ECONOMIC STUDY OF POST HARVEST LOSSES OF MAJOR FRUITS IN BILASPUR DISTRICT OF CHHATTISGARH

Ph.D. (Ag.) THESIS

by

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DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
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ECONOMIC STUDY OF POST HARVEST LOSSES OF MAJOR FRUITS IN BILASPUR DISTRICT OF CHHATTISGARH

Thesis

Submitted to the

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by

NARESH KUMAR

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MAY, 2020

CERTIFICATE –I

This is to certify that the thesis entitled **"Economic Study of Post Harvest Losses of Major Fruits in Bilaspur District of Chhattisgarh"** submitted in partial fulfilment of the requirements for the degree of **Doctor of Philosophy in Agriculture** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Naresh Kumar** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (Certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been only acknowledged by him.

Chairman

Date: 29/05/2020

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman	(Dr. B. C. Jain)
Member	(Dr. M. R. Chandrakar)
Member	(Dr. M. A. Khan)
Member	(Dr. R. R. Saxena)
Head of Department	(Dr. V.K. Choudhary)

CERTIFICATE – II

This is to certify that the thesis entitled **"Economic Study of Post Harvest Losses of Major Fruits in Bilaspur District of Chhattisgarh"** submitted by **Naresh Kumar** to the Indira Gandhi KrishiVishwavidyalaya, Raipur in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Agriculture** in the Department of **Agricultural Economics** has been approved by the external examiner and Student's Advisory Committee after oral examination.

Signature External Examiner

Date: 31-08-2020

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Major Advisor 31.8.20

Head of the Department

Faculty Dean

Approved/Not approved

Director of Instructions

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"I start in the name of God-who has bestowed upon me all the physical and mental attributes that I possess and skills to cut through and heal a fellow human. "Education plays of fundamental role in personal and social development and teacher plays a fundamental role in imparting education. Teachers have crucial role in preparing young people not only to face the further with confidence but also to build up it with purpose and responsibility. There is no substitute for teacher pupil relationship".

With great reverence I express my warmest feelings with deep sense of gratitude to my advisor and chairman of my Advisory committee Dr. B.C. Jain, Professor, Department of Agricultural Economics, IGKV, Raipur. I have no words to express my heartfelt thanks to him for his illuminating guidance, unfailing encouragement, scholarly suggestions, unique supervision, construction criticism, sympathetic attitude and keep interest during the course of my research and preparation of this manuscript. Moreover, I am highly indebted to him for his painstaking efforts in trying to instill in my same important and who through his intelligent decisions made the work gorgeous. He is really worthy of reverence for his blessings, stead inspiration, expert guidance.

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Naresh Kumar

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LIST OF ABBRAVIATIONS

Viz	**Namely**
et al.	Et alii (and others/co-workers)
Qt.	Quintal
Rs.	Rupees (Indian Currency)
Kg	Kilogram
Fig.	Figure
ha.	Hectare
B:C	Benefit:Cost
Mt	Million Tonnes

THESIS ABSTRACT

a) Title of Thesis	: "Economic study of post harvest losses of major fruits in Bilaspur district of Chhattisgarh"
b) Full Name of the Students	: Naresh Kumar
c) Major Subject	: Agricultural Economics
d) Name and Address of the Major Advisor	: Dr. B.C. Jain Professor, Department of Agricultural Economics, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur, Chhattisgarch
e) Degree to be awarded	: Doctor of Philosophy in Agricultural Economics

Signature of Major advisor

Signature of the student

Date 29.5.2020

Signature of Head of the Department

ABSTRACT

This study was undertaken to fulfill the following objectives:

1. To estimate compound growth rate of area, production, and productivity of major fruits in the study area .
2. To find out the cost of cultivation of selected major fruits in the study area .
3. To estimate the post harvest losses of major fruits in the study area .
4. To study the factor affecting post harvest losses at farm level.
5. To identify the constraints of post harvest management of major fruits and suggest some measures for the improvement of the same in the study area .

A multi-stage sampling design was adopted for the ultimate selection of fruit growing farmers. Chhattisgarh plains were selected based on highest area under fruits in Chhattisgarh state. Bilaspur district was selected for papaya, banana and mango. Three blocks from Bilaspur district were selected based on highest area of the respective fruits. One hundred fifty farmers from fifteen villages of Bilaspur district were selected for the study. Forty retailers and ten wholesalers were selected from the selected districts. Major fruits were selected based on the highest contribution of the area under fruits in Chhattisgarh plains. The primary data has been collected from the survey of sampled cultivators through personal interview with the help of pre-tested and structured schedules and the secondary data were collected from published sources and from various government offices and websites including the district statistical department and district horticulture department etc. Growth rate in area, production and productivity of major fruits was work out from 2007-08 to 2016-17.

The major findings of this study revealed that compound growth rate in area of papaya in Bilaspur district was found 1.26 per cent which were significant at 1 per cent, production and productivity of papaya in Bilaspur district was found 5.08 and 3.77 per cent respectively which were significant at 5 per cent probability level of distribution. It can be inferred from the result that significance increased in growth of production was due to significance increase in area and productivity of papaya. The growth in production of papaya in Chhattisgarh state was found in 10.40 per cent which was attributed by significantly increase in area by 10.57 per cent only whole growth in productivity was found to be negative and non-significant and area of banana in Bilaspur district was found 3.50 per cent which were significant at 1 per cent, production and productivity of banana in Bilaspur district was found -1.19 and -4.64 per cent respectively which were production and productivity was found to be negative and non- significant. The growth in production of banana in Chhattisgarh state was found in 12.42 per cent which was attributed by significantly increase in area by 13.52 per cent only whole growth in productivity was found to be negative and non-significant. Area and production of mango in Bilaspur district was found 5.75 and 5.52 per cent respectively which were significant at 1 per cent, and productivity of mango in Bilaspur district was found -0.24 per cent it was found to be negative and non- significant. The growth in production of mango in Chhattisgarh state was found in 16.13 per cent which was 5 per cent level of significant, area

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शोध ग्रन्थ सारांश

शोध ग्रंथ का शीर्षक	: "छत्तीसगढ़ के बिलासपुर जिले की मुख्य फलों में आर्थिक एवं कटाई उपरांत क्षति का अध्ययन करना"
छात्र का पूर्ण नाम	: नरेश कुमार
मुख्य विषय	: कृषि अर्थशास्त्र
मुख्य सलाहकार का नाम और पता	: डॉ. बी.सी. जैन प्राध्यापक कृषि अर्थशास्त्र विभाग, कृषि महाविद्यालय, इंदिरा गाँधी कृषि विश्वविद्यालय रायपुर, छत्तीसगढ़
प्रदान की जाने वाली उपाधि	: कृषि अर्थशास्त्र में डॉक्टर ऑफ़ फिलॉसफी

मुख्य सलाहकार के हस्ताक्षर

छात्र के हस्ताक्षर

दिनाँक 29.5.2020

विभागाध्यक्ष के हस्ताक्षर

सारांश

निम्नलिखित उद्देश्यों को पूर्ण करने के लिए यह अध्ययन किया गया था

1 छत्तीसगढ़ राज्य के बिलासपुर जिले में प्रमुख फलों के क्षेत्र, उत्पादन और उत्पादकता की चक्रवृद्धि दर का अनुमान लगाने के लिए।

2 अध्ययन क्षेत्र में प्रमुख फलों की लागत और प्रतिफल के कार्य के लिए।

3 अध्ययन क्षेत्र में प्रमुख फलों के कटाई उपरांत क्षति का अनुमान लगाने के लिए।

4 कृषि क्षेत्र स्तर पर कटाई उपरांत क्षति को प्रभावित करने वाले कारको का अध्ययन करना।

5 प्रमुख फलों के कटाई उपरांत क्षति के प्रबंधन एवं इसके सुधार के लिए कुछ उपयुक्त उपायों का सुझाव देना।

फल उगाने वाले किसानों के अंतिम चयन के लिए "मल्टी–स्टेज सैंपलिंग डिज़ाइन" को अपनाया गया। छत्तीसगढ़ राज्य के मैदानों को फलों के तहत उच्चतम क्षेत्र के आधार पर चुना गया था। बिलासपुर जिले को पपीता, केला और आम के लिए चुना गया था। बिलासपुर जिले के तीन ब्लॉकों को संबंधित फलों के उच्चतम क्षेत्र के आधार पर चुना गया था। बिलासपुर जिले के पंद्रह गांवों के एक सौ पचास किसानों को अध्ययन के लिए चुना गया। चालीस खुदरा विक्रेताओं और दस थोक विक्रेताओं को चयनित जिले से चुना गया था। छत्तीसगढ़ के मैदानी इलाकों में फलों के अंतर्गत क्षेत्र के सर्वोच्च योगदान के आधार पर प्रमुख फलों का चयन किया गया। पूर्व–परीक्षण की मदद से व्यक्तिगत साक्षात्कार के माध्यम से नमूना

कृषकों के सर्वेक्षण से प्राथमिक डेटा एकत्र किया गया, और संरचित अनुसूचियां और द्वितीयक डेटा प्रकाशित स्रोतों से और जिला सांख्यिकीय विभाग सहित विभिन्न सरकारी कार्यालयों और वेबसाइटों से एकत्र किए गए थे। और जिला बागवानी विभाग आदि से प्रमुख फल, क्षेत्र, उत्पादन और उत्पादकता में वृद्धि 2007–08 से 2016–17 तक काम किया गया था।

इस अध्ययन के प्रमुख निष्कर्षों से पता चला कि बिलासपुर जिले में पपीता के क्षेत्र में चक्रवृद्धि दर 1.26 प्रतिशत पाई गई जो 1 प्रतिशत महत्वपूर्ण थी, बिलासपुर जिले में पपीते का उत्पादन और उत्पादकता 5.08 और 3.77 प्रतिशत क्रमशः पाई गई। जो वितरण के 5 प्रतिशत संभावना स्तर पर महत्वपूर्ण थे। इस परिणाम से यह अनुमान लगाया जा सकता है कि उत्पादन में वृद्धि के कारण पपीता के क्षेत्र और उत्पादकता में महत्वपूर्ण वृद्धि हुई थी। छत्तीसगढ़ राज्य में पपीते के उत्पादन में वृद्धि 10.40 प्रतिशत पाई गई, जो कि 10.57 प्रतिशत के क्षेत्र में उल्लेखनीय वृद्धि के कारण उत्पादकता में पूरी वृद्धि नकारात्मक और गैर–महत्वपूर्ण पाई गई, बिलासपुर जिले में केले का क्षेत्र 3.50 प्रतिशत पाया गया, जो 1 प्रतिशत महत्वपूर्ण थे, बिलासपुर जिले में केले का उत्पादन और उत्पादकता क्रमशः –1.19 और –4.64 प्रतिशत पाया गया, जो उत्पादन और उत्पादकता नकारात्मक और गैर–महत्वपूर्ण पाया गया था। छत्तीसगढ़ राज्य में केले के उत्पादन में वृद्धि 12.42 प्रतिशत पाई गई, जिसका क्षेत्रफल में 13.52 प्रतिशत की वृद्धि के कारण उत्पादकता में पूरी वृद्धि नकारात्मक और गैर–महत्वपूर्ण पाई गई। बिलासपुर जिले में आम का क्षेत्रफल और उत्पादन क्रमशः 5.75 और 5.52 प्रतिशत पाया गया, जो 1 प्रतिशत महत्वपूर्ण था, और बिलासपुर जिले में आम की उत्पादकता–0.24 प्रतिशत था, जो नकारात्मक और" गैर–महत्वपूर्ण पाया गया। छत्तीसगढ़ राज्य में आम के उत्पादन मे वृद्धि 16.13 प्रतिशत पाई गई जो कि 5 प्रतिशत महत्वपूर्ण स्तर, क्षेत्रफल और उत्पादकता क्रमशः 8.30 और 7.01 प्रतिशत थी जो नकारात्मक और गैर–महत्वपूर्ण थी।

पपीता, केला और आम की प्रति हेक्टेयर खेती की लागत पर औसतन क्रमशः 1542207.01, 179450.27 और 78029.69 रुपये की गणना की गई। पपीता, केला, और आम का औसत इनपुट–आउटपुट अनुपात नमूना फार्मों पर क्रमशः 1:2.77, 1:2.94, और 1:2.58 था। सभी फसलों में सीमांत से बड़े खेतों तक बढ़ती प्रवृत्ति दिखा रहा था। क्योंकि किराए पर श्रम, पौधे संरक्षण रसायनों, खाद और उर्वरकों आदि का अधिक उपयोग। पपीता, केला और आम में फसल के बाद का नुकसान 16.26, 17.58 और 18.43 किलोग्राम प्रति क्विंटल पाया गया। आम में अधिकतम नुकसान क्रमशः 11.48, 4.42 और 2.35 किलोग्राम प्रति क्विंटल, किसान, थोक व्यापारी और खुदरा स्तर पर पाया गया। नुकसान का अधिकतम हिस्सा किसान स्तर पर था। सकारात्मक रूप से फलों के कटाई उपरांत नुकसान को प्रभावित करने वाले महत्वपूर्ण कारक गांव से प्रतिवादी की उम्र और बाजार की दूरी के बारे में सकारात्मक थे। इसलिए यह सुझाव दिया जा सकता है कि किसानों को बेहतर विपणन सुविधाएं प्रदान करके, पपीते में फसल के बाद के नुकसान को खेत स्तर पर कम किया जा सकता है। कटाई के बाद के नुकसानों को प्रभावित करने वाले महत्वपूर्ण कारक समय पर श्रम की उपलब्धता और परिवहन की सुविधा को नकारात्मक रूप से प्रभावित करते थे, जबकि गाँव से बाजार की दूरी, फसल के बाद के नुकसान को सकारात्मक रूप से प्रभावित करती थी। इसलिए यह सुझाव दिया जा सकता है कि यदि आवश्यक समय पर किसानों को श्रम उपलब्ध कराया जाएगा, तो फसल के बाद के नुकसान में काफी कमी आ सकती है। कटाई के बाद के नुकसान को प्रभावित करने वाले महत्वपूर्ण कारक समय पर श्रम उपलब्धता और भंडारण की सुविधा को नकारात्मक रूप से प्रभावित करते थे। इसलिए आम में फसल के बाद के नुकसान को आवश्यक समय पर खेत स्तर पर श्रम प्रदान करके काफी कम किया जा सकता है। पपीता, केला और आम के कटाई प्रबंधन में प्रमुख बाधाएं श्रम की कमी, प्रतिकूल मौसम की स्थिति और अपर्याप्त भंडारण सुविधाओं की स्थिति थी, जो क्रमशः 87, 94 और 90 प्रतिशत उत्तरदाताओं द्वारा अनुभव की गई थी। भंडारण संरचना में

सुधार के बाद फसल के नुकसान को कम किया जा सकता है, किसानों को शिक्षित करके और ऐसी नीतियां विकसित करके जो अध्ययन क्षेत्र के किसानों के लिए श्रम समस्या को कम कर सकते हैं।

CHAPTER-I
INTRODUCTION

1.1 Background

Horticulture has aroused as a major agricultural enterprise in accelerating the pace of the economy. This sector not only provides abundant scope for supporting wide range of agro based industries generating ample employment opportunities but also presents myriad options for income diversification to the farmers. While agriculture, considered as the strength of the Indian economy, with a share of about 15 per cent to the country's GDP and employment provider to around 58 per cent of its total population, the horticultural sector contributes to about 30 per cent in agricultural GDP from about 14 per cent of the total area under horticultural crops and contribution of about 40 per cent of the total area under horticultural crops and contribution of about 40 per cent of total agricultural export earnings besides its share of nearly 20 per cent in total agricultural labour force. Thus operation and cultivation of horticultural crops continues to play a fundamental role raising propensity of our nation and fortunes of its people (vision 2050 IIHR, 2014). It is vividly clear that, for the 4 per cent annual growth in the economy of Indian agriculture, the horticultural sector needs to grow at 8 per cent annually to encounter the growing demand for food. There is a growing consciousness about the benefits and grains of the horticultural crops which is certain to leap with the rise socioeconomic status of the people.

As a consequence of technology, research and policy initiatives, India continues to be the II largest producer of fruits and vegetables with a share of about 13.6 per cent and 14 per cent to the worldwide fruits and vegetables production respectively. Due to its significant share in the worldwide horticultural production, India is very well recognized as fruits and vegetables basket of the world India's varied climate and physic-geographical conditions ensures availability of all kinds of horticultural crops such as fresh fruits and vegetables, spices, nuts, flowers and plantation crops (cocoa, cashew nut, and coconut). As per the NHB database (2016-17) India produced about 92.8 million tons of fruits and 175 million tones of vegetables with 6.40 million hectares and 10.30 million hectares land under fruits

and vegetables cultivation, respectively. India is the largest producer of mango (45%), banana (29%), papaya (37%), pomegranate, sapota and acid lime beside recording highest productivity in grapes (21.6 t/ha) in the world (Anonymous, 2015). The vast production base offers India tremendous opportunities for export . Export of fruits from India during 2015-16 was pegged at Rs. 3, 524.50 crores and export of vegetables was of 4,866.91 crores. Bananas, Mangoes, pomegranate, grapes and walnuts accounted for major share of fruits export while potatoes, green chilies, okra, bitter gourd and onions were major vegetables exported from India. Bangladesh, Nepal, Sri Lanka, UAE, Qatar, Malaysia and UK remained the top destination countries for the Indian fruit and vegetables (APEDA, 2017).

1.2 Fruit production in the World

India's diverse climate ensures availability of all varieties of fresh fruits & vegetables. It ranks second in fruits production in the world, after China. As per horticulture at a glance database during 2014, India produced 88.48 million tonnes of fruits. The area under cultivation of fruits stood at 7.15 million hectares. China tops the list of fruit production with 161.00 million tonnes in 2014 followed by India (88.48 million tonnes), Brazil (37.41 million tonnes), USA (25.95), Mexico (17.85 million tonnes), Spain (17.76 million tonnes), Indonesia (17.37 million tonnes), Phillipines (16.23 million tonnes), Itely (15.64 million tonnes), and Turky (14.19 million tonnes). Surprisingly, through productivity is a weak spot, India does better than Chaina and Spain.

1.3 Fruit production in the India

Through, the contribution of India in global market is nearly about 1 per cent but this is certain to go up with the growing acceptance of India's horticulture produce in the world Mango and banana accounted for around 55 per cent of total fruit production among fruits in both the consecutive years (2013-14 and 2014-15) with alone 33 per cent was occupied by potato (26%), tomato and onion (8%) and brinjal (8%) in the year 2014-15. The state wise production of fruit crops in India states that Maharashtra has the major (11.17%) share followed by U.P. (11.15%) while Telangana, Karnataka, Tamil Nadu, MP, and Gujarat each contributed 5 per cent in total fruit production in the country during 2014-15 and these 8 states

accounted for around 70 per cent of the total area under cultivation of fruits (MOSPI, Annual Report 2016).

1.4 Fruit production in the Chhattisgarh

The major fruit crops grown in Chhattisgarh state are Mango, Guava, Lime, Litchi, Cashew-nut , Cheeku etc., apart from these major fruit crops minor fruits like Custard apple, Bael, Ber, Anola etc., are also grown both as cultivated and wild crop. The total area of the fruit crops in the state is 26,1,512 hectares. Along with the production of 25,92,450 million tonnes in the year 2017-2018. Fruit production in Chhattisgarh contributes 25.27 per cent of total horticultural crops. Mango is having highest area among the fruit crops followed by banana, papaya, and guava while in terms of fruit production. The major mango, banana and papaya growing district Korba, Bilaspur, Raipur, Mahasamund, Durg, Balodabazar and Janjgeer Chapa. The highest mango, banana and papaya production in state with 21401, 53903 and 51221 metric tonnes in Bilaspur, Durg and Durg respectively. With regards highest area under mango, banana and papapya cultivation Bilaspur district ranks first with 6447, 2689 and 1959 hectare respectively. Agro climatically Mango can be grown in the whole part of the state successfully while the northern hilly area of Sarguja and Jashpur district is suitable for production of Litchi. Cashew nut can be grown well in the plateau region of the Bastar and Raigarh district . **(Government of Chhattisgarh 2017).**

1.5 Importance of fruits in the Indian economy

The horticulture has gained importance in recent years as a significant component of agriculture in India. The new impetus is given for the development of the horticulture , particularly for growing fruits and vegetables, which constitute important segment of India Dietary System (IDS). The development of horticulture and also securing of a larger share and the export market are emphasized more during the Five Year Plans. India is one among the many important fruits and vegetables producing countries of the world . It ranks third after China and U.S.A. in the production of horticultural crops . It is the world largest producer of mangoes and occupies second place among the banana and onion producing countries of the world. The recent breakthrough in technology

coupled with the concerted and sustained efforts to augment the food production has transformed India in achieving self-sufficiency in food grains. However, the problem of malnutrition needs to be overcome. The need for meeting the minimum nutritional level of the diet of common man is assuming greater significance today. Horticultural crops i.e. fruits and vegetable acquire a place of important as protective food. They provide much needed health supporting vitamins, minerals.

Besides, their value in human consumption, horticultural crops play an important role in commerce, particularly in export trade and processing industry . Horticulture is now regarded as the largest sub-sector of agriculture producing high quality traditional and exotic fruits and vegetables. Employment opportunities provided by this sector to the farm population engaged in production, transportation, processing and marketing operations in addition to the entrepreneurs seeking self employment. Keeping in view its importance much emphasis has been laid to augment the production of horticultural crops in our national plans. There are now many agricultural universities, research institutions and state departments of horticulture directly engaged in fundamental an applied research producing new strains with good varietal characteristics. They run constantly adjusted training programmers for enterprising farmers motivation them to adopt modern technology an develop their skills in producing and preparing quality produce.

1.6 Nutritional value of fruit crops

The nutrition value of fruits places on the crest of our edibles. Fruits contain vitamins and minerals in large quantities. Fruits are the oldest food of mankind. Taking fruits everyday strengthens our vitality. Nutrition scientists advise us to take at least 115 grams of fruit every day for balanced diet. Fruits like papaya, mango, guava, jackfruit, pineapple, lemon, etc. abound with vitamins A, B and C. Moreover, they have calcium, magnesium, iron and potassium. Phosphorus and amino acid abound in adequate amount in wood apple, litchi, almond, karamcha, etc. Rice and wheat are staple food in India. In many countries, people eat fruits as their staple food. For example: People in South American Countries eat banana as the main course of their meal. Banana, Jackfruit, Guava, pineapple etc. Can

reduce our food deficit to a great extent. Fruits are important as food because they have sufficient amount of vitamin and mineral. We should eat 115 grams fruit every day. Fruits increase our digestive power. An intake of fruit every day keeps us hale and hearty . (Rahman,1998).

Fruits are consumed in all times, and due to their convenient size; they are an excellent between-meal snack. They are relatively low in calories and fat (avocado and olives being the exceptions), they have no cholesterol, they are rich in carbohydrates and fiber, they contain vitamins C and carotene, and some are a good source of vitamin $B_{6..}$ Fruits and vegetables are relatively low in sodium and high in potassium. Ascorbic acid in fruits and vegetables enhances the bioavailability of iron in the diet. Because of all these characteristics, fruits and vegetables have a unique role in a healthy diet. A growing body of research has shown that fruit and vegetable consumption is associated with reduced risk of major disease, and possibly delayed onset of agr-related disorders, promoting good health. However, in many cases fruit and vegetable consumptions still below the dietary guideline goal of consuming 5-10 servings each day. The nutritional value of fruits depends on their composition, which shows a wide range of variation depending on the species, cultivar and maturity stage. The composition of fruits includes a great number of metabolites however, it could be predicted that no single commodity might be rich in all these constituents. Therefore the present study is a comprehensive attempt to estimate the dimensions of losses occurring during the post harvest stages of major fruit crops with the following objectives.

1.7 Objectives

1. To estimate compound growth rate of area, production, and productivity of major fruits in the study area.
2. To find out the cost of cultivation of selected major fruits in the study area.
3. To estimate the post harvest losses of major fruits in the study area.
4. To study the factor affecting post harvest losses at farm level .
5. To identify the constraints of post harvest management of major fruits and suggest some measures for improvement of the same in the study area.

CHAPTER-II
REVIEW OF LITERATURE

In this chapter, an attempt has been made to review pertinent literature keeping in view the problem entitled **"Economic study of post harvest losses of major fruits in Bilaspur district of Chhattisgarh".** A brief account of the work reported by the past researchers has been discussed under the following heads:

2.1.1. Studies on compound growth rate of area, production and productivity of crops.

2.1.2. Studies on the cost and returns of major fruits.

2.1.3. Studies on post harvest losses in major fruits.

2.1.4. Factors affecting post harvest losses in fruits.

2.1.5. Studies related to constraints.

2.1 A brief resume of work done in Chhattisgarh, in India and abroad

2.1.1. Growth rate of Area, Production, and Productivity of crops.

Subrahmanyam (1984) analysed the growth rate in area, production and productivity of fruits and vegetables in India from 1949-50 to 1980-81 and found that the growth rate of production (2.92%) was higher than that of area (0.90%), indicating that the growth in production was the combined effect of the growth in both area productivity.

Subrahmanyam (1984) observed an appreciable improvement in the growth of horticultural crops in India during the period from 1949-50 to 1980-81. But the growth was not sufficient to meet the requirements based on the suggested levels of consumption, through, there was a positive significant growth at All India level the position in individual states was not satisfactory and some of them had recorded a negative growth.

Singh et al. (1987) reported that fruit crops recorded a significant growth rate of 12.95 per cent per annum during the period 1981-85, the growth rate of area per annum was significant and positive for all the fruit crops. It was highest for

kinnow (32.20%) followed by that of ber (14.96%), pear (13.30%), mango (6.75%) and guava (5.44 %)

Jairath (1990) computed the growth rates in area, production and productivity of sweet potato of major sweet potato growing states from 1974-75 to 1985-86 and the growth rate were found to be positive with 2.24, 2.94 and 0.71 percent respectively in Orissa. However, growth rates in area (-0.896%) and production (-0.244%) were negative on All India basis mainly due to negative growth rates in area, production and productivity of major sweet potato producing states of Bihar and Utter Pradesh.

Madan and Ullasa (1991) conducted a survey in orchids, markets and processing units in Karnataka to determine the extent and causes of post-harvest losses in mango. The post-harvest losses to the extent of 4 per cent was estimated at the processing unit end. The major cause for the loss was the occurrence of post-harvest diseases including stem-end-rot, anthracnose, Aspergillus and Rhizopus rots. The authors suggested that these losses could be reduced by following the recommended production technology.

Handiganur (1994) estimated the trend in growth of area under grape in Bijapur district and trends in area, production and productivity of grape in Karnataka using exponential form of the function. The area under grape in Bijapur district and area, production and productivity in Karnataka showed a positive growth rate. There was in increase of 7.15 per cent in area in Bijapur district and at the state level the growth rates in area, production and productivity were 0.6 per cent, 2.8 per cent and 2 per cent respectively.

Sharma and Thakur (1995) in their study on prospects and problems of fruit industry in Himachal Pradesh worked out the compound growth rates in area and production of apple for the period from 1966-67 to 1984-85. The compound growth rates were 6.15 and 8.4 per cent for area and production of apple, respectively.

Saraswati (1996) worked out the compound growth rates for area and production of citrus in Himachal Pradesh during the triennium period from 1975-78 to 1989 -78. Area under citrus showed increasing trend at an annual compound rate of 11.09 per cent. The higher growth rate than the state average

was observed in the districts of Una (16.46%), Hamirpur (12.87 %), Bilapur (12.08%) and Kangra (12.08%). The production of citrus fruits in the state increased at an annual growth rate of 4.74 per cent. The highest growth rate was observed in Una district (31.98%) followed by that in Himirpur (16.72%) and Sirmour (5.77%).

Pawar (1997) observed that the average productivity of Pomegranate fruits in Pandhrpur and Sangola tehsils of Solapurt district was 3,463 dozens of which 87.70 per cent was marketed at different markets and the remaining 12.30 per cent was for home consumption. The net prices received from the sale of pomegranate for each dozen ranged from Rs.9.28 (for grade III produce in local market) to Rs. 73.78 (for grade I in state level wholesale market). Whereas, the overall per dozen prices of grades together realized were Rs. 13.21, Rs. 41.87 and Rs. 50.87 from the sale of pomegranates in local, district and sale level markets, respectively .

Sharma (1997) studied some aspects of fruit production and consumption in India. The study revealed that through India ranks first in fruit production in the world with the share of 9. per cent, its per capita production was 37.8 kg/ annum as compared to world (66.9kg/annum). In India, out of total fruit production, share of Utter Pradesh was highest (19.7 per cent) followed by Andhra Pradesh (12.5 per cent) and Maharashtra (11.0 per cent). However, per capita per annum production was highest in Karnataka (71.0 kg) and lowest in West Bengal (16.6 kg). In terms of productivity, Tamil Nadu (16.5 tonnes/hectares) rank first whereas, Himachal Pradesh (2.1 tonnes/hectares) ranks last among the major fruit growing states in India. Per capita per annum consumption of fruits was estimated to 16.6 kg based on National Sample Survey Organization (NSSO) data for 1987-88 and it was about 44 per cent of per capita fruit production. Hence, it was recommended to undertake development of various infrastructural facilities for bridging the gap between existing consumption level, availability level and recommended level.

More (1999) studied the growth rate in area, production and productivity of banana in Nanded district, Parbhani district and Maharashtra state as a whole (4.50%) due to suitability of climate to cultivate banana in addition to more awareness of farmers towards horticultural crops in Nanded district. In Nanded

district production growth rate had shown higher growth rare (21.04%). The higher growth in production was contributed mainly by significant increase in area coupled with productivity. The growth rates of productivity were high (1.43%) in Maharashtra state as whose as compared to Nanded (1.40%) and Parbhani (0.90%) district. It was due to the use of improved cultural practices, higher use of manures and fertilizers, more use of other inputs and also increased yield levels in other districts of the state.

Gangal (2002) studied the growth rate in area, production and productivity of banana in North Karnataka and Karnataka state as a whole. The growth rates in area (6.69%) in Karnataka state between 1980 and 2000 was substantially higher than all the other major banana growing states and all India average .

Sananse et al. (2003) studied the export scenario of fruits and vegetables in post WTO era. Compound growth rates were estimated to know per cent annum growth in the export. The results indicated that the quantity of fresh fruits and vegetables increased by 2.56 per cent per annum. However, it increased significantly by 15.02 per cent per annum for processed fruits and vegetables. The overall growth per annum was 6.40 per cent. At an overall level, the export value received for total fruits and vegetables increased significantly per annum by 8.67 per cent .

Jayesh Talati (2003) studied the demand for fruits and vegetables in the early 21st century. Annual compound growth rate for area production of fruits and vegetables was calculated from time series data for the period of 1991 to 2000 and data was collected from National Horticulture Board (NHB). Fruits and vegetables production growing with an annual compound growth rate of 5.25 and 5015 per cent, respectively during last decade. If the fruit and vegetables production will continue to grow at the same rate, there will be 170.82 million tones gross fruits production and 308.74 million tones gross vegetables production in the year 2025.

Jaini et al. (2003) examined production and exports of fruit in India. The study has used secondary data and five major fruit crops i.e. mango, banana, orange, grape, and apple were selected. The linear and compound growth rate of production and exports of selected fruit crops were worked out. In case of production of mango, the highest linear and compound growth rate of production

and exports of selected fruit crops were worked out. In case of production of mango, the highest linear and compound growth rate in India were observed (4.4 and 8.9 per cent) during the period 1981-82 to 1991-92 but statistically non significant. In case of banana production, the linear and compound growth increased significantly during the period 1971-72 to 1999-2000, the production of orange, grape and apple increased significantly during the period 1971-72 to 1999-2000. On the basis of these findings, it may be safely inferred that cultivation of fruits has good potential an can be economically viable alternative to the existing crop cultivation in the area. This may require giving incentives to the growers in the form of subsidized seed/seedling, fertilizer and credit. The analysis of growth rate of export of fruits indicates increasing trends in mango, orange and grape over the period which show that there was a still scope for increasing the export potential of these commodities in the country while in case of banana and apple, there was a decreasing trend in export which needs to be supported by the suitable policies of the government in order to increase their export .

Sadhan Kumar Chattopadhyay (2003) studied the prospects for export of horticulture products in West Bengal. Annual compound growth of area, production and productivity of fruits was analyzed. Both area and production of fruits in the state have increased during the past decade, i.e., 1991-92 to 2000-01. While the area has increased at an annual compound growth of 1.9 per cent and the production has increased by an annual compound growth of 3.9 per cent. However compound growth rate of both area and production of fruits are lower than the national average. In fact, the state share in area under fruit cultivation has gone down from 3.9 per cent in 1991-92 to 3.4 per cent in 2000-01.The share of fruit production has also gown down from 4.0 per cent to 3.7 per cent in 2000-01. The share of fruit production has also gown down from 4.0 per cent to 3.7 per cent during the same period. The productivity of fruits in West Bengal has been satisfactory during the past decade. It has increased from 10.2 MT/Ha in 1991-92 to 12.4 MT/Ha in 2000-01, higher than the national average. At the all India level,

the productivity of fruits has increased from 10.0 MT/Ha to 11.7 MT/Ha in 2000-0 .

Jayesh Talati (2003) studied the demand for fruits and vegetables in the early 21st century. Annual compound growth rate for area production of fruits and vegetables was calculated from time series data for the period of 1991 to 2000 and data was collected from National Horticulture Board (NHB). Fruits and vegetables production growing with an annual compound growth rate of 5.25 and 5015 per cent, respectively during last decade. If the fruit and vegetables production will continue to grow at the same rate, there will be 170.82 million tones gross fruits production and 308.74 million tones gross vegetables production in the year 2025.

Sananse et al. (2003) studied the export scenario of fruits and vegetables in post WTO era. Compound growth rates were estimated to know per cent annum growth in the export. The results indicated that the quantity of fresh fruits and vegetables increased by 2.56 per cent per annum. However, it increased significantly by 15.02 per cent per annum for processed fruits and vegetables. The overall growth per annum was 6.40 percent. At an overall level, the export value received for total fruits and vegetables increased significantly per annum by 8.67 per cent.

Shaheen et al. (2004) studied the growth and instability in area, production and yield of fruit crops in Jammu and Kashmir. The study was based on the secondary data collected from published sources. The temporal change in area under different crops revealed a significant increase in area under apple, cherry and walnut over time. Moderate to high significant growth was observed in area, production and yield of all the fruit crops for the period from 1947-2002 at state level.

Sanjeev Panwar et al. (2004) studied the trend in area, production and productivity of fruits in Himachal Pradesh. The time series data on annual production of fruits in Himachal Pradesh and India from 1985-2001 were collected from various published sources. The annual compound growth rate for the area of fruit crops in India was 2.63 per cent. Whereas, that of Himachal Pradesh was 2.95

per cent. Production of fruit crops showed a negative growth rate which is mainly contributed by the apple crop whose growth rate in production declined by 16.24 per cent per annum. At the national level, the growth rate of almost all the fruit crops are positive and the growth rates of citrus and guava were the highest. The productivity of growth rates of major fruits crops are either negative or minimal, while that of other crops (minor fruit crops) were positive and significant at 5.05 per cent per annum.

Verma and Singh (2004) studied the growth in production and export of banana in the world and India for the period 1991-92 to 2000-01. The results indicated that banana is mainly consumed as a fresh fruit an in total 124 countries produced banana. Within country banana covered about 3 per cent of the total cultivated is for fruits and accounting one-third of total fruits production of country. The states of Maharashtra, Tamil Nadu and Madhya Pradesh have productivity more than national level. The area of banana had increased to 25.8 per cent during last decade, i.e. from 383.9 to 482.8 thousand hectares and production of banana has registered an appreciable shot up to 16,167 from 7, 790 thousand tones with 107.5 per cent increase. They have underlined, the increase in production of banana has been facilities by improvement in productivity from 20.3 to 33.5 tonnes per hectares. To sum up, most of the researchers either used linear exponential or modified exponential for estimating the growth rates of horticultural crops in general and for fruit crops in particular either at all India level or state level or original level by using time-series data. The time series data. The time-series data have been analyzed in most of the studies by splitting the periods in terms of decades or pre-green and post-green revolution period. In most of the studies, the performance of horticultural crops in general and for fruit crops in particular across the states and for the country as a whole was quite poor during the pre-green revolution period and the same improved to greater extent during the post-green revolution period. On the basis of these findings, it may be safely inferred that cultivation of fruits has good potential and can be an economically viable alternative to the existing crop cultivation in the area.

Saraswat and Rana (2006) conducted a study on production and marketing of peach fruit: a case study of Raigarh area of district Sirimour in Himachal Pradesh. The compound growth rate with respect to area and production shows that the area under peach increased at the rate of 4.31 per cent per annum. The highest area under peach was recorded in Sirmous district, whereas district Mandi registered the highest rate of production growth in the state i.e., 9.32 per cent per annum. The district wise production scenario indicate that there are variations out of 12 district only 4 district have registered a positive growth in production i.e., solan (22.55%) followed by Una Bilaspur and mandi.

