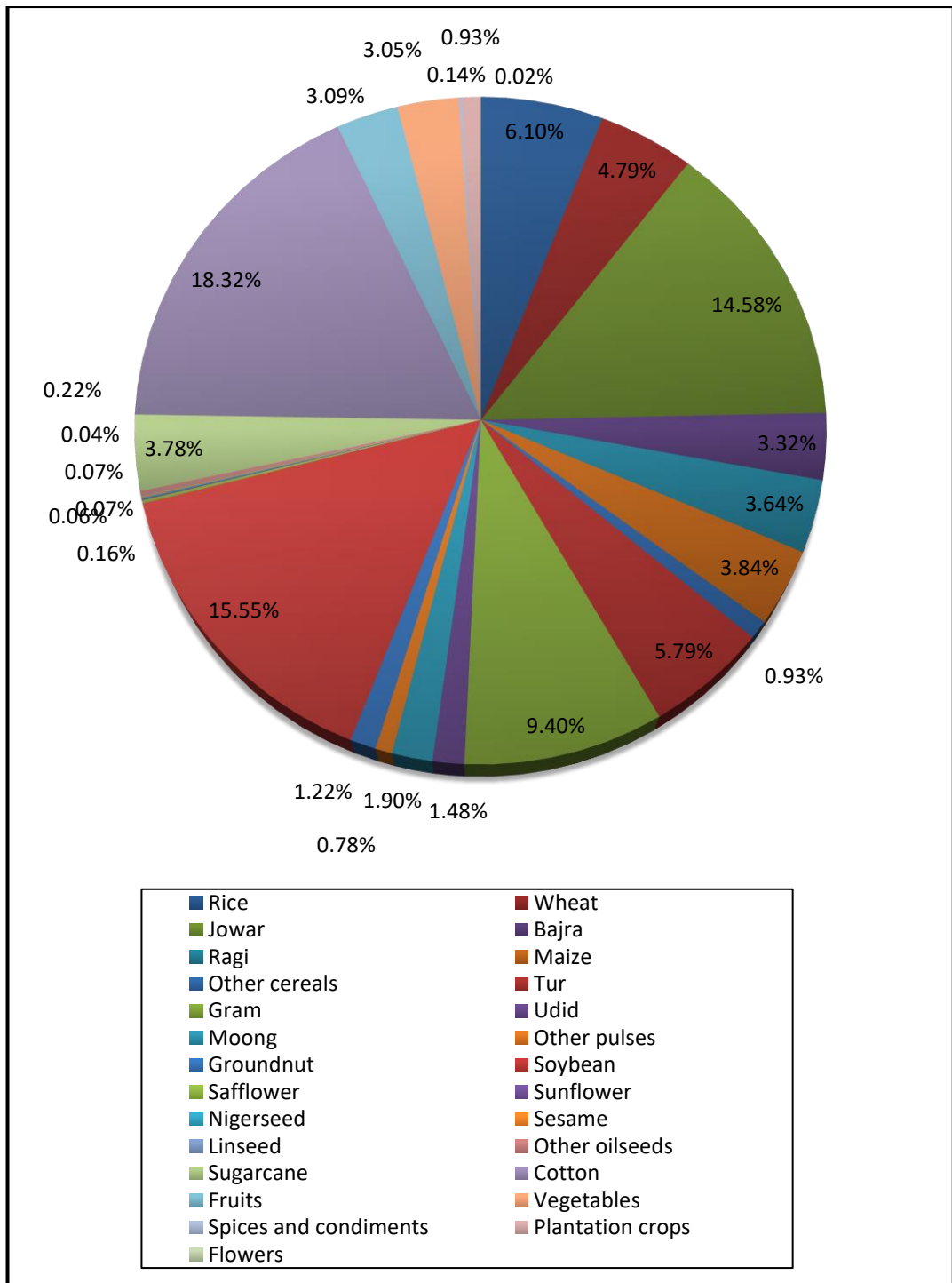


Fig 4.4 Cropping Pattern of Maharashtra

10. Input Supply

Agricultural inputs like seeds, fertilizers, manures, insecticides, pesticides etc. required to the farmers are made available to them through number of agricultural service centers established at district level and block levels.

Maharashtra State Seed Corporation and other private seed companies supply quality seeds to the farmers. The farm input is made available to the farmers by co-operative societies functioning at block level, Panchayat samiti also provides input to the farmers. Co-operative society supply input against the loan sanctioned by DCCB to individual cultivator.

10. Credit Supply

Agricultural credit is important in crop production. Co-operatives are main source of agricultural credit. Maharashtra occupies important place in the field of co-operatives in the country. All the villages in the state have been covered by the cooperative sector. The credit supply in Maharashtra is done by Primary Agriculture Co-operative credit society, Non- agricultural Credit Society, production Society, Panan Sanstha and Social Service Society. Primary Agriculture Co-operative credit societies are gross root level co-operative credit institution playing a vital role in the disbursement of short-term credit. According to the Economic Survey of Maharashtra, 2018-19, there has been considerable increase in the number of advances to agricultural sectors by the cooperatives in Maharashtra. In Maharashtra there are total 1, 98,252 cooperative societies and the loan advanced in 2010-11 was 1, 00,681 crore which increased up to 1, 44,268 crores in 2017-18. The cooperative movement has formed a strong link between credit and marketing.

11. Markets

Department of Agricultural Marketing establishes Agricultural Produce Market Committees (APMC) under Maharashtra Agricultural Produce Marketing (Development & Regulation) Act, 1963 and provides infrastructure for sale of agricultural produce so that farmers get adequate price of their agricultural produce and are protected from exploitation by

traders and middleman by offering low prices. Total 305 APMC and 624 sub-markets have been established in the State. These sub-markets are connected with roads and having facilities of banking electricity etc.

CHAPTER V

RESULTS AND DISCUSSION

The chapter is devoted to the presentation of and discussion on the empirical findings of the study regarding different objectives as stated in chapter I followed by economic interpretations and analytical inferences. Both descriptive statistics and functional analyses are used to present the results of the study. The results obtained from this study have been presented and discuss critically.

5.1 Area, production and productivity of Chickpea in major states and India

The information on area, production and productivity of Chickpea during the year 2017-18 in major producing states and India is presented in Table 5.1.

In 2017-18, the chickpea producing area in India was 105.73 lakh hectares and chickpea production in India was 111.58 lakh tonnes with overall chickpea productivity was 10.50 qts/ha.

The chickpea area of Maharashtra in 2017-18 was 20 lakh hectares, which was 18.92 per cent of chickpea area of the country. The production of chickpea in Maharashtra was 17.61 lakh tonnes, which was 15.78 per cent of total chickpea production of India. The productivity of chickpea in Maharashtra was 8.80 qts/ha.

It is revealed from the Table 5.1 that, Maharashtra state ranks second in area and production of chickpea in India. Madhya Pradesh ranks first in area and production of Chickpea. However, in case of productivity, Telangana ranks first and Maharashtra ranks seventh in productivity of Chickpea. In India three major states Madhya Pradesh, Maharashtra and Rajasthan contributes more than 65 per cent area and 70 per cent production of the Chickpea.

Table 5.1: Area, Production and Productivity of Chickpea in major states and India (2017-18)

(Area –Lakh ha, Production – Lakh tons and Productivity- qts/ha)

Sr. No.	State	Area	Rank	Production	Rank	Productivity	Rank
1	Madhya Pradesh	35.90 (33.95)	1	45.95 (41.18)	1	12.70	3
2	Maharashtra	20.00 (18.92)	2	17.61 (15.78)	2	8.80	7
3	Rajasthan	13.75 (13.01)	3	14.71 (13.19)	3	10.60	6
4	Karnataka	13.75 (13.00)	4	8.25 (7.39)	4	6.00	10
5	Uttar Pradesh	6.11 (5.78)	5	6.84 (6.13)	5	11.20	5
6	Andhra Pradesh	5.21 (4.93)	6	6.76 (6.06)	6	12.90	2
7	Gujarat	2.95 (2.79)	7	3.62 (3.24)	7	12.20	4
8	Chhattisgarh	2.93 (2.77)	8	2.60 (2.33)	8	8.80	7
9	Jharkhand	2.33 (2.20)	9	2.03 (1.82)	9	8.70	8
10	Telangana	1.03 (0.97)	10	1.50 (1.34)	10	14.50	1
11	Others	1.77 (1.67)	11	1.50 (1.52)	11	8.40	9
	All India	105.73 (100.00)		111.58 (100.00)		10.50	

Source: Ministry of Agriculture and Farmers welfare, Govt. of India, 2017-18.

5.2 Region wise Area, Production & Productivity of Chickpea in Maharashtra

The information on area, production and productivity of Chickpea in different decades year in Maharashtra states are presented in Table 5.2 to Table 5.4.

5.2.1 Area of Chickpea

Table 5.2 : Region wise Area of Chickpea in Maharashtra (Area: 00 ha)

S. N.	Year	Region				
		Western Maharashtra	Marathwada	Vidarbha	Konkan	Maharashtra
1	1990-91	2895.00 (43.02)	2109.00 (31.32)	1671.00 (24.82)	57.00 (0.84)	6732.00 (100.00)
2	2000-01	2719.00 (40.21)	2224.00 (32.89)	1761.00 (26.04)	58.00 (0.86)	6762.00 (100.00)
3	2010-11	4662.00 (32.42)	4536.00 (31.55)	5120.00 (35.61)	61.00 (0.42)	14379.00 (100.00)
4	2018-19	2363.40 (18.30)	4739.60 (36.70)	5787.20 (44.81)	24.00 (0.18)	12914.20 (100.00)

Source: Ministry of Agriculture and Farmers welfare, Govt. of India, 2018-19.

The Table 5.2 revealed that, the area of Chickpea in Maharashtra State was observed that more in Vidarbha region i.e 578720 ha in the year 2018-19. It means the Chickpea crop in last decade observed that the more important crop in Vidarbha region followed by Marathwada i.e. 473960 ha & Western Maharashtra i.e. 236340 ha.

5.2.2 Production of Chickpea

Table: 5.3 Region wise Production of Chickpea in Maharashtra
(Production : 00 Tonnes)

S. N.	Year	Region				
		Western Maharashtra	Marathwada	Vidarbha	Konkan	Maharashtra
1	1990-91	1623.00 (52.09)	1016.00 (32.60)	447.00 (14.34)	30.00 (0.96)	3116.00 (100.00)
2	2000-01	1554.00 (44.30)	1097.00 (31.27)	826.00 (23.55)	31.00 (0.88)	3508.00 (100.00)
3	2010-11	4161.00 (31.98)	3654.00 (28.08)	5134.00 (39.45)	63.00 (0.48)	13012.00 (100.00)
4	2018-19	1585.80 (16.09)	2789.90 (28.32)	5463.00 (55.45)	12.70 (0.13)	9851.40 (100.00)

Source: Ministry of Agriculture and Farmers welfare, Govt. of India, 2018-19.