Ramachandra (2006) studied the production and marketing of sapota in Northern Karnataka. The results revealed that the Belguam and Dharward districts were found to be having negative growth in area production (-3.07 and -9.18% and 3.73 and -4.77%, respectively).While the productivity of both the district was negative viz., -6.30 and -8.20 respectively. On the country, a lower but positive and significant growth rate was observed in sapota area for the state as a whole, whereas the production and yield showed negative trend (-1.98 and -6.24 respectively).

Prakash (2012) studied the export potential of grapes from northern Karnataka, the results of the growth rate analysis of the area, production and productivity of grapes in Karnataka shown that, growth instability index of 9.97 per cent while in the same period, a positive and significant growth rate of production was observed (3.11%) with instability index of 20.34 per cent, and a negative and significant growth rate of productivity (-3.65%) was observed.

Singh et al. (2013) Present Paper estimates growth rate of area, production and productivity of fruit crops in Jharkhand. The study revealed positive growth rate in all selected fruits (litchi, mango, guava and banana) except citrus. It has also been observed that among periods, IVth period (2005-10) was found to be favorable for litchi, mango and guava particularly, while negative growth rate was found in banana and citrus. The productivity growth rate was also observed to be positive nearly 2.56 percent, 2.56 per cent, 1.50 per cent, 5.21 per cent

respectively in litchi, mango, guava and banana. This trend resulted in positive growth in volume of these fruits in the state. The study further revealed that variability in area was highest in litchi (71 per cent) due to shifting in area from other fruit crops in the litchi area followed by mango and banana respectively. Similarly variability in productivity was observed to be high in banana and there was no considerable variation in the yield of other fruit crops .

Jamal et al. (2016) the growth rates of area for mango, jackfruit, litchi and pineapple were increased impressively and significantly. This might be due to the adoption of improved variety and management practices by the farmers. The growth rate of area, production and yield of banana decreased drastically over the period due to absence of modern variety of banana and lack of improved management practices in the region. The growth rates of production for mango were found to be highest in the period III (2004/05-2009/10). But the growth rate of yield of mango was found to be decreased significantly over the periods due to improper management against the pest and diseases by the farmers. The highest percentage of output changed was observed in Banana (149%) followed by pineapple (106%) and jackfruit (83%) between the periods. The lowest percentage of output changed was found in guava (11.7%). The contribution of area was the highest in changing output for mango, jackfruit, litchi, guava, ber, pomelo, watermelon, lime and lemon. The contribution of yield was the highest for banana (135.57%), papaya (76.92%) and pineapple (158.62%) for changing output indicated that the increased area was more responsible for changing in output growth of selected fruits. To increase the growth rate of fruits, improved variety and management practices should be disseminated through undertaking special programmed and strengthening research-extension linkage in the Chittagong region .

Meera et al. (2016) horticultural crops constitute a significant component of total agricultural production of the country and cover nearly 11.6 million ha area with a total production of over 91 million tonnes per year. Production of fruits and vegetables play an important role in generating employment, income and meeting household nutritional security. The combined annual production of fruits and vegetables in India is likely to cross 377 million tonnes (MT) mark by 2021 from

the current level of over 227 MT. However, the projected production of fruits and vegetables would only cater to domestic demand leaving no scope for growth on export front due to the huge wastage would continue to rise simultaneously in absence of on-farm processing facilities. Post-harvest losses are very high in fruit, vegetables and root crops as they are much less hardy and are quickly perishable, and if care is not taken in their harvesting, handling and transport, they soon decay and become unfit for human consumption. The importance of post-harvest management for fruit and vegetable trade should not be ignored. New strategies need to be developing to promote adoption of post-harvest technology by the fruit and vegetable growers for good marketing. The creation of market infrastructure from export point of view such as creation of pre-cooling, cold storage, air cargo, packinghouse etc. may be taken up by the concerted efforts of the state government.

2.1.2. Studies on the cost and returns of major fruits.

Rana (1984) studied fruit production and marketing in India and observed that the perennial horticultural crops differ very much from field crops in view of long commitments of land, labour and capital for cultivation. Although operating costs of well established orchards may not be very high those of field crops, yet the initial capital requirement for establishing orchard are certainly on the higher side.

Thomas and Gupta (1987) studied the economics of banana cultivation in Kottayam district of Kerala. The study revealed that the expenditure on manures and fertilizers followed by labour cost were the major item of cost of cultivation of banana. He found that an amount of more than Rs. 6000 per ha can be gained as profit by undertaking banana cultivation.

Azad (1987) studied the economics of production, marketing cost and the problems of guava production manly confined to the vicinity of Allahabad city. The study revealed the financial hardship faced by the growers to invest in their orchards to boost higher yields. There was neither fruit preservation centre available in the study area or proper technology developed for increasing guava production. The growers also suffered from lack of assured irrigation facilities.

Sikka and Swarup (1988) studied the economics of fruits production in Himachal Pradesh and examined the production costs, the marketing system and the economic viability of stoned fruits and pear growing. The maintenance costs of all orchards were found to have a direct relationship with age of plants. The marketing channel of producer-forwarding agent -consumer agents-wholesaler-retailer-consumer I most prevalent in the case of plum and peach. Pears were sold directly at village level. Lack of proper storage and transport facilities were the major problems faced by the growers.

Sharma and Singh (1990) examined tips of papaya growing for Tripura state. They stated that papaya is an early bearing and highly remunerative crop supplying fruits throughout the year which are delicious nutritive and medicinal valued fruits of several uses. For every rupee invested on nursery, fruit seed and papain industry of papaya got a profit of Rs. 2.26 from fruit production (Rs. 780.95 per hectare) Rs. 3.26 from seed (Rs.103095 per hectare) and Rs. 2.35 from papain can be fetched out from hermaphrodite variety like Coorg honeydew of this crop cultivated for these purposes. As papaya plant supplies the fruit at any time during the year, unripe fruits are therefore cooked as vegetables throughout the year owing to the paucity of other greens in this isolated region of the country. Unripe fruits of papaya are sold @ Rs . 3 to 5 per kg while ripened ones @ Rs. 10 to 15 per fruit. Commercial cultivation of papaya on large scale in state may attract the attention of fruit preservation factories preserving at present only pineapple and also commands a bright potential of exporting unripe fruit.

Singh and Singh (1991) stated that the papaya growers can get maximum income by growing papaya crop for seedlings, seed production and fruit as well as for papain. An experimental trial on papaya production carried at Kanpur farm indicated that for papaya seedling the net profit will be Rs. 1.26 per rupee invested. While if it is taken for papaya seed, fruit and papain production, farmers will earn Rs. 2.00, Rs. 1.66 and Rs. 1.35 as gross returns per rupee invested.

Hugar et al. (1991) reported that guava is a valuable source of income and nutrition in India but the fruit has not fulfilled its potential profitability. They evaluated the perspective income from guava production on a commercial scale under scientific management in Karnataka. The data for the years 1973-74 to

1978-88 suggested that farmers can realize greater returns than they are earning at present by intercropping guava trees with vegetables. There are also other positive side effects from such strategy in the form of increased employment.

Mohan et al. (1991) studied the citrus fruits cultivation in Andhra Pradesh State, which enjoys a monopoly over the rest of India in the production. The study focused on the contribution of citrus to the States gross income. The data were provided for the year 1980-81 to 1984-85 on acreage, production level, productivity and income. While taking in account of planned projections, it believed that the government is neglecting this sector which has considerable potential .

Rangaswami et al. (1992) examined the information about a new tray for papain extraction developed by Tamil Nadu Agricultural University , Coimbatore, which is convenient to fix and remove from papaya tree. The cost of try being terrifically reduced from Rs.250 to Rs. 20 only will augment market for papain to U.K, U.S.A, Japan and Germany. The in-house consumption by the food, drug, tanning, textile, brewing and cosmetic industries fluctuates between 10 to 20 tonnes a year. He also estimated that one hectare papaya over a period of three years can give 480-600 kg of dried papain. The taste and edible value of the fruit remain unaltered after papain extraction. Pockets of plains free from extremes of summer and winter may be brought under papaya cultivation for higher returns .

Aparna and Bansal (1993) explained the tenure system in Nagaland. The study reported that land ownership is vested in the village community and not the State. The violent movements for self-determination by the Nagas are contributory factors in their demands for special constitutional safeguards to protect their traditional rights and ways of life. The recent emergence of share cropping system in the Jalukie valley" plan is an aberration from the traditional land relations. The traditional way of life of the Nagas is one of shifting cultivation, and a complete change over to terraced or settled cultivation is not desirable .

Mishra (1994) worked on the various practices in papaya cultivation and recommended scientific method to be adopted by farmers for papaya cultivation. They estimated as Rs. 50000 cost per hectare papaya cultivation while yield to be

600 quintals resulting in gross income of Rs. 150000 and leaving as Rs.100000 as net profit.

Gadre (1997) studied per hectare input utilization and cost of cultivating papaya and intercrops and input output ratio. The per hectare cost of cultivation of papaya was Rs. 16018.10 and 31902.20 for papain extraction and intercropping whereas the per hectare gross income was Rs. 81302.62 of which Rs. 55208.17 was from papain and Rs. 26094.45 from papaya fruits and Rs. 14835.18 from intercropping. He observed that input output ratio was 1:4.76 indicating thereby cultivation of papaya for papain as highly profitable .

Mali et al. (2001) studied the economics of production and marketing of banana in Jalgaon district of western Maharashtra found that the per hectare cost of cultivation of banana worked out to Rs. 133477.36. The gross returns per hectare of banana come to Rs. 214867.24 and net returns of Rs. 66761.87 were obtained.

Sundarevarodarayan and Ramanathan (2003) estimated that the establishment cost of cashew plantation for the first year was Rs.7690, Rs. 9491 for marginal, small and large farmers, respectively. The maintenance cost of cashew plantations in the case of marginal farms were Rs. 4059, Rs. 4410, Rs.4910, Rs.5385, Rs.841, Rs. 6332, Rs.6771 and Rs. 6990 for second, third, fourth, fifth, sixth. Seventh , eighth and ninth year, respectively and in case of large farms the maintenance cost were Rs. 5040, Rs.5250, Rs. 5764, Rs. 6145, Rs. 6558, Rs. 7021, Rs. 7438 and Rs. 774 for second, third, fourth, fifth, sixth, seventh , eighth, and ninth year, respectively. The output ratio per hectare was 1.43, 1.55 and 1.83 for marginal, small and large farms, respectively.

Gawankar et al. (2005) had studied on investment on rainfed anonla cultivation in Maharashtra during the year 2003. They observed that the annual cost for aonla crop was Rs. 13500, Rs. 26966 and Rs. 28316 as Cost A, Cost B, Cost C. The annual total cost of rainfall aonla cultivation included the cost of fixed items like irrigation, working cost like wages, fertilizers, insecticide, supervision, rents and maintenance, etc. was found to be Rs. 28316 per hectare. Gross returns and net return obtained Rs. 76000 and Rs. 47684 per hectare, respectively.

Umesh et al. (2005) observed that the establishment cost of cashewnut was Rs. 15631 per hectare in all the varieties studied during the first three years. The

maintenance cost per hectare from fourth year onwards varied from Rs. 5881 to Rs. 8254 in Chintamani-1, Rs. 5640 to Rs. 8254 in Ullal-4, Rs. 5812 to Rs. 7882 in Ullal- 3 and Rs. 5821 to 7229 in ullal-1. The net returns of cashew orchard per hectare being fairly high were in the order of Rs. 61314, Rs. 62425, Rs. 49672 and Rs. 34231 in Chintamani-1 Ullal;-4, Ullal -4, Ullal-3 and Ullal-1.

Patil and Umale (2008) revealed that the majority of problems faced by the respondents in banana cultivation were lack of plant doctoral advisory service at field level, lack of awareness about latest technologies, inadequate credit facilities, and complexity of messages and difficulty in their interpretation, irregular visits by the concerned authority.

2.1.3. Studies on post harvest losses in major fruits.

Mandal and Dasgupta (1981) estimated the post-harvest losses for eight fruit crops and six vegetable crops both in terms of quantity and monetary value in wholesale and retail markets of Calcutta, West Bengal during 1977 and 1978. The fruits considered for the study together lost 35.46 thousand tonnes worth of Rs. 82.72 million and the 6 vegetables together lost 73.24 thousand tonnes amounting to a monetary loss of Rs. 6.12 million. The study showed that the losses varied depending upon locality, month, transportation chain followed etc.

Madan and Subrahmanyam (1987) conducted a survey in Kolar district of Karnataka to assess the post-harvest loss in mango fruit at field level as well as at the markets. The overall assessment of the commodity movement system technique was used to identify the points for stages where the loss occurred and to identify how the commodity was handled by the different market functionaries. The post-harvest losses of mango was noticed at two stages, one at the assembling markets (14.30%) and other at the time of storage for ripening at wholesale and retail markets and processing units (11.91%).

Madan and Ullasa (1991) conducted a survey in orchards, markets and processing units in Karnataka to determine the extent and causes of post-harvest losses in mango. The post-harvest losses to the extent of 4 per cent was estimated at the processing unit end. The major cause for the loss was the occurrence of post-harvest diseases including stem-end-rot, anthracnose, Aspergillus and Rhizopus

rots. The authors suggested that these losses could be reduced by following the recommended production technology.

Roy and Pal (1991) assessed the extent of losses in mango at various stages of postharvest operations. They found that the fruits discarded at field level were 1.30 per cent, culled fruits ranged from 12 to 18 per cent and were sold at lower prices. The physiological loss in weight during transportation of the produce was 3.68 per cent. At the time of ripening in the boxes total loss was 7.53 per cent, the extent of loss was still higher in pile ripening method. To reduce post-harvest losses in mango, they suggested taking up the spray of fungicides to control storage diseases, which occur due to anthracnose and stem-end-rot.

Anonymous (1992) reported the post-harvest losses in mango, orange and banana among the fruit crops and onion and tomato among the vegetable crops. The estimated postharvest loss is in different varieties of mango varied from a minimum of 17.10 per cent (Dashehari) to a maximum of 36.70 per cent (Totapuri). The estimated post-harvest loss was 11 to 14 per cent in the case of banana. Two per cent loss occurred in field after harvest, two per cent loss occurred with the wholesale trader and eight per cent after the ripened fruits reached the retail stage. Out of the total Coorg oranges harvested, 8.5 per cent was rejected on the field, 3.5 per cent after transportation to the wholesale market and a further 3.5 per cent at the retail level. The post-harvest losses in vegetables revealed that the total loss in Bangalore Rose onion and Bellary Red onion was estimated at 13.5 and 30 per cent, respectively. The study also showed that the extent of loss as directly depended on the variety of crop, season and area of production.

Atteri (1994) worked out the physical and economic losses of Dashehari and Chausa varieties of mango in New Sabji Mandi of Delhi and found that the quantity of fruits affected ranged from 1.0 per cent to over 50 per cent. It was 15.2 per cent at the wholesale and 7.74 per cent at the retail level for Dashehari whereas, the figures for Chausa were 21.83 per cent and 9.62 per cent. The percentage of economic losses for Dashehari at wholesale and retail levels were found to be 7.73 per cent and 5.73 per cent, respectively. The corresponding figures for Chausa variety were 6.02 per cent and 6.71 per cent. The study

suggested to make efforts to train farmer for judging the right stage of harvesting so that the losses could be minimized.

Rao and Mannohar (1995) studied the losses of fruits in packing and transportation and observed the occurrence of damage to the fruits mainly at three stages viz., harvesting and transportation of the produce to the wholesale markets, repacking and transportation by retail sellers and loading and unloading of the fruits. They also reported that extent of damage of fruits varies with the packing material used. About 100-200 kg of fruits was damaged in a lorry carrying 7-10 tonnes of fruits where leaves were used as packing material while as the extent of loss was only 10 percent when the boxes of 6 mm thickness were used as packing material .

Anonymous (1996) conducted a survey in Farukhabad and Kanpur regions of Uttar Pradesh to quantify the post-harvest losses in papaya. It was reported that the harvesting losses occurred mainly because of accidental falling of the fruits. About 10 per cent of the fruits got cracked in varying intensities during harvesting. Rottening losses to the extent of 25.1 per cent were observed at the ripening stage. The aggregate loss at retailer level was 7.2 per cent. An analysis of pooled losses in entire post-harvest distribution system of papaya revealed that only 53.03 per cent of the produce reached the consumer in sound marketable condition .

Srinivas et al. (1997) conducted a survey to assess the post-harvest losses of Totapuri (Bangalore) and Alphonso (Badami) mangoes in Karnataka and reported a total post-harvest loss of 17.9 per cent (3.5% orchard or field, 4.9% transportation, 4.1% storage and 5.4% retail level) and 14.4 per cent (1.9% orchard or field, 3.7% transportation, 3.5% storage and 5.3% retail level), respectively. The major causes for losses observed in the order of their occurrence were; mechanical injuries, spoilage, either over mature /shriveling or immature/unmarketable sizes, pilferage and damage by birds/hailstorm.

Karwasra et al. (1997) reported that post-harvest losses in fruits and vegetables in India is worth about Rs. 4,000 crores annually. In general, in physical terms post-harvest losses in these commodities vary from 9 to 40 percent. Any losses in through proper post-harvest management will generate additional

quantity to meet internal as well as external requirement even at existing level of production.

Shellikeri and Mundinamani (1999) studied the post-harvest losses and price spread in marketing of perishables in Bijapur district of Karnataka. The main findings of the study revealed that the grape growers lost 362.80 kg of grape out of 32,347.20 kg produced per ha, the monetary worth of which was Rs.5,548.83. The post-harvest dropping of berries, shot berries and mummification were the main factors causing the loss on farm. The extent of loss estimated at pre -harvested contractor level was 1,264.20 kg valued at Rs.14,778.50, whereas the loss at commission agent-cum-wholesaler level was 3,762.60 kg valued at Rs. 62,534.40. The retailers lost 131.40 kg of grape (worth of Rs. 1,307.84) due to weight loss, loose berries and spoilage of berries in the process of handling .

Gajanana (2002) studied the marketing practices and post-harvest loss assessment in Poovan variety of Banana in Tamil Nadu. Trichy district was selected based on its maximum contribution to the area under banana. The producers of banana were found to use two main channels for marketing their produce namely, selling in the local market either through preharvest contractor or commission agents (Channel-I) and selling to the agents of the wholesaler in the distant markets like Bangalore, Mumbai and Chennai (Channel-II). The post-harvest losses in Channel-I was found to be slightly less at around 19 per cent compared to 21 per cent in Channel-II. The main reason for the higher loss in Channel-II was transit loss due to long distance of transportation. Further, in order to make the best use of the utilizable waste Banana fruits, it was suggested to establish processing units of banana in the production area as it was found feasible.

Sreenivasa Murthy et al. (2002) conducted post-harvest loss estimation in Banganapalli variety of mango at different stages of marketing. Krishna district in Andhra Pradesh was selected as it ranked first in terms of area and production in the state. The postharvest losses in mango at different stages of marketing were estimated under two heads viz., physical post-harvest loss (PHL) and economic PHL. The average physical PHL at the farm level in Banganapalli variety was 15.6 per cent. This was due to the harvest of immature and small fruits, which accounted for about 66 per cent of the total loss at farm level. It was observed that

physical PHL at market level was virtually zero. On an average about 128 fruits out of 1440 fruits were found to be damaged which worked out to 8.8 per cent loss at ripening and storage. The physical PHL at the retail marketing was found to be 5.25 per cent. The economic loss at the farm level was estimated at 11.7 per cent, compared to 15.6 per cent in physical terms. The economic loss at the large, medium and small sized fruits worked out to 5.3 per cent, 5.9 per cent and 4.2 per cent, respectively indicating that economic loss varied with the size of fruits unlike in physical loss where the loss is almost the same in all categories. The economic loss at retail level was worked out to be 4.5 per cent only. Thus, the total economic loss at different stages from the production point to consumption point works out to be 21.7 per cent against the total physical loss of 29.7 per cent .

Sudha et al. (2005) studied the post-harvest handling and marketing of banana (cv. Tella Chakkara keli) in Rajahmundry region of Andhra Pradesh. This study indicated that self marketing at the wholesale/retail market fetched higher producer's share of 64 to 76.2 percent in the consumer's rupee. The post-harvest loss was assessed at the field level, market level and retail sales. The marketing efficiency worked out to be 1.41 in channel II. Inclusion of PHL as an additional item of cost increased the marketing cost and reduced the marketing efficiency.

Ashok and Maheswari (2008) analysed the post harvest losses in banana in Tamil Nadu. The total post harvest loss from harvesting to consumer was 4.62 kg per bunch which accounted for 30.8 per cent of the total weight of the bunch. Post harvest loss at farmers' level was 1.41 kg per bunch which accounted for about 9.4 per cent of the total weight .

Msogoya and Kimaro (2011) to assess postharvest losses, mature fruits were packed on semi-rigid bamboo cartons, loaned on a truck without separators in between cartons and transported from Mkuyuni ward to Morogoro urban, Tanzania. The effect of heat stress during the wholesale market was evaluated by storing mango fruits under the sun, woven polypropylene shade and black net shade at Sokoine University of Agriculture. Mango fruits dipped in hot water at 60^{o} C for 10 minutes were compared with untreated ones as control. Results showed that the fruit total post-harvest losses were 43.8% with wholesale market, transport and harvest stages accounting for 30.6%, 10.6% and 2.6% of the total

losses, respectively. The main features of fruit deterioration during the wholesale market stage were softening and microbial decay each accounting for 50.7 and 39.6% of the total losses within the stage, respectively. Microbial decays of 7.2 % and mechanical injuries of 2.0 % were the major features of mango fruit deterioration during the transport and harvest stages. Storing fruits for three days under the woven polypropylene and black net shades significantly reduced fruit sun. Hot water treatment reduced the incidence of microbial decay by 85 % and improved fruit total soluble solids content by 15 % in comparison to untreated fruits .

Sab et al. (2017) the research study was carried out in Dharwad and Belgaum districts of North Karnataka during the year 2013-14. Following the simple random sampling, 120 respondents were selected from six villages of two taluks. The data was elicited through personal interview method. The important findings of the study were; majority of the respondents possessed medium level of knowledge (72.50%) and adoption (68.33%) about improved cultivation practices of mango. Almost all the mango grower had grown Alphonso and Totapuri varieties. More than half the number of mango growers had followed the recommended spacing, irrigation for young gardens and applied different chemicals for the control of the mango hopper and the powdery mildew disease. Majority (79.16%) of the respondents had followed manual harvesting by labours, cent per cent of the respondents stored the mangoes on the ground itself. Majority of the respondents (81.66%) had used truck for transportation. Only 20.00 and 15.00 per cent of the respondents followed the processing for juice and pickle making, respectively. Majority (59.17%) of the respondents belonged to the middle age group. A considerable percentage of respondents (23.33%) educated upto primary school. Further, they had medium level of management orientation, risk orientation, scientific orientation, extension contact, extension participation and mass media participation, respectively. Majority of the mango growers (64.17%) had small farms. Majority of the respondents (74.17%) possessed television sets, among them 55.83 per cent of farmers regularly viewed the news. Post-harvest losses at farm level were quantified, which accounted for about 8.44 per cent. Losses at wholesale market including transportation accounted for about 4.93 per

cent. Losses at retailing market, losses at storage unit and losses at consumer level accounted for about 5.46, 3.19 and 6.82 per cent respectively. Overall post-harvest losses in mango at different stages from harvesting to consumption were quantified which accounted for about 34.49 per cent. Majority (78.00%) of the respondents expressed the problems such as lack of knowledge on the post-harvest technologies, lack of storage facilities even for few days (65.00%), problem of market transportation (62.00%) and lack of technical guidance about post-harvest technologies (64.66%).

2.1.4. Factors affecting post harvest losses in fruits.

Arora and Raju (1991) analysed storage situation in Sao Paulo. They felt that State's storage capacity was adequate for the available produce. However, there was problem with regard to location, suitability, quality, ownership and use of storage units .

Saraswati (1996) studied the problems with regard to the production and marketing of the oranges in Himachal Pradesh. The post-harvest problems included shortage of packing materials (baskets) during the peak season, lack of cold storage facilities in the area, lack of timely availability of vehicles for transportation, higher transportation charges , and lack of all weather roads.

Murthy et al. (2007) presented in his study on marketing losses in Karnataka that is in the two major channels of marketing of banana var. Ney-poovan, viz. Wholesale and co-operative, the latter is a more efficient system in terms of both operation and price. The operational efficiency has been reflected by the reduced post-harvest losses (18 compared to 29%) due to strict procurement procedure, better transportation and handling and lower price-spread, higher efficiency index, increased producers share and lower consumer's price. The existing methods tend to overstate the farmers net price and marketing margins of intermediaries. In fact, the margin of the retailers after taking in to account the physical loss during retailing has been found to be negative (loss), which otherwise, was positive (profit) in the conventional estimation. Similarly, the producer's net share and wholesaler's margins also decrease substantially. It has been shown that marketing efficiency is inversely proportional to the marketing

losses. Marketing cost has been identified as the costs, particularly the commission charges as demonstrated in the co-operative channel, will help in reducing the price-spread and increasing the producer's margin. The need for specialized transport vehicles for perishable commodities has been highlighted .

Ashok and Maheswari (2008) analyzed the factors affecting the post harvest losses at farm level. To study the influence of different socio economic features of farmers on post harvest losses at farm level, a multiple linear regression model was estimated. The variables specified in the model explained 68 per cent variation in post harvest loss in banana at the farmers' level. Experience in farming and education had significant negative influence on post harvest loss. Inadequate labour availability and transport facilities increased the post harvest losses as the coefficient of these variables was positive and significant.

Davara and Patel (2009) assessed post-harvest losses (at field, trader, and processors level) in Gujarat and the effect of various ripening methods on post harvest losses in five varieties viz., Robusta, Grande Naine, Sona, Mahalaxmi and Shreemanthi were also determined. The study revealed that overall post harvest loss in banana after harvesting till ripening was found to be 15.43%, which included losses at field level (0.77%), at trader's level comprising of transportation and handling losses (5.86%) as well as ripening losses (8.80%). Only negligible losses were observed during processing of banana. The highest loss (16.00%) was observed in the case of smoking + room temperature method of ripening, while the lowest (4.66%) was observed under ethephon + air-cooled chamber method. Ethephon + ice treatment method resulted in ripening loss to loss to the tune of 7.43%, but the method was most widely adopted in Gujarat owing to its convenience and better appearance of banana after ripening.

Ramesh et al. (2013) conducted a study in Shimoga district on post-harvest losses in banana of Karnataka during 2012-13. The result indicated that there existed two major marketing channels viz., local market and distant market. The total PHL in the local market was 24.12 per cent consisting of field level loss (7.64%), transit loss (5.09%), ripening loss (4.95%) and retail level loss (6.44%). In the distant market, Bangalore the total PHL was observed to be 27.18 per cent the transit and ripening losses being higher (8.31 per cent and 6.11 per cent) than

the local market. Harvesting injury, small and immature fruits, canker, cracks, bird attack at field level; rotten fruits fungus formation and block layered fruits at the wholesale and retail levels were the major factors responsible for post-harvest losses. The economic loss was observed to be much less compared to physical PHL. The study indicated that the quantity of banana lost in shimoga district amounted to 39325 tonnes (24.12%) worth Rs. 42.88 crores .

Mitrannavar and Yeledalli (2014) conducted study in Karnataka state which aims at estimation of post-harvest losses in major fruits. The results of the study revealed that the overall loss at different stages was around 60.08 kg (13.09 %) in mango. The maximum loss was found to occur at the field level. The overall loss at different stages was around 392.66 kg (11 .08 %) in banana. The maximum loss was found to occur at the retail level. The overall loss at different stages was around 31.97 kg (9.06 %) in citrus. The maximum loss was found to occur at the field level. The overall loss at different stages was around 37.30 kg (12.64 %) in guava. The maximum loss was found to occur at the retail level. The overall loss at different stages was around 55.37 kg (14.60 %) in sapota. The maximum loss was found to occur at the retail level. It is observed from the analysis that the post-harvest losses in fruits accented from mechanical handling, packaging, storage and transportation (Gajanana, 2002). The policy measure need to be directed towards creating infrastructure conductive to transport of delicate fruits appropriate transport protocols adaptable for Indian fruits, develop inter-model transportation system with complementary roles between road railways network .

Sab et al. (2017) the research study was carried out in Dharwad and Belgaum districts of North Karnataka during the year 2013-14. Following the simple random sampling, 120 respondents were selected from six villages of two taluks. The data was elicited through personal interview method. The important findings of the study were; majority of the respondents possessed medium level of knowledge (72.50%) and adoption (68.33%) about improved cultivation practices of mango. Almost all the mango grower had grown Alphonso and Totapuri varieties. More than half the number of mango growers had followed the recommended spacing, irrigation for young gardens and applied different chemicals for the control of the mango hopper and the powdery mildew disease.

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Sachine et al. (2017) Fruits play a good role in nutritional security as well as generate high income to the growers. Pre-harvest factors have a great effect on postharvest quality of fruits. The combination of these factors includes genetic, environmental, cultural practices and physiological components. In this paper, we provide a review of studies on how pre-harvest factors influence the post quality of fruits. The influence of pre-harvest factors can be controlled by various cultural practices and high tech recent management practices. It was concluded by this study that understanding and managing pre-harvest factors properly will maintain the postharvest quality of fruits .

2.1.5. Studies related to constraints.

Kadam and Borse (1993) revealed that, the problems of banana growers in jalgaon district were; lack of cultural and marginal requirement of the crop in relation to variety of soil climate, problem of availability of rhizomes perishability of banana fruits, disease and pest control in the field and marketing of banana fruits.

Mishra et al.(2000) in their study on production and marketing of Banana in Gorakhpur district of utter Pradesh assessed that problems faced by the farmers in the production and marketing of banana had been the non-availability of suckers and the high costs of the seed suckers, the high costs of transportation, the lower ruling prices for the produce due to the non-availability of the supply of adequate

electric power during critical periods, and the non-availability of fertilizers and insecticides at reasonable prices had been faced by the farmers.

Gowda (2002) in his study on sustainable grape cultivation reported the important constraints in grape marketing as, no fixed price, low price lack of regulated markets, exploitation by middle men, lack of cold storage facility, no guidance on marketing aspects and lack of transportation facilities. Further, constraints perceived by them in availing credit were non availability of credit in time and inadequate quality of credit.

Mali et al. (2003) studied economics of production and marketing of banana in jalgaon district of Maharashtra. The study identified that high cost of transportation, non availability of sufficient credit by the institution in time, high price fluctuation, the problem of cheating in weighing of produce and lack of suitable grading of the produce according to quality as main problems in production and marketing.

Nagesh (2006) in his study on pomegranate in Bagalkot district of Karnataka reported the constraints faced by pomegranate growers as lack of storage facility, high incidence of pests and diseases, non-availability of skilled labour for pruning, expensiveness of pruning operation, costely chemicals and fertilizers and lack of processing units were the major constraint.

Manoj kumar et al. (2006) studied crop insurance scheme for banana in Wayanad district in Kerala and concluded that the majority of the farmers cultivating banana in Kerala had agriculture as their main source of income. The reason stated for non-enrolment in insurance was not lack of awareness or high premium rate but cumbersome administrative procedure and financial difficulty to pay premium at the pre-gestation stages of cultivation. Even the farmers who had adequate financial resources were reluctant to pay premium in bulk, out of their own sources. Linking of a credit facility with crop insurance programmed is found to be an inevitable condition for its success. The crop insurance scheme shall be made viable by spreading the risk horizontally by enrolling all the farmers in a locality in the scheme. The scheme should be attractive, credit-linked, and should have support facilities like a reinsurance package. Majority of farmers are not willing to leave banana cultivation in future even if it involves high risk. So a

package that covers a longer period (for example a three-year package) with a premium that considers the cost of cultivation for the period as a whole has to be thought of. This will help to bring down premium rates, by saving on cost of land preparation, especially in reclaimed lands.

Kumar et al. **(**2007) revealed that the majority of the orchards are having the problem of drought stress, poor canopy management, poor orchard and nutrient management, physiological disorder, viz., boron deficiencies, zinc deficiency and bronzing, disease like wilt, canker and insect pests like fruit fly, tea mosquito bug etc. It is required to adopt proper canopy and ground management practices, adequate nutrient application, good irrigation management, use of suitable rootstocks and controlling disorder.

Hiremath et al. (2007) revealed that the major constraints were broadly classified as economical, infrastructural, agro-climatic and technological aspects, about 60 to 90 per cent of the farmer responded in adoption of recommenced package of practices like selection of suitable cultivar, spacing and timely inter-cultivation, while the reverse is true in adoption of use of manures and recommended fertilizers, application of protective irrigation and timely and need based plant protection measures.

Raghavendra (2007) in his study on management practices of pineapple growers in Karnataka reported that constraints in production and marketing of pineapple crop found that cent per cent of the respondents were facing the problem of lack of regulated markets, whereas high majority of the farmers facing problem of low market price for their produce (97.50 %), followed by micronutrient deficiency in soil (92.50 %), lack of storage facility (88.12 %), lack of technical guidance (85.63 %), lack of processing units (80.00%), non availability and high labour change (70.63 %). Further less than sixty per cent of respondents expressed problems like exploitation by pre-harvest contractors and middle men (57.50 %) and non availability of required quantity of fertilizers in time (33.32 %). It is evident from the above reviews that most important problems faced by the respondents were lack of technical guidance, lack of transport facilities and wide price fluctuation.

Mishra et al. (2008) observed that lack adequate training facilities occupied the first rank (70.00 per cent) followed by costly technology (65.00 per cent), lack or technical advice (60.00 per cent), skeptical due to adverse effect of health (57.50 per cent) and lack of accessibility to produce technological inputs from market (57.75 per cent) for improved fruit preservation practices.

More et al. (2008) studied constraints faced by banana growers in production and marketing of banana and revealed that in production of banana 100 per cent of cultivation faced the constraints of Musa sercospora followed by 45 per cent faced the problem of high wages of labour while major constraints in marketing of banana was delayed payments (67.50%) followed by high commission of market intermediaries (55.00%).

Kathirvel (2008) analyzed the economics factors limiting to banana production with the help of Garrett Ranking Technique. High pointed out that credit inadequacy was the major problems (Rank 1) in the production of banana. High Fertilizer cost was the next important problem (Rank 2). The small size of farm holdings, the lack of technical guidance was the least important problems.

Muthupandi (2009) analyzed the production problems of banana growers by using Garret Ranking Technique and found that the severity of wind which was the major problem with a mean score of 61.64. Severity of disease is the next important problem with a mean score of 58.81. The third important problem faced by the growers was severity of rain which had a mean score of 45.18 Soil condition was the fourth problem which has a mean score of 35.63 .

Geetha and Meena (2010) have adopted factors analysis to find out the problems faced in the production of banana. They found that financial, environmental, farming natural and personal risk and spoilage factors were the important problem factors in the production of banana.

Ashok Kumar Bennur (2011) studied entrepreneurial qualities and adoption behavior of banana growers in Gulbarga district of North Karnataka and revealed that labour problem (94.17%), electricity problem (90.83%) and storage facility problem were the major constraints expressed by the banana growers. An equal proportion (52.50%) of the banana growers expressed training needs regarding disease control and marketing as most needed.

Deshmukh et al. (2013) studied constraints in Banana Marketing for Jahaon Region of Maharashtra and revealed that the banana marketing in Jalgaon and in the Maharashtra region and in the Maharashtra State in synonym of co-operative societies. They have completely dominant the market and have performed much superior also. Banana farmers are associated with the societies and also express satisfaction with their functioning and have preferred societies and also express satisfaction with their functioning and have preferred societies as their sell outlets. Banana societies are the first preference for taking loan by the farmers. Farmers have expressed their dissatisfaction with the Government initiatives regarding banana farming promotion. Societies are playing pivotal role in the banana marketing chain. They must be given statutory protection so that they can better do their jobs. Banana by-product making has lot of hidden potential which has not been utilized at the fullest extent yet now. Banana by-product making has scope to emerge as small scale enterprises in Jalgoan region. Government incentives can promote growth of this sector. Loan is a very important factor in banana marketing chain and Government authorities must make necessary arrangements for giving loans and nominal interest for banana farming.

Naveen B. (2013) conducted a study to assess the production and marketing of banana in Chikkaballapur district. The study revealed that the major constraints in production of banana were: inadequate irrigation water during summer season, incidence of viral disease, destruction of crop due to high wind velocity and erratic monsoon during the rainy season. In the marketing of banana, farmers were facing the problems such as markets being far away from farm, price fluctuation, lack of market information, high cost of transportation, too many markets intermediaries and delays in payment after sale.

Anap et al. (2014) in his study on constraints of Banana growers regarding production in Wardha district in Vidarbha region of Maharashtra state found that the constraints faced by majority of the respondents were non-availability of electricity in time, losses due to high temperature, fertilizer cost, labour efficiency and other constraints faced by Banana growers like lacunae in government policies, subsidies for the banana suckers.

Bennur et al. (2015) in his study conducted in Gulbarga district of Karnataka during 2010-11 revealed that most of the farmers (45.83%0 belonged to medium level of adoption of banana farming practices while 94.17, 91.67, 82.50 and 75.00 per cent had adopted variety, spacing, suckers type and FYM application practices respectively. The respondents indicated labour (94.17%) and electricity (90.83%) to be the most important problems faced by them. Around 75.00 per cent of the banana growers expressed the constraint of exploitation by middleman .

Chandrakar et al. (2015) examined constraints in Banana production and supply chain management of Banana in Raipur district of Chhattisgarh. It was found that, most of the respondent belonged to other backward caste; school educated and was having large size of land holding. They were mostly performed irrigated agriculture with an average area of 2.17 ha. Under Banana cultivation, overall on an average cropping intensity was observed to be 259.89 per cent. Consumption of Banana was found very low and farmers prefer to sold-out more than 99.08 per cent of their total produce in mostly through channel-I involving wholesaler. Charges were having highest share of marketing cost in both the channels of marketing. The producer receives same amount by selling of producer through both the channels of marketing. High temperature and problem of electricity, lack of improved varieties for Banana cultivation was found as most important constraint faced by the Banana growers. Similarly, lack of processing industry, storage, fluctuation of price and regulated marketing system was reported as most important constraint faced by the farmers during supply chain management of Banana .

Rajesh et al. (2015) in his study on resource use efficiency and constraints in production and marketing of tissue culture and propagated Banana in Utter Pradesh revealed that the value of coefficient of determination (R2) and returns to scale were 0.86 and 0.625 respectively for suckers propagated banana production while for tissue culture propagated banana, the value of coefficient of determination (R2) and returns to scale were found 0.46 and 0.37 respectively. Result also shows that technical, allocate and economic efficiencies were higher in case of sucker propagated banana compare to tissue culture banana. The technical, allocate and economic efficiency of sucker propagated banana were 79.40, 69.30

and 55.02 respectively. Similarly in case of tissue culture banana they were 75.80, 55.60 and 42.14 respectively. Non availability of labour in sufficient quantity at correct time was the major problem identified both in sucker and tissue culture banana production lack market for banana nearer (district market) to farm or village was major problem felt by the farmers, lack of regulated market, Non availability of proper storage facilities and lack of grading and packaging. High cost of planning materials was a severe problem in tissue culture banana. The fluctuation in the market prices, distant location of regulated markets and lack of grading and packaging of the produce were also some identified problems in the study area.

Anap et al. (2016) studied constraints of banana regarding production in Wardha district in Vidarbha region of Maharashtra state revealed that the constraints faced by majority of the respondents were non-availability of electricity in time, losses due to high temperature, fertilizer cost, labour efficiency and other constraints faced by banana growers like lacunae in government policies, subsidies for the banana suckers.

Pawar et al. (2016) in his study on constraints faced by banana growers in adoption of banana production technology in Nanded district of Marathwada region of Maharashtra state depicted that the majority of the banana growers faced the constraint of load shedding of electricity during irrigation followed by non-availability of suckers at the time of planning, high cost of wages for preparatory tillage operations, high cost of FYM or compost and chemical fertilizers and poor quality of suckers for planning. The data regarding suggestions to overcome the constraints faced by them in adoption of banana production technology revealed that the information regarding irrigation should be given at time by extension agencies followed by tissue cultured plants should be made available in sufficient quantities, government should provide NADEP and vermin composting unit and pesticide should be provided at low cost, message alerts through SMS about insect pests and its control measures should be given to farmers in time, god quality sucker should be provided to farmers in time and reducing the cost of fertilizers were the major suggestions.

Mohan and Prathapa (2017) this study aims to define the critical constraints in production and marketing of Papayain Kadapa district of Andhra Pradesh. The four villages of Pullampeta and Obulavaripalli mandals namely Bommavaram,Y.Kota, Pullampeta and Reddipalli were selected to collect the requiredinformation on constraints in production and marketing aspects of Papaya. The growers were classified as small (upto 2 acres.) and large (above 5 acres.) categories. The problem of disease/insect/pest in these fruit crop is felt by all farmers followed by high labour charges.

Priyanka Kumari et al. (2018) the study was conducted during 2017-18 entitled "post-harvest losses at different stages during marketing and constraints in banana cultivation in Vaishali district (Bihar)." A extended survey was conducted in Vaishali district and its major fruit markets to signify the entitled objective of post-harvest losses in banana. The total post-harvest losses in banana were found to be 2.90% of total farm produce. There were various sources of losses which include disease, inefficient harvesting techniques, transportation and loading, packing and packaging, as well erratic post-harvest techniques leading to major losses physically and economically. Total post-harvest loss was estimated 15 quintal/hectare quantitatively. Major constraints during the study was found to be high cost of fertilizer and less awareness about new technologies among different farm size group followed by a high transportation cost was the major marketing constraints.

CHAPTER-III
MATERIALS AND METHODS

The conceptual and analytical framework used in this study is presented in this chapter. Selection of the study area, method of selection of respondents, collection of data and the analytical framework are briefly discussed here.

3.1. Sampling procedure:

A multi-stage sampling design was adopted for the ultimate selection of fruit growing farmers. The zone was the first stage, district was the second stage, Blocks were the third stage and villages were the fourth stage. Households of farm categories, retailers and wholesalers were the ultimate stage (Appendix-A).

3.1.1. Selection of Zone:

Chhattisgarh state consists of three agro-climatic zones i.e. Chhattisgarh Plains, Northern hills, and Bastar Plateau. As Chhattisgarh plains with 1,33,087 ha. area under fruits contributing 50.89 percentage of total area of fruits in Chhattisgarh. Thus, Chhattisgarh plains were selected based on highest area of fruits in the state.

3.1.2. Selection of major fruit crops:

Major fruits will be selected purposively based on the contribution of the area under fruit in Chhattisgarh Plains. So, three major fruits i.e. mango, banana and papaya contributing area which is 29.78, 12.67, and 7.21 per cent to the total area of fruits in Chhattisgarh plains respectively.

3.1.3. Selection of districts:

Districts under Chhattisgarh plains are Raipur, Gariyaband, Baloda Bazar, Mahasamund, Dhamtari, Durg, Bemetra, Balood, Rajnandgaon, Kabirdham, Bilaspur, Mungeli, Korba, Janjgir and part of Kanker district (Narharpur & Kanker block) along with part of Raigarh district. Highest area under fruits lies under Bilaspur district. Bilaspur district have highest area under papaya, mango and banana contributing 20.40, 16.26 and 15.94 per cent to the total area under fruits in Chhattisgarh plains respectively. So, Bilaspur district will be selected for papaya, mango and banana crop in the study.(Figure 3.1).

3.1.4. Selection of blocks:

Bilaspur district has seven blocks i.e. Belha, Masturi, Takhatpur, Gaurela, Pendra, Marwahi and Kota. According to table number 3.1, the maximum area under mango, banana and papaya was found as 26.64, 17.96 and 13.48 per cent in mostely Belha and Takhatpur respectively, so, Masturi, Belha and Takhatpur blocks were selected parposively from Bilaspur district. In all, three blocks i.e. Masturi, Belha and Takhatpur from Bilaspur district were selected for the study.

3.1.5. Selection of villages:

Five villages were selected from each block. So, fifteen villages were selected from Masturi, Belha and Takhatpur blocks. In all, fifteen villages were selected for the study. Bareli, Deogaon, Hardi, Jewara, and Kukada were the villages of Masturi block, and Akaltari, Gidhauri, Birkoni, Lagra and Manikpur were the villages of Belha block, and Belsara, Belpan, Ghoghara, Khapri and Domanpur were the villages of Takhatpur block in Bilaspur district.

3.1.6. Selection of respondents:

Ten farmers were selected from each village. So, 150 farmers were selected from Bilaspur district. In all 150 farmers were interviewed for the study. For the estimation of post-harvest losses at different levels forty retailers and ten wholesalers were selected from district. In all, forty retailers and ten wholesalers were interviewed for the study.

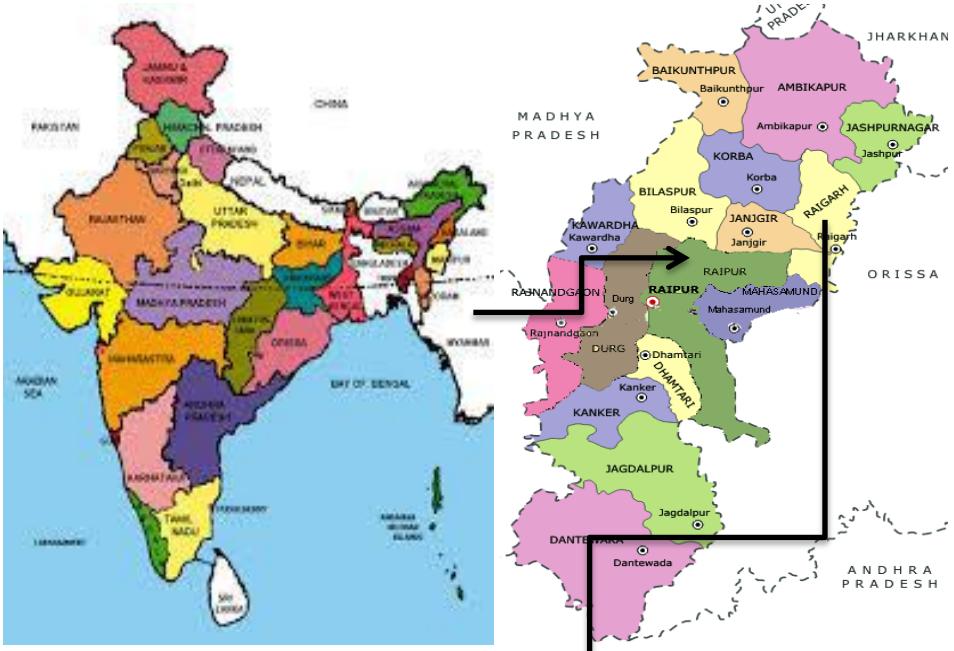
3.2 Method of enquiry and data collection:

3.2.1 Primary data:

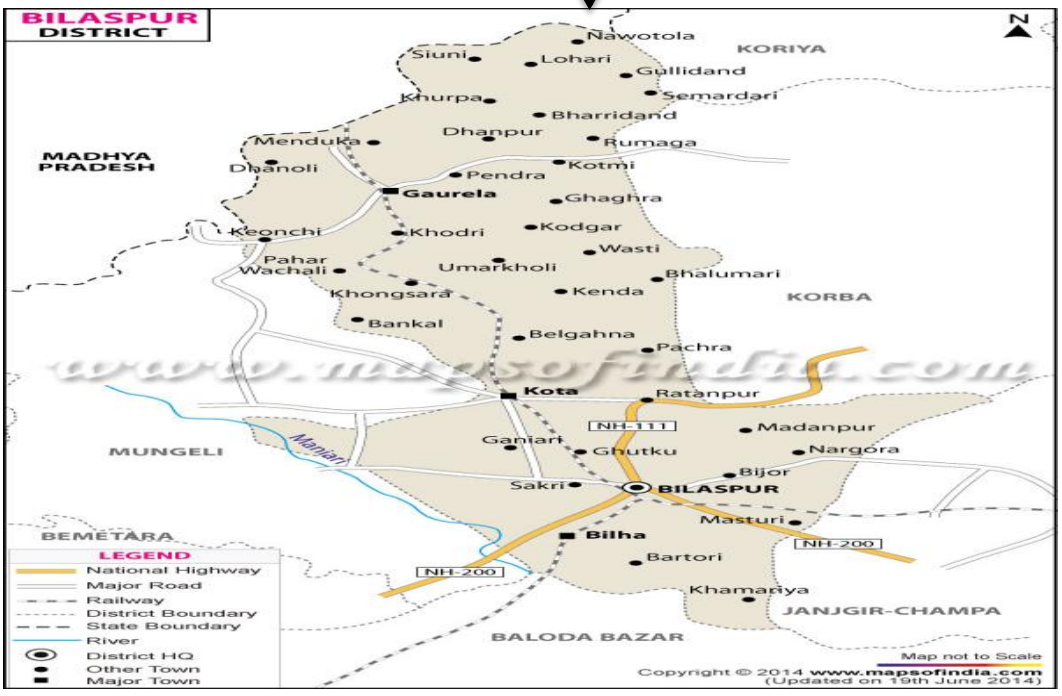
The primary data has been collected from the survey of sampled cultivators through personal interview with the help of pre-tested and structured schedules. The data collected from the farmer respondents included general information about the age, education, family size, total holding, cultivation of fruits, labour and input used for production, total production of crop, selling price, methods of harvesting, mode of packaging, storage system, mode of transportation and losses during post-harvest stages such as harvesting, transportation, storage and weather loses.

3.2.2 Secondary data:

The secondary data were collected from published sources and from various government offices and websites including the district statistical department and district.



Map- I: Map of India **Map- II: Map of Chhattisgarh**



Map-III: Map of Bilaspur district

Figure 3.1: Map of India, Chhattisgarh and Bilaspur district

Table 3.1: Block wise area of mango, banana and papaya in Bilaspur district

S.No.	Block	Area under Mango (ha.)	Area under Banana (ha.)	Area under Papaya (ha.)	Total area under Mango, Banana and Papaya
1	Belha	1284 (17.71)	542 (7.47)	393 (20.47)	2219 (17.96)
2	Masturi	1956 (26.99)	982 (13.55)	354 (18.44)	3292 (26.64)
3	Takhatpur	966 (13.32)	408 (5.62)	292 (15.21)	1666 (13.48)
4	Gaurela	841 (11.60)	348 (4.80)	255 (13.28)	1444 (11.68)
5	Pendra	774 (10.68)	321 (4.42)	237 (12.35)	1332 (10.78)
6	Marwahi	522 (7.20)	213 (2.93)	155 (8.07)	890 (7.20)
7	Kota	904 (12.47)	375 (5.17)	233 (12.14)	1512 (12.23)
	Total	**7247 (100.00)**	**3189 (100.00)**	**1919 (100.00)**	**12355 (100.00)**

Note: Figures in the parenthesis indicate the percentage to the total area
Source: Department of horticulture district Bilaspur (2017-18)

3.3 Analytical tools:

3.3.1. Growth rate:

Annual Compound growth rates in area, production and productivity of major fruits were estimated from 2007-08 to 2016-17 in the study area, all the agro-climatic zones and for Chhattisgarh state by fitting an exponential function of the following form.

$Y=AB^t$

Log y= log A+ t log B

Y= area/ production/ productivity

A= constant.

B= regression coefficient. t= time in year.

Compound growth rate = (Anti-log of B-1) 100

3.3.2. Cost of cultivation:

To work out the cost of cultivation standard Cost concept were used which includes cost A_1, cost A_2, cost B_1, cost B_2, cost C_1, cost C_2 and cost C_3.

Cost A_1: Consist of following items of costs:-

1. Value of hired human labour (permanent & casual)
2. Value of hired and owned bullock labour
3. Value of hired and owned machinery
4. Value of seed (both farm-produced and purchased)
5. Value of manure (produced on farm and purchased) and fertilizers
6. Value of insecticides and fungicides.
7. Irrigation charges
8. Land revenue and other taxes
9. Depreciation
10. Interest on the working capital.
11. Miscellaneous expenses (wages of artisans, and repairs to small farm implements)

Cost A_2 = Cost A_1+ rent paid for leased-in land.

Cost B_1 = Cost A_1+ interest on value of owned capital assets (excluding land)

Cost B_2 = Cost B_1+ rental value of owned land + rent paid for leased in land

Cost C_1 = Cost B_1+ imputed value of family labour.

Cost C_2 = Cost B_2+ imputed value of family labour.

Cost C_3 = Cost C_2+10 per cent of cost C_2 as managerial cost

- **Interest on working capital:**

  It was calculated @ 4% per annum for half of the crop period.

- **Interest on fixed capital:**

  It was calculated @ 10% per annum for the crop period.

- **Rental value of owned land:**

  It was calculated based on the prevailing rates in the sampling villages.

- **Depreciation:**

  It represents the value by which a farm resource decreased in value as a result of cause other than a change in general price of the item. Straight line method was used for calculating the depreciation:

$$\text{Depreciation} = \frac{\text{Purchase value of the asset - Junk value}}{\text{No. of useful years of life (expected life)}}$$

Input: output ratio:

It is ratio between input and output and computed by dividing value of total output by value of total input.

Input output ratio = O/I

Where,

I = Total input and
O = Total output

3.3.3 Post harvest losses:

Crop production undergoes a series of operations such as harvesting, drying, transportation, storage, whole selling and retailing before reaching the consumer, and there are sizable losses in crop output at all these stages. The data collected from the farmers included general information about the cultivation of food crops, methods of harvesting, storage system, mode of transportation and losses at farm level during post-harvest operations through enquiry method.

3.3.4. Factors affecting post harvest losses:

Functional analysis was carried out to examine the factors affecting post harvest losses at farm level in fruits. The following multiple linear regression function was used in the study.

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \ldots + a_9X_9 + e$$

Where,

Y: Post-harvest loss at farm level in quintals per hectare,

a_1: Area under crop

a_2: Age of the respondents in years,

a_3: Education of the respondents in years,

a_4: Production of crop in quintals per ha,

a_5: Distance of market from village.

a_6: Weather condition (dummy variable).

a_7: Timely labour availability (dummy variable).

a_8: Storage availability (dummy variable).

a_9: Transportation availability (dummy variable).

e: Random error.

3.4 General profile of the study area:

3.4.1 Situation of Bilaspur district

Bilaspur district is situated between 21'47 and 23'8 north latitudes and 81'14 and 83'15 east latitudes. The district is bounded by Korea on the north, Anuppur District and Dindori District of Madhya Pradesh state on the West, Kawardha on the southwest, Durg and Raipur on the south and Korba and Janjgir-Champa on the East. The area of the district is 5815.87 sq. k.m. The total population of the district is approx. 1,961,922. The major river of Bilaspur district is Arpa. The river originates in Khodri Khongsara of Pendra sub division and is the largest river in the district and is about 100 k.m.long. Other major rivers of the district are as Leelagar and Maniyari. Bilaspur had population of 1,961,922 of which male and female were 996,125 and 965797 respectively. Average literacy rate of Bilaspur was 65.89 per cent. Gender wise, male and female literacy were 81.54 and 59.71 respectively. Gender wise, male and female literacy stood at 78.22 and 53.41 per cent respectively. In total, 1,292,809 people were literate of which males and females were 776,977 and 515,832 respectively. With regards to sex ratio in Bilaspur, it stood at 970 per 1000 male. Out of the total Bilaspur population, 31.32 per cent lives in urban regions and 68.68 per cent population lives in rural regions of the district. In total 614,431 people lives in urban areas of which males are 288,782 and females are 325,649. The total Bilaspur district population living in rural areas is 1,347,491 of which males and females are 635,796 and 700,695 respectively.

3.4.2 Climate and Soil

The climate of Bilaspur district is sub-tropical, semi-arid, continental and monsoon type. Thus, it has hot summers, cool winters and small rainy season. The winter season starts towards the latter half of November and extends till about the middle of March followed by summer, which continues till about the end of June when maximum temperature reaches up to 45^{o}C and dust cyclones are

common. After it, southwest monsoon arrives. The rainy season remains between July to September. The post monsoon months October and November constitute a transitional period from monsoon to winter season. Annual rainfall of the district is about 58 .cm. Rainfall is unevenly distributed and decreases form south cast to Southwest. Rainy season starts from July to September. About 80% of the total rainfall is received during this period. Some amount of rainfall is received from western disturbances during winter season. Due to less rainfall and its short duration the agricultural activity is mostly dependent upon canal irrigation and tube wells. The soil in the study area reveals main soil categories, namely red gravely soil, red sandy soil, lateritic soil, red soil, yellow soil and black soil.

Table 3.2: Demographic features of Bilaspur district

S. No.	Particulars	Bilaspur district
1	Area (Km^2)	5815.87
2	Population	1961922 (100)
	a. SC Population	358222 (18.26)
	b. ST Population	425688 (21.70)
	c. Male	996125 (50.77)
	d. Female	965797 (49.23)
	e. Rural	1347491 (68.68)
	f. Urban	614431 (31.32)
	g. Literate population	1220337 (62.20)
3	% increase in population (10 years)	31.59
	a. Male	31.35
	b. Female	31.83
4	Population density	337
5	Sex ratio	970

Note: Figure in the parenthesis indicate percentage to total population
Source: District statistical book, Bilaspur (2015-16)

3.4.3. Distribution of land holdings in Bilaspur district:

The distribution of land holdings according to size, total cultivated area and average size of holding per farm falling under each category are presented in table 3.3. It is clear from the table that the concentration of marginal farmers is

more as compared to small, medium and large farmers, implying that the majority of land owners are marginal in the district. The largest number of holdings falls under marginal farm size category however; farmers in this category owned only a small proportion of the cultivated land. Number of land holdings decreases from marginal to large farmers on the other hand area under cultivation is showing an inverse trend. Due to this, few large farmers own larger part of cultivated land which results higher average size of holding in case of large farmers.

Table 3.3: Distribution of land holdings in Bilaspur district

S.No.	Size of holding	No. of holdings	Area of holdings (ha.)	Average size of holdings
1	Marginal (up to 1.00 ha.)	185791 (69.74)	74056.01 (29.19)	0.40
2	Small (1.00 - 2.00 ha.)	48464 (18.19)	67115.89 (26.45)	1.38
3	Medium (2.00 - 4.00 ha.)	23820 (8.94)	62448.90 (24.61)	2.62
4	Large (Above 4 ha.)	8313 (3.12)	50110.47 (19.75)	6.03
5	**Total**	**266388 (100)**	**253731.27 (100)**	**2.61**

Note: Figures in the parenthesis indicate percentage to total number of holdings and total area.
Source: District statistical book, Bilaspur (2015-16)

3.4.4. Land use pattern in Bilaspur district:

Land use pattern of Bilaspur district is portrayed in the table no 3.4. Total geographical area of the Bilaspur district is 5,81,849 ha, out of which net sown area is 40.01 per cent, gross sown area is 2,91,360 ha being 50.07 per cent to the total geographical area. Area under forest is 37.54 per cent to the total geographical area. Land not available for cultivation in the form of barren and uncultivable land and land to non-agricultural use is 1.79 and 5.35 per cent to the total geographical area respectively. Current fallows are 2.36 per cent and old fallows are 1.85 per cent to the total geographical area respectively.

Table: 3.4: Land use pattern of Bilaspur district

S.No.	Particulars	Area	Percentage
1	Total geographical area	581849	100.00
2	Area under forest	218436	37.54
3	Barren and uncultivable land	10390	1.79
4	Land put to non-agricultural use	31128	5.35
5	Cultivable barren land	16504	2.84
6	Permanent pasture and other grazing land	48037	8.26
7	Current fallow land	13742	2.36
8	Old fallow land (2 to 5 years)	10738	1.85
9	Net sown area	232816	40.01
10	Net sown more than once	58544	10.06
11	Gross sown area	291360	50.07

Source: Economic survey; directorate of economics and statistics Chhattisgarh 2015.

3.4.5. Sources of irrigation in Bilaspur district:

The different sources of irrigation in the Bilaspur district are shown in table 3.5. The table clearly point out that the maximum area is irrigated by canal (64,841ha.) which is 60.81 per cent of the total irrigation in the Bilaspur district followed by Tube well (34,855 ha.) which contributes 32.69 per cent to the total irrigation in the district. Ponds and wells are contributing 3.79 per cent and 2.49 per cent respectively in Bilaspur district. Contribution of other sources is very limited with 0.22 per cent to the total area under irrigation. The total irrigated area is only 10,6,625 ha.

Table 3.5: Source-wise irrigated area in Bilaspur district.

S. No.	Source of irrigation	Area (ha.)	Percentage
1	Tube well	34855	32.69
2	Canal	64841	60.81
3	Wells	2659	2.49
4	Ponds	4038	3.79
5	Others	232	0.22
	Total	**106625**	**100.00**

Source: District statistical book, Bilaspur (2015-16).

3.4.6. Area, production and productivity of different fruits in Bilaspur district:

Table 3.6 presents the area, production and productivity under different fruits in the district. Mango occupies largest area under fruits followed by banana, guava

and papaya. In production, papaya occupies maximum share among all the fruits followed by banana and mango.

Table 3.6: Area, production and productivity of different fruits in Bilaspur district.

S.No.	Crop	Area (hectare)	Production (Metric Tonnes)	Productivity (qu./ha.)
1	Mango	6447	21401	331.95
2	Banana	2689	48311	1796.61
3	Papaya	1959	48316	2466.36
4	Guava	2549	18502	725.5
5	Lemon	1923	12704	660.63
6	Orange	5	17	340
7	Jack Fruit	1593	23068	1448.08
8	S. Orange	7	6	85.71
9	Cashew Nut	0	0	0.00
10	Custard Apple	1814	4401	242.61
11	Litchi	10	13	130
12	Water Melon	12	44	366.66
13	Musk Melon	37	66	178.37
14	Ber	29	88	303.44
15	Aonla	74	192	259.45
16	Sapota	0	0	0.00
17	Pome Granate	0	0	0.00
18	Grape	0	0	0.00
19	Coconut	39	70	179.48
20	Pear	0	0	0.00
21	Others	7502	38663	515.36
	Total	**26,989**	**21,5,862**	**799.81**

Source: Department of Horticulture, Bilaspur (2017-18)

CHAPTER-IV
RESULTS AND DISCUSSION

The present chapter deals with the results and discussion of various objectives of the study. The chapter is arranged in different sub-sections according to objectives of the study. The demographic features of the sampled households and growth rate in major fruits in terms of area, production and productivity is described in sub-section 4.1 and 4.2 respectively. Section 4.3 discusses about cost and returns in cultivation of major fruits. Post harvest losses of major fruits and factors affecting them are discussed section 4.4. Last sub section of the chapter i.e. section 4 .5 discusses about the constraints faced by the farmers in post harvest management of major fruits under study.

4.1 Demographic features of sampled farmers

4.1.1 General characteristics of the sampled households in Bilaspur district:

The general characteristics of sample households are present in table 4.1 and figures 4.1, 4.2, 4.3, 4.4. Represents the general characteristics of farm family's size and level of education at the sampled farms. The table reveals that the average number of family members of major fruit growers is observed as 20.09. This number is estimated as 5.46, 5.00, and 5.23 at small, medium and large farms respectively. The overall male-female ratio is 60.30:39.69 per cent in the total population. It is observed that 30.09 per cent of the total sampled populations have middle level of education while these figures are 23.72 per cent and 7.16 per cent for high school and graduate level of education.

The table also reveals the caste and occupation pattern at the sampled farms. It is also observed that on an average 27.59 per cent of the sampled families belong to scheduled caste, 37.24 per cent belong to other backward class, 23.44 per cent belong to scheduled tribe and 11.72 per cent belong to general category. The occupation of farmers is also presented in the table . The table shows that 37.58 per cent farmers of total family members are involved in farming. The percentage of members involved in farming as the main occupation in small, medium and large categories of farmers is estimated at about 43.97, 44.93, and 48.67 per cent respectively. The Business in small, medium and large categories

of farmers is estimated at about 11.34, 13.92, and 17.46 per cent respectively.

Table 4.1 General characteristics of sample households

S. No.	Particulars	Small	Medium	Large	Aggregate
1.	**Total no. of households**	**37**	**51**	**62**	**150**
2.	No. of family member				
	Male	121	152	198	471
		(59.90)	(59.60)	(61.11)	(60.30)
	Female	81	103	126	310
		(40.09)	(40.39)	(38.88)	(39.69)
	Total	202	255	324	781
		(100.00)	(100.00)	(100.00)	(100)
3.	Average family size	5.46	5.00	5.23	5.21
4.	**Age groups (years)**	**Small**	**Medium**	**Large**	**Aggregate**
	a. Below 15 years				
	i Male	12	16	23	51
		(]5.94)	(6.27)	(7.10)	(6.53)
	ii Female	11	19	32	62
		(5.45)	(7.45)	(9.88)	(7.94)
	b. 15-60 years				
	i Male	41	47	54	142
		(20.30)	(18.43)	(16.67)	(18.18)
	ii Female	33	30	48	111
		(16.33)	(14.85)	(23.76)	(54.95)
	c. Above 60 years				
	i Male	20	13	7	40
		(9.90)	(5.10)	(2.16)	(5.12)
	ii Female	33	30	48	111
		(16.34)	(11.76)	(14.81)	(14.21)
5.	**Education level**	**Small**	**Medium**	**Large**	**Aggregate**
i.	Illiterate	49	33	21	103
		(16.17)	(16.17)	(17.35)	(16.40)
ii.	Middle school	93	59	34	189
		(30.69)	(28.92)	(28.09)	(30.09)
iii.	Higher secondary	54	61	29	149
		(17.82)	(29.90)	(23.96)	(23.72)
		19	18	23	45
iv.	Graduate/post Graduate	(6.27)	(8.82)	(19.00)	(7.16)
	Total	**303**	**204**	**121**	**628**
6.	**Social groups**	**Small**	**Medium**	**Large**	**Aggregate**
	a.Other backward caste	28	17	9	54

S. No.	Particulars	Small	Medium	Large	Aggregate
		(38.36)	(36.17)	(36.00)	(37.24)
	b.Schedule tribe	18	10	6	34
		(24.65)	(21.27)	(24.00)	(23.44)
	c.Schedule caste	19	14	7	40
		(26.03)	(29.78)	(28.00)	(27.59)
	d.General	8	6	3	17
		(10.96)	(12.77)	(12.00)	(11.72)
	Total	**73**	**47**	**25**	**145**
		(100)	**(100)**	**(100)**	**(100)**
7.	**Occupation**	**Small**	**Medium**	**Large**	**Aggregate**
		62	71	92	225
	a.Agriculture	(43.97)	(44.93)	(48.67)	(37.58)
		42	37	23	102
	b.Agricultural worker	(29.78)	(23.41)	(12.16)	(20.90)
	c.Govt. & private service	21	28	41	90
		(14.89)	(17.72)	(21.69	(18.44)
		16	22	33	71
	d.Business	(11.34)	(13.92)	(17.46)	(14.54)
	Working members	141	158	189	488

Note 1: Figures in the parenthesis indicate percentage to the total number of family members.
Note 2: Figures in the parenthesis represent percentage to the total number of samples .

Fig.4.1: Caste wise classification in sampled households (in percentage)

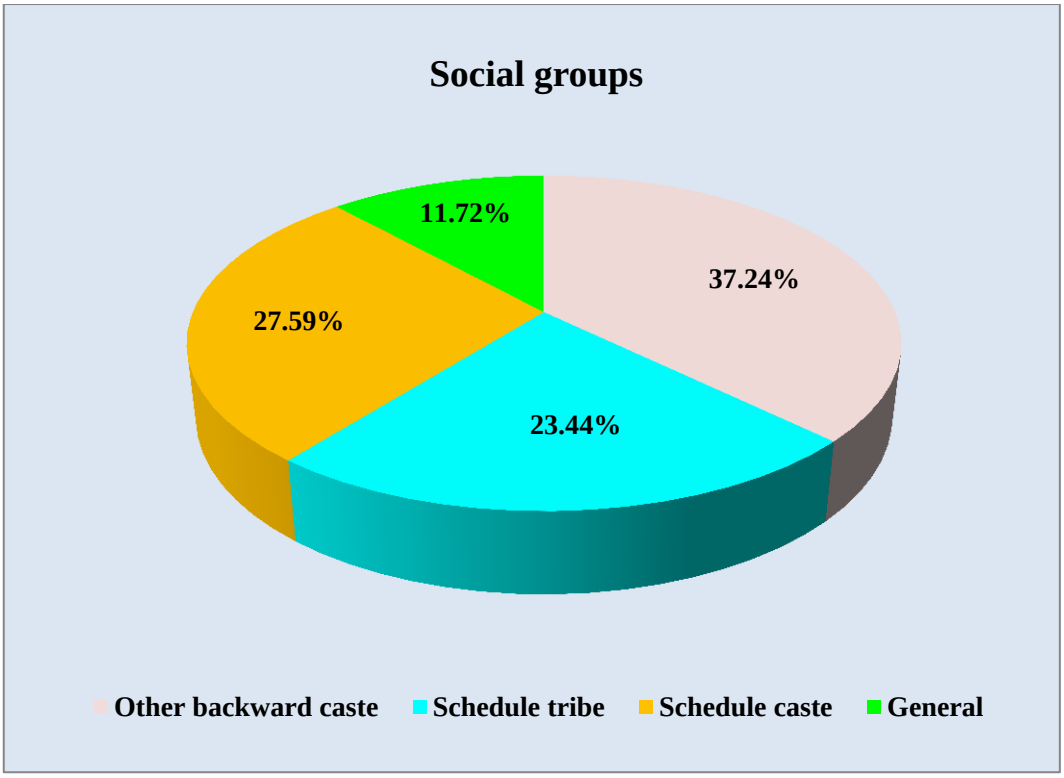


Fig. 4.2: Age groups in sampled households (in percentage)

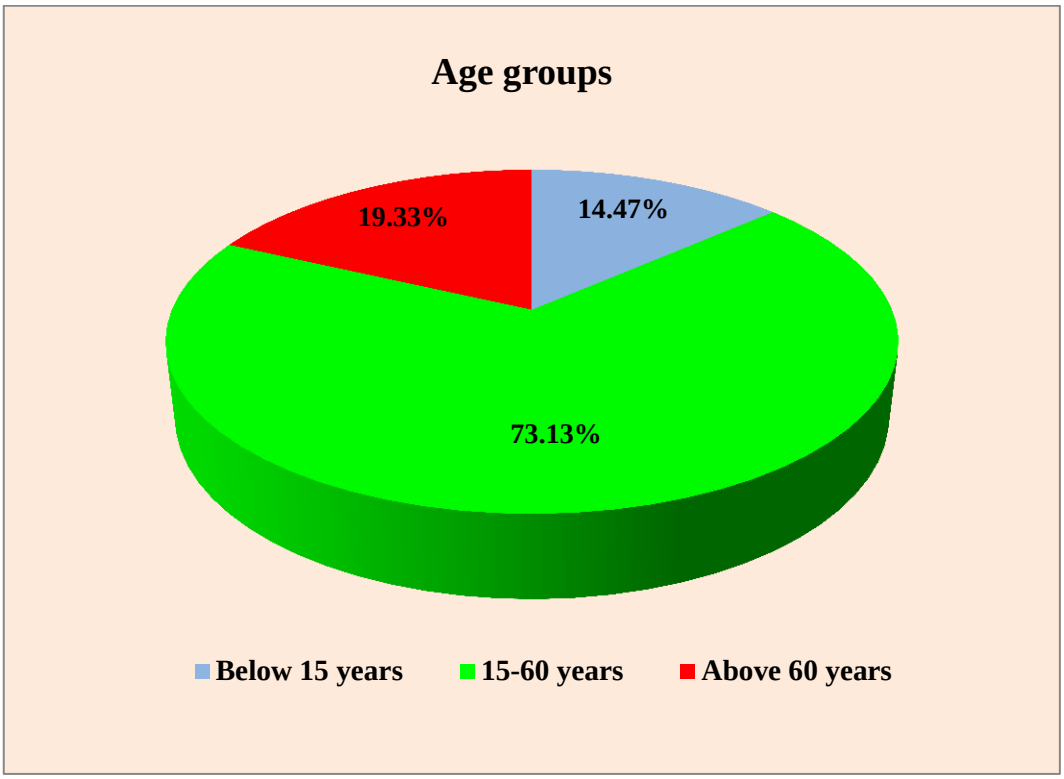


Fig. 4.3: Average family member in sampled households

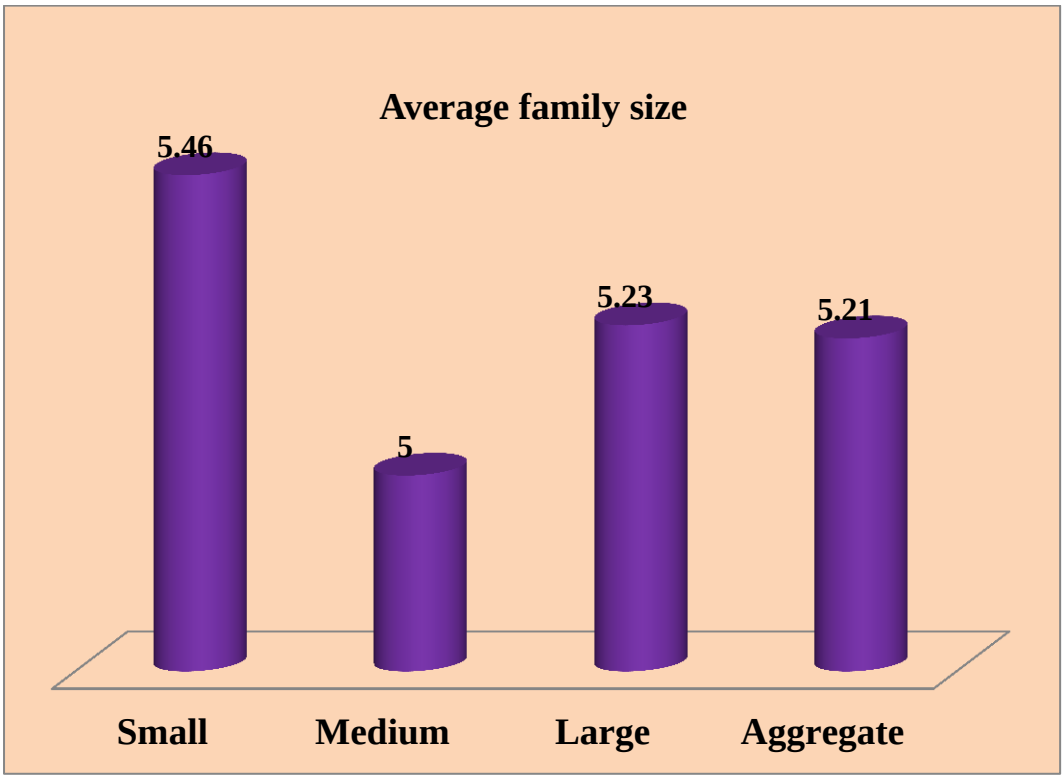
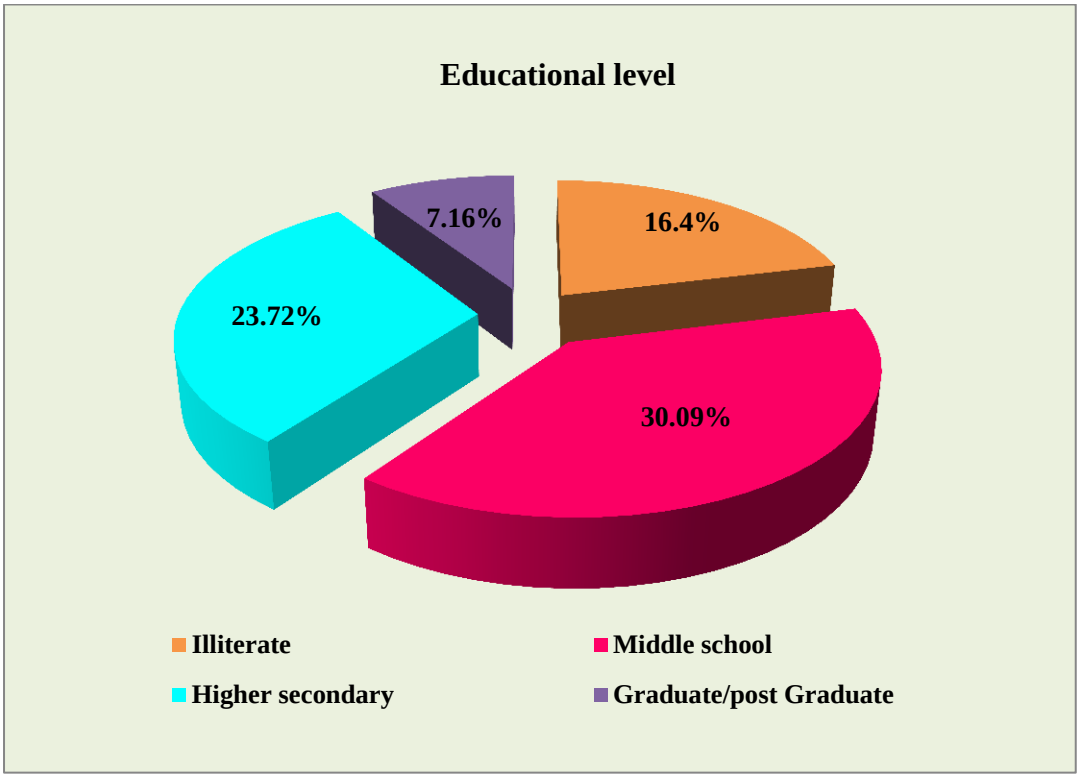


Fig. 4.4: Educational level in sampled households



4.1.2 Land use pattern of sample farmer

Size of holding and irrigated area at sampled farms is presented in table 4 .2 and figure 4.5. The per farm total cultivated area is observed to be during kharif season at 0.99, 1.85, 3.25 and 7.29 hectare at small, medium and large farms, respectively overall 4.57 hectare area is under cultivation. The overall irrigated area is 86.87 per cent to the total cultivated land. The percentage of irrigated area varied from 79.45 per cent at small farms, 84.61 per cent at medium farms, 88.75 per cent at large farms. The overall allocation of area under fruits was found to be 26.47 per cent of the total cultivated area. Which was noticed to be 27.56, 28.61 and 25.65 per cent area of fruits at small, medium and large farms respectively.