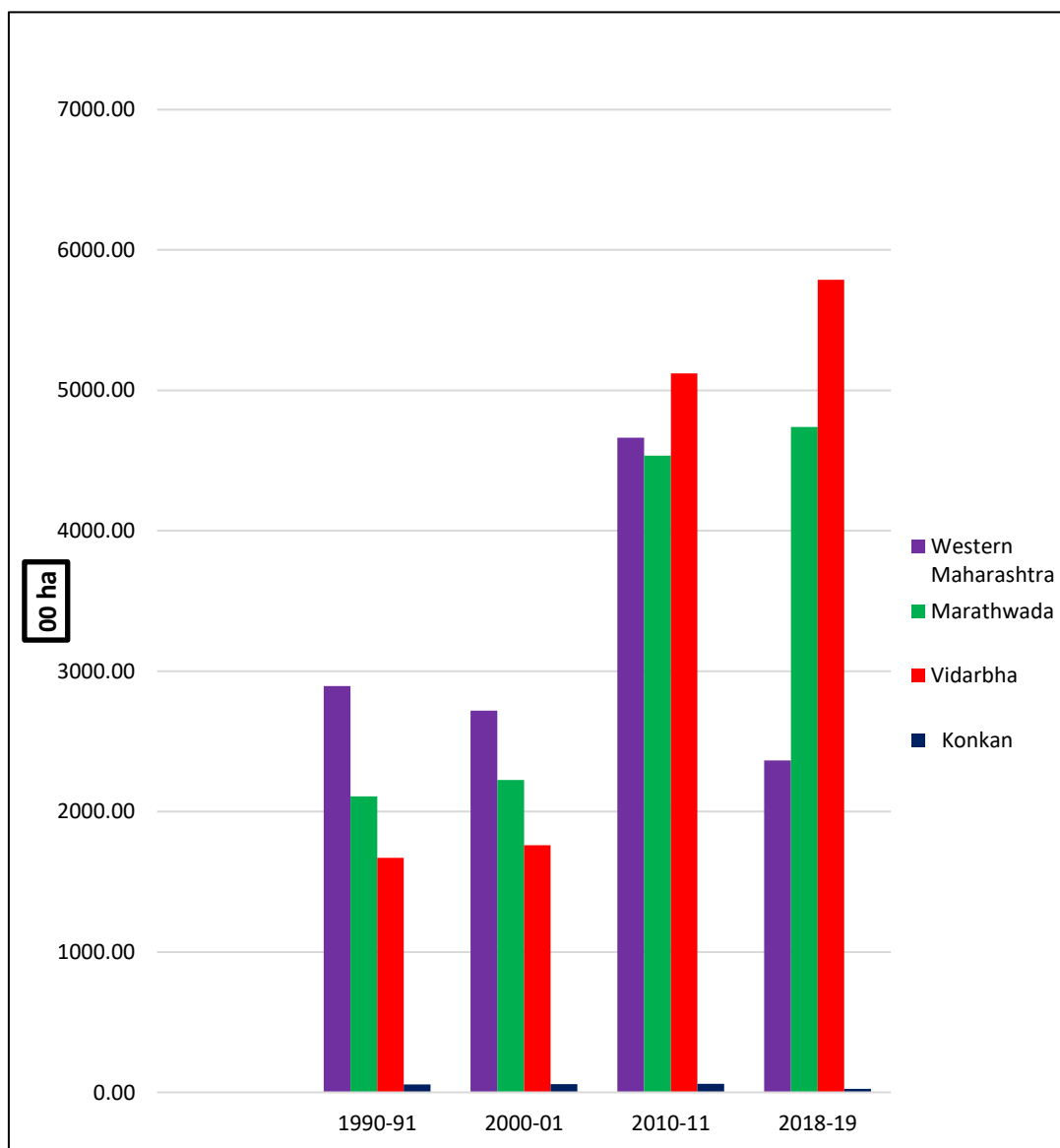
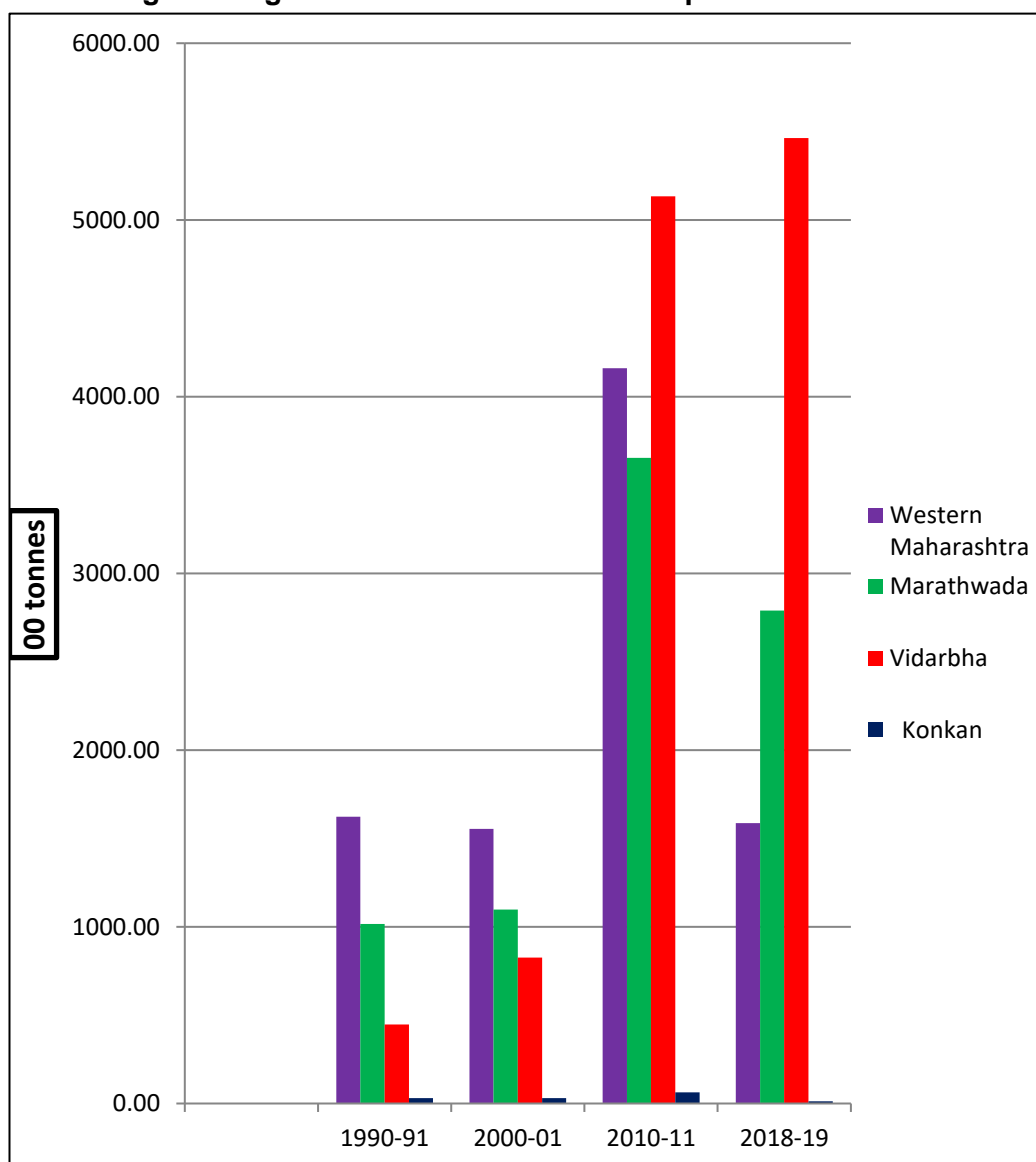


Fig. 5.1: Region wise Area of Chickpea in Maharashtra

Fig: 5.2 Region wise Production of Chickpea in Maharashtra



The Table 5.3 revealed that, the Production of Chickpea in Maharashtra state was observed that more in Vidarbha region i.e 546300 tonnes in the year 2018-19. It means the Chickpea crop production in last decade was more in the Vidarbha region followed by the Marathwada i.e. 278580 tonnes & Western Maharashtra i.e. 158580 tonnes.

5.2.3 Productivity of Chickpea

Table 5.4 : Region wise Productivity of Chickpea in Maharashtra

Productivity : Kg/ha

S.N.	Year	Region				
		Western Maharashtra	Marathwada	Vidarbha	Konkan	Maharashtra
1	1990-91	828.00	978.00	956.00	532.00	823.50
2	2000-01	871.50	983.00	939.00	536.00	832.38
3	2010-11	1350.00	1610.00	1883.00	866.00	1427.25
4	2018-19	980.30	1680.00	1918.00	594.20	1118.13

Source: Ministry of Agriculture and Farmers welfare, Govt. of India, 2018-19.

The productivity of Chickpea during the period 2018-19 for different regions of Maharashtra was more in Vidarbha region i.e. 1918.00 Kg per hector followed by Western Maharashtra i.e. 1680 kg/ha and Marathwada region i.e. 980 kg/ha. It is concluded that in Vidarbha region Productivity was observed more.

5.4 Compound growth rates

The compound growth rates of area, production and productivity of Chickpea during the period 1990-11 to 2018-19 for different regions of Maharashtra have been estimated and presented in the Table 5.5 to Table 5.7.