Table 4.2 Size of land use pattern at sampled of farms

(ha./farm)

S. No.	Particulars	Small	Medium	Large	Overall
1.	**Total cultivated area**	**1.85**	**3.25**	**7.29**	**4.57**
		(100)	**(100)**	**(100)**	**(100)**
2.	Area under cultivation	1.85	3.25	7.29	4.57
		(100)	(100)	(100)	(100)
3.	Irrigated area	1.47	2.75	6.47	3.97
		(79.45)	(84.61)	(88.75)	(86.87)
4.	Un-irrigated area	0.38	0.50	0.82	0.60
		(20.54)	(15.38)	(11.24)	(13.29)
5.	**Area under fruits**	**0.51**	**0.93**	**1.87**	**1.21**
		(27.56)	**(28.61)**	**(25.65)**	**(26.47)**

Note: Figures in the parentheses indicate the percentages to the total cultivated area.

4.1.3 Source of irrigation

Category wise area under various sources of irrigation is presented in table 4.3 and figure 4.6. Table shows that tube well and canals are the main sources of irrigation as 88.47 per cent of the area is irrigated by these two sources in the sampled farms. These figures are clear indication that farmers of this region are very cautious about the irrigation in agriculture . Remaining area is covered by wells as another source of irrigation in the district. On an overall tube wells contributed 55.57 per cent area under irrigation which was highest at 56.51 per cent at large farms and small, medium farms 47.02, and 57.23 farms respectively.

Table 4.3 Source wise irrigated area at sampled farms

(ha./farm)

S. No	Source	Small	Medium	Large	Overall
1	Tube well	0.87	1.86	4.12	2.54
		(47.02)	(57.23)	(56.51)	(55.57)
2	Canal	0.45	0.97	2.33	1.36
		(24.32)	(29.84)	(31.96)	(29.75)
3	Pond	0.17	0.00	0.00	0.04
		(9.18)	(0.00)	(0.00)	(0.87)
4	Stop dam	0.36	0.42	0.84	0.57
		(19.45)	(12.92)	(11.52)	(12.47)
	Total	**1.85**	**3.25**	**7.29**	**4.57**
		(100)	**(100)**	**(100)**	**(100)**

Note: Figures in the parenthesis indicate the percentage to total irrigated area.

Fig. 4.5: Total cultivable area and area under fruits in sampled households (in hectare)

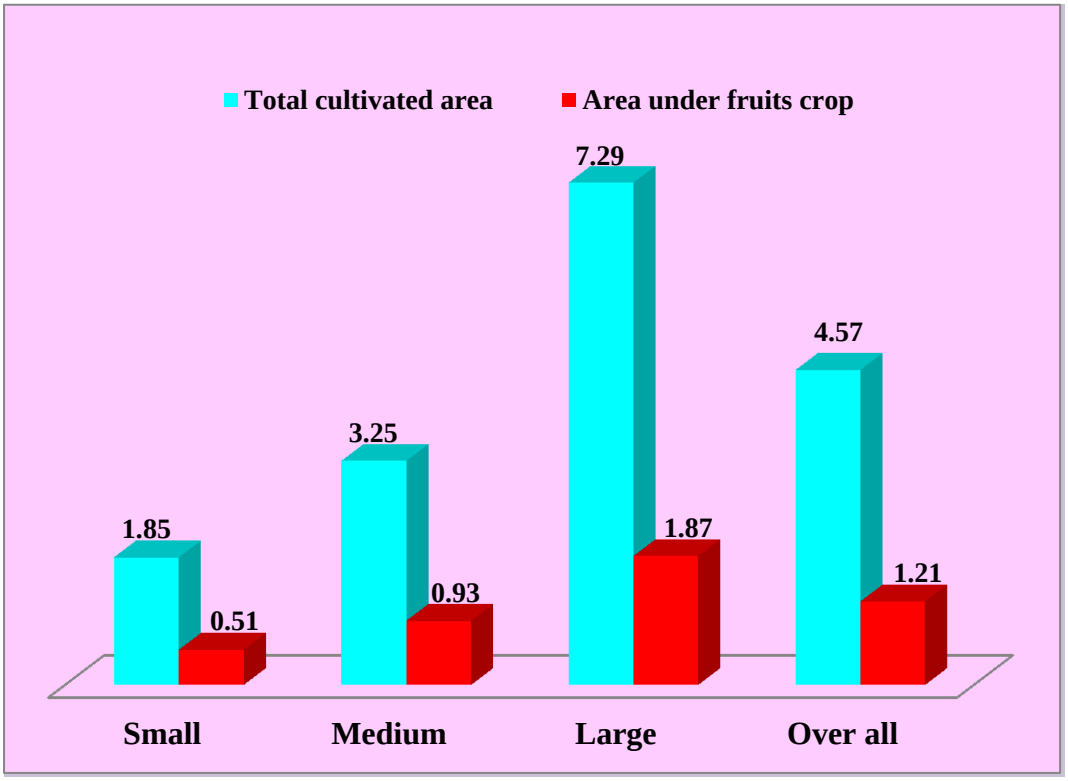
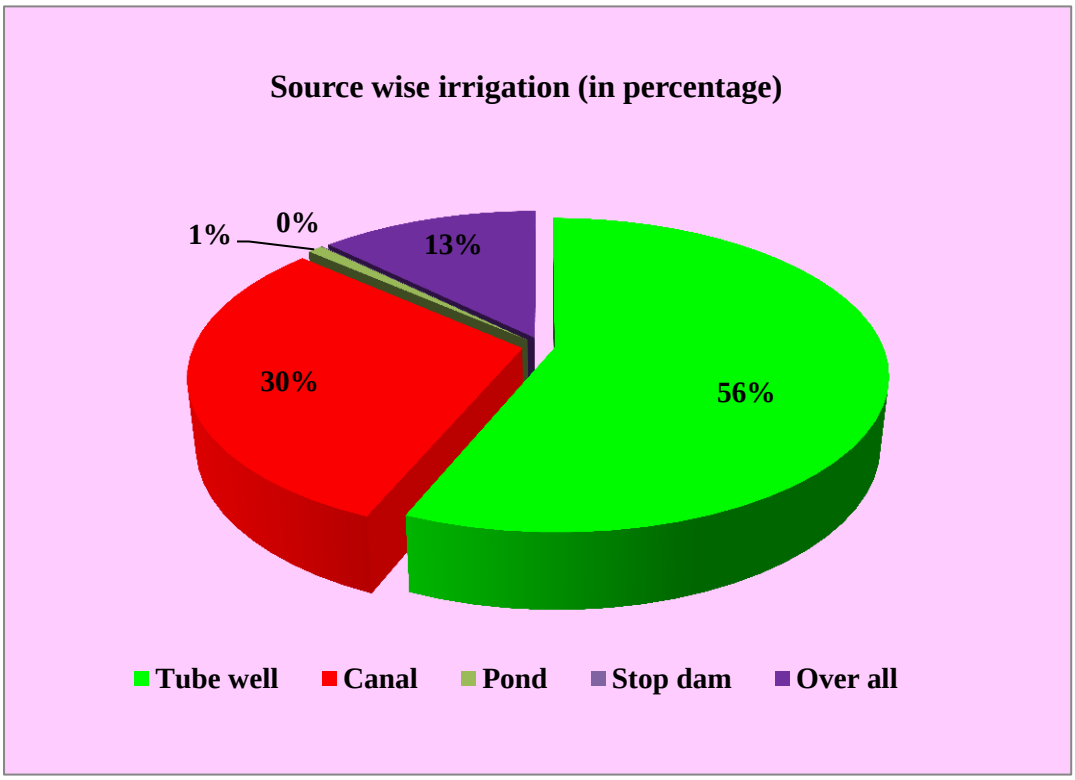


Fig. 4.6: Source wise irrigation percentage in sampled farms. (in percentage)



4.1.4 Cropping pattern

The cropping pattern and cropping intensity represent the diversity of crop grown and it computed on per farm area under crops which is presented in table 4.4. and figure. 4.7, 4.8, 4.9. It may be seen that the total cropped area is observed to be 1.85, 3.25, 7.29 and 4.57 hectare at small, medium large farms and overall farms respectively. The area under different crops in kharif season is observed to be 39.95, 36.33, 38.83 and 39.02 per cent at small, medium, large and overall farms respectively. It is evident that with 14.36 per cent (1.38 hectare) area was under rice and it is the principal crop followed by papaya at 6.24 per cent (0.60 hectare) area for the sampled farms in kharif season. The area under different crops in rabi season accounted 39.64 per cent area at overall farm. The overall cropping intensity was 210.28 per cent at sampled household. It is concluded that the cropping intensity of small, medium and large farm is 231.35, 263.38, 178.73 and 334.80 per cent respectively.

Table 4.4: Cropping pattern followed by sampled farmers

(ha./farm)

S. No.	Particulars	Small	Medium	Large	Overall
1	**Kharif**				
	Rice	0.52	1.21	2.05	1 .38
		(12.14)	(14.13)	(15.69)	(14.36)
	Tomato	0.22	0.21	0.41	0.29
		(5.14)	(2.45)	(3.14)	(3.01)
	Papaya	0.22	0.44	0.96	0.60
		(5.14)	(5.14)	(7.36)	(6.24)
	Brinjal	0.09	0.11	0.39	0.22
		(0.21)	(1.28)	(2.99)	(2.28)
	Banana	0.18	0.32	0.57	0.38
		(4.20)	(3.73)	(4.37)	(3.95)
	Chilli	0.11	0.09	0.16	0.12
		(2.57)	(1.05)	(1.22)	(1.24)
	Pigeon pea	0.11	0.14	0.31	0.20
		(2.57)	(1.63)	(2.37)	(2.08)
	Soybean	0.15	0.32	0.41	0.31
		(3.50)	(3.73)	(3.14)	(3.00)
	Mango	0.11	0.27	0.34	0.25
		(2.57)	(3.15)	(2.60)	(2.60)
	Sub total	**1.71**	**3.11**	**5.06**	**3.75**
		(39.95)	**(36.33)**	**(38.83)**	**(39.02)**
2	**Rabi**				
	Chickpea	0.83	2.00	2.11	1.75

S. No.	Particulars	Small	Medium	Large	Overall
		(19.39)	(23.36)	(16.19)	(18.21)
	Wheat	0.19	0.32	0.31	0.28
		(4.43)	(3.73)	(2.37)	(2.91)
	Papaya	0.21	0.41	0.85	0.54
		(5.21)	(4.78)	(6.52)	(5.61)
	Vegetables	0.26	0.39	0.47	0.39
		(4.90)	(4.55)	(6.60)	(4.05)
	Banana	0.19	0.35	0.41	0.33
		(4.43)	(4.08)	(6.14)	(3.43)
	Pigeon pea	0.18	0.32	0.33	0.28
		(4.20)	(3.73)	(2.53)	(3.58)
	Mango	0.11	0.27	0.31	0.24
		(2.57)	(3.15)	(2.37)	(2.91)
	Sub total	**1.97**	**4.06**	**4.79**	**3.81**
		(37.23)	**(47.42)**	**(36.76)**	**(39.64)**
3	**Summer**				
	Vegetables	0.10	0.41	1.62	0.83
		(2.33)	(4.78)	(12.43)	(8.63)
	Papaya	0.21	0.39	0.92	0.56
		(4.90)	(4.55)	(7.06)	(5.82)
	Banana	0.18	0.34	0.61	0.41
		(4.20)	(3.97)	(4.68)	(4.26)
	Mango	0.11	0.27	0.30	0.24
		2.57	(3.15)	(2.30)	(2.49)
	Sub total	**0.60**	**1.41**	**3.45**	**2.05**
		(14.01)	**(16.47)**	**(26.47)**	**(21.33)**
	Grass Cropped area	**4.28**	**8.56**	**13.03**	**9.61**
		(100)	**(100)**	**(100)**	**(100)**
	Net Cultivated Area	**1.85**	**3.25**	**7.29**	**4.57**
	Cropping intensity	231.35	263.38	178.73	210.28

Note: Figures in the parenthesis indicate the percentages to the total cropped area

Fig. 4.7: Crop wise area (kharif season) in sampled households (in percentage)

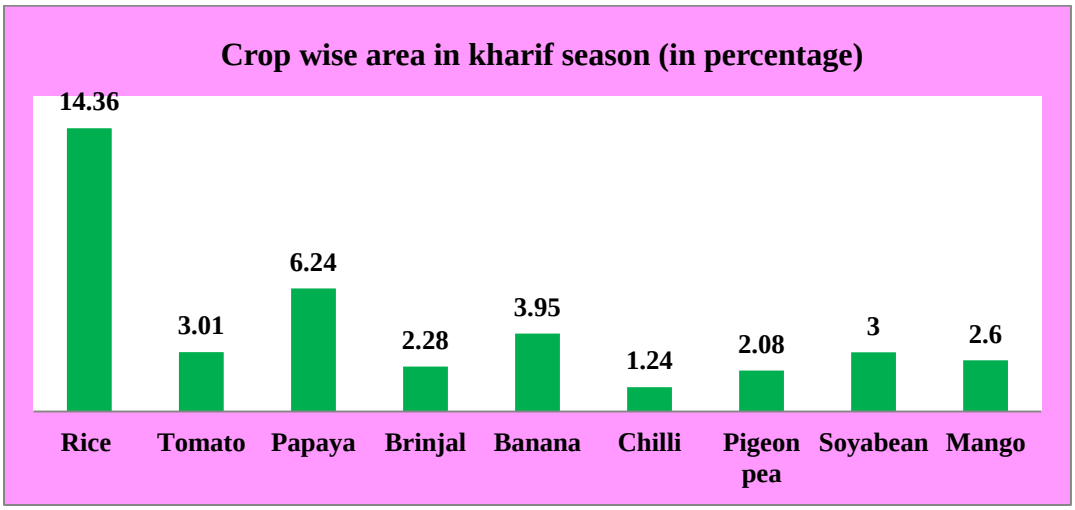


Fig.4.8: Crop wise area (rabi season) in sampled households (in percentage)

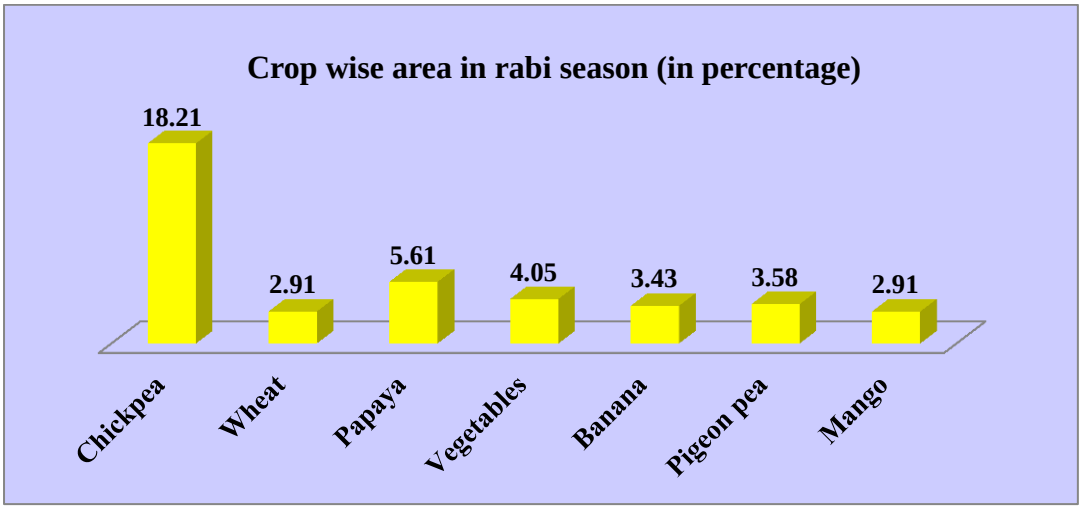
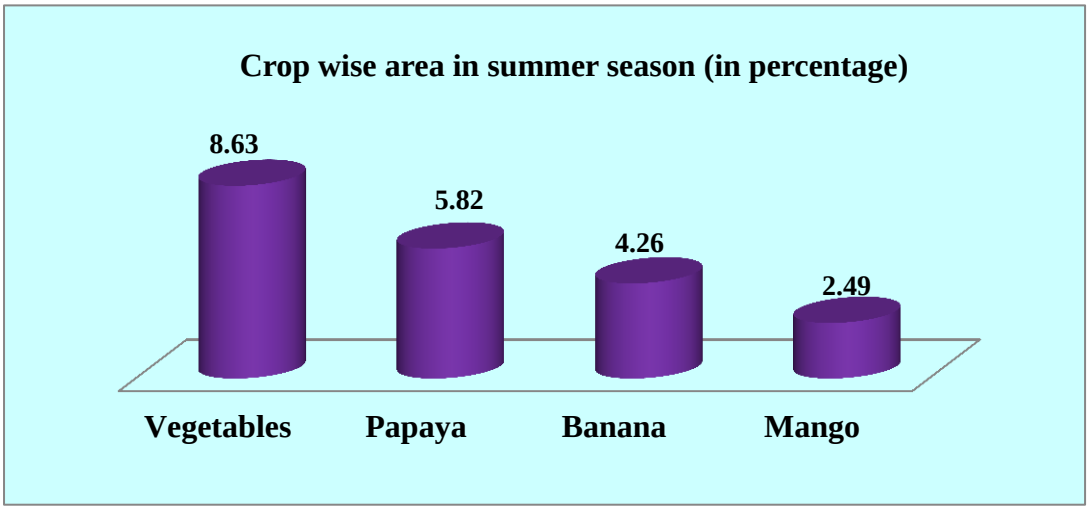


Fig.4.9: Crop wise area (summer season) in sampled households (in percentage)



4.2 Compound growth rates in area, production and productivity of major fruits

The development and growth in area, production and productivity of major fruits is presented by present status trend and growth in area, production and productivity of major fruits with consideration of secondary data from 2007-08 to 2016-17 and it is presented in fallowing sub section:

4.2.1 Status of papaya:

The present status of papaya in depicted by district and Chhattisgarh as a whole through tabulation of area, production and productivity for the year 2016-17 which is given in table 4.5 it reveal that total area under and production of papaya cultivation in Chhattisgarh state is observed as 14408 hectare and 380445 metric tonnes.

Table 4.5: Area, production and productivity of papaya in Chhattisgarh state (2016-17)

District	Area	Production	Productivity
Raipur	1156	46818	40.05
	(8.02)	(12.30)	
Balodabazar	972	21839	22.46
	(6.74)	(5.74)	
Gariyaband	0	0	0.00
	(0.00)	(0.00)	
Mahasamund	1815	4684	25.80
	(12.59)	(12.31)	
Dhamtari	450	3744	8.32
	(3.12)	(0.98)	
Durg	1300	51400	39.53
	(9.02)	(13.51)	
Balod	177	7104	40.13
	(1.22)	(1.86)	
Bemetara	655	26335	40.20
	(4.54)	(6.92)	
Rajnandagoan	355	6568	18.50
	(2.64)	(1.72)	
Kabirdham	270	3259	12.07
	(1.87)	(0.85)	

District	Area	Production	Productivity
Jagdalpur	100	2518	25.18
	(0.69)	(0.66)	
Kondagoan	353	8507	24.09
	(2.45)	(2.23)	
Kanker	210	3385	16.11
	(1.45)	(0.88)	
Dantewada	44	1084	24.63
	(0.30)	(0.28)	
Sukma	30	300	10.00
	(0.20)	(0.07)	
Bilaspur	1889	46590	24.66
	(13.11)	(12.24)	
Mungeli	500	13816	27.63
	(3.47)	(3.63)	
Janjgeer	758	17358	22.89
	(5.26)	(4.56)	
Korba	102	3488	34.19
	(0.70)	(0.91)	
Raigarh	354	12213	34.05
	(2.45)	(3.21)	
Jaspur	110	2585	23.05
	(0.76)	(0.67)	
Surguja	600	8855	14.75
	(4.16)	(2.32)	
Balrampur	988	18771	18.99
	(6.85)	(4.93)	
Koriya	600	14625	24.37
	(1.16)	(3.84)	
Narayanpur	201	6030	30.00
	(1.39)	(1.58)	
Bijapur	165	660	4.00
	(1.14)	(0.17)	
Surajpur	254	5752	22.64
	(1.76)	(1.51)	
Total	**14408**	**380445**	
	(100.00)	**(100.00)**	

Source: Directorate of Horticulture, Chhattisgarh

Note: Figures in the parenthesis indicate the percentage area of papaya.

Bilaspur, Mahasamund and Raipur district are major papaya growing districts which are jointly contributing more than 36.69 per cent area to total area and 36.85 per cent production of papaya in the Chhattisgarh state. The area under papaya cultivation in these three districts is observed as 1889 hectare, 1815 hectare and 1156 hectare area respectively of total area of the state. Similarly, the production of these three districts is estimated at 98092 metric tonnes of the total production in the state. Durg is the highest papaya producing district of Chhattisgarh however it is due to large area under papaya cultivation.

4.2.2. Trend in Area, production and productivity of papaya in Bilaspur district and Chhattisgarh state

The trend in area, production and productivity of papaya was estimated by computing linear equation for the period of 2007-08 to 2016-17 and which is presented in table 4.6, figure 4.10, 4.11, 4.12, 4.13, 4.14 and 4.15. The area of papaya increased from 1602 ha. in 2007-08 to 1889 ha. in 2016-17 showing a tremendous increasing in the area of papaya, the production of papaya also increased from 32144 metric tonnes in 2007-08 to 46590 metric tonnes in 2016-17. The productivity of papaya varied from 20.06 to 24.66 tonnes per hectare during this period. The improvement in productivity was due to new improved variety of papaya, availability and inputs in the study area.

4.2.3 Compound growth rate in area, production and productivity of papaya

The compound growth rate was computed on the basis of 10 years secondary data of area, production and productivity of papaya (2007- 08 to 2016-17). It is presented in growth in area of papaya in Bilaspur district was found 1.26 per cent which were significant at 1 per cent, production and productivity of papaya in Bilaspur district was found 5.08 and 3.77 per cent respectively which were significant at 5 per cent probability level of distribution. It can be inferred from the result that significance increased in growth of production was due to significance increase in area and productivity of papaya.

The growth in production of papaya in Chhattisgarh state was found in 10.40 per cent which was attributed by significantly increase in area by 10.57 per cent only write growth in productivity was found to be negative and non-significant.

Table 4.6: Area, production and productivity of papaya in Bilaspur district and Chhattisgarh state

		Bilaspur district			Chhattisgarh state		
S.No.	Years	Area (inha.)	Production (mt)	Productivity (t/ha.)	Area (in ha.)	Production (mt)	Productivity (t/ha.)
1	2007-08	1602	32144	20.06	7409	136077	18.37
2	2008-09	1750	32147.5	18.37	8063	148117	18.37
3	2009-10	1785	32243.94	18.06	3341	211734	63.37
4	2010-11	1785	40341	22.60	10597.3	247051	23.31
5	2011-12	1578	43480.5	27.55	11042.8	268308	24.30
6	2012-13	1626	44133	27.14	11884	289886	24.39
7	2013-14	1785	44195	24.76	11459	286844	25.03
8	2014-15	1810	47885	26.46	12410	245788	19.81
9	2015-16	1875	46410	24.75	13722	341932	24.91
10	2016-17	1889	46590	24.66	14408	380445	26.40

Table 4.7: Compound growth rate of area, production and productivity of papaya in Bilaspur district and Chhattisgarh state

		Compound growth rate (2007-08 to 2016-17)	
S.No.	Particular	Bilaspur district	Chhattisgarh state
A	Area	1.26*	10.57*
B	Production	5.08**	10.40*
C	Productivity	3.77**	-0.12

Note: *significant in 1% level of probability, **significant in 5% level of probability

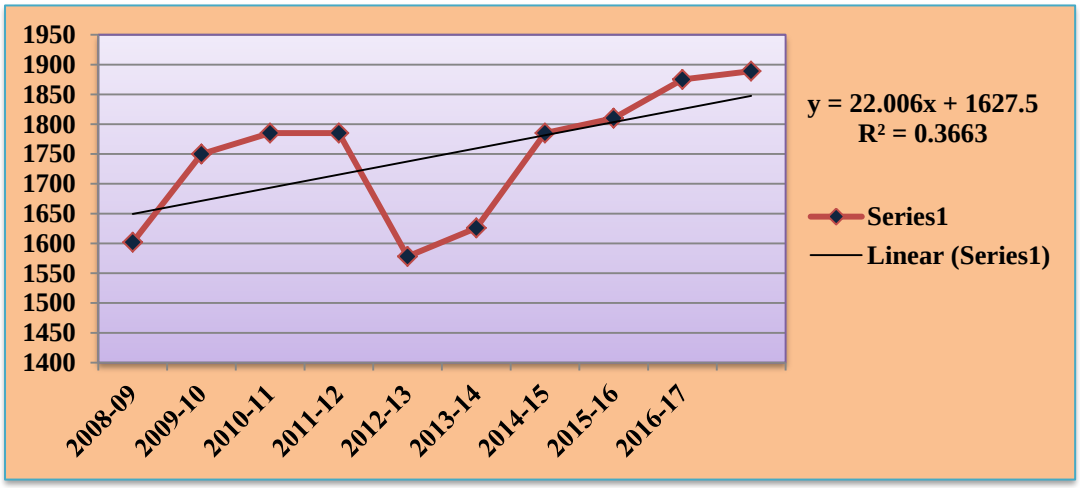


Fig. 4.10: Area of papaya in Bilaspur district

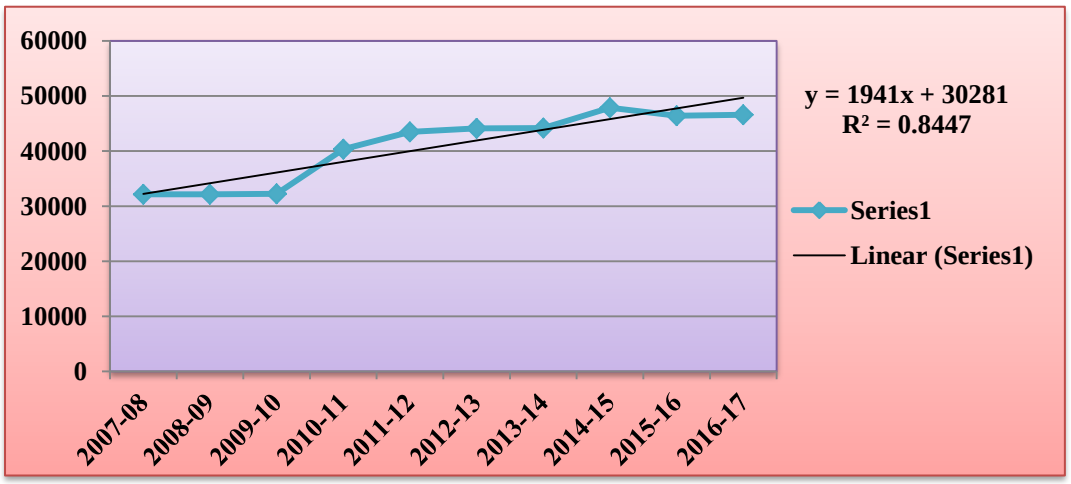


Fig. 4.11: Production of papaya in Bilaspur district

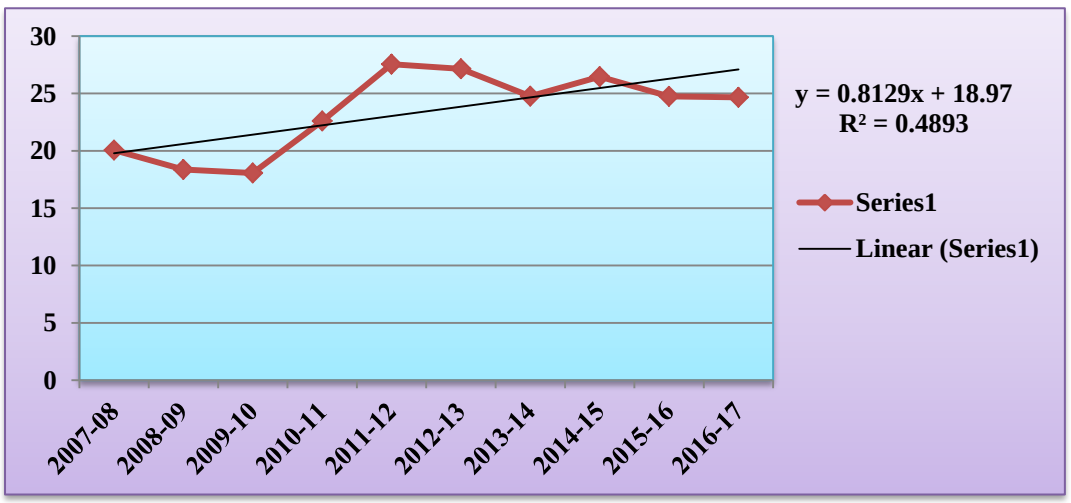


Fig. 4.12: Productivity of papaya in Bilaspur district

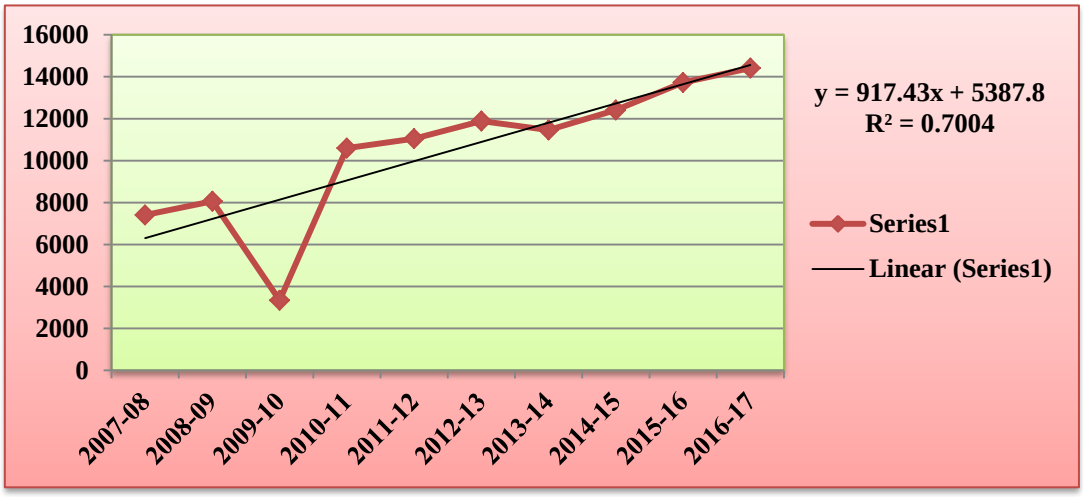


Fig. 4.13: Area of papaya in Chhattisgarh

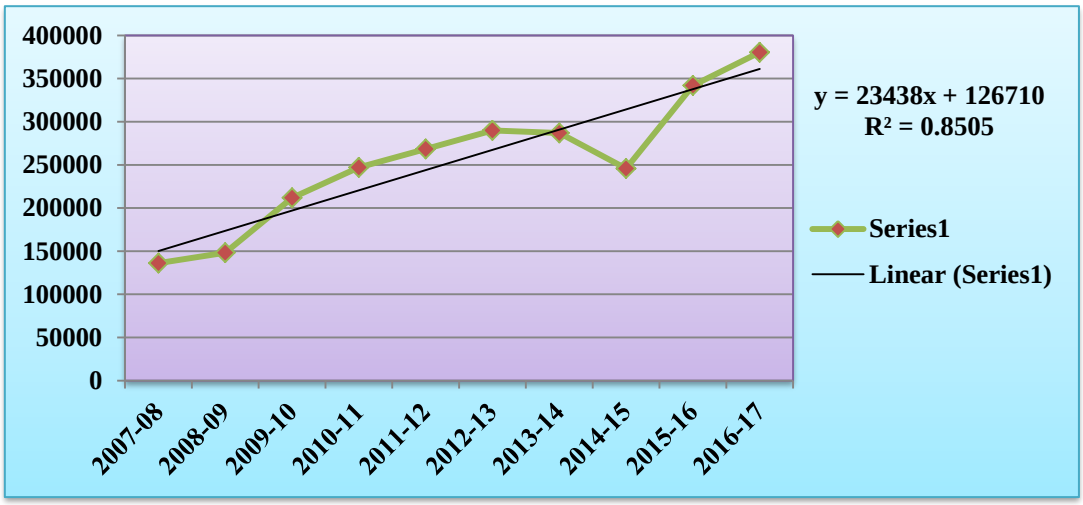


Fig. 4.14: Production of papaya in Chhattisgarh

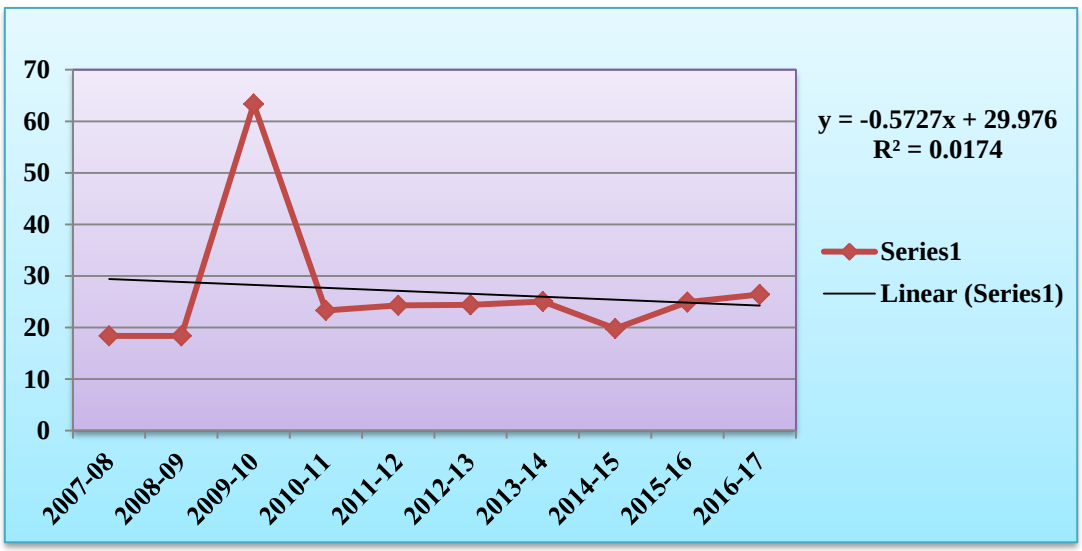


Fig. 4.15: Productivity of papaya in Chhattisgarh

4.2.4 Status of banana:

The present status of banana in depicted by district and Chhattisgarh as a whole through tabulation of area, production and productivity for the year 2016-17 which is given in table 4.8 it reveal that total area under and production of banana cultivation in Chhattisgarh state is observed as 26322 hectare and 611263 metric tonnes.