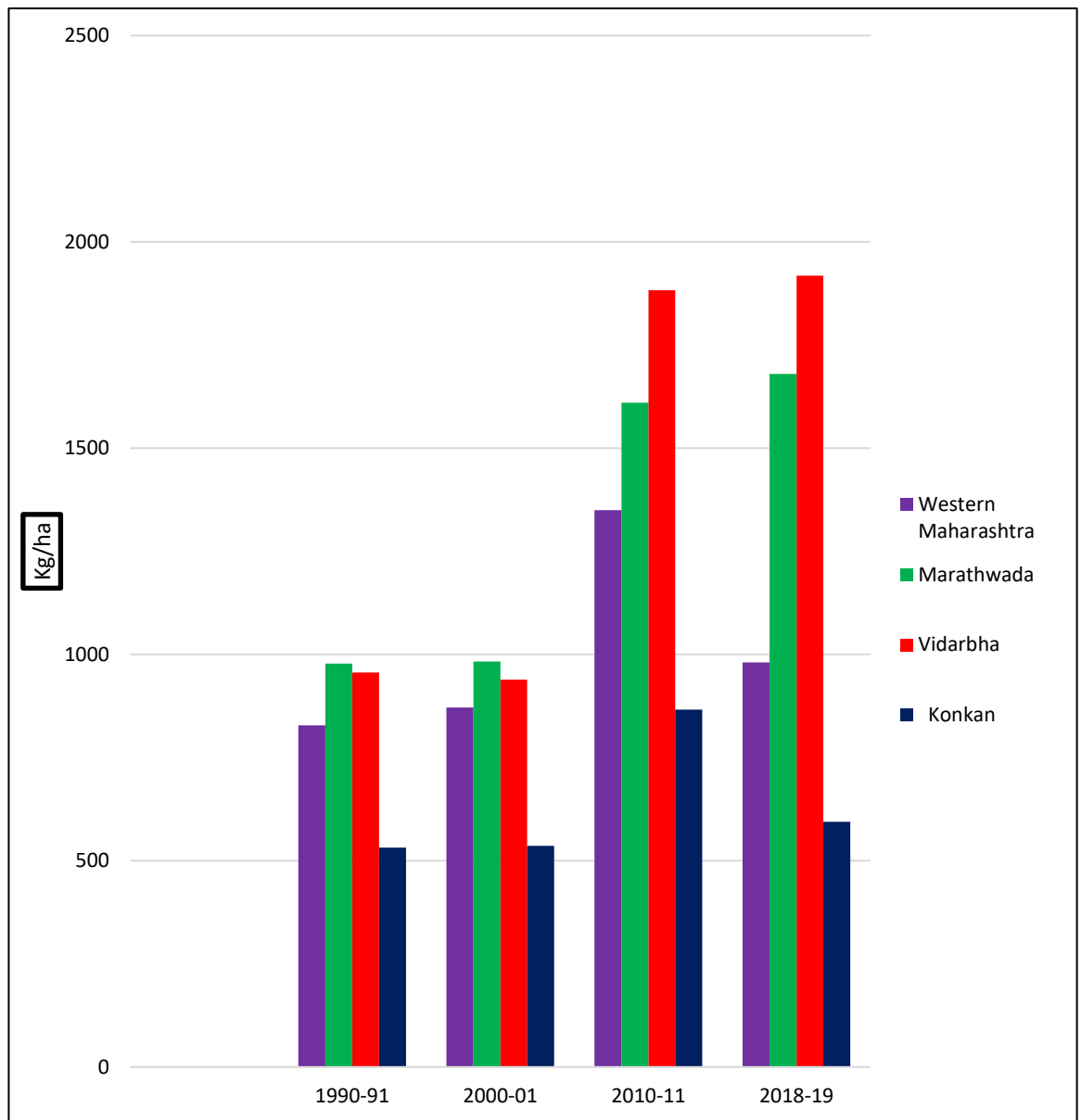


Fig 5.3: Region wise Productivity of Chickpea in Maharashtra

5.3 Region wise Pie chart of area & Production of Chickpea in Maharashtra:

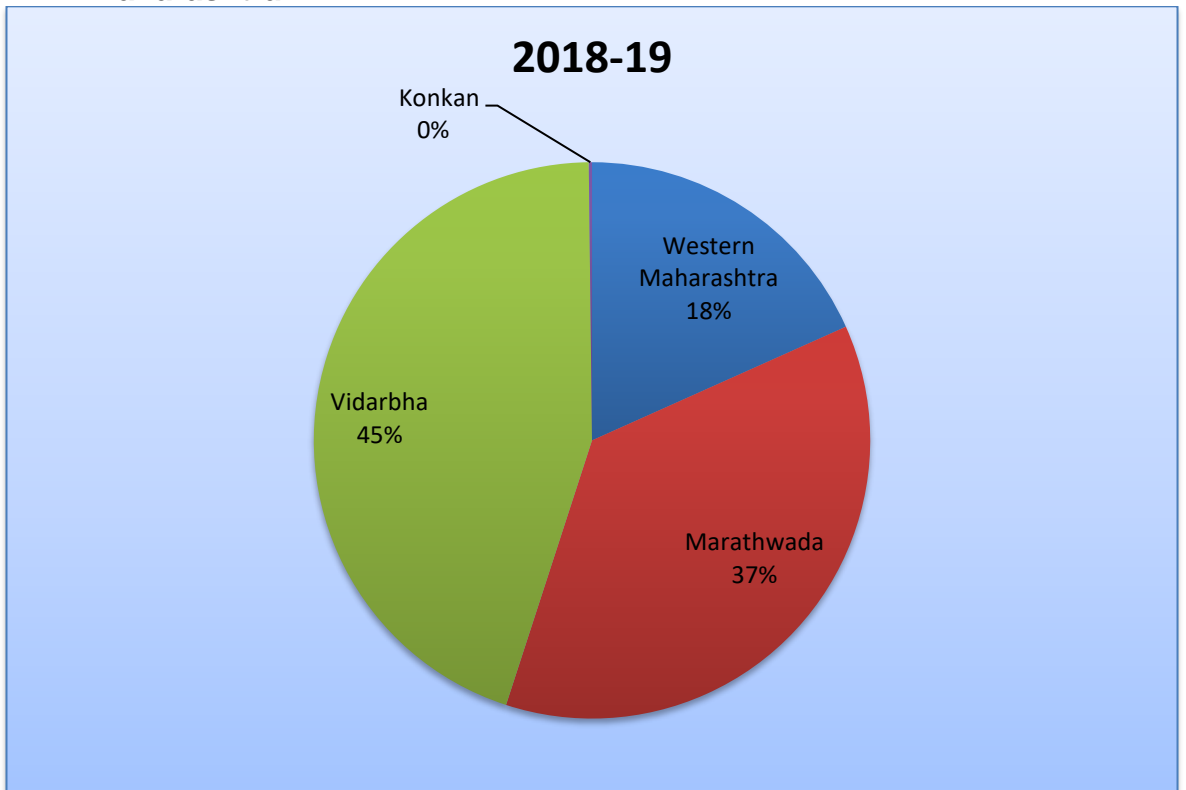


Fig 5.4: Region wise Pie chart of Area of Chickpea in Maharashtra

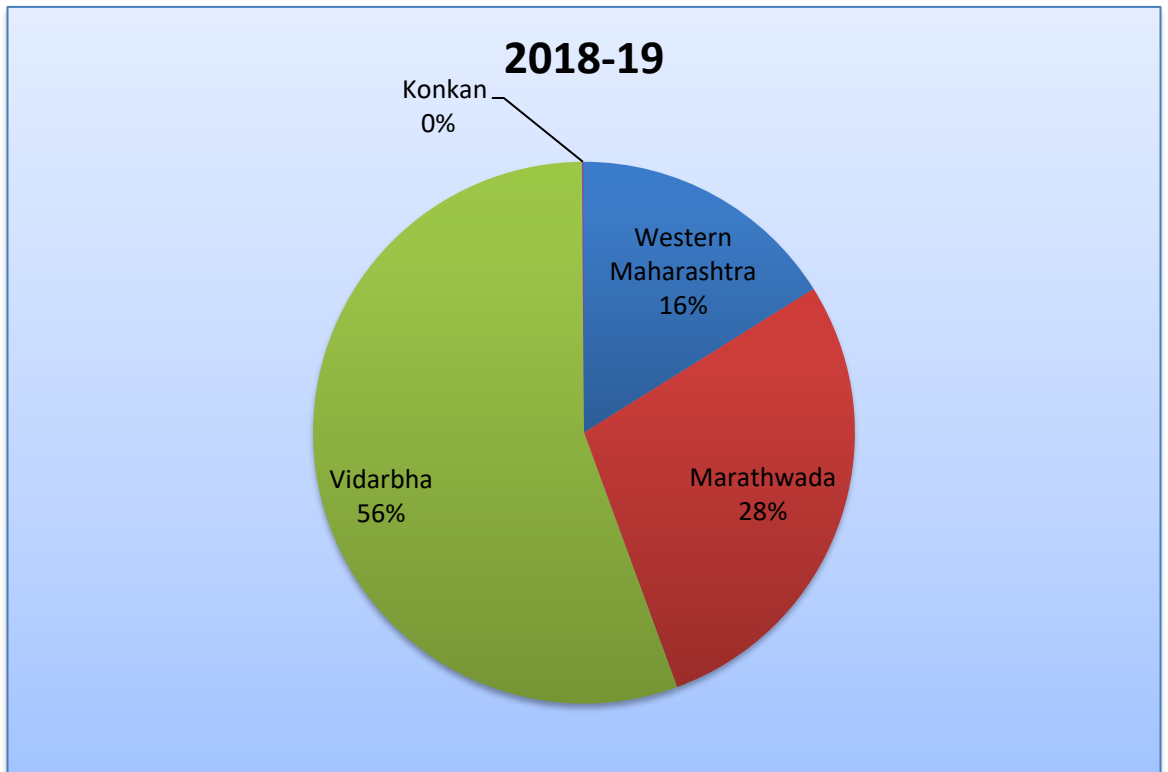


Fig 5.5: Region wise Pie chart of Production of Chickpea in Maharashtra

5.4.1 Compound Growth Rate of area

Note: * & ** indicate significance at 5 and 1 per cent level

Table: 5.5 Region wise CGR of Area of Chickpea in Maharashtra

Period	Region				
	Western Maharashtra	Marathwada	Vidarbha	Konkan	Maharashtra
Period-I (1990-1999)	1.29**	1.16*	1.04**	-	0.42**
Period-II (2000-2009)	1.01**	1.05**	0.39**	-	0.24**
Period-III (2010-2018)	0.10	0.15	0.17	-	0.8
Overall Period (1990-2018)	1.24**	0.96**	0.93**	-	0.41**

The time series data on area(A), production(P) and productivity(Y) of Chickpea in Maharashtra were divided into four sub periods as period I (1990-99), period II (2000-2009), period III (2010-18) and entire period (1990-2018).

From Table 5.5, it is revealed that, during period-I, out of four regions Western Maharashtra has the highest positive compound growth rate of area in Maharashtra (1.29 %) at 1 per cent significant level, followed by Marathwada (1.16 %) and Vidarbha (1.04 %). During period-II, compound growth rate of area was the highest in Western Maharashtra (1.01 %) with statistically significant at 1 per cent level followed by Marathwada (1.05 %) and Vidarbha (0.39 %) with 1 per cent level of significance. During period-III, the compound growth rate was positive in all regions. In overall period, Western Maharashtra consist highest growth rate (1.24 %) followed by Marathwada (0.96 %) and Vidarbha (0.93 %) which found to be statistically significant at 1per cent level. It means that growth rate of area in Maharashtra was positive.

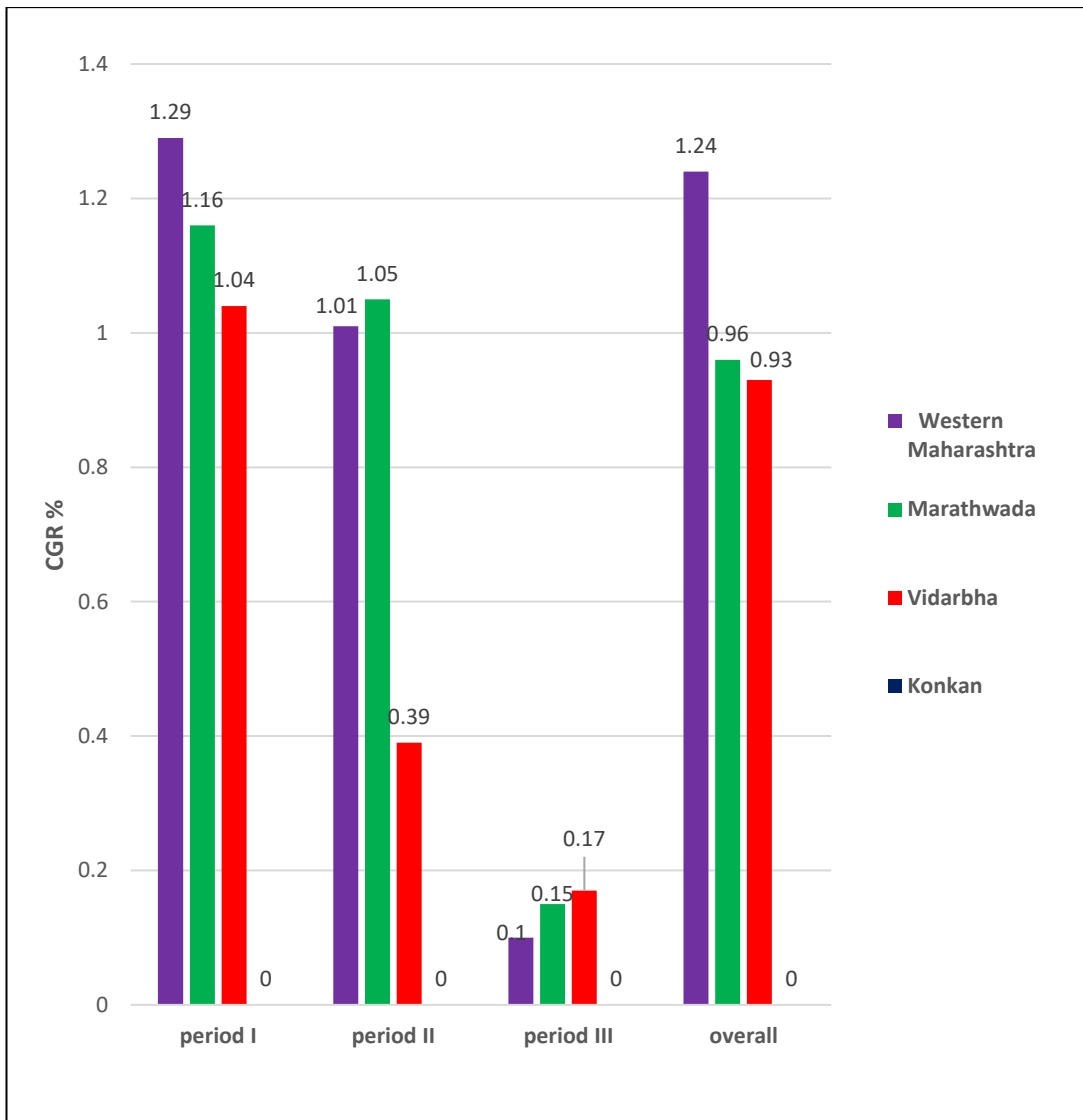


Fig 5. 6. Region wise CGR of Area of Chickpea in Maharashtra

5.4.2 Compound Growth Rate of Production

Table: 5.6 Region wise CGR of Production of Chickpea in Maharashtra

Period	Region				
	Western Maharashtra	Marathwada	Vidarbha	Konkan	Maharashtra
Period-I (1990-1999)	2.51*	0.70	0.88	-	1.37*
Period-II (2000-2009)	3.27**	3.40**	2.00**	-	2.13**
Period-III (2010-2018)	-0.30	-0.17	0.04	-	-0.01
Overall Period (1990-2018)	3.50**	2.15**	2.82**	-	2.51**

Note: * & ** indicate significance at 5 and 1 per cent level

From Table 5.6, it is revealed that, during period-I, compound growth rate of production of Western Maharashtra was the highest (2.51 %) with 5 per cent significant level followed by Vidarbha (0.88 %) and Marathwada (0.70 %). In period- II, growth rate of Marathwada was the highest (3.40 %) followed by Western Maharashtra (3.27 %) and Vidarbha (2.00 %) at significance of 1 per cent level. During period- III, Western Maharashtra and Marathwada regions were consist negative growth (-0.30% and -0.17 %, respectively) which were non-significant. Only Vidarbha region shows positive growth (0.04%). In overall period, the compound growth rate of production of chickpea was positive with 1 per cent level of significance. It means that growth rate of chickpea in Maharashtra was positively significant except in period- III.

5.4.3 Compound Growth Rate of Productivity

Table: 5.7 Region wise CGR of Productivity of Chickpea in Maharashtra

Period	Region				
	Western Maharashtra	Marathwada	Vidarbha	Konkan	Maharashtra
Period-I (1990-1999)	1.22	-0.11	-0.04	-	0.91
Period-II (2000-2009)	2.26**	2.35**	1.68*	-	1.89**
Period-III (2010-2018)	-0.45	-0.79	-0.06	-	-0.95
Overall Period (1990-2018)	2.63**	1.84	1.94**	-	2.29**

Note: * & ** indicate significance at 5 and 1 per cent level.

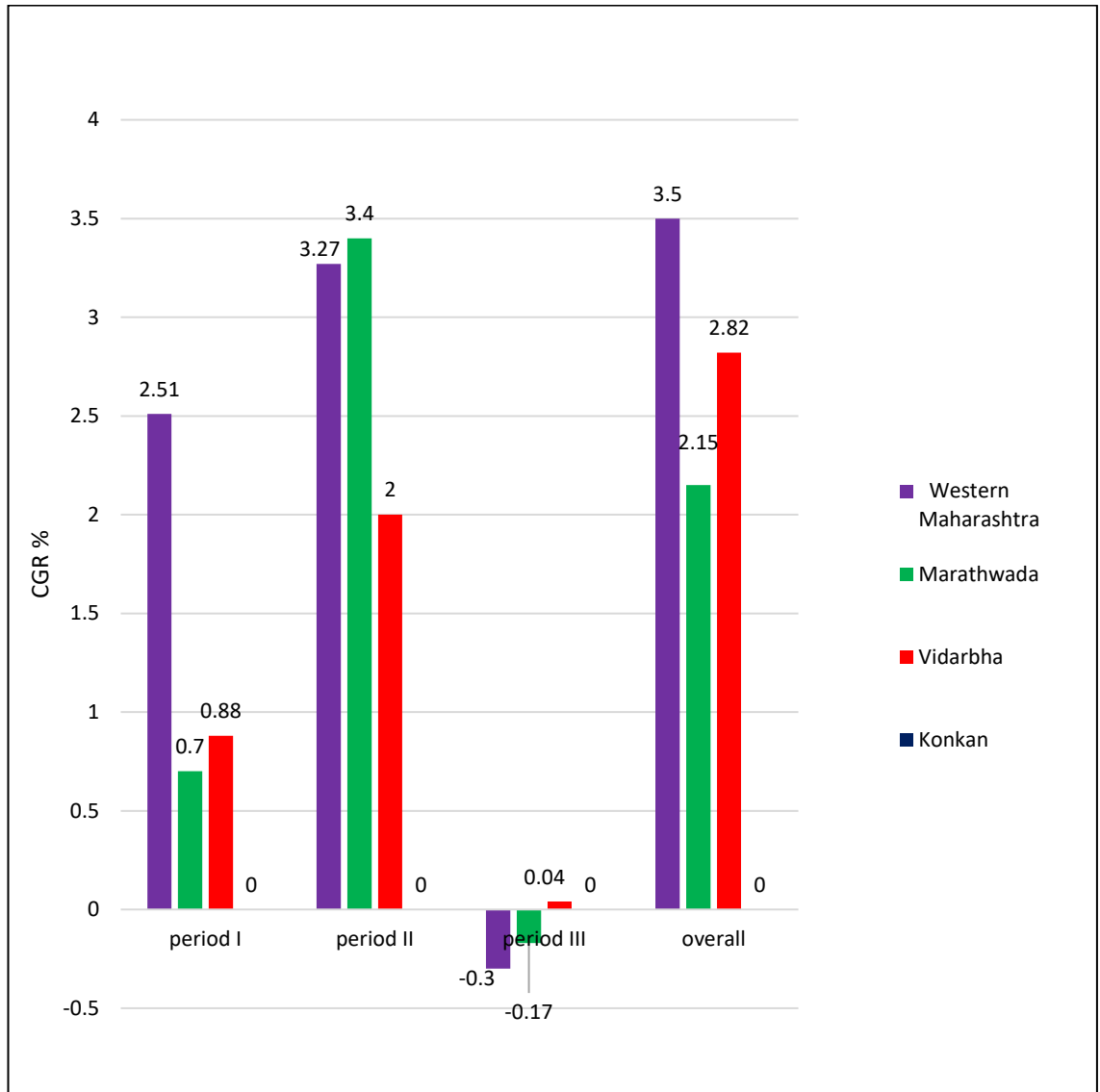


Fig 5.7 Region wise CGR of Production of Chickpea in Maharashtra

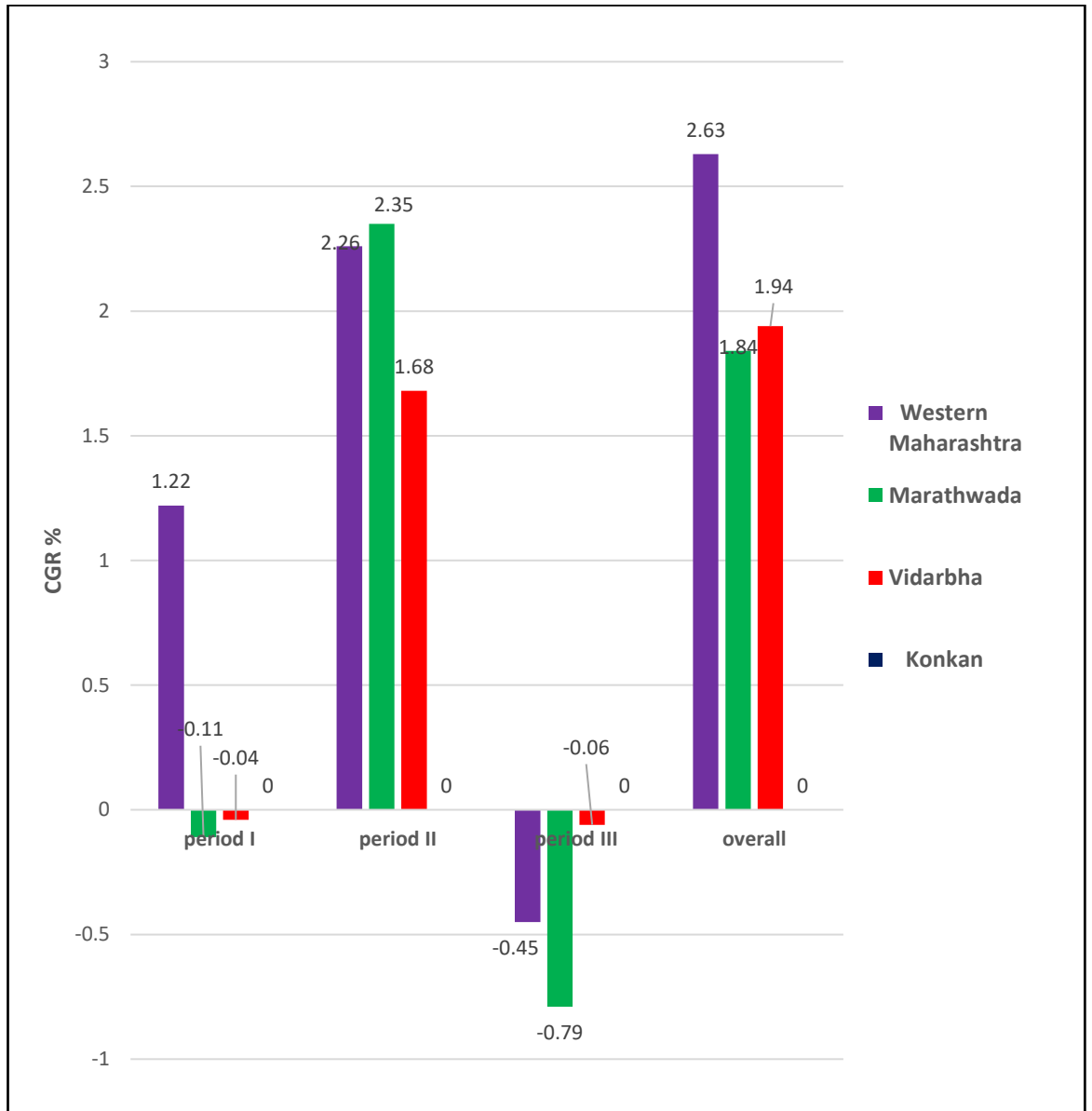


Figure 5.8 Region wise CGR of Productivity of Chickpea in Maharashtra

From Table 5.7, it is revealed that, during period-I, compound growth rate of productivity of Western Maharashtra was positive and highest (1.22 %), but Marathwada and Vidarbha region was registered negative growth rate (-0.11 and -0.04 %, resp.) of productivity of chickpea. In period-II, productivity growth rate was positively significant in all regions and which was highest in Marathwada (2.35 %) followed by Western Maharashtra (2.26 %) at 1 per cent significance level followed by Marathwada (2.35 %) and Vidarbha (1.68 %) at 1 per cent level of significance. In period- III in all regions growth rate of productivity was negative and non-significant. But in overall period, the compound growth rate of productivity was positively significant except in period- III. It is explained graphically in Fig 5.8.

Similarly, the growth rate of area, production and productivity of overall Maharashtra state explained in Fig 5.9.