Table 4.8: Area, production and productivity of banana in Chhattisgarh state (2016-17)

District	Area	Production	Productivity
Raipur	2402 (9.12)	56963 (9.31)	23.71
Balodabazar	1088 (4.13)	24356 (3.98)	22.38
Gariyaband	160 (0.60)	3680 (0.60)	23.00
Mahasamund	1437 (5.45)	30174 (4.93)	20.99
Dhamtari	1030 (3.91)	18540 (3.03)	18.00
Durg	1890 (7.18)	53832 (8.80)	28.48
Balod	413 (1.51)	11669 (1.90)	28.25
Bemetara	980 (3.72)	27735 (4.53)	28.30
Rajnandagoan	895 (3.40)	25850 (4.39)	28.88
Kabirdham	810 (3.07)	14872 (2.43)	18.36
Jagdalpur	310 (1.17)	4553 (1.23)	14.68
Kondagoan	487 (1.85)	14883 (2.23)	30.56
Kanker	315 (1.19)	7891 (1.29)	25.05
Dantewada	240 (0.91)	5483 (0.89)	22.84
Sukma	280 (1.06)	5600 (0.91)	20.00
Bilaspur	2659 (10.01)	47772 (7.81)	17.96
Mungeli	855 (3.24)	23940 (3.91)	28.00
Janjgeer	875 (3.32)	23468 (3.83)	26.82
Korba	1126 (4.27)	31359 (5.13)	27.84
Raigarh	1570 (5.96)	78510 (12.84)	50.00

District	Area	Production	Productivity
Jaspur	375 (1.42)	9000 (1.47)	24.00
Surguja	1050 (3.98)	12600 (2.06)	12.00
Balrampur	2267 (8.61)	30493 (4.98)	13.45
Koriya	890 (3.38)	19800 (3.23)	22.24
Narayanpur	11 (0.04)	330 (0.05)	30.00
Bijapur	245 (0.93)	2460 (0.40)	10.04
Surajpur	1662 (6.31)	21450 (3.50)	12.90
Total	**26322 (100.00)**	**611263 (100.00)**	

Source: Directorate of Horticulture, Chhattisgarh
Note: Figures in the parenthesis indicate the percentage area of banana.

Bilaspur, Raipur and Durg district are major banana growing districts which are jointly contributing more than 26.31 per cent area to total area and Raigarh, Raipur and Durg district which are jointly contributing more than 30.95 per cent production to total production of banana in the Chhattisgarh state. The area under banana cultivation in these three districts is observed as 2659 hectare, 2402 hectare and 1890 hectare area respectively of total area of the state. Than production of Raigarh, Raipur and Durg in these three districts is estimated at 189305 metric tonnes of the total production in the state. Raigarh is the highest banana producing and Bilaspur is the largest area under banana cultivation district in Chhattisgarh state.

4.2.5. Trend in Area, production and productivity of banana in Bilaspur district and Chhattisgarh state

The trend in area, production and productivity of banana was estimated by computing linear equation for the period of 2007-08 to 2016-17 and which is presented in table 4.9, figure 4.16, 4.17, 4.18, 4.19, 4.20 and 4.21. The area of banana increased from 1927 ha. in 2007-08 to 2659 ha. in 2016-17 showing a tremendous increasing in the area of banana, the Production of banana also increased from 45073 metric tonnes in 2007-08 to 47772 metric tonnes in 2016-17. The productivity of banana varied from 23.39 tonnes per hectare to 17.96

tonnes per hectare during this period. The improvement in productivity was due to new improved variety of banana, availability and inputs in the study area.

4.2.6. Compound growth rate in area, production and productivity of banana

The compound growth rate was computed on the basis of 10 years secondary data of area, production and productivity of banana (2007-08 to 2016-17). It is presented in growth in area of banana in Bilaspur district was found 3.50 per cent which were significant at 1 per cent, production and productivity of banana in Bilaspur district was found -1.19 and -4.64 per cent respectively which were production and productivity was found to be negative and non- significant.

The growth in production of banana in Chhattisgarh state was found in 12.42 per cent which was attributed by significantly increase in area by 13.52 per cent only write growth in productivity was found to be negative and non-significant.

Table 4.9: Area, production and productivity of banana in Bilaspur district and Chhattisgarh state

		Bilaspur district			Chhattisgarh state		
S.No.	Years	Area (inha.)	Production (mt)	Productivity (t/ha.)	Area (in ha.)	Production (mt)	Productivity (t/ha.)
1	2007-08	1927	45073	23.39	8586	227695.40	26.51
2	2008-09	2050	54345.50	26.51	9292	246330.92	26.51
3	2009-10	2091	54508.54	26.99	14320.30	296884.32	20.73
4	2010-11	2100	52500.00	25.00	14800.50	351436.52	23.74
5	2011-12	2193	43480.50	19.82	16403.50	381656.50	23.26
6	2012-13	2259	44133	19.53	18677	413400	22.13
7	2013-14	2425	44178	18.21	20792	498814	23.99
8	2014-15	2450	45633	18.62	23870	564434	23.64
9	2015-16	2550	46398	18.19	25762	587421	22.80
10	2016-17	2659	47772	17.96	26322	611263	23.22

Table 4.10: Compound growth rate of area, production and productivity of banana in Bilaspur district and Chhattisgarh state

S.No.	Particular	Compound growth rate (2007-08 to 2016-17)	
		Bilaspur district	Chhattisgarh state
A	Area	3.50*	13.52**
B	Production	-1.19	12.42**
C	Productivity	-4.64	-0.97

Note: *significant in 1% level of probability, **significant in 5% level of probability

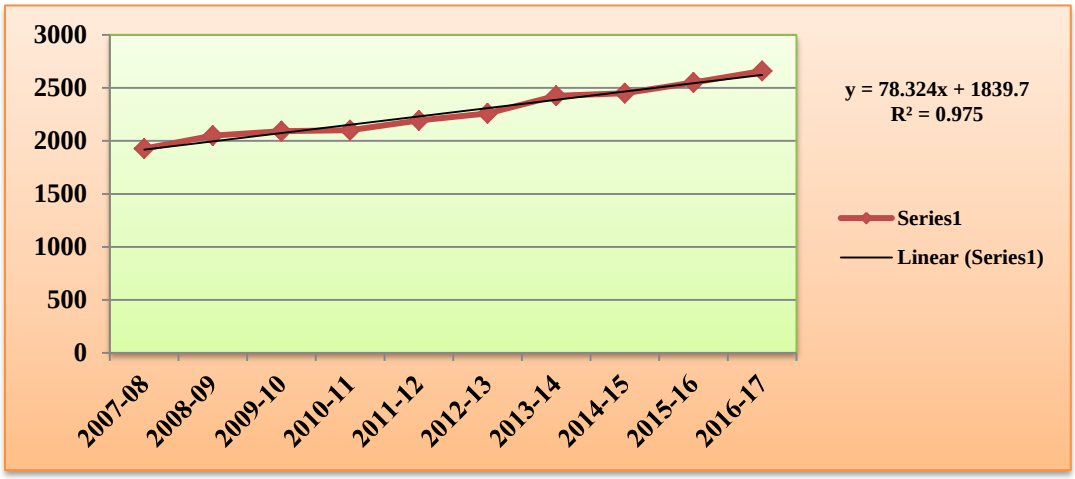


Fig. 4.16: Area of banana in Bilaspur district

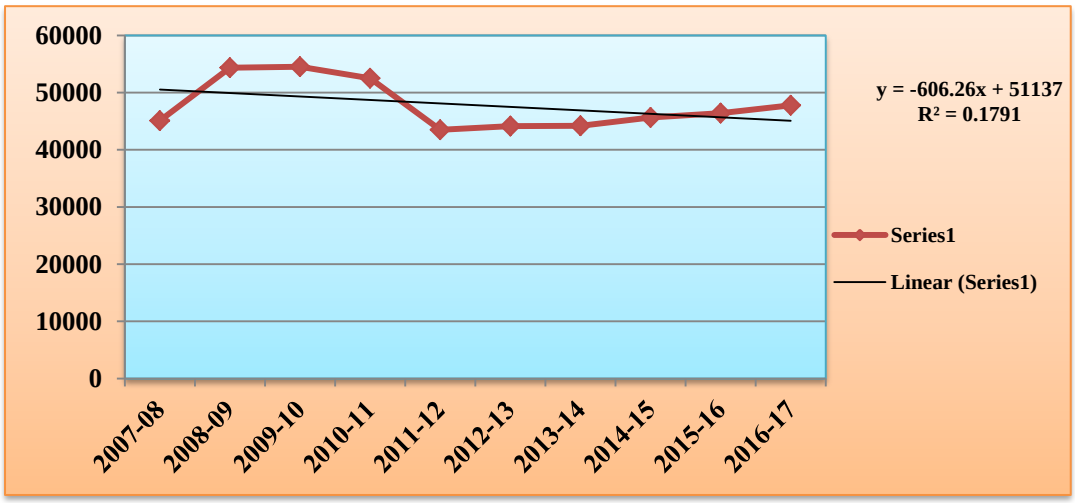


Fig. 4.17: Production of banana in Bilaspur district

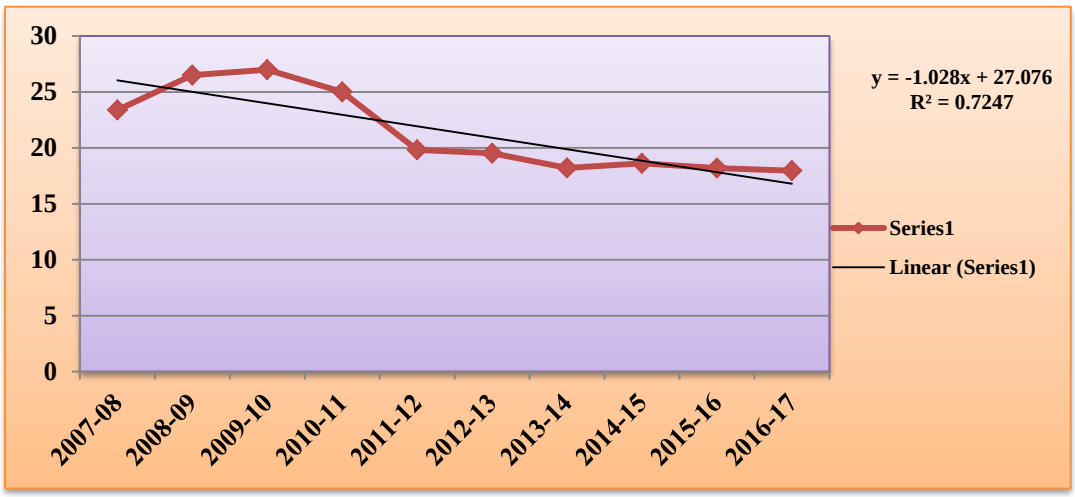


Fig. 4.18: Productivity of banana in Bilaspur district

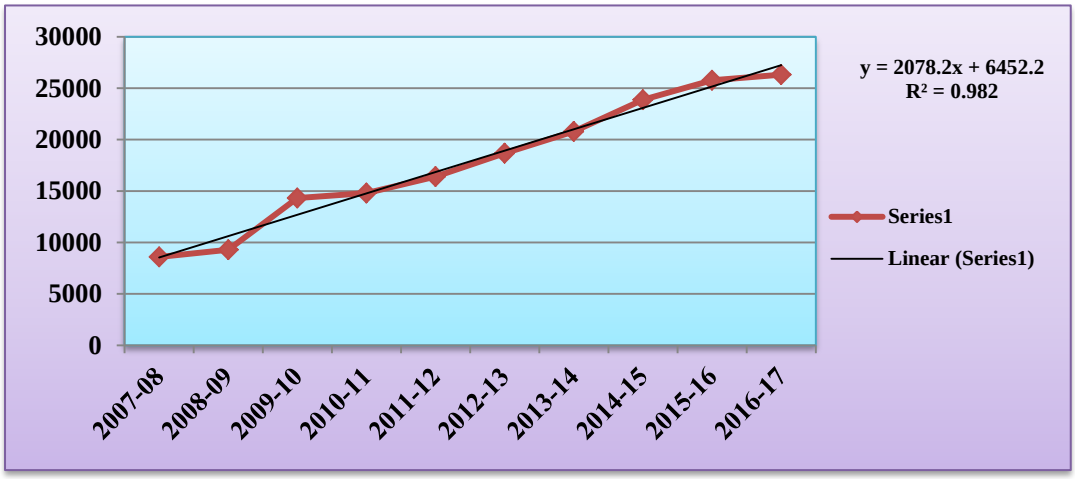


Fig. 4.19: Area of banana in Chhattisgarh

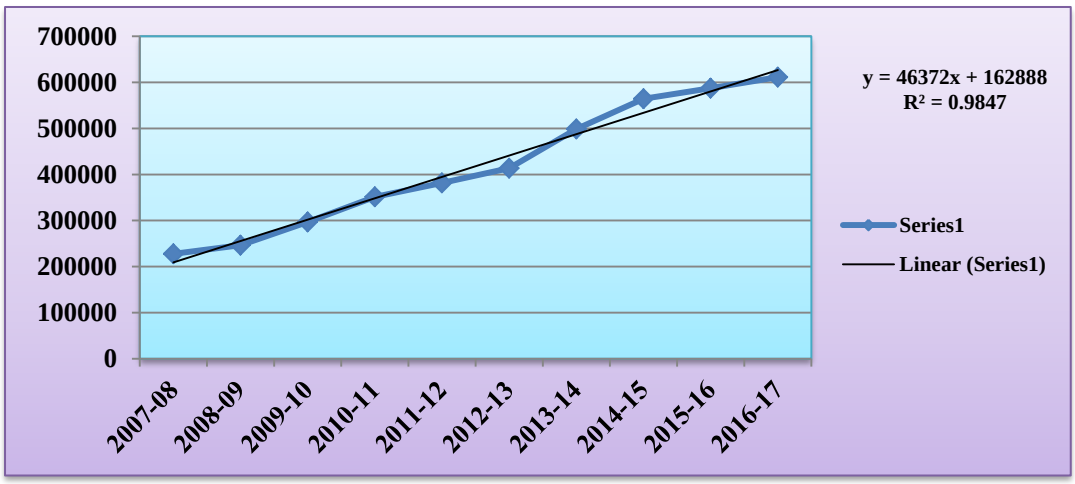


Fig. 4.20: Production of banana in Chhattisgarh

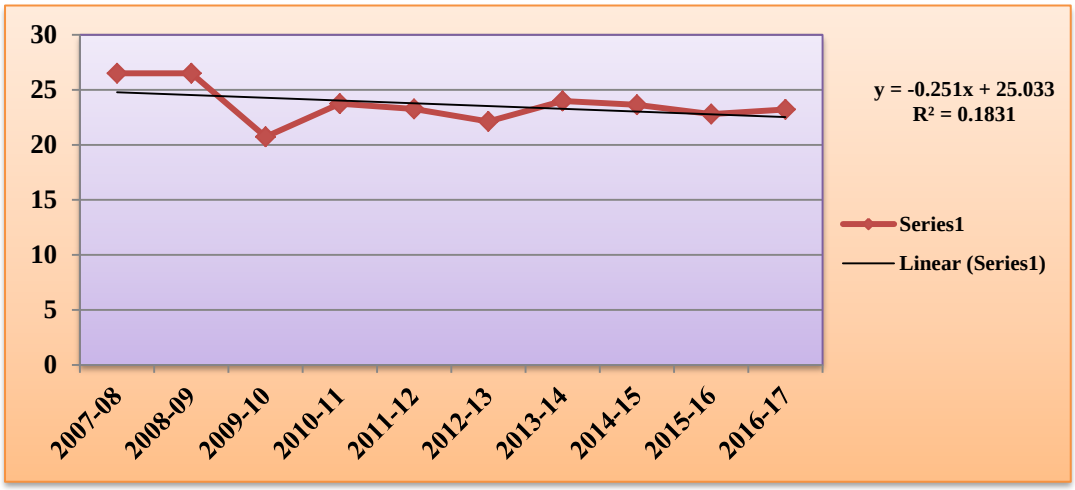


Fig. 4.21: Productivity of banana in Chhattisgarh

4.2.7 Status of mango:

The present status of mango in depicted by district and Chhattisgarh as a whole through tabulation of area, production and productivity for the year 2016-17 which is given in table 4.11 it reveal that total area under and production of mango cultivation in Chhattisgarh state is observed as 74375 hectare and 434783 metric tonnes.

Table 4.11: Area, production and productivity of mango in Chhattisgarh state (2016-17)

District	Area	Production	Productivity
Raipur	2497 (3.35)	12169 (2.79)	4.87
Balodabazar	2863 (3.84)	19607 (4.50)	6.84
Gariyaband	600 (0.80)	3000 (0.68)	5.00
Mahasamund	983 (1.32)	5409 (1.24)	5.50
Dhamtari	2275 (3.05)	7143 (1.64)	3.13
Durg	1050 (1.41)	3950 (0.90)	3.76
Balod	1213 (1.63)	4712 (1.08)	3.88
Bemetara	975 (1.31)	3780 (0.86)	3.87
Rajnandagoan	2600 (3.49)	9100 (2.09)	3.50
Kabirdham	2966 (3.98)	17173 (3.94)	5.78
Jagdalpur	1662 (2.23)	8390 (1.92)	5.04
Kondagoan	1690 (2.27)	14281 (3.28)	8.45
Kanker	2970 (3.99)	12771 (2.93)	4.30
Dantewada	1172 (1.57)	6891 (1.58)	5.87
Sukma	120 (0.16)	1200 (0.27)	10.00
Bilaspur	6157 (8.27)	20438 (5.62)	3.31
Mungeli	2165 (2.91)	9177 (2.11)	4.23
Janjgeer	3276	11433	3.48

District	Area	Production	Productivity
	(4.40)	(2.62)	
Korba	5698 (7.66)	23875 (5.49)	4.19
Raigarh	7447 (10.01)	36814 (8.46)	4.94
Jaspur	4635 (6.23)	46316 (10.65)	9.99
Surguja	6050 (8.13)	57475 (13.21)	9.05
Balrampur	3682 (4.95)	24654 (5.67)	6.69
Koriya	2740 (3.68)	18150 (4.17)	6.62
Narayanpur	1889 (2.53)	14169 (3.25)	7.50
Bijapur	150 (0.20)	1401 (0.32)	9.34
Surajpur	4850 (6.52)	41305 (9.50)	8.51
Total	**74375** (100.00)	**434783** (100.00)	

Source: Directorate of Horticulture, Chhattisgarh
Note: Figures in the parenthesis indicate the percentage area of mango.

Raigarh, Bilaspur and Surguja district are major mango growing districts which are jointly contributing more than 26.41 per cent area to total area and Surguja, Jaspur and Surajpur district which are jointly contributing more than 33.36 per cent production to total production of mango in the Chhattisgarh state. The area under mango cultivation in these three districts is observed as 7447 hectare, 6157 hectare and 6050 hectare area respectively of total area of the state. than production in Surguja, Jaspur and Surajpur in these three districts is estimated at 145096 metric tonnes of the total production in the state. Surguja is the highest mango producing and Raigarh is the largest area under mango cultivation district in Chhattisgarh state.

4.2.8. Trend in Area, production and productivity of mango in Bilaspur district and Chhattisgarh state

The trend in area, production and productivity of mango was estimated by computing linear equation for the period of 2007-08 to 2016-17 and which is presented in table 4.12, figure 4.22, 4.23, 4.24, 4.25, 4.26 and 4.27. The area of mango increased from 3872 ha. in 2007-08 to 6157 ha. in 2016-17 showing a

tremendous increasing in the area of mango, the Production of mango also increased from 12791 metric tonnes in 2007-08 to 20438 metric tonnes in 2016-17. The productivity of mango varied from 3.30 tonnes per hectare to 4.42 tonnes per hectare during this period. The improvement in productivity was due to new improved variety of mango, availability and inputs in the study area.

4.2.9. Compound growth rate in area, production and productivity of mango

The compound growth rate was computed on the basis of 10 years secondary data of area, production and productivity of mango (2007-08 to 2016-17). It is presented in growth in area and production of mango in Bilaspur district was found 5.75 and 5.52 per cent respectively which were significant at 1 per cent , and productivity of mango in Bilaspur district was found -0.24 per cent it was found to be negative and non-significant.

The growth in production of mango in Chhattisgarh state was found in 16.13 per cent which was 5 per cent level of significant, area and productivity was 8.30 and 7.01 per cent respectively was found to be negative and non-significant.

Table 4.12: Area, production and productivity of mango in Bilaspur district and Chhattisgarh state

		Bilaspur district			**Chhattisgarh state**		
S.No.	**Years**	**Area (in ha.)**	**Production (mt)**	**Productivity (t/ha.)**	**Area (in ha.)**	**Production (mt)**	**Productivity (t/ha.)**
1	2007-08	3872	12791.23	3.30	36339.00	121900.95	3.35
2	2008-09	3975	12998.25	3.27	37288	121931.76	3.27
3	2009-10	4054.5	13037.24	3.21	51537	191671.79	3.61
4	2010-11	5182.50	22906.65	4.42	49765	236969.90	4.76
5	2011-12	5384.94	18971.29	3.52	56714.50	271467.41	7.78
6	2012-13	5547	19256	3.47	60146	291827	4.85
7	2013-14	5729	19264	3.36	64350	327914	5.09
8	2014-15	5841	19647	3.36	67119	386667	5.76
9	2015-16	6016	20236	3.36	71515	420609	5.88
10	2016-17	6157	20438	3.31	74375	434783	5.84

Table 4.13: Compound growth rate of area, production and productivity of mango in Bilaspur district and Chhattisgarh state

		Compound growth rate (2007-08 to 2016-17)	
S.No.	**Particular**	**Bilaspur district**	**Chhattisgarh state**
A	Area	5.75*	8.30*
B	Production	5.52*	16.13**
C	Productivity	-0.24	7.01*

Note: *significant in 1% level of probability, **significant in 5% level of probability

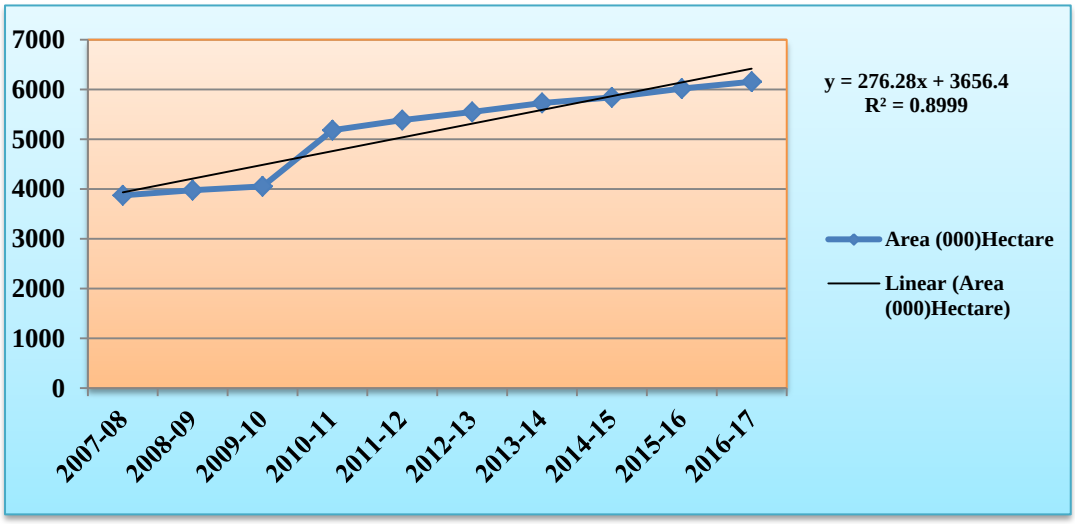


Fig. 4.22: Area of mango in Bilaspur district

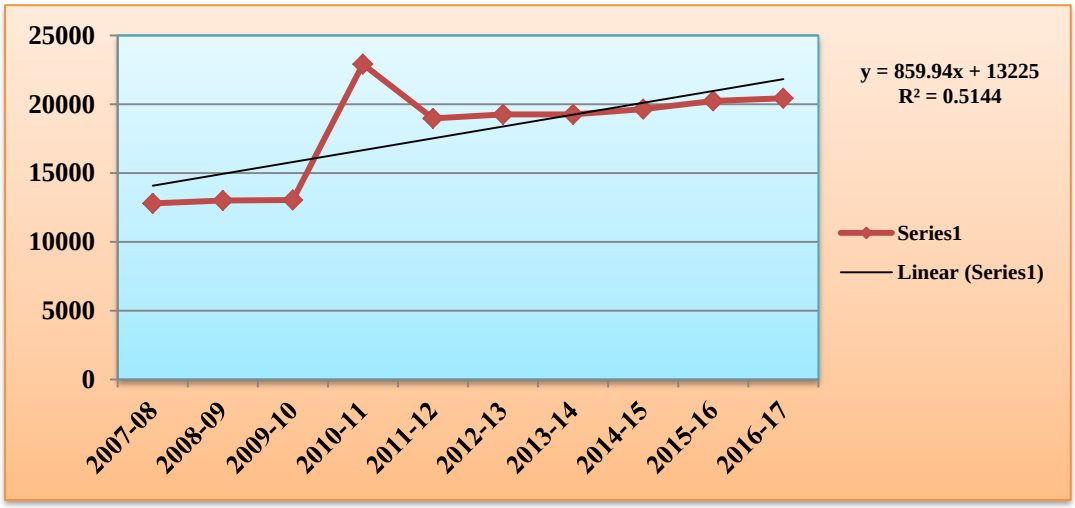


Fig. 4.23: Production of mango in Bilaspur district

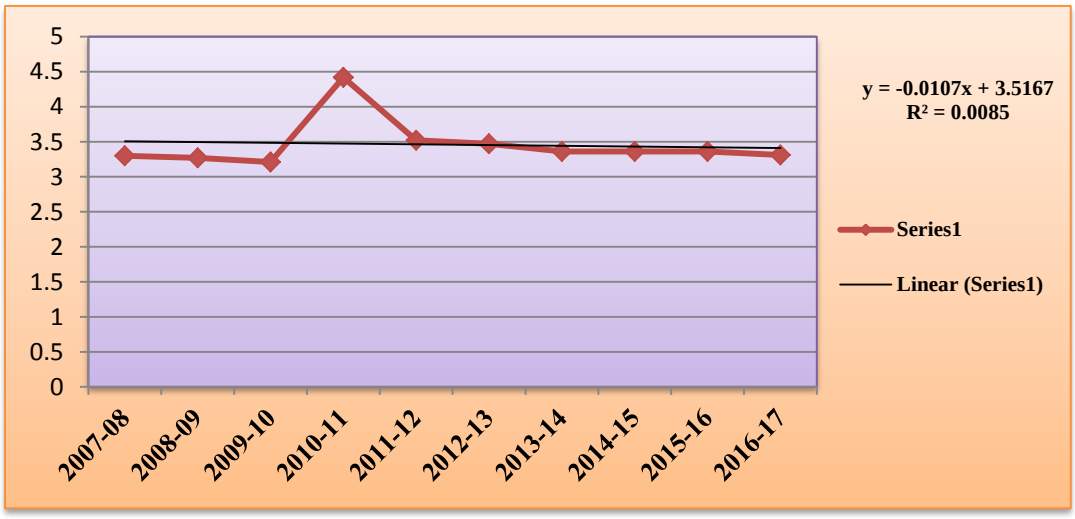


Fig. 4.24: Productivity of mango in Bilaspur district

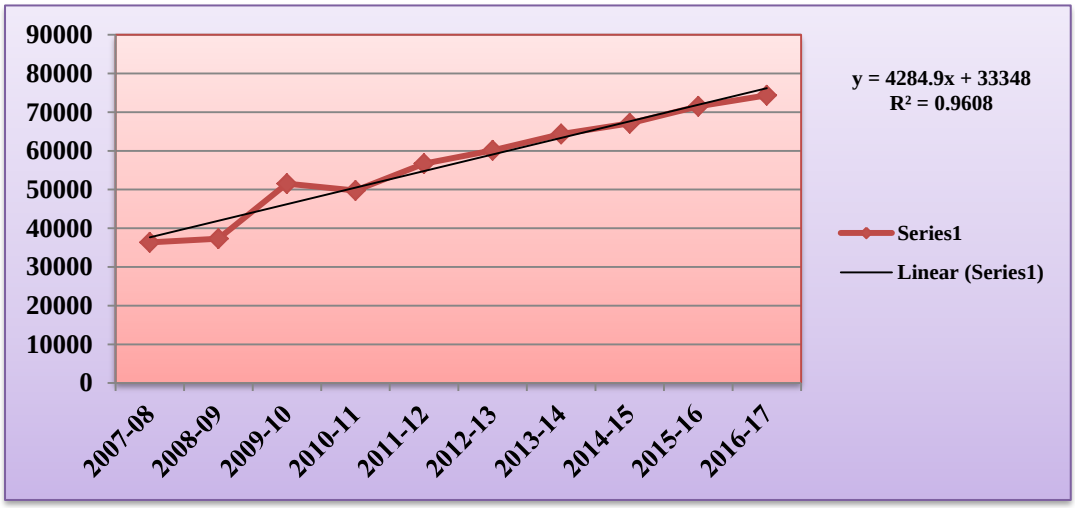


Fig. 4.25: Area of mango in Chhattisgarh

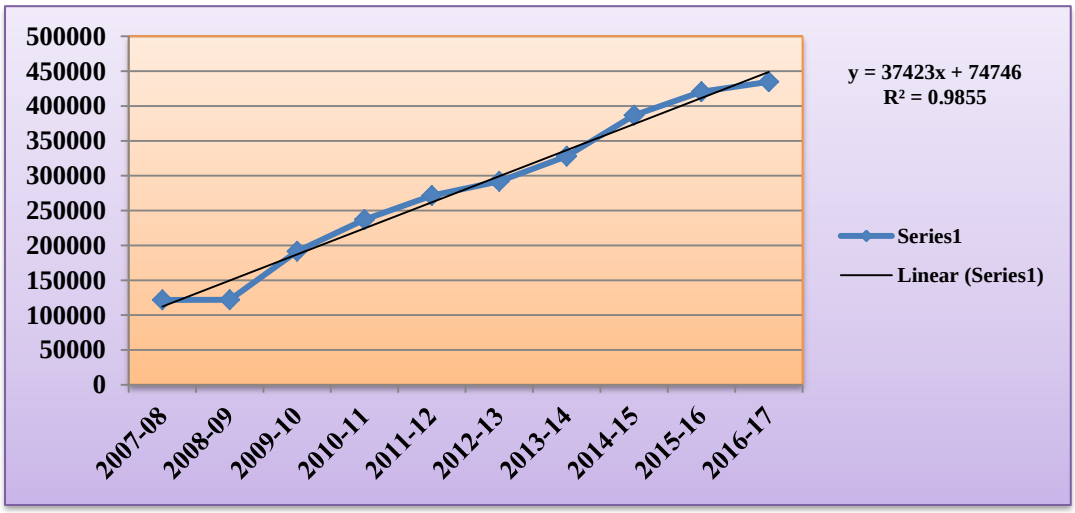


Fig. 4.26: Production of mango in Chhattisgarh

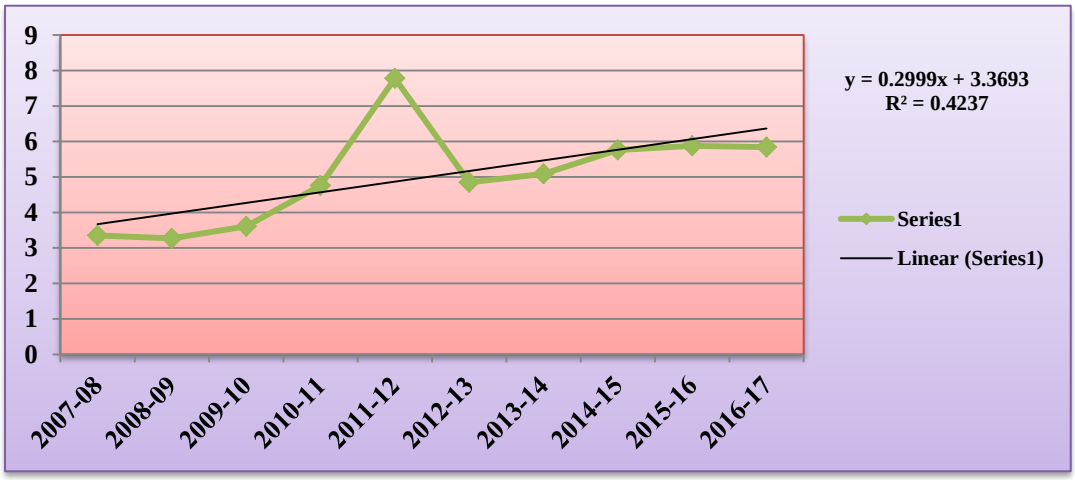


Fig. 4.27: Productivity of mango in Chhattisgarh

4.3 Economics of crop production of major fruits crop

4.3.1 Economics of papaya crop

The economics of papaya crop is presented in table 4.14 and figure 4.28. It clearly shows that the cost of cultivation per hectare of papaya was higher on large farms as compared to small farms. Over all, on an average the cost of cultivation per hectare of papaya was found to be Rs. 142207.01 per hectare. The cost of cultivation in case of large farm was higher Rs .151874.51 per hectare as compared to small Rs.130337.38 per hectare and medium farms Rs.139065.69 per hectare. The cost of cultivation per hectare showed a rising trend with the increase in size of farm. It was due to the fact that the large farmers incurred more expenditure on modern farm input like quality seed, fertilizer, plant protection material, hired labour etc. As their capabilities of investment on major inputs which result better economic status compared to small and medium farmer.

4.3.2 Yield, value of output and cost of production per quintal

The yield, value of output per hectare and cost of production per quintal of papaya on the sample farms have been worked out in table 4 .15 and figure 4.29, 4.30. It indicates that the average yield per hectare of papaya was 776.35 quintal on the sample farms. The cost of production per quintal of papaya on an average was worked out to Rs .182.99. It came to Rs. 173.54, Rs.182.45 and Rs.189.08 for small, medium and large farm size respectively. It decreased with the increased in the size of farm due to higher yields in return to the cost of cultivation on the large farm. The gross income per hectare came to Rs. 395376.59. It was Rs.380193.91, Rs.388013.06 and Rs.410494.34 on small, medium and large farmer respectively. The higher value of output on large farms was associated with the higher yield.

Table 4.14: Economics of papaya on different size groups of farms

(Rs./ha.)