Table 5.8 Comparison of growth in area, production and productivity of chickpea in four economic regions of Maharashtra

Region	Particulars	Growth Rate (%)			
		I Period	II Period	III Period	Overall Period
Western Maharashtra	Area	1.29**	1.01**	0.10	1.24**
	Production	2.51**	3.27**	-0.30	3.50**
	Productivity	1.22	2.26**	-0.45	2.63**
Marathwada	Area	1.16*	1.05**	0.15	0.96**
	Production	0.70	3.40**	-0.17	2.15**
	Productivity	-0.11	2.35**	-0.79	1.84
Vidarbha	Area	1.04**	0.39**	0.17	0.93**
	Production	0.88	2.00**	0.04	2.82**
	Productivity	-0.04	1.68*	-0.06	1.94**
Konkan	Area	-	-	-	-
	Production	-	-	-	-
	Productivity	-	-	-	-
Maharashtra	Area	0.42**	0.24**	0.8	0.41**
	Production	1.37*	2.13**	-0.01	2.51**
	Productivity	0.91	1.89**	-0.95	2.29**

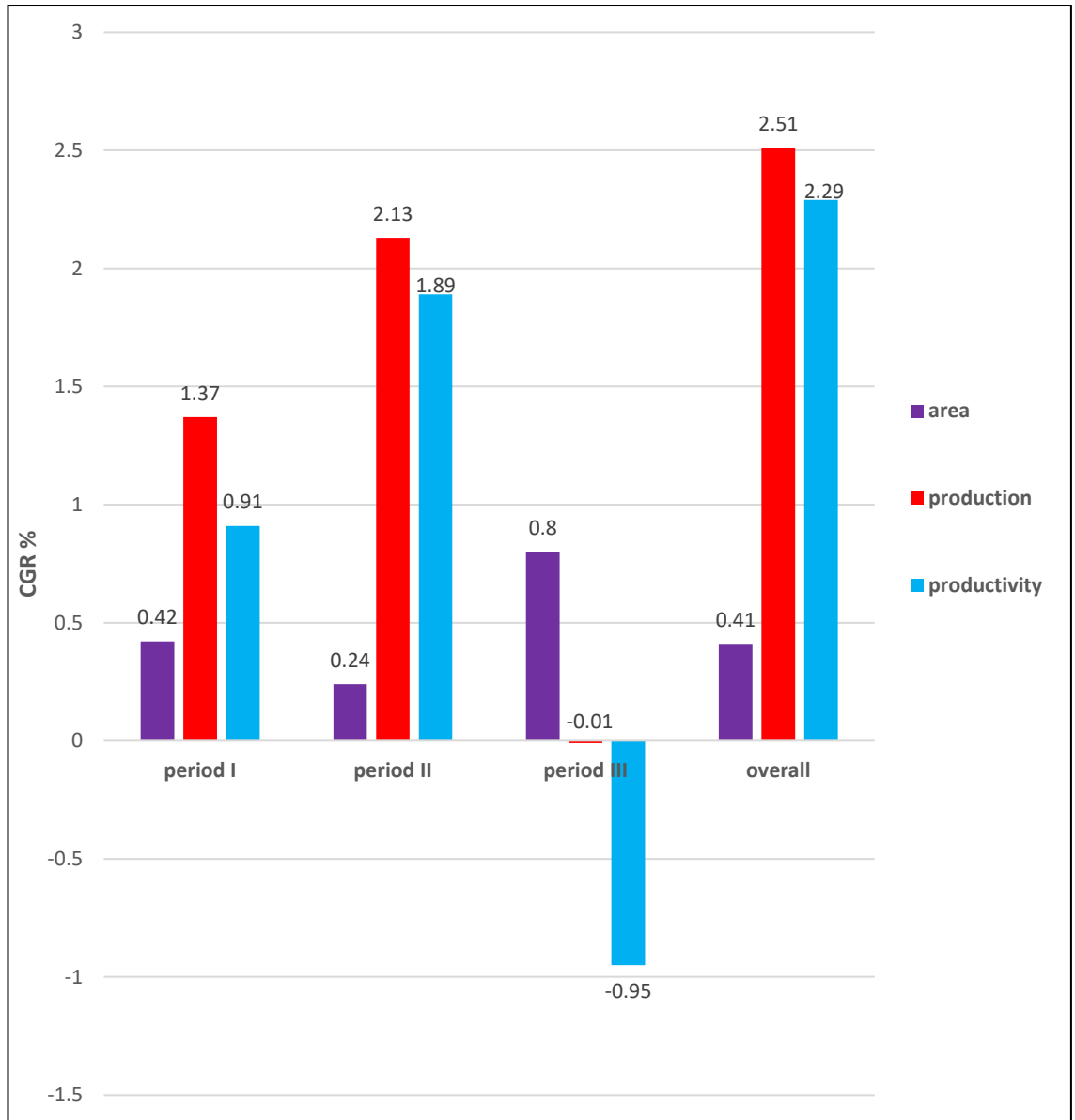


Fig 5.9 Growth Rate of area, production, productivity of Maharashtra

It is revealed from the Table 5.5 to Table 5.7 that, the area, production and productivity of Chickpea have fluctuated widely during the period under study in different regions and state. The growth rates of area, production and productivity of Chickpea for regions as well as state as a whole are presented in Table 5.8 was observed to be positive and highly significant at 1 per cent level of significance for the entire period of 28 years except period-III. The area, production and productivity of Chickpea increased at the rate of 0.41 per cent, 0.51 per cent and 6.89 per cent per annum, respectively, during the entire period. It clearly indicates that the production of Chickpea was increased due to both area expansion and productivity improvement for the entire period in the state. Similar trend was observed for all regions viz; western Maharashtra, Vidarbha, Marathwada and Konkan region for the entire period under study. This growth in area and productivity may be due to the Chickpea varieties developed by the Dr. PDKV, Akola during the entire period 1990-2018.

Among the different periods, the performance of area, production and productivity of Chickpea was satisfactory in period I, II, III and entire period. The area, production and productivity of Konkan region were very low. So, here it was not considered for calculating compound growth rate.

5.5 Varietal status of Chickpea varieties:

The Pulses Research Unit on Chickpea, Dr. PDKV, Akola has released remarkable varieties of Chickpea since its establishment. The important Chickpea varieties released by Dr. PDKV, Akola since establishment are presented in Table 5.9.

Table: 5.9 Varieties developed by Dr. PDKV, Akola in Pulses Research Unit

S.N.	Variety	Year of Release	Place
1	ICCV-2	1992	Akola
2	Hirwa Chaffa (AKGS-1)	1996	Akola
3	SAKI-9516	2001	Central Zone: M.P. Gujarat, Rajasthan, Maharashtra, Chhattisgarh
4	Gulak-I	2001	Akola
5	PKV Kabuli-2 (KAK-2)	2000	Central Zone: M.P. Gujarat, Maharashtra, Chhattisgarh
6	JAKI-9218	2007	Central Zone: M.P. Gujarat, Maharashtra, Chhattisgarh
7	PKV Kabuli-4	2010	Central Zone: M.P. Gujarat, Maharashtra, Chhattisgarh
8	PKV - Harita (AKG-9303-12)	2012	Akola
9	PDKV-Kanchan (AKG-1109)	2017	Akola
10	PDKV-KANAK (AKG-1303)	2019	AICRP WCZ Maharashtra, Gujarat, Western Part of MP.

The varieties viz., ICCV-2 and Hirwa Chaffa (AKGS-1) were very old varieties released in the year 1992 and 1996, respectively. These varieties were very popular amongst the farmers in earlier period. ICCV-2 is also known as 'Sweta'. It is a kabuli gram variety. It is a spreading type variety and suitable for October- November sowing as well as late planting up to December. It shows resistance to wilt and botrytis grey mould disease. Area of adoption of ICCV-2 variety is in Maharashtra and Andhra Pradesh and yield is up to 12-13 qs/ ha. Hirwa Chaffa (AKGS-1) is mostly adopted in Maharashtra state. It is a green seeded variety and yields up to 15-17 qs /ha. It is suitable in both irrigated and rainfed area.

In between 2000 to 2001 university released promising varieties of Chickpea viz; SAKI-9218, Gulak-I & PKV Kabuli-2 (KAK-2), which also occupied major area of Chickpea. Among the three, PKV Kabuli-2

variety is famous in farmers due its characters high yield potential, wilt resistant, drought tolerant, early maturing, suitable for rain fed, irrigated. Also, it is a bold seeded with 17-18 qts/ ha yield. It is non- lodging and non-shattering variety. It is adopted in Central Zone i.e. Madhya Pradesh, Gujarat, Maharashtra and Chhattisgarh. SAKI-9516 is a wilt resistant variety and yields up to 18-20 qts/ ha. Its area of adoption is in Central zone i.e. Madhya Pradesh, Maharashtra and Gujarat. Gulak-1 variety has medium maturity and it is moderately resistant to fusarium wilt. Seeds are pinkish bold type for parched kernel. It gives yield about 20 qts/ ha. It is also non-lodging and non-shattering variety.

In the year 2007, University released a promising variety of Chickpea viz; JAKI-9218. This JAKI-9218 variety was very famous in farming community due to its Medium bold seed (JAKI- 9218 variety), resistant to wilt, root rot and collar rot, fetches higher market price etc. It yields up to 18-20 qts/ ha. And mostly adopted in Central Zone: Madhya Pradesh, Gujarat, Maharashtra, and Chhattisgarh.

In year 2010, PKV Kabuli 4 variety of chickpea was released by university. It is moderately resistant to fusarium wilt, dry rot and botrytis grey mould. Its yield is 15-16 q/ ha. It is mostly adopted in Maharashtra and Madhya Pradesh.

In 2012, university released PKV Harita (AKG-9303-12) variety. It is mostly suitable for Vidarbha region of Maharashtra. It is bold seeded, tolerant to wilt and drought and mainly useful for culinary purpose. It yields up to 12-18 qts/ ha.

In 2017, PDKV-Kanchan (AKG-1109) variety was released by university. It is generally high yielding (21-23 q/ ha), medium bold seeded and wilt resistant variety. It is mostly suitable for irrigated condition. Recently in 2019, university released chickpea variety PDKV-KANAK (AKG-1303). It is mostly adopted in Maharashtra, Gujarat, and Western Part of Madhya Pradesh.

Among the seeds of all improved varieties of Chickpea especially PKV Kabuli-2 (KAK-2) & JAKI-9218 were tremendously demanded by the farmers.

University alone unable to supply the huge demand of seeds. The MAHABEEJ, Akola and NSC, Pune selling the seeds to farmers from 2000 onwards. At present the area under Chickpea varieties released by Dr. PDKV, Akola is 45-50 per cent to the total area under Chickpea of Maharashtra.

5.6 Economic impact of university released Chickpea varieties

Partial budgeting approach was used to capture the economic impact of the university released Chickpea variety. In partial budgeting the debit and credit side are prepared (Table 5.10). Table 5.10 includes list of all increased expenses due to new technology over the counterfactual (or control which is competing to university variety). In this study the control or check variety of Chickpea is local variety. The Chickpea varieties were released from the year 2007 onwards. However, the majority and prominent varieties of Chickpea were released after 2007.

It is noted from the Table 5.10 that the total additional cost (Direct +Indirect) of University released variety over other competing variety were observed to be Rs. 915.40 per hectare. However, the reduced costs (or saving) and added returns due to University released varieties over other competing varieties was Rs.15808.00 per hectare. Thus, the total economic worthiness of University released Chickpea production technology over other competing varieties of Chickpea in the region was Rs.14892.60 per hectare.

Table: 5.10 Economic Impact of University released Chickpea variety JAKI- 9218

Debit Side		Credit Side	
Particular	Cost (Rs/ha)	Particular	Cost (Rs/ ha)
A. Item of added expenditure due to cultivation of improved variety of Chickpea JAKI- 9218.		C. Reduced cost (or savings) due to cultivation of University released variety	0
i. Additional total Human Labour Cost	326.38		
ii. Additional total Bullock Labour cost	0.00		
iii. Additional total Machine Labour cost	150.00		
iv. Additional total Seed Cost	0.00		
v. Additional Fertilizers Cost	0.00		
vi. Additional Irrigation Charges	0.00		
vii. Additional Bio-fertilizers/Micronutrient	0.00		
viii. Additional Insecticide	0.00		
ix. Total additional cost	476.38	Total saving due to cultivation of University Released Variety	0
x. Opportunity cost of capital @ 6 % per annum for 6 months	14.29		
xi. Management cost @ 5 %	23.82		
xii. Risk premium @ 5 %	23.82	D. Added returns from university Released variety 4.16 qtl. Added Main produce @ 3800.00/-/qls.	15808
xiii. Research Cost Per ha.	348.29		
xiv. Extension cost per ha.	28.80		
Total additional cost due to cultivation of Chickpea	915.40		
B. Reduced returns due to cultivation of Improved Chickpea variety	0.00		
Total debit side	915.40	Total credit side	15808.00
Economic Impact of University released Chickpea Production technology over other competing variety of Chickpea: 15808.00 – 915.40 = 14892.60			14892.60

5.6.1 Up scaling the economic impact

In order that the results of the partial budgeting is applicable for wider area under university released Chickpea variety, linear extrapolation of the benefits of Rs. 14892.60 per ha is not tenable due to operation of the law of diminishing marginal returns at an early stage in agriculture. Accordingly, to reflect the operation of LDMR, three parameters such as i) Probability performance of the technology, ii) Rate of adoption of the technology and iii) Depreciation in the technology are applied in linear extrapolation.

Table: 5.11 Upscaling the economic Impact of Chickpea Variety JAKI-9218 covering the area of adoption

S.N.	Economic impact of University released chickpea varieties	Value
1	Probability performance of Chickpea variety	0.70
2	Rate of adoption of Chickpea variety	0.75
3	Depreciation of technology (if 1, No depreciation)	1
4	Economic worthiness of university released variety per ha	14892.60
5	Economic impact of university released variety per ha	7818.62
6	Area adopted under university released Chickpea Variety JAKI- 9218 in 2019-20 (ha)	190343.00
7	Total economic impact (Rs. in crores) for the year 2019-20	148.82

These implicitly capture the operation of the LDMR since the field conditions are not akin to the lab conditions and the farmer is different from the researcher. The upscaling the economic impact of Chickpea research is presented in Table 5.11. Accordingly, the ultimate economic impact of chickpea per hectare works out to $14892.60 \times 0.7 \times 0.75 \times 1 = 7818.62$. The area under University released Chickpea varieties for the year 2019-20 was 190343.00 ha. So, the Total Economic Impact to the farming

community in Maharashtra state was Rs. 148.82 crores for the year 2019-20.

5.6.2 Economic impact of Chickpea varieties in India (Maharashtra + Other state)

The economic impact of Chickpea varieties for 12 years (from 2008-09 to 2019-20) has been estimated and presented in the Table 5.12.

Table 5.12 Economic impact of Chickpea variety JAKI-9218 in India (Maharashtra + Other state)

Sr. No.	Year	Gross Gain (Rs/ha)	Net Gain (Rs/ha)	Area (MS+OS) (ha)	Net Economic Impact (Crores)	Gross economic Impact (Crores)
1	2008-09	27615.54	3537.80	1178.83	0.42	3.26
2	2009-10	31488.64	4033.97	5586.67	2.25	17.59
3	2010-11	35182.84	4507.23	16032.82	7.23	56.41
4	2011-12	38876.06	4980.37	31799.40	15.84	123.62
5	2012-13	43195.62	5533.74	29201.63	16.16	126.14
6	2013-14	47677.29	6107.88	80833.33	49.37	385.39
7	2014-15	50612.83	6483.95	92318.17	59.86	467.25
8	2015-16	53220.65	6818.04	209415.72	142.78	1114.52
9	2016-17	55728.43	7139.31	251302.47	179.41	1400.47
10	2017-18	57809.57	7405.92	166673.00	123.44	963.53
11	2018-19	59395.43	7609.08	244349.10	185.93	1451.32
12	2019-20	61031.06	7818.62	190343.00	148.82	1161.68
Total Economic Impact for 12 Years					931.50	7271.18

The gross and net gain from University released variety for the year 2019-20 over check variety has been deflated on the basis of Consumer Price Index (CPI). It is noted from the Table 5.6.3 that the gross and net economic impact of Chickpea variety to the farming community in Maharashtra state for the 12 years was Rs.7271.18 crores and Rs.931.50 crores. The net and gross economic impact of chickpea variety is explained graphically in Fig 5.10 and Fig 5.11, respectively.

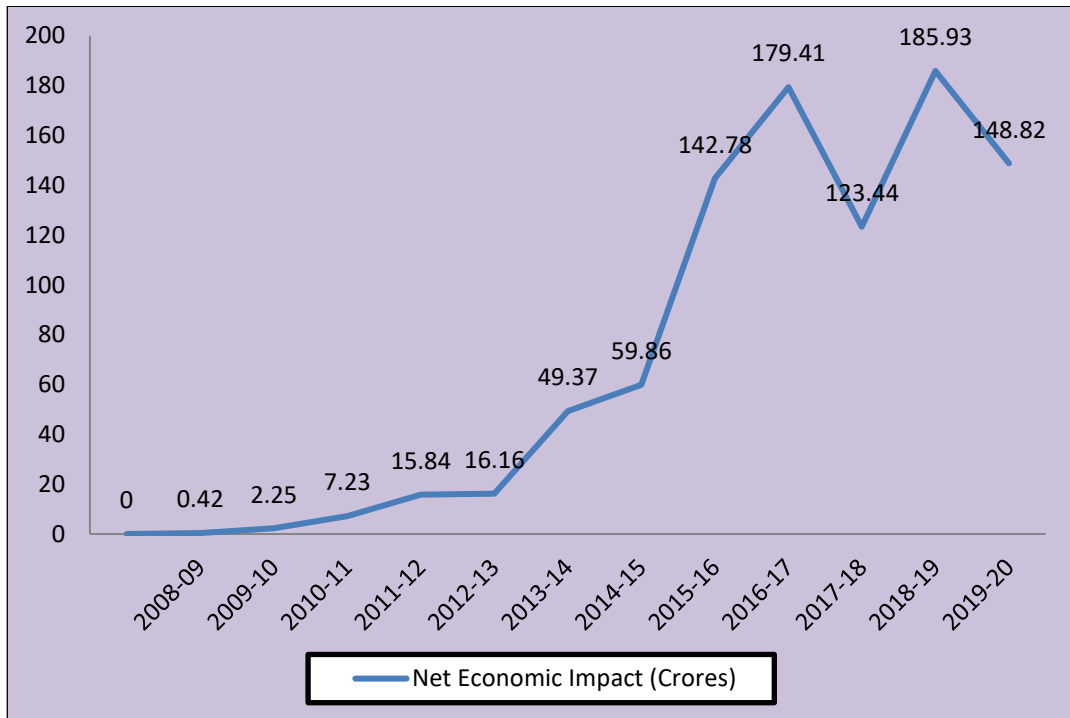


Fig 5.10 Net Economic impact of Chickpea Variety (JAKI- 9218)

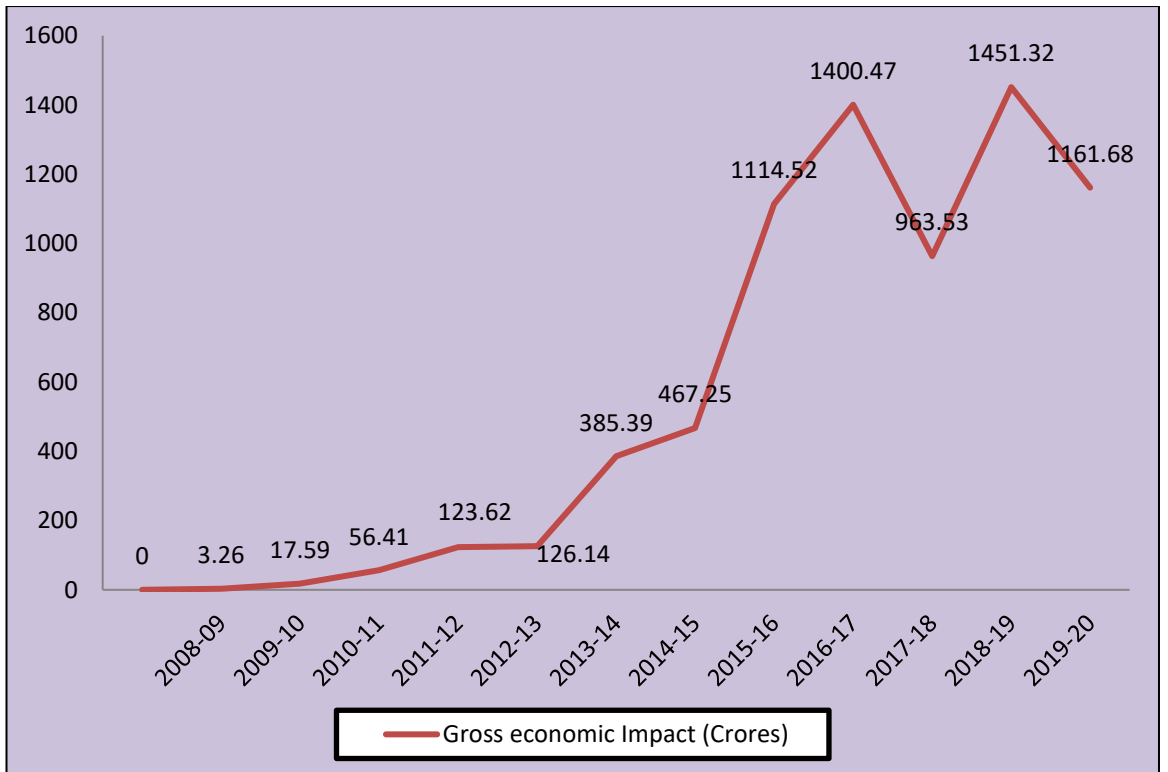


Fig 5.11 Gross economic impact of Chickpea Variety (JAKI- 9218)

The data on actual seed sell of Chickpea varieties from different agencies was not available. Hence, the data under University released Chickpea varieties was estimated on the basis of breeder seed produced by the University. Breeder seed was converted into foundation and certified seed.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Pulses are the important crops grown in India. The different pulses grown in the country are an integral part of subsistence farming. The different pulses play an important role in sustainable production system and household nutritional security. Chickpea or chana is a very important pulse crop in the world after peas & beans named *Cicer arietinum* in the *Leguminosae* family. It is commonly known as chana, harbhara, chhole, Bengal gram in India. Generally, it is grown in tropical, sub-tropical and temperate regions. Chickpea is an important source of proteins and vitamin A, C, K and Riboflavin. India contributes over 70-80 per cent of chickpea production in the world where it is mostly consumed as de-husked splits or dal. In Turkey and Latin America, it is mainly consumed as canned peas.

The productivity of chickpea in Maharashtra was lower than our national average of 9.82 q/ha. Therefore, the major challenge to chickpea production in the state is enhancing the production and productivity. Development of improved variety is one such step in this direction. There is a need for greater breeding efforts to develop varieties according to the need of the farmers.

Chickpea variety JAKI-9218 was notified in the year 2007. It is mostly adopted in states like Maharashtra, Madhya Pradesh, Gujarat, Rajasthan and Chhattisgarh. The chickpea variety still cultivated by farmers after 13 years of its release. The variety is wilt resistant, suitable for both rainfed and irrigated conditions, bold seeded and high yielding. This makes impact assessment of this popular variety important for policy making, agricultural research and development.

In view of the need for stronger accountability in agricultural research in recent years, there is now a great demand not only for demonstrating the actual impact of research but also for maximizing impact through targeting research benefits to the society. The agricultural technology is the product of agricultural research; thus, impact assessment of agricultural research means the assessment of impact of agricultural

technology. The agricultural technology includes modern crop varieties, crop and resource management, plant health management and post-harvest management.