S. No.	Cost	Farm size			
		Small	**Medium**	**Large**	**Overall**
(A)	**Variable cost**				
1.	Human labour				
(a)	Family labour	13346.42 (10.23)	11332.11 (8.14)	9842.62 (6.48)	11213.31 (5.17)
(b)	Hired labour	11355.23 (8.71)	13712.34 (9.86)	16723.99 (11.01)	14375.73 (6.63)
	Total human labour	24701.65 (18.95)	25044.45 (18.00)	26566.61 (17.48)	25589.05 (11.80)
2.	Bullock labour	550.21 (0.42)	0 (0.00)	0 (0.00)	135.71 (0.06)
3.	Machine labour	6115.21 (4.69)	7281.91 (5.23)	8253.22 (5.43)	7395.59 (0.34)
4.	Plant (seed) cost (1.8x1.8 meter)	29438.31 (22.58)	31123.11 (22.38)	33183.63 (21.84)	31559.20 (1.450
5.	Manure & fertilizer cost	21383.53 (16.40)	22138.23 (15.91)	25631.19 (16.87)	23395.82 (10.79)
6.	Plant protection chemicals	11431.17 (8.77)	13438.64 (9.660	15251.21 (10.04)	9213.11 (4.24)
7.	Irrigation charges	5432.13 (4.16)	5614.29 (4.03)	5661.12 (3.72)	5588.71 (2.570
8.	Interest on working capital@8%	7924.01 (6.07)	8371.25 (6.01)	9163.75 (6.03)	8588.53 (3.960
	Total variable cost	**106976.38 (82.07)**	**113011.88 (81.26)**	**123710.73 (81.45)**	**190533.15 (87.88)**
(B)	**Fixed cost**				
1.	Depreciation	121.23 (0.09)	379.11 (0.27)	487.13 (0.32)	360.17 (0.160
2.	Land revenue	12.00 (0.00)	12.00 (0.00)	12.00 (0.00)	12.00 (0.00)
3.	Rental value of owned land	21104.05 (16.19)	23294.18 (16.75)	25104.31 (16.52)	23502.13 (10.84)
4.	Interest fixed capital	2123.72 (1.62)	2368.52 (1.70)	2560.34 (1.68)	2387.42 (1.10)
5.	**Total fixed cost**	**23361.00 (17.92)**	**26053.81 (18.73)**	**28163.78 (18.54)**	**26261.52 (12.11)**
	Total cost = (A+B)	**130337.38) (100.00)**	**139065.69 (100.00)**	**151874.51 (100.00)**	**216794.67 (100.00)**

Table 4.15: Per hectare yield value of output and cost of production per quintal of papaya.

(Rs./ha.)

S. No.	Particulars	Small	Medium	Large	Overall
1.	Main yield (qt./ha.)	751.03	762.11	803.19	776.35
2	Price (Rs./qt.)	506.23	509.13	511.08	509.22
3	Gross income	380193.91	388013.06	410494.34	395376.59
4	Cost of cultivation	130337.38	139065.69	151874.51	142207.01
5	Cost of production (Rs./qt.)	173.54	182.45	189.08	182.99
6	Input output ratio	1:2.99	1:2.91	1:2.77	1:2.87

Fig.4.28: Cost of cultivation of papaya on the sample farms (Rs./ha.)

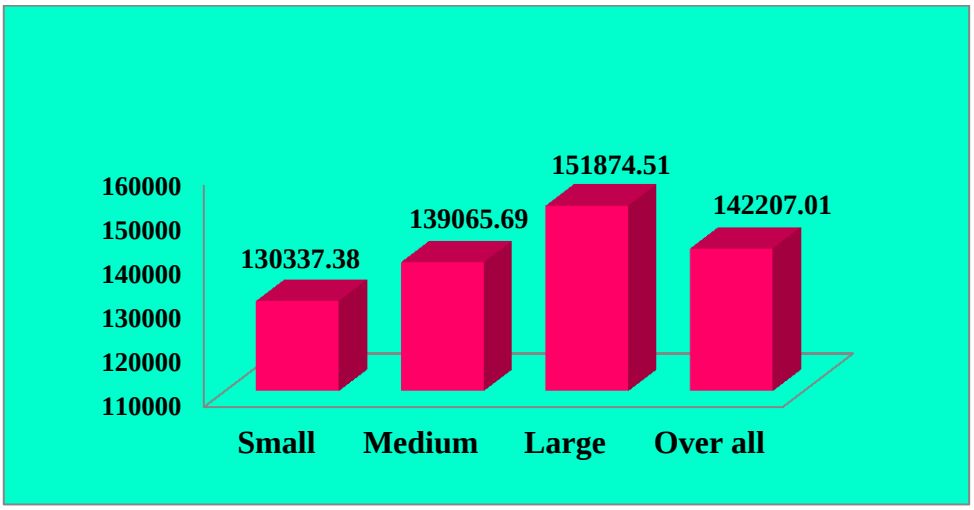


Fig.4.29: Cost of production of papaya on the sample farms (Rs./ha.)

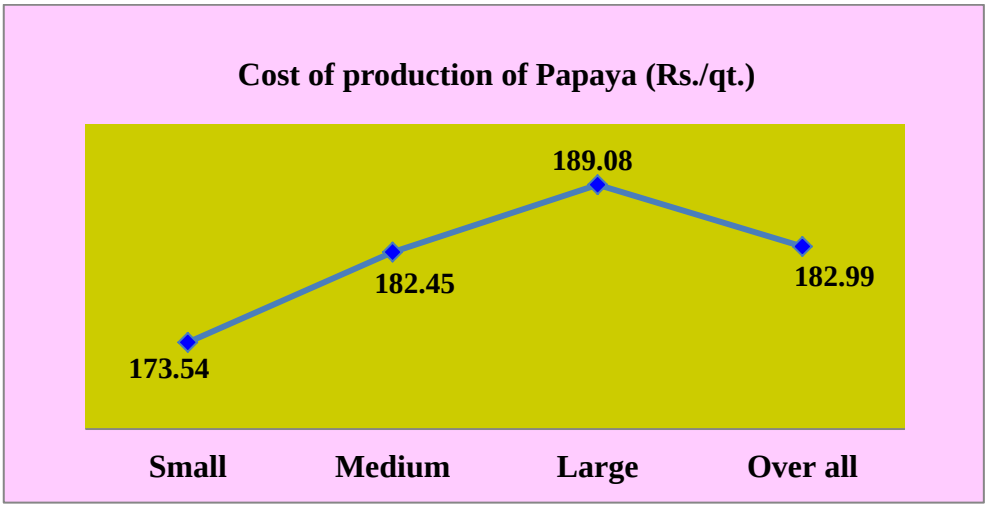
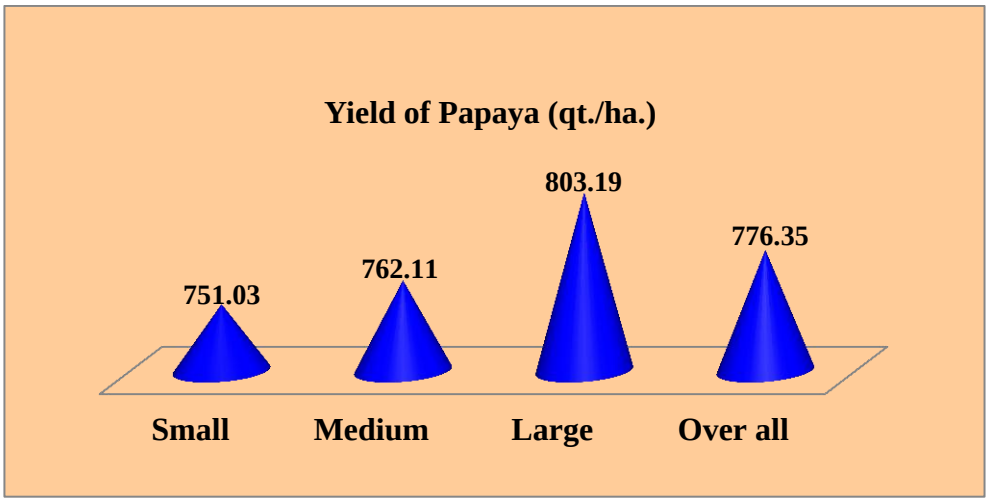


Fig.4.30: Yield of papaya (qt./ha.)



4.3.3 Measure of farm profit

The values of net income, family labour income and farm business the per hectare the sample farms of different size groups have been worked out in the table 4 .16 and figure 4.31. The table indicates that, on an average the value of net average family labour income and farm business income per hectare came Rs .292292.33 and Rs.290272.41, respectively, on the sample farms of different sizes. Overall an average the input-output ratio of papaya came to 1:2.87 on the sample farms.

Table 4.16: Cost and return of papaya on the sample farm for different groups of farms (Rs./ha.)

S. No.	Particulars	Farm size			
		Small	Medium	Large	Overall
1.	Input cost	130337.38	139065.69	151874.51	142207.01
2.	Output cost	380193.91	388013.06	410494.34	395376.59
3.	Net income	249856.53	248947.37	258619.83	253169.57
4.	Family labour income	263202.95	372885.03	243358.14	292292.33
5.	Farm business income	286430.72	285942.18	296127.01	290272.41
6.	Farm investment income	273084.03	274610.07	286284.48	279059.06

Cost and returns on the basis of cost concept

The cost and returns on the basis of cost concept in the production of papaya have been presented in the table 4.17 and figure 4.32.

Table 4.17 portrays that, on an average cost -A_1, A_2, cost-B_1, B_2 and cost-C_1, C_2, C_3 were worked out to Rs.11585.31, 11585.31, Rs.13972.73, 37474.86 and Rs.48688.17, 48688.17, 53556.98. Per hectare respectively on the sample farms. It was noted that average rupees 23502.13 were considered as imputed rental value of owned land for crop season. The incomes over different costs were also worked out. The average income over cost -A_1, A_2 cost-B_1, B_2 and cost-C_1, C_2, C_3 were calculated as Rs. 383791.28, 383791.28, Rs. 381403.86, 357901.73, and Rs. 346688.42, 346688.42, 346688.42, 341819.61 per hectare, respectively.

Table 4.17: Per hectare yield value of output and cost of production per quintal of papaya.

(Rs./ha.)

S. No.	Cost/category	Small	Medium	Large	Overall
A.	**Break-up cost**				
1.	Cost A_1 (all actual expenses)	107109.61	11723.22	10341.75	11585.31
2.	Cost A_2=Cost A_1+Rent paid for leased in land	107109.61	11723.22	10341.75	11585.31
3.	Cost B_1=Cost A_1+Interest on value of owned fixed capital	109233.33	14091.74	12902.09	13972.73
4.	Cost B_2=Cost B_1+Rental value of owned land and rent paid for leased inland	130337.38	37385.92	38006.04	37474.86
5.	Cost C_1=Cost B_1+Imputed value of family labour	143683.08	48718.03	47849.02	48688.17
6.	Cost C_2=Cost B_2+Imputed value of family labour	143683.08	48718.03	47849.02	48688.17
7.	Cost C_3=Cost B_2+10% of cost C_2 on account of managerial function performed by farmer	158051.38	53589.83	52633.92	53556.98
B.	**Income over different cost**				
	I.O.D.C. A_1	273084.03	376289.84	400152.59	383791.28
	I.O.D.C A_2	273084.03	376289.84	400152.59	383791.28
	I.O.D.C. B_1	270960.58	373921.32	397592.25	381403.86
	I.O.D.C. B_2	249856.53	350627.14	372483.03	357901.73
	I.O.D.C. C_1	236510.83	339295.03	362645.32	346688.42
	I.O.D.C. C_2	236510.83	339295.03	362645.32	346688.42
	I.O.D.C. C_3	222142.53	334423.23	357860.42	341819.61
C.	**Gross income**	**380193.91**	**388013.06**	**410494.34**	**395376.59**
D.	**Input output ratio**	**1:2.99**	**1:2.91**	**1:2.77**	**1:2.87**

Note: Figures in parentheses indicates in total percentage.

Fig.4.31: Cost and return of papaya on the sample farm for different groups of farms (Rs./ha.)

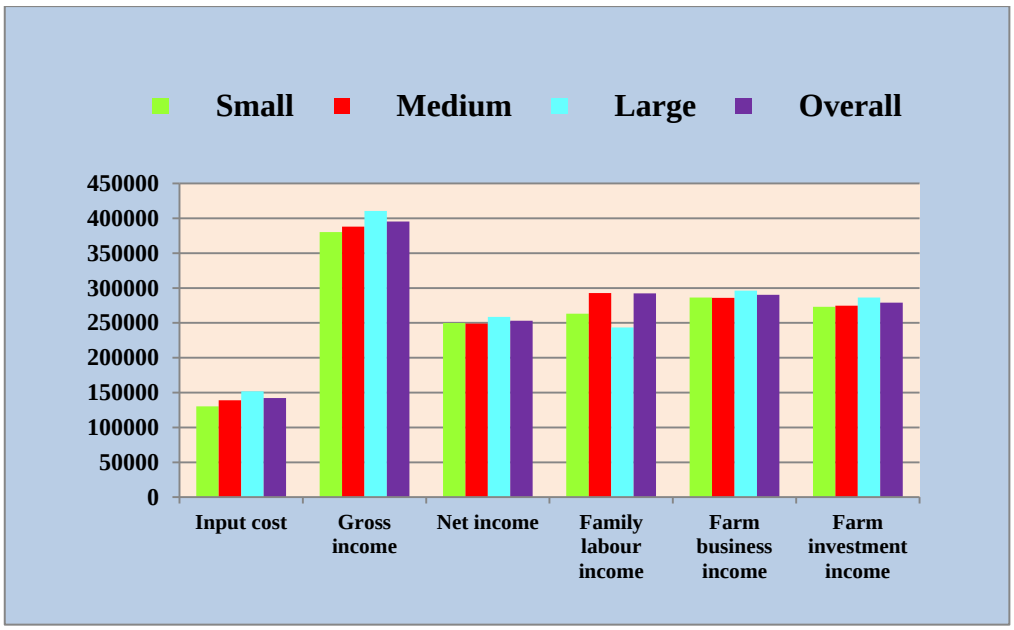
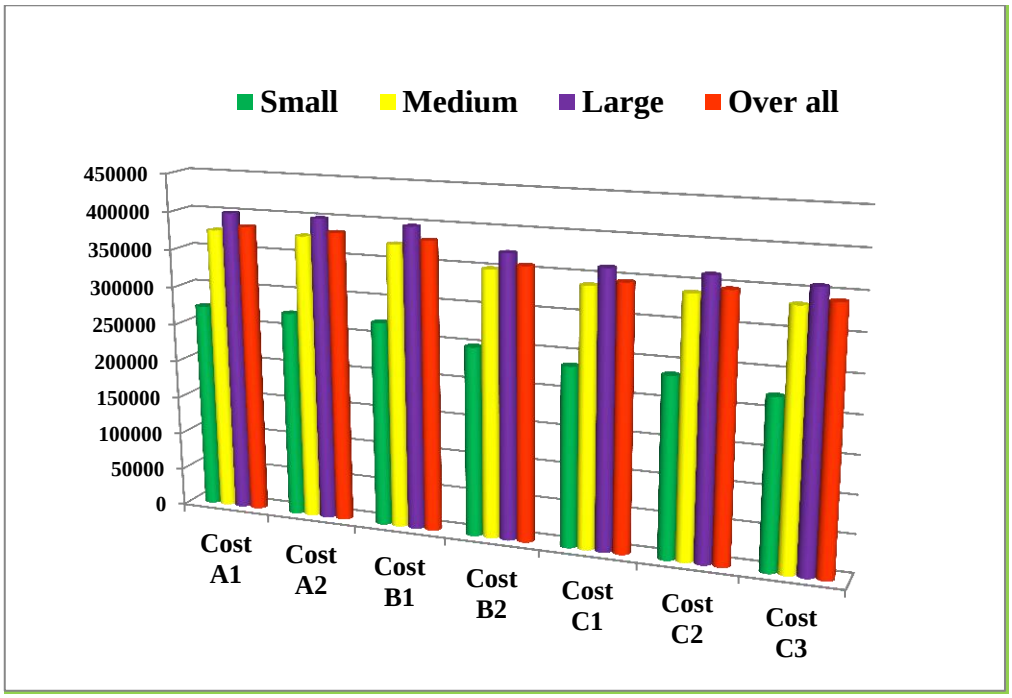


Fig.4.32: Cost concept of papaya on the sample farms

(Rs./ha.)



4.3.4. Economics of banana crop

The economics of banana crop is presented in table 4.18 and figure 4.33. It clearly shows that the cost of cultivation per hectare of banana was higher on large farms as compared to small farms. Over all, on an average the cost of cultivation per hectare of banana was found to be Rs. 179450.27 per hectare. The cost of cultivation in case of large farm was higher Rs . 187063.35 per hectare as compared to small Rs.168152.84 per hectare and medium farms Rs.178391.35 per hectare. The cost of cultivation per hectare showed a rising trend with the increase in size of farm. It was due to the fact that the large farmers incurred more expenditure on modern farm input like quality seed, fertilizer, plant protection material, hired labour etc. As a result of borrowing from credit institutions and better economic status compared to small and medium farmer.

4.3.5. Yield, value of output and cost of production per quintal

The yield, value of output per hectare and cost of production per quintal of banana on the sample farms have been worked out in table 4 .19 and figure 4.34, 4.35. It indicates that the average yield per hectare of banana was 773.25 quintal on the sample farms. The cost of production per quintal of banana on an average was worked out to Rs .231.97. It came to Rs.222.71, Rs.231.37 and Rs.237.99 for small, medium and large farm size respectively. It decreased with the increased in the size of farm due to higher yields in return to the cost of cultivation on the large farm. The average gross income per hectare came to Rs.543585.43. It was Rs.536223.65, Rs.540178.02 and Rs.550781.64 on small, medium and large farmer respectively. The higher gross income on large farms was associated with the higher yield.

Table 4.18: Economics of banana on different size groups of farms

(Rs./ha.)

S. No.	Cost	Farm size			
		Small	**Medium**	**Large**	**Overall**
(A)	**Variable cost**				
1.	Human labour				
(a)	Family labour	15324.34	9214.23	6431.13	6955.71
		(9.11)	(5.16)	(3.43)	(3.87)
(b)	Hired labour	9231.08	16123.21	20214.94	16114.39
		(5.48)	(9.03)	(10.80)	(8.97)
	Total human labour	24555.42	25337.44	26646.07	25685.44
		(14.60)	(14.20)	(14.240	(14.31)
2.	Bullock labour	825.23	635.36	443.31	602.81
		(0.49)	(0.33)	(0.230	(0.33)
3.	Machine labour	6450.33	8795.23	11050.12	9148.84
		(3.83)	(4.93)	(5.09)	(5.09)
4.	Plant (seed) cost	42255.14	42424.19	42613.22	42460.62
	(1.8x1.8 meter)	(25.12)	(23.78)	(22.78)	(23.66)
5.	Manure & fertilizer cost	23214.31	24337.12	25223.19	24426.40
		(13.80)	(13.64)	(13.48)	(13.61)
6.	Plant protection chemicals	5340.21	6631.03	7534.42	6686.02
		(3.17)	(3.71)	(4.02)	(3.72)
7.	Irrigation charges	6523.32	7231.21	7542.92	7185.43
		(3.87)	(4.05)	(4.03)	(4.00)
8.	Interest on working capital@8%	10697.55	11258.32	11815.94	11350.47
		(6.36)	(6.31)	(6.31)	(6.32)
	Total variable cost	**144416.93**	**151987.34**	**159515.26**	**153231.51**
		(85.88)	**(85.19)**	**(85.27)**	**(85.38)**
(B)	**Fixed cost**				
1.	Depreciation	425.23	650.31	785.11	650.50
		(0.25)	(0.36)	(0.41)	(0.36)
2.	Land revenue	12.00	12.00	12.00	12.00
		(0.00)	(0.00)	(0.00)	(0.00)
3.	Rental value of owned land	21140.87	23341.42	24246.61	23172.76
		(12.570	(13.080	(12.960	(12.91)
4.	Interest fixed capital	2157.81	2400.37	2504.37	2383.52
		(1.28)	(1.340)	(1.33)	(1.32)
5.	**Total fixed cost**	**23735.91**	**26404.01**	**27548.09**	**26218.76**
		(14.11)	**(14.80)**	**(14.72)**	**(14.61)**
	Total cost = (A+B)	**168152.84**	**178391.35**	**187063.35**	**179450.27**
		(100.00)	**(100.00)**	**(100.00)**	**(100.00)**

Table 4.19: Per hectare yield value of output and cost of production per quintal of banana.

(Rs./ha.)

S. No.	Particulars	Small	Medium	Large	Overall
1.	Main yield (qt./ha.)	755.00	771.00	786.00	773.25
2	Price (Rs./qt.)	710.23	700.62	700.74	703.04
3	Gross income	536223.65	540178.02	550781.64	543585.43
4	Cost of cultivation	168152.84	178391.35	187063.35	179450.27
5	Cost of production (Rs/qt.)	222.71	231.37	237.99	231.97
6	Input output ratio	1:3.18	1:3.02	1:2.94	1:3.02

Fig.4.33: Cost of cultivation of banana on the sample farms (Rs./ha.)

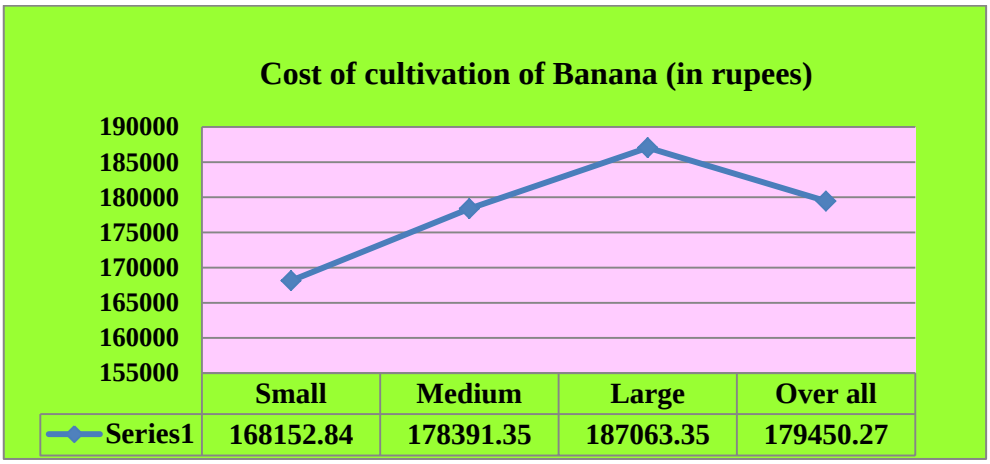


Fig.4.34: Cost of production of banana on the sample farms (Rs./ha.)

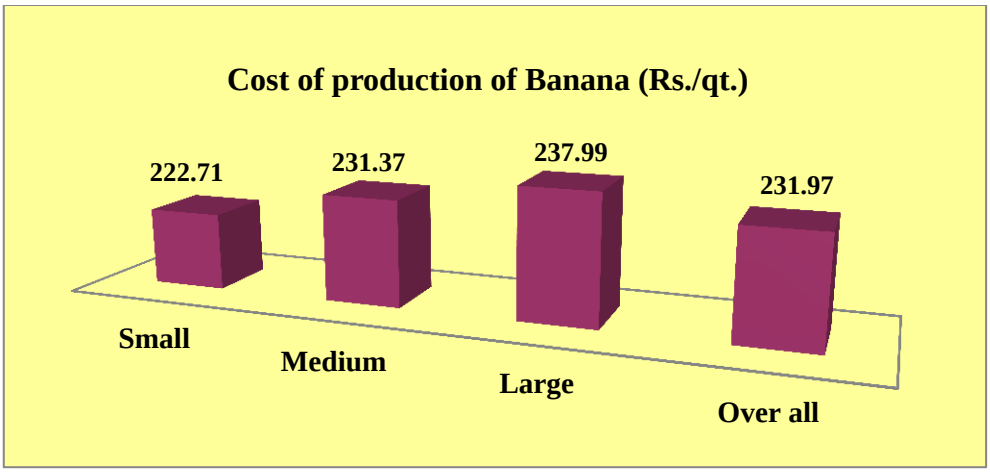
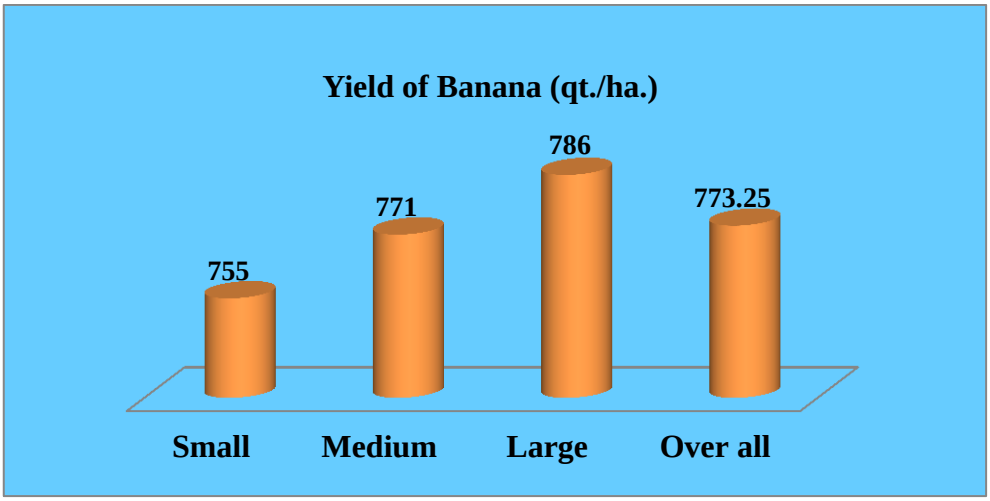


Fig.4.35: Yield of banana (qt./ha.)



4.3.6. Measures of farm profit

The values of net income, family labour income and farm business the per hectare the sample farms of different size groups have been worked out in the table 4 .20 and figure 4.36. The table indicates that, on an average the value of net average family labour income and farm business income per hectare came Rs .407001.67 and Rs.381445.39, respectively, on the sample farms of different sizes. Overall on an average the input-output ratio of banana came to 1:3.02 on the sample farms.

Table 4.20: Cost and return of banana on the sample farm for different groups of farm

(Rs./ha.)

S. No.	Particulars	Farm size			
		Small	Medium	Large	Overall
1.	Input cost	168152.84	178391.35	187063.35	179450.27
2.	Output cost	536223.65	540178.02	550781.64	543585.43
3.	Net income	368070.81	361786.67	363718.29	364135.16
4.	Family labour income	400218.29	405380.55	412383.34	407001.67
5.	Farm business income	376919.61	379638.76	385632.36	381445.39
6.	Farm investment income	391369.49	387528.46	390469.27	389691.44

Cost and returns on the basis of cost concept

The cost and returns on the basis of cost concept in the production of banana have been presented in the table 4 .21. It is evident from table 4.18 and figure 4.37 that, the per hectare cost-A_1, A_2, cost-B_1, B_2, and cost-C_1, C_2, C_3 at the overall level were Rs.144322.97, 144322.97, Rs.146706.50, 169879.15, and Rs. 153620.36, 179450.19, 197395.21 per hectare, respectively on the sample farms. The average income per hectare over cost - A_1, A_2, cost-B_1, B_2 and cost-C_1, C_2, C_3 were worked out to Rs.399262.12, 399262.12 Rs.396878.93, 373706.15 and Rs.389965.07, 364135.24, 346190.22, respectively. The income over different costs also increased with the increase in the farms size because of higher output in relation to total input cost.

Table 4.21: Per hectare yield value of output and cost of production per quintal of banana.

(Rs./ha.)

S. No.	Cost/category	Small	Medium	Large	Overall
A.	**Break-up cost**				
1.	Cost A_1 (all actual expenses)	129529.82	143435.42	153881.24	144322.97
2.	Cost A_2=Cost A_1+Rent paid for leased in land	129529.82	143435.42	153881.24	144322.97
3.	Cost B_1=Cost A_1+Interest on value of owned fixed capital	131687.63	145835.79	156385.61	146706.50
4.	Cost B_2=Cost B_1+Rental value of owned land and rent paid for leased inland	152828.05	169177.21	180632.22	169879.15
5.	Cost C_1=Cost B_1+Imputed value of family labour	147011.97	155053.02	156385.61	153620.36
6.	Cost C_2=Cost B_2+Imputed value of family labour	168152.39	178391.44	187063.35	179450.19
7.	Cost C_3=Cost B_2+10% of cost C_2 on account of managerial function performed by farmer	184967.62	196230.58	205769.68	197395.21
B.	**Income over different cost**				
	I.O.D.C. A_1	406693.83	396742.06	396900.04	399262.12
	I.O.D.C A_2	406693.83	396742.06	396900.04	399262.12
	I.O.D.C. B_1	404536.02	394342.23	394396.03	396878.93
	I.O.D.C. B_2	383395.06	371000.81	370149.42	373706.15
	I.O.D.C. C_1	389211.68	385125.00	394396.03	389965.07
	I.O.D.C. C_2	368071.26	361786.58	363718.29	364135.24
	I.O.D.C. C_3	351256.03	343947.44	345011.96	346190.22
C.	**Gross income**	**536223.65**	**540178.02**	**550781.68**	**543585.43**
D.	**Input output ratio**	**1:3.18**	**1:3.02**	**1:2.94**	**1:3.02**

Note: Figures in parentheses indicates in total percentage

Fig.4.36: Cost and return of banana on the sample farm for different groups of farms (Rs./ha.)

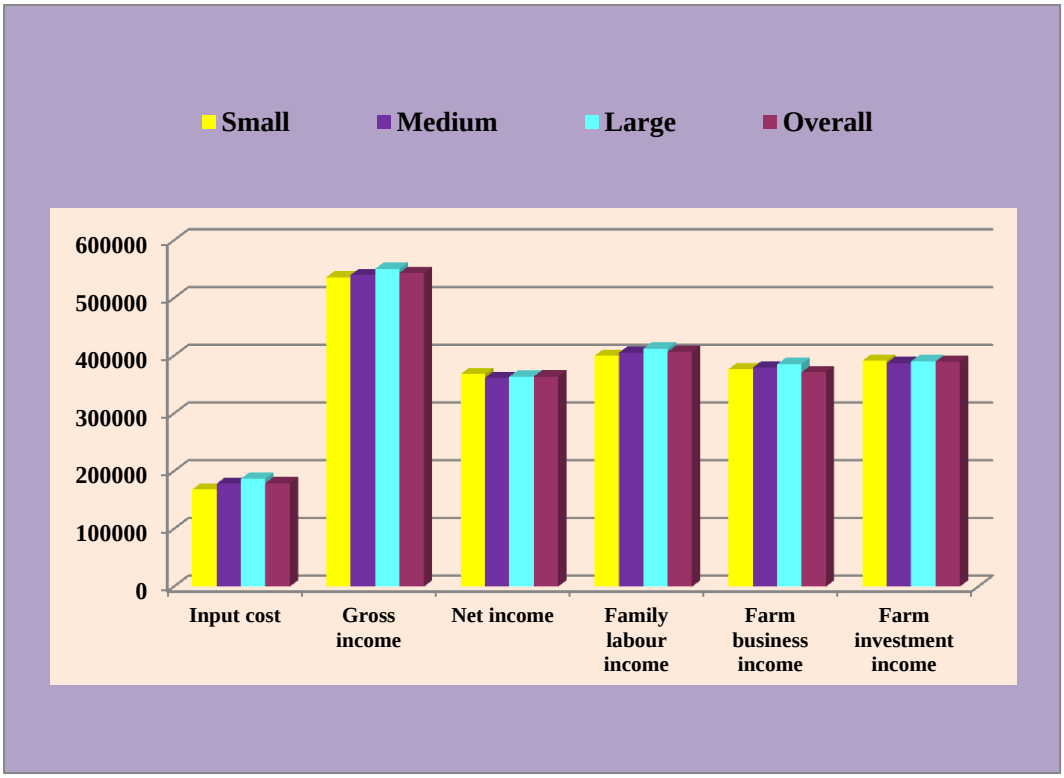
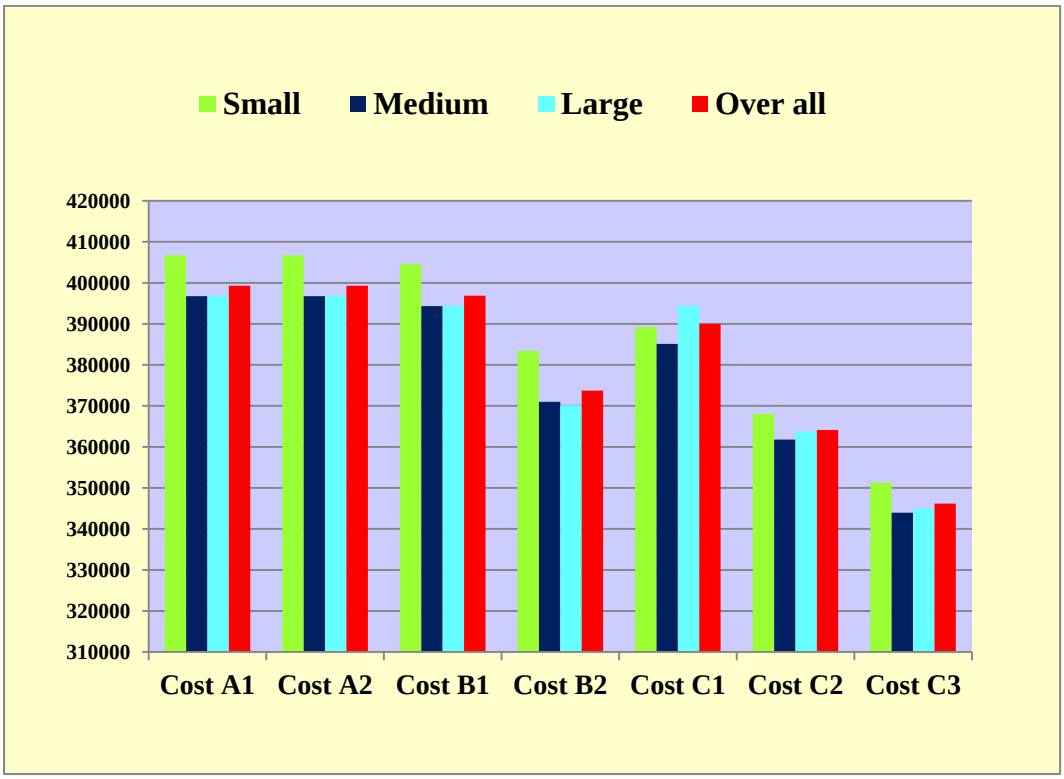


Fig.4.37: Cost concept of banana on the sample farms (Rs./ha.)



4.3.7. Establishment cost of mango orchard

The pre-bearing costs incurred in the establishment of mango orchard up to bearing stage formed the establishment cost. The establishment cost included all the costs incurred from the initial establishment i.e., planting material, fencing and gap filling up to the stage of bearing, i.e ., 5^{th} year. The total establishment cost included that of initial establishment, plant protection, fertilizer and manures, human labour, tillage, watch and ward, land tax up to the stage of bearing and repair and upkeep of farm implements. The implement cost for five years was accordingly estimated at the prevailing prices of inputs. The cost of establishment of mango orchard is presented in table 4.22.

Table 4.22: Cost of establishment of mango orchard for five years

(Rs./ha.)

S. No.	Cost	Amount	Per cent
(A)	**Variable cost**		
1.	Human labour		
(a)	Family labour	16682.17	8.39
(b)	Haired labour	24531.31	12.33
	Total human labour	**41213.48**	**20.72**
2.	Initial Establishment		
(i)	Planting material	5287.11	2.65
(ii)	Gap filling	850.23	0.42
(iii)	Fencing	18672.33	9.39
	Total Initial Establishment	24809.67	12.47
3.	Manure & fertilizer cost	19782.10	9.94
4.	Bullock labour	12457.19	6.26
5.	Machine labour	2268.07	1.14
6.	Plant protection chemicals	21432.43	10.77
7.	Irrigation charges	13372.02	6.72
8.	Watch & ward	8232.16	4.14
9.	Interest on working capital	25673.00	12.91
	Total variable cost	**169240.12**	**85.11**
(B)	**Fixed cost**		
1.	Depreciation	3075.43	1.54
2.	Land revenue	60.00	0.03
3.	Rental value of owned land	16467.22	8.28
4.	Interest fixed capital	9986.18	5.02
5.	**Total fixed cost**	**29588.83**	**14.88**
	Total establishment cost = (A+B)	**198828.95**	**100.00**
	Income from inter crop	82425.34	
	Net establishment cost	**116401.28**	

Total cost of establishment of mango orchard per hectare for five years was found to be Rs .198828.95. The net establishment of mango orchard per hectare was Rs.116401.28. The initial establishment costs such as planting material, gap filling and fencing account for 12.47 per cent of the total establishment cost. The average initial establishment cost was Rs .24809.67. Planting material cost was Rs. 5287.11. The cost figures were Rs.18672.33 for fencing and Rs.850.23 for gap filling. Application of fertilizers was not unique to all orchards. The cost of fertilizer was Rs .19782.10 for mango cultivation and its percentage share in the total establishment cost was 9 .94 per cent. The cost of human labour charges per hectare for five years was worked out to Rs . 41213.48 and it was accounted 20.72 per cent in the total cost of establishment. Cost of human labour included the expenditure on labour for filling the digs, planting, application of manures and fertilizers, de blossoming, after cultivation such as weeding, hoeing, guiding the water, etc. More men and women were used for proper watering up to six months in and further wage rates are higher for both men and women .

Bullock labour cost per hectare was worked out to be Rs .12457.19. The cost of bullock labour in the total establishment cost was 6 .26 per cent. Watch and ward cost was found to be Rs .8232.16. The percentage share was 4.14 per cent. The interest on fixed capital and rental value of land were substantial and it shared 5.02 and 8.28 per cent of the total establishment cost. The interest on fixed capital and rental value of land during the period under study were Rs .9986.18 and Rs. 16467.22, respectively per hectare.

The mango orchards, especially in the first 5 years of their life are intercropped with minor millets , pulses and spices to utilize profitably the vacant space lying between the trees. The average net cost per acre to establish a mango orchard was worked by deducting the average per hectare income from intercrop from the total establishment cost. The average total establishment cost per hectare of mango orchard amounted to Rs .198828.95. The net establishment cost for establishing one hectare mango orchard was Rs .116401.28. Mango being a perennial crop; its life time extends over a period of 50 years .