The present study was undertaken with the following specific objectives.

1. To study the growth rates of area, production and productivity of Chickpea.
2. To examine the varietal status of University released Chickpea varieties.
3. To assess the economic impact of University released Chickpea varieties.

The chickpea crop is grown in the entire Maharashtra state except Konkan region. However, the major chickpea growing regions are Marathwada, Western Maharashtra and Vidarbha and in Konkan there is very little area grown under chickpea as compare to other regions.

Based on the objective of the study, for the analysis of growth rate the period was divided into three sub periods and overall, as shown below.

Period I	: 1990-91 to 1999-2000
Period II	: 2000-01 to 2009-10
Period III	: 2010-11 to 2017-18
Overall	: 1990-91 to 2017-18

The present study was based on time series secondary data of area, production and productivity of chickpea in Maharashtra. The compound growth rate of area, production and productivity of chickpea growing regions were estimated by study of growth.

In the varietal front the Pulses Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola has made significant progress by releasing 10 excellent Chickpea Varieties for Maharashtra. JAKI-9218 variety was selected for the present study because this variety was widely used under cultivation of Chickpea and the local variety used as a check.

The varietal impact was analysed by partial budgeting method. The main findings of the study are given below.

The result of study is summarised as follows

In Western Maharashtra, compound growth rate of area, production and productivity was positively significant and highest except the production and productivity in period- III which was negative (-0.30 and -0.45 %, respectively).

In Marathwada region, compound growth rate of area was positively significant. Growth rate of production in Marathwada was also significant and positive except of period-III which was negative (-0.17 %). Productivity growth rate was positive and significant (2.35 %) at 1 per cent level in period- II and negative in period- I and period- III (-0.11 and -0.79 %, resp.).

In Vidarbha region, compound growth rate of area was positive and significant at 1 per cent level of significance. Growth rate of production in Vidarbha was positive in all study periods and significant at 1 per cent level in period- II and in overall period (2.00 and 2.82 %, resp.). Productivity growth in Vidarbha was positively significant at 5 per cent level in period-II (1.68 %) and significant in overall period (1.94 %) and it was negative in Period I and III (-0.04 and -0.06 %, resp.)

The growth rates of area, production and productivity of Chickpea for state was observed to be positive and highly significant at 1 per cent level of significance for the entire period of 28 years. The area, production and productivity of Chickpea increased at the rate of 0.41 per cent, 0.51 per cent and 6.89 per cent per annum, respectively, during the entire period.

While assessing the impact of university released chickpea varieties, it was revealed that, the total economic worthiness of University released Chickpea production technology over other competing varieties of Chickpea in the region was Rs.14892.60 per hectare. The gross and net economic impact of Chickpea varieties to the farming community in Maharashtra state for the 12 years was Rs.7271.18 crores and Rs.931.50

crores. The area under University released Chickpea varieties for the year 2019-20 was 190343.00 ha.

CONCLUSIONS

The result of the study leads to conclude that;

1. Maharashtra state ranks second in area and production of Chickpea in India. Madhya Pradesh ranks first in area and production of Chickpea.
2. The major challenge to chickpea production in Maharashtra is to enhance the production and productivity. A huge potential lies in improving the chickpea productivity in Maharashtra.
3. The compound growth rates of area were positive indicating increase in area of all the chickpea growing region during all four periods i. e. period- I, period- I, period- III and overall, in Western Maharashtra, Marathwada and Vidarbha region. In Konkan region, there was very low chickpea production.
4. The region wise compound growth rates were positive for almost all the regions except production and productivity of some study periods of Marathwada and Vidarbha region. The highest growth rate of area was registered in Western Maharashtra (1.29 %) was found to be significant at 1 per cent level.
5. Maharashtra as a whole registered positive growth rate in area (0.41 %) and found statistically significant at 1 per cent level while the growth rate in production (0.51 %) and productivity (6.29 %) were also satisfactory significant at 1 per cent level of significance.
6. The growth rate of area, production and productivity of Chickpea for entire Maharashtra were observed to be positive and significant. It indicates that the production of Chickpea was increased by area expansion, production and productivity improvement for the entire period in the state.
7. JAKI- 9218 is still popular variety in Maharashtra. The area coverage of JAKI- 9218 among the study area i. e. in Maharashtra state is 14.74 per cent of total chickpea area.

8. JAKI- 9218 has a broad adaptation characteristic as it is wilt resistant, bold seeded and suitable for both rain fed and irrigated situation. The variety can be defined as resource saving and these traits can be further utilized in the development of other chickpea varieties.
9. The total economic worthiness of University released Chickpea production technology over other competing varieties of Chickpea in the region was Rs. 14892.60 per hectare. It means the Total Economic Impact to the farming community in Maharashtra state was Rs. 148.82 crores for the year 2019-20. This implies that the investment on agricultural research and development give convincing impacts.

Policy implications of the study

1. Chickpea is an important pulse crop. So, efforts should be made on increasing area, production and also productivity of chickpea.
2. The farmer's community in Maharashtra earns gross economic returns and net economic returns amounting Rs. 7271.18 Crores and 931.50 crores, respectively, from the variety JAKI-9218. Therefore, there is a need of strong breeding efforts to develop varieties which satisfy the requirement of the farmers in Maharashtra. The farmers prefer varieties which are high yielding as well as require low resources.
3. The future increase in crop production must come from increase in yield. Therefore, there is a need to strengthen adoptive research and technology assessment.
4. The traits in the chickpea variety preferred by the farmers should be incorporated in the development of new varieties and new improved varieties should be developed.
5. The gap between researchers and farmers should be bridged so that need based technology is developed.
6. The studies related to impact assessment at each stage of development of agricultural technology should be encouraged.

CHAPTER VII

LITERATURE CITED

- Acharya, S. P., H. Basavaraja, L. B. Kunnal, S. B. Mahajanshetti and A. R. S. Bhat, 2012. Growth in area, production and productivity of major crops in Karnataka. *Karnataka J. Agric. Sci.*, 25 (4): (431-436) 2012.
- Alshi, M. R. and C. K. Joshi, 1984. Measurement of agricultural growth in vidarbha. *Agresco report submitted to the Agricultural Economics and Statistics, subcommittee*, Department of Agricultural Economics and Statistics, Dr. PDKV, Akola.
- Ambulkar, P. L., H. Dixit, 2014. Impact assessment of gram for enhancing production for food nutritional security and livelihood of remote tribal community under pulses. *Agriculture Update* 9 (2), 252-255.
- Bhokare, K. R., B. S. Thorat, S. S. Raykar, R. R. Patil and S. N. Ingle, 2017. Performance of chickpea production in Amravati district of Maharashtra. *Journal of Pharmacognosy and Phytochemistry* 2017; 6(6): 62-64
- Bhuiyan, M. A. H., D. Khanam, M. H. Ullah and M. M. Alam, 2009. Effect of inoculation and varietal interactions of chickpea at southern region of Bangladesh. *Bull. Inst. Trop. Agr., Kyushu Univ.* 32: 17-23.
- Chaitanya, S. K. and V. Chandrika, 2006. Performance of chickpea varieties under varied dates of sowing in Chittoor district of Andhra Pradesh. *Legume Research-An International Journal* 29(2), 137-139.
- Gajbhiye, S., R. N. Wankhede and S. J. Kakde, 2010. Growth and Instability of chickpea production in Vidarbha region of Maharashtra. *Indian Journal of Commerce and Management* 3 (2), 172-174.
- Ghosh, R., S. Pande, R. Telangre, D. Kathal, S. Singh, G. Usmani, A. Patel, S.K. Rao, S. Mishra, A. Pachuri, S. Verma, R.N. Sharma, P.M. Gaur and M. Sharma, 2014. Participatory varietal selection of chickpea in rainfed rice fallow lands of Chhattisgarh and Madhya Pradesh in India for sustainable crop production. *International Journal of Plant Production*, 8 (2).
- Gulpadiya, V. K. and D. S. Chhonkar, 2014. Effect of phosphorus on growth, productivity and economics of chickpea varieties. *Annals of Plant and Soil Research* 16(4): 334-337.
- Gupta, M. and J. K. Gupta, 2016. Dynamics of gram production in major gram producing districts of Madhya Pradesh. *International Journal of Research in Applied, Natural and Social Sciences*, ISSN(P): 2347-4580; ISSN(E): 2321-8851.
- Joshi, P. K., M. C. S. Bantilan, R. L. Shiyani, M. Ashokan and S. C. Sethi, 1998. Chickpea in the hot and dry climate of India- adoption and impact of improved varieties. *Assessing joint research impacts*.

Proceeding of an International workshop on joint impact assessment of NARS/ICRISAT Technologies for the Semi-Arid Tropics, Patancheru, India. pp:94-102.

- Kaliyas, R. P., 1985. Production technology for gram in Himachal Pradesh. *Indian farming*, (35): 9-11.
- Katerji, N., J.W. van Hoorn, A. Hamdy, M. Mastrorilli, T. Oweis and R.S. Malhotra, 2001. Response to soil salinity of two chickpea varieties differing in drought tolerance. *Agricultural Water Management*, 50 (2001) 83-96.
- Khan, R. and I. A. Khan, 2015. Varietal Response of Chickpea (*Cicer arietinum* L.) Towards the Allelopathy of Different Weeds. *Sains Malaysiana* 44(1) (2015): 25–30.
- Khatun, A., M. A. H. Bhuiyan and M. K. Hasan, 2009. Effect of seed collected from different parts of chickpea varieties on growth, yield and yield attributes of chickpea. *Bull. Inst. Trop. Agr., Kyushu Univ.* 32: 9-16.
- Khoiwal, S. K., R. L. Solanki and M. P. Jain, 2017. Evaluation of Chickpea Varieties under Different Moisture Stress Condition on Growth and Yield of Chickpea (*Cicer arietinum* L.). *Int.J.Curr.Microbiol.App.Sci* (2017) 6(6): 272-278.
- Lockeretz, W. and M. D. Anderson, 1993. *Agricultural Research Alternatives*. Lincoln, Nebraska: University of Nebraska Press.
- Macharia, I., A. Orr, F. Simtowe and S. Asfaw, 2012. Potential economic and poverty impact of improved chickpea technologies in Ethiopia. In: IAAE Triennial Conference, 18- 24 August 2012, Rafain Convention Center, Foz do Iguaçu, Brazil.
- Mackay, R. and D. Horton, 2003. Expanding the use of impact assessment and evaluation in agricultural research and development. *Agricultural systems* 78 (2), 143-165.
- Manyong, V. M., B. Douthwaite, O. Coulibaly and J. D. H. Keatinge, 2001. Participatory impact assessment at the International Institute of Tropical Agriculture: functions and mechanism. Pages 69-74 (Annex) in the future of impact assessment in the CGIAR: needs, constraints and options. Proceedings of a workshop organized by the Standing Panel on Impact Assessment of the Technical Advisory Committee, 3-5 May 2000. FAO, Rome, Italy.
- Mathur, B. K. and A. Henry, 2006. Trends in area, production and productivity of chickpea in arid zone of western Rajasthan, Rajasthan and India. *Arid Legumes for Sustainable Agriculture and Trade* (vol. 2), 303.
- Mathur, S. and S. S. Dhaka, 2017. Impact assessment of chickpea (Chana) price forecast advice on economic status of the farmers. *Indian Journal of Economics and Development* 13 (2a), 304-308.

- Maurya, O. and H. Kumar, 2018. Growth of chickpea production in India. *Journal of Pharmacognosy and Phytochemistry* 2018; 7(5): 1175-1177.
- Meena, M. L., A. Dudi, 2012. On farm testing of chickpea (*Cicer arietinum* L.) cultivars for site specific assessment under rainfed condition of western Rajasthan. *Indian Journal of Extension Education* 48 (3 and 4), 93-97.
- Nanjareddy, C., J. V. Venkataram, P. Gracy and G. N. Nagraj, 1990. Economics of production of hybrid tomato in Bangalore district. Division of Agricultural Economics, University of Agricultural Sciences, Hebbal, Bangalore, Karnataka, India.
- Neugschwandtner, R. W., S. Wichmann, D.M. Gimplinger, H. Wagentristl and H.P. Kaul, 2013. Chickpea performance compared to pea, barley and oat in central Europe: growth analysis and yield. *Turkish Journal of Field Crops* 2013, 18(2), 179-184.
- Nielsen, D. C., 2001. Production Functions for Chickpea, Field Pea, and Lentil in the Central Great Plains. *Agron. J.* 93:563–569.
- Pal, S. and D. Jha, 1996. Funding Agricultural Research, NIAP Policy Brief No. 3.
- Parmar, R., A. Sharma, A. Thaku, R. S. Gurjar and K. N. Pathak, 2018. Adoption of Improved Varieties of Chickpea in Sehore District of Madhya Pradesh. *BEPLS Vol 7* [12].
- Patil R. S., R. G. Deshmukh, P. S. Deshmukh and S. W. Jahagirdar, 2016. Performance of Growth and Instability of Chickpea (*Cicer arietinum*) in India. *Asian Journal of Agricultural Extension, Economics & Sociology* 14(2): 1-5.
- Patil, S. L., N. Loganandhan and M. N. Ramesha, 2016. Evaluation of chickpea varieties under compartmental bunding in rainfed situation. *Legume Research*, 39 (6) 2016: 890-895
- Raghuwanshi, R. S., N. P. Sharma and S. N. Sharma, 2001. Growth of chickpea in Bundelkhand region of Madhya Pradesh. *Agricultural Science Digest* 21 (4), 265-266.
- Rani, B. S. and T. G. Krishna, 2016. Response of chickpea (*Cicer arietinum* L.) varieties to nitrogen on a calcareous vertisols. *Indian J. Agric. Res.*, 50 (3) 2016: 278-281.
- Ravi, K., M. Ali, R. L. Arya and J. P. Mishra, 2006. Enhancing productivity and profitability of chickpea (*Cicer arietinum*) + Indian mustard (*Brassica juncea*) intercropping system. *Indian Journal of Agronomy*. 51(1):27-30.

- Reddy, A. and D. Mishra, 2006. Growth and Instability in Chickpea Production in India: A State Level Analysis. *Agricultural Situation in India*, 130-145.
- Reddy, G. R., K. Dattatri, N. Sudhakar, T. Himabindu, M. Osman and K. L. Sharma, 2014. Assessment of improved varieties under different climate vulnerabilities. *Indian Journal of Dryland Agricultural Research and Development* 29 (1), 11-22.
- Rimal, N. S., S. Kumar, V. P. Chahal and V. Singh, 2015. Impact of adoption of improved varieties of chickpea (*Cicer arietinum*) on yield and income in Madhya Pradesh. *Indian Journal of Agricultural Sciences* 85 (4): 555–60.
- Sandeep M. V., D. H. Ulemale and S. S. Thakare, 2015. Decomposition analysis and acreage response of chickpea in western Vidarbha. DOI: 10.15740/HAS/AU/10.4/300-306.
- Sharma, J. L., 1988. Production performance of Punjab Agriculture, “District Wise Analysis”. *Agril. Situation in India* XLIII (8): 675-680.
- Sharma, S., N. Yadav, A. Singh and R. Kumar, 2013. Nutritional and antinutritional profile of newly developed chickpea (*Cicer arietinum* L) varieties. *International Food Research Journal* 20(2): 805-810.
- Shiferaw, B., S. Salim, G. Muricho, P. Audi, J. Mligo, S. Lyimo, L. You and J. L. Christiansen, 2005. Assessment of the adoption and impact of improved pigeonpea varieties in Tanzania. *Journal of SAT Agricultural Research* 3(1).
- Shivakumar B. G., 2001. Performance of chickpea (*Cicer arietinum*) varieties as influenced by sulphur with and without phosphorus. *Indian Journal of Agronomy* 46 (2), 273-276.
- Shiyani, R. L., P. K. Joshi, M. Ashokan and M. C. S. Bantilan, 2005. Assessment of varietal preferences of chickpea in Gujarat. Impact of Agricultural Research: Post-Green Revolution Evidence from India, 131-140. New Delhi, India: National Centre for Agricultural Economics and Policy Research and Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.
- Shiyani, R. L., P. K. Joshi, M. Ashokan and M. S. Bantilan, 2000. Adoption of Improved Gram Varieties; Evidence from tribal region of Gujrat. *Indian Journal of Agril. Econ.* SS (2): 159 to 175.
- Shiyani, R. L., P. K. Joshi, M. Ashokan, M. C. S. Bantilan and S. C. Sethi, 1996. Adoption of improved chickpea varieties in Panchmahal district of Gujarat. *Assessing joint research impacts. Proceeding of an International workshop on joint impact assessment of NARS/ICRISAT*

Technologies for the Semi-Arid Tropics, Patancheru, India. pp:103-113.

- Singh, K. M. and J. N. Chaudhari, 1993. An analysis of CGR and factors affecting area, production, productivity of gram in Bihar. *Agril situation in India*, 96 (11): 841.
- Singh, R. P. and R. Renu, 2009. Growth of production and productivity of different pulses in Jharkhand. *Journal of Economic and Social Development*, Vol. V, No. 1 & 2.
- Singh, S. and S. K. Kumar, 1997. Chickpea promises food security. *Intensive Agriculture*, PP. 41-45.
- Singh, S. K. and A. Prakash, 2014. Growth and Instability analysis of chickpea production in Maharashtra: A district-wise analysis. *Current Advances in Agricultural Sciences (An International Journal)* 6(2), 169-172.
- Smale, m., J. D. Horna and M. V. Oppen, 2007. Farmer willingness to pay for seed-related information: rice varieties in Nigeria and Benin. *Environment and Development Economics*, 799-825.
- Venkaart, S., B. G. Munyua, K. Mausch and J. D. Michler, 2017. Welfare impacts of improved chickpea adoption: A pathway for rural development in Ethiopia. *Food Policy* 66, 50-61.

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APPENDIX – I

Area, Production, Productivity of Chickpea in Maharashtra

(Area in '00 ha, Production in '00 Tonnes, Productivity in Kg /ha)

Year	Area	Production	Productivity
1990-91	6729	3116	824.4
1991-92	4336	2521	771.4
1992-93	5914	3015	819.4
1993-94	6810	4934	1132.2
1994-95	7612	4686	969
1995-96	7171	3760	839.6
1996-97	7495	4984	1049.4
1997-98	7151	2909	686
1998-99	9042	5624	991.6
1999-2000	7902	4566	915.9
2000-01	6762	3508	840.2
2001-02	7563	4505	946.2
2002-03	7962	4485	924
2003-04	7952	4211	894
2004-05	8299	4662	942.6
2005-06	10204	7052	1091.6
2006-07	13081	9251	1125.8
2007-08	13533	11157	1301.4
2008-09	11433	7739	1099.4
2009-10	12914	11144	1287.8
2010-11	14379	13012	1411.8
2011-12	10751	8571	1283.8
2012-13	11345	8676	1105.4
2013-14	18199	16714	1384
2014-15	14275	10877	1196.6
2015-16	14420	7767	931.4
2016-17	14420	7767	921.4
2017-18	22323.1	15671	1504.2
2018-19	12914.2	9851.4	1089.16

APPENDIX – II

Region wise area of chickpea in Maharashtra

(Area: '00 ha)

Year	Area of Western Maharashtra	Area of Marathwada	Area of Vidarbha	Area of Konkan
1990-91	2895	2109	1671	57
1991-92	2223	1114	942	57
1992-93	2437	1820	1592	65
1993-94	2781	2101	1861	67
1994-95	2906	2164	2483	59
1995-96	2809	2019	2284	59
1996-97	3127	2223	2084	61
1997-98	3006	2028	2060	57
1998-99	3726	2671	2585	60
1999-2000	3222.5	2447.5	2173	59
2000-01	2719	2224	1761	58
2001-02	2914	2644	1947	58
2002-03	3008	2750	2155	49
2003-04	2572	2850	2480	50
2004-05	3239	2850	2160	50
2005-06	3496	3467	3182	59
2006-07	4173	3925	4925	58
2007-08	3745	3584	6144	60
2008-09	3360	3858	4152	63
2009-10	4166	4089	4595	64
2010-11	4662	4536	5120	61
2011-12	2792	3647	4252	60
2012-13	2987	3788	4545	25
2013-14	3424	6589	8140	46
2014-15	4158	4873	5198	46
2015-16	4350	4500	5530	40
2016-17	4350	4500	5530	40
2017-18	6733.57	9534.77	6040.72	14.07
2018-19	2363.4	4739.6	5787.2	24

APPENDIX – III

Region wise Production of chickpea in Maharashtra

(Production: '00 tonnes)

Year	Production of Western Maharashtra	Production of Marathwada	Production of Vidarbha	Production of Konkan
1990-91	1623	1016	447	30
1991-92	1156	431	909	25
1992-93	1336	826	818	35
1993-94	1913	1417	1559	45
1994-95	1967	1184	1503	32
1995-96	1633	962	1138	27
1996-97	2182	1295	1468	39
1997-98	1627	521	727	34
1998-99	2513	1377	1697	37
1999-2000	2033.5	1237	1261.5	34
2000-01	1554	1097	826	31
2001-02	1803	1385	1288	29
2002-03	1668	1510	1275	32
2003-04	1440	1229	1508	34
2004-05	2280	1392	957	33
2005-06	2514	2261	2238	39
2006-07	2962	2697	3549	43
2007-08	3060	2825	5224	48
2008-09	2495	2650	2550	44
2009-10	3466	2921	4714	43
2010-11	4161	3654	5134	63
2011-12	2372	2765	3382	52
2012-13	1893	2523	4243	17
2013-14	3060	5622	8002	30
2014-15	3388	3903	3548	38
2015-16	2739	1291	3710	27
2016-17	2739	1291	3710	27
2017-18	7308	2563	5788	12
2018-19	1585.8	2789.9	5463	12.7

APPENDIX – IV

Region wise Productivity of chickpea in Maharashtra

(Productivity: kg/ ha)

Year	Productivity of Western Maharashtra	Productivity of Marathwada	Productivity of Vidarbha	Productivity of Konkan
1990-91	828	978	956	532
1991-92	787.5	780	1071	431
1992-93	812.5	914	1019	539
1993-94	1046	1341	1556	672
1994-95	1000	1124	1195	526
1995-96	910.5	939	980	458
1996-97	1053	1157	1354	630
1997-98	818.5	541	669	583
1998-99	1032.5	1046	1241	606
1999-2000	952	1014.5	1090	571
2000-01	871.5	983	939	536
2001-02	949	1038	1291	504
2002-03	856	1123	1132	653
2003-04	871	846	1205	677
2004-05	1074	1027	888	650
2005-06	1077	1299	1351	654
2006-07	1055	1432	1346	741
2007-08	1253	1594	1602	805
2008-09	1110.5	1390	1195	691
2009-10	1242.5	1442	1848	664
2010-11	1350	1610	1883	866
2011-12	1256.5	1462	1574	870
2012-13	963	1113	1809	679
2013-14	1450.5	1542	1825	652
2014-15	1245	1322	1337	834
2015-16	1024	580	1355	674
2016-17	1024	580	1355	624
2017-18	1584.5	1503	1947	902
2018-19	980.3	980	1911	594.2