4.3.8. Economics of mango orchard

The economics of mango orchard is presented in table 4.23 and figure 4.38. It clearly shows that the cost of cultivation per hectare of mango orchard was higher on large farms as compared to small farms. Over all, on an average the cost of cultivation per hectare of mango orchard was found to be Rs. 78029.69 per hectare. The cost of cultivation in case of large farm was higher Rs. 80050.39 per hectare as compared to small Rs.75291.44 per hectare and medium farms Rs. 77559.75 per hectare. The cost of cultivation per hectare showed a rising trend with the increase in size of farm. It was due to the fact that the large farmers incurred more expenditure on modern farm input like fertilizer, plant protection material, hired labour etc. As a result of borrowing from credit institutions and better economic status compared to small and medium farmer.

4.3.9. Yield, value of output and cost of production per quintal

The yield, value of output per hectare and cost of production per quintal of mango orchard on the sample farms have been worked out in table 4 .24 and figure 4.39, 4.40. It indicates that the average yield per hectare of mango orchard was 100.01 quintal on the sample farms. The cost of production per quintal of mango orchard on an average was worked out to Rs.780.55. It came to Rs.799.86, Rs.763.53 and Rs.783.04 for small, medium and large farm size respectively. It increased with the decreased in the size of farm due to higher yields in return to the cost of cultivation on the large farm. The average gross income per hectare came to Rs.202399.73. It was Rs. 189779.25, Rs. 205433.36 and Rs. 207435.91on small, medium and large farmer respectively. The higher gross income on large farms was associated with the higher yield.

Table 4.23: Economics of mango orchard on different size groups of farms

(Rs./ha.)

S. No.	Cost	Farm size			
		Small	**Medium**	**Large**	**Overall**
(A)	**Variable cost**				
1.	Human labour				
(a)	Family labour	11067.21 (14.69)	10123.39 (13.05)	9873.46 (12.33)	10252.89 (13.13)
(b)	Hired labour	21261.67 (28.23)	22616 (29.15)	22942.27 (28.65)	22416.89 (28.72)
	Total human labour	**32328.88 (42.93)**	**32739.69 (42.21)**	**32815.73 (40.99)**	**32669.78 (41.86)**
2.	Bullock labour	1561.11 (2.07)	1664.97 (2.14)	1736.82 (2.16)	1668.71 (2.13)
3.	Machine labour	4382.78 (5.82)	4567.47 (5.88)	4838.17 (6.04)	4633.80 (5.93)
4.	Manure & fertilizer cost	12679.63 (16.89)	12881.23 (16.60)	13231.78 (16.52)	12976.07 (16.62)
5.	Plant protection chemicals	5332.22 (7.08)	5738.32 (7.39)	6224.71 (7.77)	5839.18 (7.48)
6.	Irrigation charges	3298.98 (4.38)	3577.63 (4.61)	3931.87 (4.91)	3655.31 (4.68)
7.	Interest on working capital	3132.63 (4.16)	3461.58 (4.46)	3821.69 (4.77)	3529.28 (4.52)
	Total variable cost	**62716.23 (83.29)**	**64630.71 (83.33)**	**66600.77 (83.19)**	**64972.76 (83.26)**
(B)	**Fixed cost**				
1.	Depreciation	558.22 (0.74)	621.82 (0.80)	732.64 (0.91)	651.93 (0.83)
2.	Land revenue	12.00	12.00	12.00	12.00
3.	Rental value of owned land	9321.32 (12.38)	9532.89 (12.29)	9814.47 (12.26)	9597.08 (12.29)
4.	Interest fixed capital	2683.67 (3.56)	2762.33 (3.56)	2891.11 (3.16)	2796.15 (3.58)
5.	**Total fixed cost**	**12575.21 (16.70)**	**12929.04 (16.66)**	**13450.22 (16.80)**	**13057.18 (16.73)**
	Total cost = (A+B)	**75291.44 (100.00)**	**77559.75 (100.00)**	**80050.99 (100.00)**	**78029.94 (100.00)**

Table 4.24: Per hectare yield value of output and cost of production per quintal of mango orchard.

(Rs./ha.)

S. No.	Particulars	Small	Medium	Large	Overall
1.	Main yield (qt./ha.)	94.13	101.58	102.23	100.01
2	Price (Rs./qt.)	2016.14	2022.38	2029.11	2023.62
3	Gross income	189779.25	205433.36	207435.91	202399.73
4	Cost of cultivation	75291.44	77559.75	80050.39	78029.69
5	Cost of production (Rs/qt.)	799.86	763.53	783.04	780.55
6	Input output ratio	1:2.52	1:2.64	1:2.59	1:2.58

Fig.4.38: Cost of cultivation of mango orchard on the sample farms (Rs./ha.)

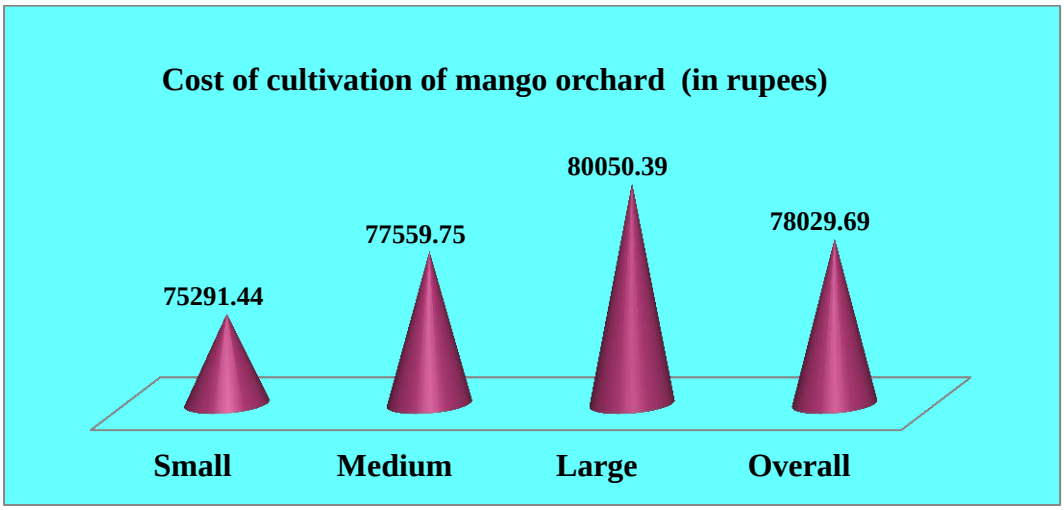


Fig.4.39: Cost of production of mango orchard on the sample farms (Rs./ha.)

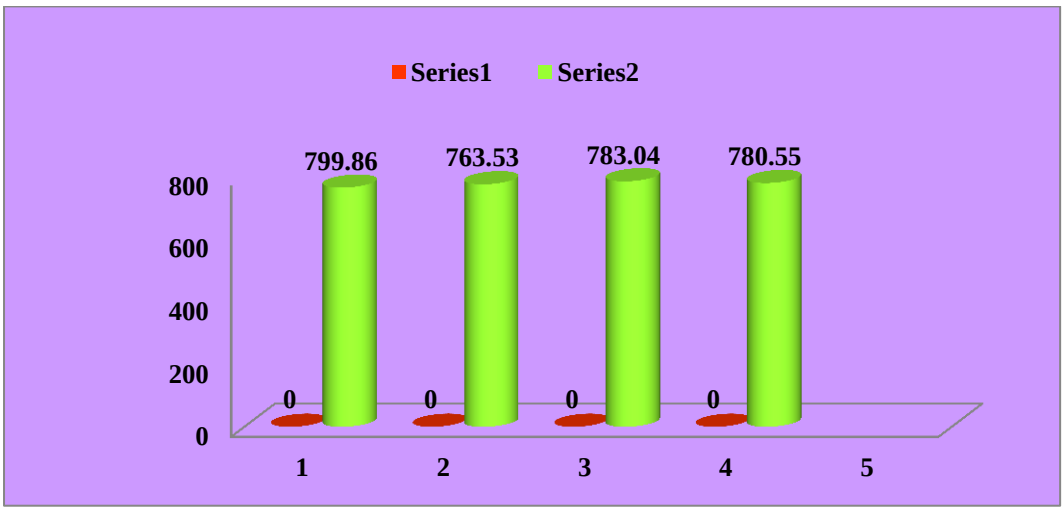
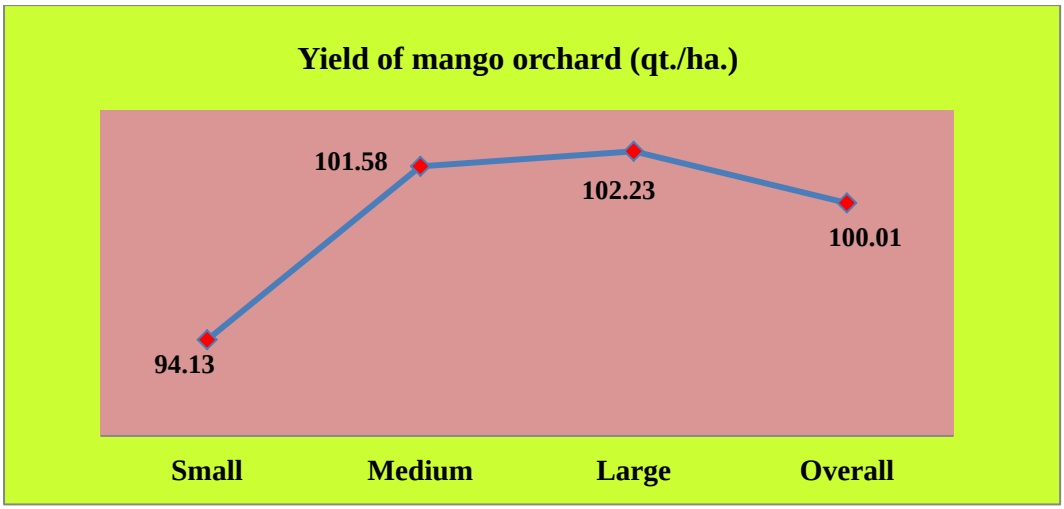


Fig.4.40: Yield of mango orchard (qt./ha.)



4.3.10. Measures of farm profit

The values of net income, family labour income and farm business the per hectare the sample farms of different size groups have been worked out in the table 4 .25 and figure 4.41. The table indicates that, on an average the value of net average family labour income and farm business income per hectare came Rs .124369.81 and Rs.136763.04, respectively, on the sample farms of different sizes. Overall on an average the input output cost ratio of mango orchard came to 1:2.60 on the sample farms.

Table 4.25: Cost and return of mango orchard on the sample farm for different groups of farm

(Rs./ha.)

S. No.	Particulars	Farm size			
		Small	Medium	Large	Overall
1.	Input cost	75291.44	77559.75	80050.39	78029.69
2.	Output cost	189779.25	205433.36	207435.91	202399.73
3.	Net income	114487.81	127873.61	127385.52	124370.08
4.	Family labour income	112509.91	127873.61	127384.92	124369.81
5.	Farm business income	126492.08	140168.83	140091.05	136763.04
6.	Farm investment income	126492.08	140168.83	140091.01	136763.31
7.	Benefit cost ratio	1:2.52	1:2.64	1:2.59	1:2.60

Cost and returns on the basis of cost concept

The cost and returns on the basis of cost concept in the production of mango orchard have been presented in the table 4 .26 and figure 4.42 that, the per hectare cost-A_1, A_2, cost-B_1, B_2, and cost-C_1, C_2, C_3 at the overall level were Rs. 65636.69, 65636.69, Rs.68432.84, 78029.92, and Rs.78685.73, 88282.81, 97111.09 per hectare, respectively on the sample farms. The average income per hectare over cost- A_1, A_2, cost-B_1, B_2 and cost-C_1, C_2, C_3 were worked out to 136763.04, 136763.04, Rs. 133966.89, 124369.81 and Rs. 123714.00, 114116.92, 105288.64, respectively. The income over different costs also increased with the increase in the farms size because of higher output in relation to total input cost .

Fig.4.41: Cost and return of mango orchard on the sample farm for different groups of farms (Rs./ha.)

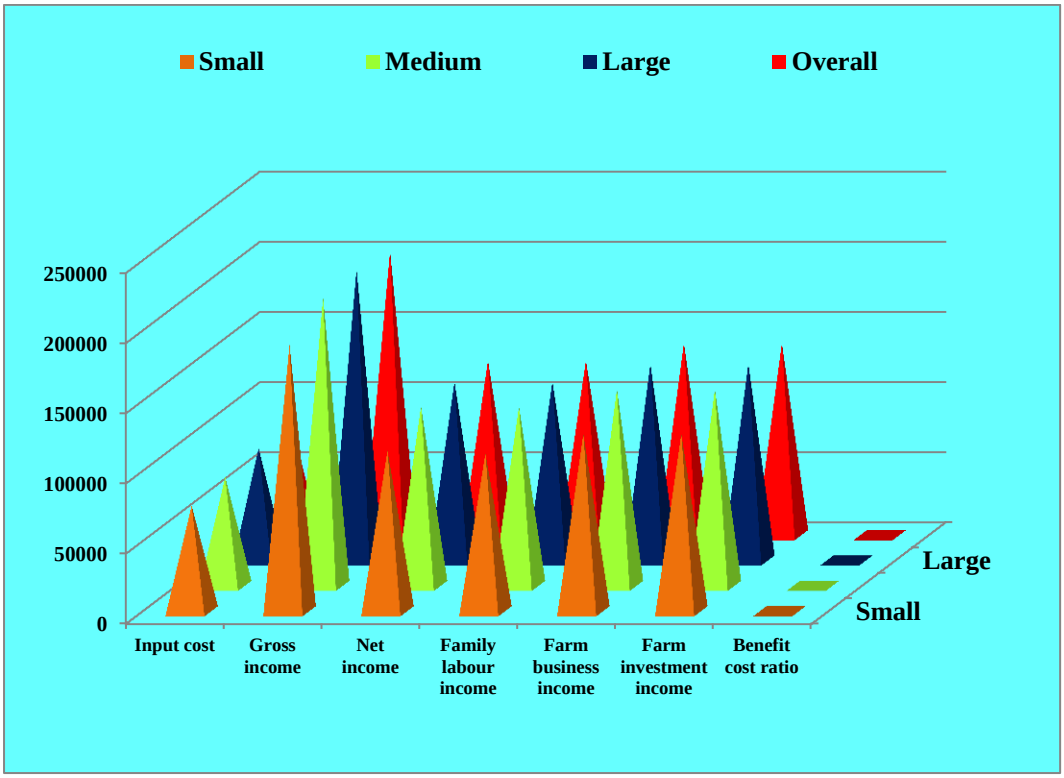


Fig.4.42: Cost concept of mango orchard on the sample farms (Rs./ha.)

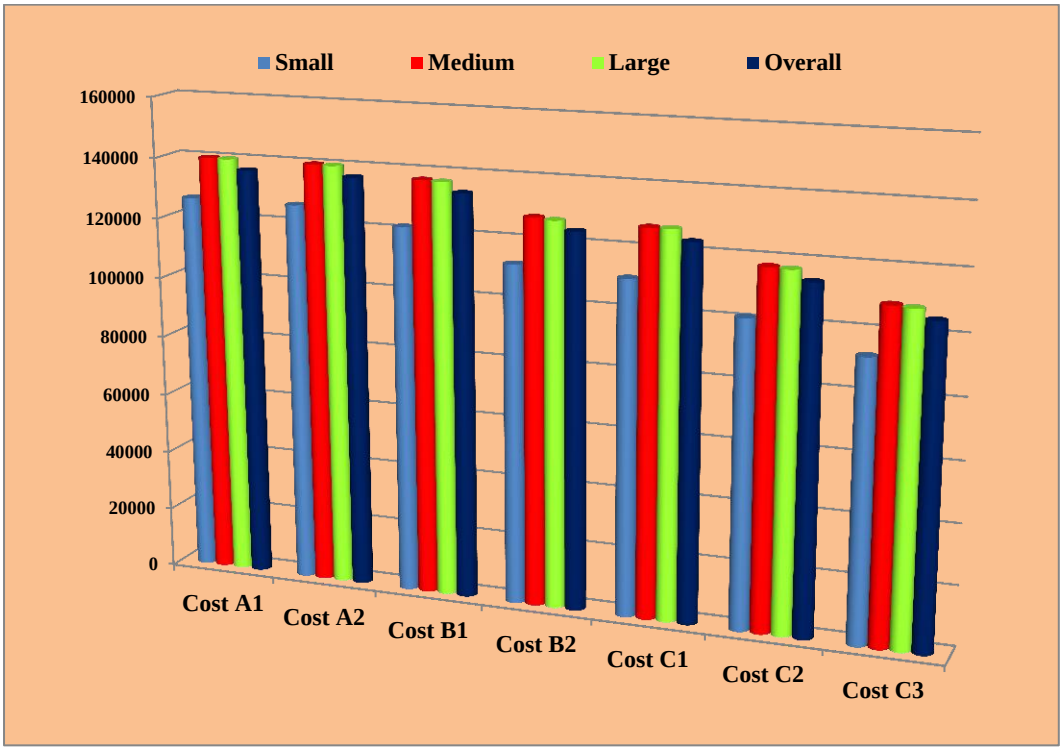


Table 4.26: Per hectare yield value of output and cost of production per quintal of mango orchard.

(Rs./ha.)

S. No.	Cost/category	Small	Medium	Large	Overall
A.	**Break-up cost**				
1.	Cost A_1 (all actual expenses)	63286.45	65264.53	67345.41	65636.69
2.	Cost A_2=Cost A_1+Rent paid for leased in land	63286.45	65264.53	67345.41	65636.69
3.	Cost B_1=Cost A_1+Interest on value of owned fixed capital	67948.02	68026.86	70236.52	68432.84
4.	Cost B_2=Cost B_1+Rental value of owned land and rent paid for leased inland	77269.34	77559.75	80050.99	78029.92
5.	Cost C_1=Cost B_1+Imputed value of family labour	79015.23	78150.25	80109.98	78685.73
6.	Cost C_2=Cost B_2+Imputed value of family labour	88336.55	87683.14	89924.45	88282.81
7.	Cost C_3=Cost B_2+10% of cost C_2 on account of managerial function performed by farmer	97170.20	96451.45	98916.89	97111.09
B.	**Income over different cost**				
	I.O.D.C. A_1	126492.08	140168.83	140090.05	136763.04
	I.O.D.C A_2	126492.08	140168.83	140090.05	136763.04
	I.O.D.C. B_1	121831.23	137406.05	137199.39	133966.89
	I.O.D.C. B_2	112509.91	127873.61	127384.92	124369.81
	I.O.D.C. C_1	110764.02	127275.11	127325.93	123714.00
	I.O.D.C. C_2	101442.07	117750.22	117511.46	114116.92
	I.O.D.C. C_3	92609.05	108981.91	108519.02	105288.64
C.	**Gross income**	**189779.25**	**205433.36**	**207435.91**	**202399.73**
D.	**Input output ratio**	**1:2.52**	**1:2.62**	**1:2.59**	**1:2.58**

4.4. Post harvest losses in major fruits

4.4.1. Post harvest losses in papaya at farm level

The estimated post harvest losses per quintal of papaya produced or handled at different stages at farm level are presented in table 4.27. These were estimated to be 17.01 kilogram per quintal in papaya at the farm level. Losses in quintal per hectare were also worked out which was found to be 25.28 quintal per hectare. Losses were found maximum in handling and transportation (35.92 per cent to the total loss at farm level) followed by marketing and packaging being 48.45 per cent to the total losses in papaya at farm level.

Table 4.27: Post harvest losses of papaya at farm level

S. No.	Stage	Losses (Kg./qt.)	Losses (qt./ha.)	Percentage
1	Harvesting	3.02	3.36	17.75
2	Grading & packaging	2.65	2.31	15.57
3	Handling & Transportation	6.11	11.09	35.92
4	Marketing	5.23	10.22	30.74
	Total	**17.01**	**25.28**	**100.00**

4.4.2. Post harvest losses in papaya at market level

The estimated post harvest losses per quintal of papaya handled at different stages at market level are presented in table 4.28. Post harvest losses in papaya at market label were estimated at wholesaler and retailer level. It has been reported that total post harvest losses at market level was found 7.24 kilogram per quintal out of which contribution of losses at wholesaler and retailer level was 4.89 and 2.35 kilogram per quintal respectively. Maximum share of losses among different operations of marketing was found in transportation (wholesaler level) being 30.11 per cent to the total losses at market level. Contribution of losses in transportation was found maximum among different operations at retailer level being 17.20 per cent to the total losses at market level.

Table 4.28: Post harvest losses of papaya at market level

S. No.	Stage	Losses (Kg./qt.)	Percentage
1.	**Losses at wholesaler level**		
	(a) Loading-unloading	0.46	6.35
	(b) Sorting & grading	0.77	10.63
	(c) Packaging	0.51	7.04
	(d) Storage	0.97	13.39
	(e) Transportation	2.18	30.11
	Sub total	**4.89**	**67.52**
2.	**Losses at retailer level**		
	(a) Loading-unloading	0.31	4.20
	(b) Transportation	1.27	17.20
	(c) Sorting grading	0.52	7.31
	(d) Selling	0.25	3.38
	Sub total	**2.35**	**32.09**
	Total	**7.24**	**100.00**

4.4.3. Post harvest losses in banana at farm level

The estimated post harvest losses per quintal of banana produced or handled at different stages at farm level are presented in table 4.29. These were estimated to be 15.49 kilogram per quintal in banana at the farm level. Losses in q/hectare were also worked out which was found to be 12.72 quintal per hectare. Losses were found maximum in handling and transportation (33.31 per cent to the total loss at farm level) followed by harvesting being 26.66 per cent to the total losses in banana at farm level.

Table 4.29: Post harvest losses of banana at farm level

S. No.	Stage	Losses (Kg/qt)	Losses (qt/ha)	Percentage
1	Harvesting	4.13	3.25	26.66
2	Grading & packaging	2.11	0.76	13.62
3	Handling & Transportation	5.16	4.19	33.31
4	Marketing	4.09	3.16	26.40
	Total	**15.49**	**12.72**	**100.00**

4.4.4. Post harvest losses in banana at market level

The estimated post harvest losses per quintal of banana handled at different stages at market level are presented in table 4.30. Post harvest losses in banana at market level were estimated at wholesaler and retailer level. It has been

reported that total post harvest losses at market level was found 5 .27 kilogram per quintal out of which contribution of losses at wholesaler and retailer level was 3.04 and 2.23 kilogram per quintal respectively. Maximum share of losses among different operations of marketing was found in transportation (wholesaler level) being 20.68 per cent to the total losses at market level. Contribution of losses in selling was found maximum among different operations at retailer level being 13.66 per cent to the total losses at market level.

Table 4.30: Post harvest losses of banana at market level

S.No.	Stage	Losses (Kg./qt.)	Percentage
1	**Losses at wholesaler level**		
	(a) Loading-unloading	0.26	4.93
	(b) Sorting & grading	0.43	8.15
	(c) Packaging	0.56	10.62
	(d) Storage	0.70	13.28
	(e) Transportation	1.09	20.68
	Sub total	**3.04**	**57.66**
2	**Losses at retailer level**		
	(a) Loading-unloading	0.25	4.74
	(b) Transportation	0.66	12.52
	(c) Sorting grading	0.60	11.38
	(d) Selling	0.72	13.66
	Sub total	**2.23**	**42.03**
	Total	**5.27**	**100.00**

4.4.5. Post harvest losses in mango at farm level

The estimated post harvest losses per quintal of mango produced or handled at different stages at farm level are presented in table 4.31. These were estimated to be 18.28 kilogram per quintal in mango at the farm level. Losses in quintal per hectare were also worked out which was found to be 25.63 quintal per hectare. Losses were found maximum in handling and transportation (33.97 per cent to the total loss at farm level) followed by marketing being 28.39 per cent to the total losses in mango at farm level.

Table 4.31: Post harvest losses of mango at farm level

S. No.	Stage	Losses (Kg./qt.)	Losses (qt./ha.)	Percentage
1	Harvesting	4.42	4.70	24.17
2	Grading & packaging	2.46	2.69	13.45
3	Handling & Transportation	6.21	6.97	33.97
4	Marketing	5.19	12.17	28.39
	Total	**18.28**	**25.63**	**100.00**

4.4.6. Post harvest losses in mango at market level

The estimated post harvest losses per quintal of mango handled at different stages at market level are presented in table 4.32. Post harvest losses in mango at market label were estimated at wholesaler and retailer level. It has been reported that total post harvest losses at market level was found 6.95 kilogram per quintal out of which contribution of losses at wholesaler and retailer level was 4.42 and 2.53 kilogram per quintal respectively. Maximum share of losses among different operations of marketing was found in transportation (wholesaler level) being 33.23 per cent to the total losses at market level. Contribution of losses in sorting and grading was found maximum among different operations at wholesaler level being 15.54 per cent to the total losses at market level.

Table 4.32: Post harvest losses of mango at market level

S. No.	Stage	Losses (Kg./qt.)	Percentage
1.	**Losses at wholesaler level**		
	(a) Loading-unloading	0.28	4.02
	(b) Sorting & grading	1.08	15.54
	(c) Packaging	0.43	6.18
	(d) Storage	0.32	4.60
	(e) Transportation	2.31	33.23
	Sub total		
2.	**Losses at retailer level**	**4.42**	**63.56**
	(a) Loading-unloading	0.18	2.58
	(b) Transportation	1.08	15.53
	(c) Sorting grading	0.98	14.10
	(d) Selling	0.29	4.17
	Sub total	**2.53**	**36.38**
	Total	**6.95**	**100.00**

4.4.7. Total post harvest losses in major fruits at different level

Table 4.33 represents the total post-harvest losses in major fruits at different levels. Total post harvest losses in papaya, banana and mango was found 24.25, 20.76, and 25.23 kilogram per quintal. Maximum losses were found in mango being 18.28, 4.42 and 2.53 kilogram per quintal at famer, wholesaler and retailer level respectively. Maximum share of losses was at farmer level.

Table 4.33: Total post harvest losses in major fruits

		Losses at different levels (Kg./qt.)			
S.No.	**Fruit**	**Farmer**	**Wholesaler**	**Retailer**	**Total**
1	Papaya	17.01	4.89	2.35	24.25
2	Banana	15.49	3.04	2.23	20.76
3	Mango	18.28	4.42	2.53	25.23

4.4.8. Factors affecting post harvest losses in papaya at farm level

Factors affecting post-harvest losses in papaya at farms level has been presented in table 4.34. Significant factors found affecting post-harvest losses positively was age of the respondent and distance of market from the village. So it can be suggested that by providing better marketing facilities to the farmers post harvest losses in papaya can be reduced at farm level.

Table 4.34: Factors affecting post harvest losses in papaya at farm level

S.No.	**Explanatory variables**	**Coefficients/Values**	**Standard error**
1	Intercept	13.8024	2.2556
2	Area of the crop	-0.2541	0.1779
3	Yield of the crop	0.0016	0.0030
4	Age of the respondent	0.0100	0.0422
5	Education of the respondent	0.2256*	0.4096
6	Distance from the market	0.0190	0.3791
7	Weather (dummy)	0.1881	0.3501
8	Timely labor availability (dummy)	0.1881	0.3501
9	Storage facility (dummy)	-0.1331**	0.5274
10	Transportation Facility (dummy)	-0.1707**	0.3761
11	R^2	0.03	-
12	F-Value	0.63	-
13	Adjusted R^2	-0.02	-

** Level of significance $p<0.01$

* Level of significance $p<0.05$

4.4.9. Factors affecting post-harvest losses in banana at farm level

Factors affecting post harvest losses in banana at farms level has been presented in table 4.35. Significant factors found affecting post harvest losses negatively was timely labour availability and transportation facility while distance of market from the village was found affecting the post-harvest losses positively. So it can be suggested that if labour will be made available on the required time and farmers then it may reduce post harvest losses in banana considerably.

Table 4.35: Factors affecting post harvest losses in banana at farm level

S. No.	Explanatory variables	Coefficients/Values	Standard error
1	Intercept	13.5003	2.3999
2	Area of the crop	-0.6585	0.2957
3	Yield of the crop	0.0034	0.0031
4	Age of the respondent	-0.0080	0.0203
5	Education of the respondent	0.2304	0.3629
6	Distance from the market	0.2124*	0.3684
7	Weather (dummy)	0.1503	0.3445
8	Timely labor availability (dummy)	-0.6535**	0.4070
9	Storage facility (dummy)	-0.0686	0.4461
10	Transportation Facility (dummy)	-0.1993**	0.3639
11	R^2	0.06	-
12	F - Value	1.06	-
13	Adjusted R^2	0.04	-

** Level of significance $p<0.01$
* Level of significance $p<0.05$

4.4.10. Factors affecting post harvest losses in mango at farm level

Factors affecting post harvest losses in mango at farms level has been presented in table 4.36. Significant factor found affecting post harvest losses negatively was timely labour availability and storage facility. So, by providing labours on the required time the post-harvest losses in mango at farm level can be reduced considerably.

Table 4.36: Factors affecting post harvest losses in mango at farm level

S.No.	Explanatory variables	Coefficients /Values	Standard error
1	Intercept	17.2842	2.2354
2	Area of the crop	-0.0250	0.5980
3	Yield of the crop	-0.0313	0.0560
4	Age of the respondent	0.0029	0.0227
5	Education of the respondent	-0.3385	0.4053
6	Distance from the market	-0.1485*	0.4057
7	Weather (dummy)	-0.0343*	0.3864
8	Timely labor availability (dummy)	-0.4906	0.4636
9	Storage facility (dummy)	-0.1155	0.4932
10	Transportation Facility (dummy)	0.4048**	0.4048
11	R^2	0.02	-
12	F - Value	0.45	-
13	Adjusted R^2	-0.03	-

** Level of significance $p<0.01$

* Level of significance $p<0.05$

4.5 Constraints in the post harvest management of major fruits

Constraints faced by farmers in post harvest management of major fruits have been presented in table 4.37. Mainly eight major constraints were found responsible for the mismanagement of post-harvest operations. Major constraints in post harvest management of papaya and banana was shortage of labour, adverse weather condition which was experienced by 131 and 142 per cent respondents respectively. Inadequate storage facilities was found to be the major constraint in mango growing farmers followed by adverse weather condition and capital unavailability experienced by 135, 134 and 132 per cent respondents respectively.

Table 4.37: Constraints in the post harvest management of major fruits

S.No	Problems	Number of respondents (150)		
		Papaya	**Banana**	**Mango**
1	Shortage of labour	131 (87.33)	112 (74.66)	125 (83.33)
2	Inadequate transportation facilities	116 (77.33)	129 (86.00)	118 (78.66)
3	Inadequate storage facilities	128 (85.33)	138 (92.00)	135 (90.00)
4	Capital unavailability	121 (80.66)	127 (84.66)	132 (88.00)
5	Insect pest and disease	102 (68.00)	92 (61.33)	110 (73.33)
6	Distance of market	85 (56.66)	88 (58.66)	82 (54.66)
7	Lack of knowledge about post-harvest technologies	118 (78.66)	122 (81.33)	112 (74.66)
8	Adverse weather condition	126 (84.00)	142 (94.66)	134 (89.33)

Note: Figures in the parenthesis represent percentage to the total no of respondents

CHAPTER-V
SUMMARY AND CONCLUSSIONS

5.1 Summary

Fruits are also grown in immense diversity in agro-climatic condition in Chhattisgarh enables to produce large varieties of fruits. Area under fruits production in Chhattisgarh state is around 261512 hectare. Total fruits production from this area is around 2592450 metric tonnes (Directorate of horticulture government of Chhattisgarh, 2017-18). Papaya, banana and mango are major fruits crop grown in Chhattisgarh. Bilaspur district covers 10.32 per cent share in total fruits area in Chhattisgarh. Growing fruits gives better returns to farmers as compared to cereals so beside health benefits vegetables can increase the income of Indian farmers. Export quality fruits fetch good price in international markets and contribute strengthening economy of the nation.

Outputs of all agricultural commodities produced in the field have to undergo a series of operations such as harvesting, transportation, processing, storage and exchange before they reach the consumer, and there are appreciable losses of outputs during these stages of their handling. The sum quantity of outputs lost in these operations at all of these stages is referred to as "post harvest losses". Losses of horticultural produce are a major problem in the post-harvest chain. They can be caused by a wide variety of factors, ranging from growing conditions to handling at retail level. During the process of distribution and marketing, substantial losses are incurred which range from a slight loss of quality to total spoilage. Postharvest losses may occur at any point in the marketing process, from the initial harvest through assembly and distribution to the final consumer. The causes of losses are many: physical damage during handling and transport, physiological decay, water loss, or sometimes simply because there is a surplus in the marketplace and no buyer can be found. Not only are losses clearly a waste of food, but they also represent a similar waste of human efforts, farm inputs, livelihoods, investments and scarce resources such as water. The reduction of post-harvest loss of fruits is a complementary means

for increasing production. It may not be necessary to considerably step up the production of fruits with the growing demand if the post-harvest loss is reduced to a great extent. From the standpoint of economy and food safety for the population of the country there is a need to reduce such losses . So it becomes important to study on the post-harvest losses of fruits so that they can be minimized. Therefore the present study is a comprehensive attempt to estimate the dimensions of losses occurring during the post-harvest stages of major fruits crop with the following objectives.

1. To estimate compound growth rate of area, production, and productivity of major fruits in the study area.
2. To find out the cost of cultivation of selected major fruits in the study area.
3. To estimate the post harvest losses of major fruits in the study area.
4. To study the factor affecting post harvest losses at farm level .
5. To identify the constraints of post harvest management of major fruits and suggest some measures for the improvement of the same in the study area .

A multi-stage sampling design was adopted for the ultimate selection of fruit growing farmers. Chhattisgarh plains were selected based on highest area under fruits in Chhattisgarh state. Bilaspur district was selected for Papaya, banana and mango crop,. Three blocks from each of the district i.e. Belha, Masturi, and Takhatpur block from Bilaspur district were selected based on highest area of the respective fruits. One hundred fifty farmers from fifteen villages of Bilaspur district were selected for the study. Forty retailers and ten wholesalers were selected from the selected districts. Major fruits were selected based on the highest contribution of the area under fruits in Chhattisgarh Plains. The primary data has been collected from the survey of sampled cultivators through personal interview with the help of pre-tested and structured schedules and the secondary data were collected from published sources and from various government offices and websites including the district statistical department and district horticulture department etc.

The data collected from the farmer respondents included general information about the age, education, family size, total holding, cultivation of major fruits, labor and Input used for production, total production of crop, selling price,

methods of harvesting, mode of packaging, storage system, mode of transportation and losses during post-harvest stages such as harvesting, transportation, storage and weather loses. The secondary data were collected from published sources and from various government offices and websites including the district statistical department and district horticulture department etc.

To work out the status of major fruits in Bilaspur district, Chhattisgarh plains and Chhattisgarh compound growth rates were estimated, to work out the cost of cultivation the standard method of cost of cultivation was adopted, to work out factors affecting post-harvest losses, regression analysis was adopted and to estimate losses at different stages, constraints in post-harvest management etc. standard methods were used.

5.2 Conclusions

1. Compound growth rate in area, production and productivity of papaya was found positively significant in Bilaspur district. Compound growth rate in area and production of banana was found positively significant and productivity is negative and non-significant in case of Chhattisgarh state.
2. Compound growth rate in area of banana was found positively significant in Bilaspur district. Production and productivity in case of negative and non-significant. Then compound growth rate in area and production of banana was found positively significant in Bilaspur district and productivity is negative and non-significant Chhattisgarh state.
3. Compound growth rate in area and production of mango was found positively significant and productivity is negative and non-significant in case of Bilaspur district. Then compound growth rate in area and production of mango was found positively significant and productivity is negative and non-significant in case of in Chhattisgarh state.
4. Total post-harvest losses in papaya and banana was found 16.26 and 17.58 kilogram per quintal, maximum losses were found in mango being 11.48 4.42 and 2.35 kilogram per quintal famer, wholesaler and retailer level respectively. Maximum share of losses was at farmer level.

5.Major constraints in post-harvest management of papaya and banana were shortage of labour, adverse weather condition which was experienced by 131 and 142 per cent respondents respectively. Inadequate storage facilities was found to be the major constraint in mango growing farmers followed by adverse weather condition and capital unavailability experienced by 135, 134 and 132 per cent respondents respectively.

5.3. Suggestions for the future work

1. Some schemes have to be launched by the governments which support mechanization on marginal and small farms.
2. Most of the farmers do not grow crops during rabi season because of unavailability of irrigation. So, policies to promote irrigation facilities should be implemented on the root level.
3. Post-harvest losses can be minimized by improving storage structures, by educating farmers and by developing such policies that can reduce the labour problem for the farmers of study area.
4. Government should construct more cold storage structures so that farmers can store their produce safely for longer periods.
5. Detailed study on post-harvest losses will require to cover all the dimensions of post-harvest losses and cost of cultivation at different agro-climatic zones of Chhattisgarh state.
6. Efficient use of input and resources so as to gain maximum output with minimum cost.
7. Easy and efficient finance service from different financing agencies is very important to promote area production of papaya, banana and mango is study area.
8. Proper cultivation practices should be followed in accordance with the latest techniques.0

APPENDICES

APPENDIX-A

INTERVIEW SECHEDULE AND QUESTIONNARE

DEPARTMENT OF AGRICULTURAL ECONOMICS
INDIRA GANDHI KRISHI VISHWAVIDYALAYA, RAIPUR (C.G.)
"ECONOMIC STUDY OF POST HARVEST LOSSES OF MAJOR FRUITS IN BILASPUR DISTRICT OF CHHATTISGARH"

Advisor:- Dr.B.C. Jain (Professor)

Investigator: - Naresh Kumar
Date:

A. General information

1. Name of Farmer……2. Age…….

3.Education……4.Cast(Gen/ST/SC/OBC)…….....

5.Village……6.Post……..

7.Tehsil……..8.District…….

9.State……10.Distance from market…….…..

11.Distance from pacca road (km)……

B. Details of the family:

S. No.	Name of the family Member	Relation head	Sex	Age	Education	Occupation	
						main	subsidiary
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

C. Details of land holding:
Land Information:

1. Total owned land (acre) …….. 2. Agriculture use (acre) …….

3. Non-agriculture use (acre) …….. 4. Leased in land (acre) ……..**.....**

5. Leased out land (acre) …… 6. Land under current fallow (acre) …….…….

7. Total cultivated area (acre) …….. a. irrigated ……...

b. un-irrigated …….…….

8. Area under major vegetables (acre) …… 9. Fruit (acre) ……

If yes, then reason for not cultivated …….....(Lack of water /barren land /any other)

D. Source of irrigation:

S. No.	Name of Source	Area (acre)	Owned /Hired	Charges (Rs./acre)
1.	Tube well			
2.	Canal			
3.	Tank			
4.	Ponds			
5.	Well (traditional)			
6.	Well (pump)			
7.	Other			

E. Cost of cultivation:

Crop ----------

Variety ----------

Area ---------- (Irrigate /unirrigated) ----------

(a) Labour cost:

S.N.	Operation	Family human labour (days)			Hired human labour (days)				Bullock power			Machine power			Total expend i-ture on parti-cular opera-tion
		M	F	T	M	R	F	R	O	H	R	O	H	R	
1.	Field preparation														
2.	Application of Manure & fertilizer														
3.	Nursery bed preparation														
4.	Sowing														
5.	Inter culture														
6.	Irrigation														
7.	Plant protection														
8.	Harvesting/Picking														
9.	Cleaning														
10.	Transportation														
11.	Miscellaneous														
	Total														

M= Male, F = Female, , T = Total, O = Family labour, H = Hired labour, R= Rate/unit(Rs.)

(b) Input cost:

S.No.	Input	Quantity	Quantity Rate(Rs.) / unit	Total value (Rs.)
1.	Seed a. b.			
2.	FYM			
3.	Fertilizer a. b. c.			
4.	Plant protection chemicals a b.			
Total				

Irrigation charges ----------

Interest on working capital ----------

Fixed cost:

a) Rental value of land/leased in land (Rs.) ----------

b) Land revenue (Rs.) ----------

F. Post harvest losses in fruit at farm level:

Stage	**Losses (Kg/qt)**	**Losses (qt/ha)**
Harvesting		
Grading & packaging		
Handling & Transportation		
Marketing		
Total		

G. Post harvest losses in fruit at wholesaler level:

S.N.	Stage	Losses (Kg/qt)
1.	Loading-unloading	
2.	Sorting & grading	
3.	Packaging	
4.	Storage	
5.	Transportation	

H. Post harvest losses in fruit at retailer level:

S.No.	Stage	Losses (Kg/qt)
1.	Loading-unloading	
2.	Transportation	
3.	Sorting Grading	
4.	Storage	
5.	Selling	

I. Factors of post harvest losses in fruit at farm level:

1. Area of the crop (ha.)…….
2. Yield of the crop (qt/ha.)……..
3. Ag of the respondent (Number)……..
4. Education of the respondent (Number)……..
5. Distance from the market (km.)……..
6. Weather (dummy). If favorable ‘1’ or non-favorable ‘0’……
7. Timely labor availability (dummy), if available ‘1’ or unavailable ‘0’…….
8. Storage facility (dummy), if adequate‘1’ or inadequate ‘0’……
9. Transportation facility (dummy), if yes ‘1’ or no ‘0’…….

J. Constraints in post harvest management of fruit crops (Tick mark the co constraint):

S. No.	Problems	No. of respondents		
		Papaya	Banana	Mango
1	Shortage of labour			
2	Inadequate transportation facilities			
3	Inadequate storage facilities			
4	Capital unavailability			
5	Insect pest and disease			
6	Distance of market			
7	Lack of knowledge about post harvest technologies			
8	Adverse weather condition			

APPENDIX-B

1. Name of farmers in Bilapur district:

S. N.	Farmers Name	S. N.	Farmers Name	S. N.	Farmers Name
1	Shri. Vardhaman Bairagi	51	Shri. Gopal Das Patel	101	Shri. Liladhar Kewat
2	Shri. Ageti Ram	52	Shri. Iteshwar Bairagi	102	Shri. Mongram Fogat
3	Shri. Hathwari Quereshi	53	Shri. Revatiram Jagat	103	Shri. Boranman Faigu
4	Shri. Keshar Kumar	54	Shri. Sukhdev Patel	104	Shri. Nangeshwar Uraon
5	Shri. Manmohan Patel	55	Shri. Pakharu Painkra	105	Shri. Onkareshwar Singh
6	Shri. Manghuram Uraon	56	Shri. Lohman Uraon	106	Shri. Lekhram Dorpa
7	Shri. Somdas Painkra	57	Shri. Dukalu RamPainkra	107	Shri. Asaru Uraon
8	Shri. Rosandas Patel	58	Shri. Jagat Pratap Patel	108	Shri. Tarkhet Kewat
9	Shri. Nakul Singh Thakur	59	Shri.Rajkumar Patel	109	Shri. BhagirathiShrivastav
10	Shri. Fulchand Kewat	60	Shri. Hariram Kaiwart	110	Shri. Tulsi Ram
11	Shri. Ramsey bais	61	Shri. Yogeshwar Yadav	111	Shri. Brajmohan
12	Shri. Dhurdu Aheer	62	Shri. Dilip Jagat	112	Shri. Ramsay Dewagan
13	Shri. Bitla Aheer	63	Shri. Ramlakhan	113	Shri. Lochan Dhruv
14	Shri. Munna Lal Nagda	64	Shri. Gaindu ram	114	Shri. Aaju Ram Gode
15	Shri. Bhadoriya Lal	65	Shri. Vikram patel	115	Shri. Mangal Chadrakar
16	Shri. Maitu Laal	66	Shri. Santosh Dahire	116	Shri Parbhu Ram
17	Shri. Satyaprakash	67	Shri. Manik Lal	117	Shri. Hemant Sahu
18	Shri. Daniyaal Paikra	68	Shri. Vishnu Prasad	118	Shri. Gendlal Koshariya
19	Shri. Sudheer Nagesiya	69	Shri. Laxmi Kant	119	Shri. Pankaj Bhargav
20	Shri. Jaypal Yadav	70	Shri. Radhe Pahare	120	Shri. Banshi Lal
21	Shri. Balkeshar Kumar	71	Shri Syam sundar Lodhi	121	Shri. Bisnu Baghel
22	Shri. Raju Kumar	72	Shri. Pankaj Lal Marar	122	Shri. Bhikham Nagraj
23	Shri. Manglu Dewatram	73	Shri. Hiteswar Sahu	123	Shri. Bholu Ram
24	Shri. Jagmohan Dewariya	74	Shri. Thanu ram Kewat	124	Shri. Chand Prakash
25	Shri. Nanheshwar	75	Shri. Brij Ram Patel	125	Shri. Tilochan Ram
26	Shri. Brij Bharti	76	Shri. Mittu Ram	126	Shri. Gajend Dhirhi
27	Shri. Rathu Kumhar	77	Shri. Lekh Ram Kujur	127	Shri. Bala Ram Bharti
28	Shri. Manglu Dewatram	78	Shri. Deva Ram Yadav	128	Shri Bhagirathi Shinha
29	Shri. Jagmohan Dewariya	79	Shri. Lila Ram Sahu	129	Shri Baiju Ram Baiga
30	Shri. Nanheshwar	80	Shri. Lokesh Dewangan	130	Shri Bihari Baid
31	Shri. Rampratap	81	Shri. Tarechand Lahre	131	Shri Bedprasad Kurre
32	Shri. Rathu Kumhar	82	Shri. Hira Lal Jataw	132	Shri Munna Lal
33	Shri. Bindul Dhariya	83	Shri. Khorbahra Markam	133	Shri Tihari Prasad
34	Shri. Dularu Kewat	84	Shri. Bisnu Bhardwaj	134	Shri Kartik Ram
35	Shri.Gofelal Tonder	85	Shri. Sanat Patel	135	Shri. Panna Lal
36	Shri.Umend Das	86	Shri. Nohar Manikpuri	136	Shri. Nand Prasad
37	Shri.Kripa Baghel	87	Shri. Dhansing Patle	137	Shri. Anjori Lal
38	Shri.Sanat Dube	88	Shri. Dharam Lal Jogi	138	Shri. Sarvan Lahre
39	Shri.Tulshi Ram	89	Shri. Shiv Patel	139	Shri. Syam Mukharjee
40	Shri.Satruhan Ghos	90	Shri. Lala Ram	140	Shri. Mahetru Patel
41	Shri.Tribhuvan Pahare	91	Shri. Jivan Lal	141	Shri Mangal Ram
42	Shri.Neman Jngde	92	Shri. Chaitu Ram	142	Shri Rohit Patel

S. N.	Farmers Name	S. N.	Farmers Name	S. N.	Farmers Name
43	Shri.Lakhan Ram Banjara	93	Shri. Shivan Sahu	143	Shri Ishwari Lal
44	Shri.Gore Hirwani	94	Shri. Badri Painkra	144	Shri Ramgopal Yadav
45	Shri.Binda Potai	95	Shri. Hemlala Yadav	145	Shri Bije Ram Manohar
46	Shri.Dhansay Dadsena	96	Shri. Awtaar Yadav	146	Shri Bindu Potai
47	Shri.Ram Kumar	97	Shri. Toran Gupta	147	Shri.Balraj Baiga
48	Shri.Narayan Prasad	98	Shri. Sita Ram Sahu	148	Shri. Manohar Lal
49	Shri.Dronak Yadav	99	Shri. Bhagwat Sonwani	149	Shri. Lakhan dewangan
50	Shri.Leela Ram	100	Shri. Mangal Ram	150	Shri. Jagtaran Sahu

2. Name of retailer and wholesalers in Bilaspur distris:

S.No.	Retailer		Wholesalers
1	Shri. Devraj	1	Shri. Vibha
2	Shri. Sakthi	2	Shri. Krisna AG
3	Shri. Vedivelu	3	Shri. Ganesh Trading
4	Shri. Roshan	4	Shri. Pravesh Chadha
5	Shri. Narayan	5	Shri. Gopal
6	Shri. Ekbal	6	Shri. Tpan
7	Shri. Manoj	7	Shri. Golu Traders
8	Shri. Jayam	8	Shri. Dilip
9	Shri. Vijay	9	Shri. Jeet
10	Shri. Neutra	10	Shri. Amarya
11	Shri. Jaylakshmi		
12	Shri. Karthik		
13	Shri. Karunakaran		
14	Shri. N.K.G		
15	Shri. Jeevan		
16	Shri. Piur		
17	Shri. Vinoth		
18	Shri. Star		
19	Shri. R.R.		
20	Shri. K.P.R		
21	Shri. Prasath		
22	Sudhakar		
23	Shri. Vinayaga		
24	Shri. Anbuselvi		
25	Shri. Arun		
26	Shri. Bhaskar		
27	Shri. B.K.M		
28	Shri. B.M. Fruits		
29	Shri. Krishna		
30	Shri. Kumaran		
31	Shri. M.K. Fruits		
32	Shri. Nathi		

33	Shri. Neejam		
34	Shri. Piyur		
35	Shri. Pramod Dev		
36	Shri. Mendu		
37	Shri. B.K.S. Fruits		
38	Shri. Brij Bharti		
39	Shri. Anish		
40	Shri. Bhojendra		

RESUME

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Academic Qualification:

Degree/ Diploma	Year of passing	Board/ University	Major Subject
HSSC	2009	CGBS. Raipur (C.G.)	Agriculture
B.Sc. (Ag.)	2014	I.G.K.V. Raipur (C.G.)	Agriculture
M.Sc. (Ag.)	2016	I.G.K.V. Raipur (C.G.)	Agricultural Economics
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Professional Experience (if any) : No

Membership of Professional Societies (if any) : No

Award/Recognition (If any) : Yes

Publications (If any): In Number Only : 05

Signature

CHAPTER-V
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for increasing production. It may not be necessary to considerably step up the production of fruits with the growing demand if the post-harvest loss is reduced to a great extent. From the standpoint of economy and food safety for the population of the country there is a need to reduce such losses . So it becomes important to study on the post-harvest losses of fruits so that they can be minimized. Therefore the present study is a comprehensive attempt to estimate the dimensions of losses occurring during the post-harvest stages of major fruits crop with the following objectives.

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To work out the status of major fruits in Bilaspur district, Chhattisgarh plains and Chhattisgarh compound growth rates were estimated, to work out the cost of cultivation the standard method of cost of cultivation was adopted, to work out factors affecting post-harvest losses, regression analysis was adopted and to estimate losses at different stages, constraints in post-harvest management etc. standard methods were used.

5.2 Conclusions

1. Compound growth rate in area, production and productivity of papaya was found positively significant in Bilaspur district. Compound growth rate in area and production of banana was found positively significant and productivity is negative and non-significant in case of Chhattisgarh state.
2. Compound growth rate in area of banana was found positively significant in Bilaspur district. Production and productivity in case of negative and non-significant. Then compound growth rate in area and production of banana was found positively significant in Bilaspur district and productivity is negative and non-significant Chhattisgarh state.
3. Compound growth rate in area and production of mango was found positively significant and productivity is negative and non-significant in case of Bilaspur district. Then compound growth rate in area and production of mango was found positively significant and productivity is negative and non-significant in case of in Chhattisgarh state.
4. Total post-harvest losses in papaya and banana was found 16.26 and 17.58 kilogram per quintal, maximum losses were found in mango being 11.48 4.42 and 2.35 kilogram per quintal famer, wholesaler and retailer level respectively. Maximum share of losses was at farmer level.

5.Major constraints in post-harvest management of papaya and banana were shortage of labour, adverse weather condition which was experienced by 131 and 142 per cent respondents respectively. Inadequate storage facilities was found to be the major constraint in mango growing farmers followed by adverse weather condition and capital unavailability experienced by 135, 134 and 132 per cent respondents respectively.

5.3. Suggestions for the future work

1. Some schemes have to be launched by the governments which support mechanization on marginal and small farms.
2. Most of the farmers do not grow crops during rabi season because of unavailability of irrigation. So, policies to promote irrigation facilities should be implemented on the root level.
3. Post-harvest losses can be minimized by improving storage structures, by educating farmers and by developing such policies that can reduce the labour problem for the farmers of study area.
4. Government should construct more cold storage structures so that farmers can store their produce safely for longer periods.
5. Detailed study on post-harvest losses will require to cover all the dimensions of post-harvest losses and cost of cultivation at different agro-climatic zones of Chhattisgarh state.
6. Efficient use of input and resources so as to gain maximum output with minimum cost.
7. Easy and efficient finance service from different financing agencies is very important to promote area production of papaya, banana and mango is study area.
8. Proper cultivation practices should be followed in accordance with the latest techniques.0

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APPENDIX-A

INTERVIEW SECHEDULE AND QUESTIONNARE

DEPARTMENT OF AGRICULTURAL ECONOMICS
INDIRA GANDHI KRISHI VISHWAVIDYALAYA, RAIPUR (C.G.)
"ECONOMIC STUDY OF POST HARVEST LOSSES OF MAJOR FRUITS IN BILASPUR DISTRICT OF CHHATTISGARH"

Advisor:- Dr.B.C. Jain (Professor)

Investigator: - Naresh Kumar
Date:

A. General information

1. Name of Farmer……2. Age…….

3.Education……4.Cast(Gen/ST/SC/OBC)…….....

5.Village……6.Post……..

7.Tehsil……..8.District…….

9.State……10.Distance from market…….…..

11.Distance from pacca road (km)……

B. Details of the family:

S. No.	Name of the family Member	Relation head	Sex	Age	Education	Occupation	
						main	subsidiary
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

C. Details of land holding:
Land Information:

1. Total owned land (acre) …….. 2. Agriculture use (acre) …….

3. Non-agriculture use (acre) …….. 4. Leased in land (acre) ……..**.....**

5. Leased out land (acre) …… 6. Land under current fallow (acre) …….…….

7. Total cultivated area (acre) …….. a. irrigated ……...

b. un-irrigated …….…….

8. Area under major vegetables (acre) …… 9. Fruit (acre) ……

If yes, then reason for not cultivated …….....(Lack of water /barren land /any other)

D. Source of irrigation:

S. No.	Name of Source	Area (acre)	Owned /Hired	Charges (Rs./acre)
1.	Tube well			
2.	Canal			
3.	Tank			
4.	Ponds			
5.	Well (traditional)			
6.	Well (pump)			
7.	Other			

E. Cost of cultivation:

Crop ----------

Variety ----------

Area ---------- (Irrigate /unirrigated) ----------

(a) Labour cost:

S.N.	Operation	Family human labour (days)			Hired human labour (days)				Bullock power			Machine power			Total expend i-ture on parti-cular opera-tion
		M	F	T	M	R	F	R	O	H	R	O	H	R	
1.	Field preparation														
2.	Application of Manure & fertilizer														
3.	Nursery bed preparation														
4.	Sowing														
5.	Inter culture														
6.	Irrigation														
7.	Plant protection														
8.	Harvesting/Picking														
9.	Cleaning														
10.	Transportation														
11.	Miscellaneous														
	Total														

M= Male, F = Female, , T = Total, O = Family labour, H = Hired labour, R= Rate/unit(Rs.)

(b) Input cost:

S.No.	Input	Quantity	Quantity Rate(Rs.) / unit	Total value (Rs.)
1.	Seed a. b.			
2.	FYM			
3.	Fertilizer a. b. c.			
4.	Plant protection chemicals a b.			
Total				

Irrigation charges ----------

Interest on working capital ----------

Fixed cost:

a) Rental value of land/leased in land (Rs.) ----------

b) Land revenue (Rs.) ----------

F. Post harvest losses in fruit at farm level:

Stage	**Losses (Kg/qt)**	**Losses (qt/ha)**
Harvesting		
Grading & packaging		
Handling & Transportation		
Marketing		
Total		

G. Post harvest losses in fruit at wholesaler level:

S.N.	Stage	Losses (Kg/qt)
1.	Loading-unloading	
2.	Sorting & grading	
3.	Packaging	
4.	Storage	
5.	Transportation	

H. Post harvest losses in fruit at retailer level:

S.No.	Stage	Losses (Kg/qt)
1.	Loading-unloading	
2.	Transportation	
3.	Sorting Grading	
4.	Storage	
5.	Selling	

I. Factors of post harvest losses in fruit at farm level:

1. Area of the crop (ha.)…….
2. Yield of the crop (qt/ha.)……..
3. Ag of the respondent (Number)……..
4. Education of the respondent (Number)……..
5. Distance from the market (km.)……..
6. Weather (dummy). If favorable ‘1’ or non-favorable ‘0’……
7. Timely labor availability (dummy), if available ‘1’ or unavailable ‘0’…….
8. Storage facility (dummy), if adequate‘1’ or inadequate ‘0’……
9. Transportation facility (dummy), if yes ‘1’ or no ‘0’…….

J. Constraints in post harvest management of fruit crops (Tick mark the co constraint):

S. No.	Problems	No. of respondents		
		Papaya	Banana	Mango
1	Shortage of labour			
2	Inadequate transportation facilities			
3	Inadequate storage facilities			
4	Capital unavailability			
5	Insect pest and disease			
6	Distance of market			
7	Lack of knowledge about post harvest technologies			
8	Adverse weather condition			

APPENDIX-B

1. Name of farmers in Bilapur district:

S. N.	Farmers Name	S. N.	Farmers Name	S. N.	Farmers Name
1	Shri. Vardhaman Bairagi	51	Shri. Gopal Das Patel	101	Shri. Liladhar Kewat
2	Shri. Ageti Ram	52	Shri. Iteshwar Bairagi	102	Shri. Mongram Fogat
3	Shri. Hathwari Quereshi	53	Shri. Revatiram Jagat	103	Shri. Boranman Faigu
4	Shri. Keshar Kumar	54	Shri. Sukhdev Patel	104	Shri. Nangeshwar Uraon
5	Shri. Manmohan Patel	55	Shri. Pakharu Painkra	105	Shri. Onkareshwar Singh
6	Shri. Manghuram Uraon	56	Shri. Lohman Uraon	106	Shri. Lekhram Dorpa
7	Shri. Somdas Painkra	57	Shri. Dukalu RamPainkra	107	Shri. Asaru Uraon
8	Shri. Rosandas Patel	58	Shri. Jagat Pratap Patel	108	Shri. Tarkhet Kewat
9	Shri. Nakul Singh Thakur	59	Shri.Rajkumar Patel	109	Shri. BhagirathiShrivastav
10	Shri. Fulchand Kewat	60	Shri. Hariram Kaiwart	110	Shri. Tulsi Ram
11	Shri. Ramsey bais	61	Shri. Yogeshwar Yadav	111	Shri. Brajmohan
12	Shri. Dhurdu Aheer	62	Shri. Dilip Jagat	112	Shri. Ramsay Dewagan
13	Shri. Bitla Aheer	63	Shri. Ramlakhan	113	Shri. Lochan Dhruv
14	Shri. Munna Lal Nagda	64	Shri. Gaindu ram	114	Shri. Aaju Ram Gode
15	Shri. Bhadoriya Lal	65	Shri. Vikram patel	115	Shri. Mangal Chadrakar
16	Shri. Maitu Laal	66	Shri. Santosh Dahire	116	Shri Parbhu Ram
17	Shri. Satyaprakash	67	Shri. Manik Lal	117	Shri. Hemant Sahu
18	Shri. Daniyaal Paikra	68	Shri. Vishnu Prasad	118	Shri. Gendlal Koshariya
19	Shri. Sudheer Nagesiya	69	Shri. Laxmi Kant	119	Shri. Pankaj Bhargav
20	Shri. Jaypal Yadav	70	Shri. Radhe Pahare	120	Shri. Banshi Lal
21	Shri. Balkeshar Kumar	71	Shri Syam sundar Lodhi	121	Shri. Bisnu Baghel
22	Shri. Raju Kumar	72	Shri. Pankaj Lal Marar	122	Shri. Bhikham Nagraj
23	Shri. Manglu Dewatram	73	Shri. Hiteswar Sahu	123	Shri. Bholu Ram
24	Shri. Jagmohan Dewariya	74	Shri. Thanu ram Kewat	124	Shri. Chand Prakash
25	Shri. Nanheshwar	75	Shri. Brij Ram Patel	125	Shri. Tilochan Ram
26	Shri. Brij Bharti	76	Shri. Mittu Ram	126	Shri. Gajend Dhirhi
27	Shri. Rathu Kumhar	77	Shri. Lekh Ram Kujur	127	Shri. Bala Ram Bharti
28	Shri. Manglu Dewatram	78	Shri. Deva Ram Yadav	128	Shri Bhagirathi Shinha
29	Shri. Jagmohan Dewariya	79	Shri. Lila Ram Sahu	129	Shri Baiju Ram Baiga
30	Shri. Nanheshwar	80	Shri. Lokesh Dewangan	130	Shri Bihari Baid
31	Shri. Rampratap	81	Shri. Tarechand Lahre	131	Shri Bedprasad Kurre
32	Shri. Rathu Kumhar	82	Shri. Hira Lal Jataw	132	Shri Munna Lal
33	Shri. Bindul Dhariya	83	Shri. Khorbahra Markam	133	Shri Tihari Prasad
34	Shri. Dularu Kewat	84	Shri. Bisnu Bhardwaj	134	Shri Kartik Ram
35	Shri.Gofelal Tonder	85	Shri. Sanat Patel	135	Shri. Panna Lal
36	Shri.Umend Das	86	Shri. Nohar Manikpuri	136	Shri. Nand Prasad
37	Shri.Kripa Baghel	87	Shri. Dhansing Patle	137	Shri. Anjori Lal
38	Shri.Sanat Dube	88	Shri. Dharam Lal Jogi	138	Shri. Sarvan Lahre
39	Shri.Tulshi Ram	89	Shri. Shiv Patel	139	Shri. Syam Mukharjee
40	Shri.Satruhan Ghos	90	Shri. Lala Ram	140	Shri. Mahetru Patel
41	Shri.Tribhuvan Pahare	91	Shri. Jivan Lal	141	Shri Mangal Ram
42	Shri.Neman Jngde	92	Shri. Chaitu Ram	142	Shri Rohit Patel

S. N.	Farmers Name	S. N.	Farmers Name	S. N.	Farmers Name
43	Shri.Lakhan Ram Banjara	93	Shri. Shivan Sahu	143	Shri Ishwari Lal
44	Shri.Gore Hirwani	94	Shri. Badri Painkra	144	Shri Ramgopal Yadav
45	Shri.Binda Potai	95	Shri. Hemlala Yadav	145	Shri Bije Ram Manohar
46	Shri.Dhansay Dadsena	96	Shri. Awtaar Yadav	146	Shri Bindu Potai
47	Shri.Ram Kumar	97	Shri. Toran Gupta	147	Shri.Balraj Baiga
48	Shri.Narayan Prasad	98	Shri. Sita Ram Sahu	148	Shri. Manohar Lal
49	Shri.Dronak Yadav	99	Shri. Bhagwat Sonwani	149	Shri. Lakhan dewangan
50	Shri.Leela Ram	100	Shri. Mangal Ram	150	Shri. Jagtaran Sahu

2. Name of retailer and wholesalers in Bilaspur distris:

S.No.	Retailer		Wholesalers
1	Shri. Devraj	1	Shri. Vibha
2	Shri. Sakthi	2	Shri. Krisna AG
3	Shri. Vedivelu	3	Shri. Ganesh Trading
4	Shri. Roshan	4	Shri. Pravesh Chadha
5	Shri. Narayan	5	Shri. Gopal
6	Shri. Ekbal	6	Shri. Tpan
7	Shri. Manoj	7	Shri. Golu Traders
8	Shri. Jayam	8	Shri. Dilip
9	Shri. Vijay	9	Shri. Jeet
10	Shri. Neutra	10	Shri. Amarya
11	Shri. Jaylakshmi		
12	Shri. Karthik		
13	Shri. Karunakaran		
14	Shri. N.K.G		
15	Shri. Jeevan		
16	Shri. Piur		
17	Shri. Vinoth		
18	Shri. Star		
19	Shri. R.R.		
20	Shri. K.P.R		
21	Shri. Prasath		
22	Sudhakar		
23	Shri. Vinayaga		
24	Shri. Anbuselvi		
25	Shri. Arun		
26	Shri. Bhaskar		
27	Shri. B.K.M		
28	Shri. B.M. Fruits		
29	Shri. Krishna		
30	Shri. Kumaran		
31	Shri. M.K. Fruits		
32	Shri. Nathi		

33	Shri. Neejam		
34	Shri. Piyur		
35	Shri. Pramod Dev		
36	Shri. Mendu		
37	Shri. B.K.S. Fruits		
38	Shri. Brij Bharti		
39	Shri. Anish		
40	Shri. Bhojendra		

RESUME

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A study on cost of cultivation and post-harvest losses of banana in Bilaspur District of Chhattisgarh State

Naresh Kumar, Dr. BC Jain and Dr. MR Chandrakar

Abstract
As a consequence of technology, research and policy initiatives, India continues to be the second largest producer of fruits and vegetables with a share of about 13.6 per cent and 14 per cent to the worldwide fruits and vegetables production respectively. Due to its significant share in the worldwide horticultural production, India is very well recognized as fruits and vegetables basket of the world India's varied climate and physic-geographical conditions ensures availability of all kinds of horticultural crops such as fresh fruits and vegetables, spices, nuts, flowers and plantation crops (cocoa, cashew nut, and coconut). As per the NHB database (2016-17) India produced about 92.8 million tons of fruits and 175 million tonnes of vegetables with 6.40 million hectares and 10.30 million hectares land under fruits and vegetables cultivation, respectively. Chhattisgarh state are Mango, Guava, Lime, Litchi, Cashew-nut", Cheeku etc., apart from these major fruit crops minor fruits like Custard apple, Bael, Ber, Anola etc., are also grown both as cultivated and wild crop. The total area of the fruit crops in the state is" 26,1,512 hectares. Along with the production of 25,92,450 million tonnes in the year 2017-2018. Fruit production in Chhattisgarh contributes 25.27 per cent of total horticultural crops. Mango is having highest area among the fruit crops followed by banana, papaya, and guava while in terms of fruit production.

Keywords: Economics of banana, cost of production, farm profit, cost concept post-harvest losses in banana at market level

Introduction
Banana (*Musa paradisica*) is one of the most important commercial tropical fruits traded. Eve was said to have used banana leaves to cover he modesty in the Garden of Paradise as revealed from antiquity. Banana is thus called "*Apple of Paradise*". It is also known as "*Adam Fig*". Banana is a type of fruit from herbaceous plants of the genus *Musa*. *Musa* species grow in a wide range of environments and have varied human uses, ranging from the edible bananas and plantains of the tropics to cold-hardy fiber and ornamental plants. They have been a staple of the human diet since the dawn of recorded history. These large, perennial herbs, 2–9 m in height, evolved in Southeast Asia, New Guinea, and the Indian subcontinent, developing in modern time is secondary loci of genetic diversity in Africa, Latin America, and the Pacific. Musa species attained a position of central importance within Pacific societies: the plant is a source of food, beverages, fermentable sugars, medicines, flavorings, cooked foods, silage, fragrance, rope, cordage, garlands, shelter, clothing, smoking material, and numerous ceremonial and religious uses. Although mostly consumed locally in the Pacific region, the fruit enjoys a significant worldwide export market.

Methodology
The study area in Chhattisgarh state comes under Bilaspur district. Bilaspur district have highest area under banana crop contributing in 15.94 percent. So, Bilaspur district will be selected for banana crop in the study. Three blocks will be selected randomly in Bilaspur district under Masturi, Belha, and Takhatpur for the present study. Five villages will be selected from each block. So, fifteen villages will be selected from Masturi, Belha and Takhtpur each. In all, fifteen villages will be selected for the study.
Ten farmers will be selected from each village. So there will be fifty farmers from Masturi, fifty farmers from Belha and fifty farmers from Takhatpur blocks in Bilaspur district. In all 150 farmers will be interviewed for the study. For the estimation of post-harvest losses at different levels twenty retailers and five wholesalers will be selected from each district. In all, forty retailers and ten wholesalers will be interviewed for the study.

Cost of cultivation

The cost of cultivation of the banana farmers was worked out by using various cost concepts *viz*. Cost A_1, Cost A_2, Cost B_1, Cost B_2, and Cost C_1, Cost C_2, Cost C_3 as defined below:

Cost A_1: Consist of following 16 items of costs

1. Value of hired human labour (permanent and casual)
2. Value of owned bullock labour
3. Value of hired bullock labour
4. Value of owned machinery
5. Hired machinery charges
6. Value of fertilizers
7. Value of manures (owned and purchased)
8. Value of seed (farm produced and purchased)
9. Value of insecticide and pesticide
10. Irrigation charges
11. Canal water charges
12. Land revenue and other taxes
13. Depreciation on farm implements (bullock drawn and use by human labour)
14. Depreciation on farm building, farm machinery and irrigation structure
15. Interest on working capital
16. Miscellaneous expenses (artisans, ropes and repair to small farm implements)

Cost A_2 = Cost A_1 + Rent paid for leased in land.
Cost B_1 = Cost A_1+Interest on value of owned fixed capital.
Cost B_2 = Cost B_1+ Rental value of owned land and Rent paid for leased in land.
Cost C_1 = Cost B_1+ imputed value of family labour.
Cost C_2 = Cost B_2+ imputed value of family labour.
Cost C_3 = Cost C_2+10% of cost C_2 on account of managerial function performed by farmer.

Income over cost A_1 = Output Value – Cost A_1
Income over cost A_2 = Output Value – CostA_2
Income over cost B_1 = Output Value – Cost B_1
Income over cost B_2 = Output Value – Cost B_2
Income over cost C_1 = Output Value – Cost C_1
Income over cost C_2 = Output Value – Cost C_2
Income over cost C_3 = Output Value – Cost C_3

Result and Discussion

Economics of banana

The economics of" banana crop "is presented in table 1 and figure 1. It clearly shows that the cost of cultivation per hectare of" banana "was higher on large farms as compared to" small "farms. Over all, on an average the cost of cultivation per hectare of" banana was found to be Rs.17,9450.27 "per hectare. The cost of cultivation in case of large farm was higher Rs.18,7063.35 per hectare as compared to small Rs.16,8152.84 per hectare and medium farms Rs.17,8391.35 per hectare. The cost of cultivation per hectare showed a rising trend with the increase in size of farm. It was due to the fact that the large farmers incurred more expenditure on modern farm input like quality seed, fertilizer, plant protection material, hired labour etc. As a result of borrowing from credit institutions and better economic status compared to small and medium" farmer.

Yield, value of output and cost of production per quintal

The yield, value of output per hectare and cost of production per quintal of" banana on the sample farms have been worked out in table 2 and figure 2, 1.3. "It indicates that the average yield per hectare of" banana was 773.25 quintal on the sample farms. The cost of production per quintal of banana "on an average was worked out to Rs".231.97. It came to Rs.222.71, Rs.231.37 and Rs.237.99 for "small, medium and large farm size respectively. It decreased with the increased in the size of farm due to higher yields in return to the cost of cultivation on the large farm. The average" gross income per hectare came to Rs.54,3585.43. It was Rs.53,6223.65, Rs.54,0178.02 and Rs.55,0781.64 on small, medium and large farmer respectively. The higher gross income on large farms was associated with the higher yield."

Table 1: Economics of banana on different size groups of farms (Rs./ha.)

S. No	Cost	Farm size			
		Small	Medium	Large	Overall
(A)	**Variable cost**				
1.	Human labour				
(a)	Family labour	15324.34 (9.11)	9214.23 (5.16)	6431.13 (3.43)	6955.71 (3.87)
(b)	Hired labour	9231.08 (5.48)	16123.21 (9.03)	20214.94 (10.80)	16114.39 (8.97)
	Total human labour	24555.42 (14.60)	25337.44 (14.20)	26646.07 (14.240	25685.44 (14.31)
2.	Bullock labour	825.23 (0.49)	635.36 (0.33)	443.31 (0.230	602.81 (0.33)
3.	Machine labour	6450.33 (3.83)	8795.23 (4.93)	11050.12 (5.09)	9148.84 (5.09)
4.	Plant (seed) cost (1.8x1.8 meter)	42255.14 (25.12)	42424.19 (23.78)	42613.22 (22.78)	42460.62 (23.66)
5.	Manure & fertilizer cost	23214.31 (13.80)	24337.12 (13.64)	25223.19 (13.48)	24426.40 (13.61)
6.	Plant protection chemicals	5340.21 (3.17)	6631.03 (3.71)	7534.42 (4.02)	6686.02 (3.72)
7.	Irrigation charges	6523.32 (3.87)	7231.21 (4.05)	7542.92 (4.03)	7185.43 (4.00)
8.	Interest on working capital@8%	10697.55 (6.36)	11258.32 (6.31)	11815.94 (6.31)	11350.47 (6.32)
	Total variable cost	144416.93 (85.88)	151987.34 (85.19)	159515.26 (85.27)	153231.51 (85.38)
(B)	**Fixed cost**				

1.	Depreciation	425.23 (0.25)	650.31 (0.36)	785.11 (0.41)	650.50 (0.36)
2.	Land revenue	12.00 (0.00)	12.00 (0.00)	12.00 (0.00)	12.00 (0.00)
3.	Rental value of owned land	21140.87 (12.57)	23341.42 (13.08)	24246.61 (12.96)	23172.76 (12.91)
4.	Interest fixed capital	2157.81 (1.28)	2400.37 (1.340)	2504.37 (1.33)	2383.52 (1.32)
5.	Total fixed cost	23735.91 (14.11)	26404.01 (14.80)	27548.09 (14.72)	26218.76 (14.61)
	Total cost = (A+B)	168152.84 (100.00)	178391.35 (100.00)	187063.35 (100.00)	179450.27 (100.00)

Table 2: Per hectare yield value of output and cost of production per quintal of banana. (Rs./ha.)

S. No.	Particulars	Small	Medium	Large	Overall
1.	Main yield (qt./ha.)	755.00	771.00	786.00	773.25
2	Price (Rs./qt.)	710.23	700.62	700.74	703.04
3	Gross income	536223.65	540178.02	550781.64	543585.43
4	Cost of cultivation	168152.84	178391.35	187063.35	179450.27
5	Cost of production (Rs/qt.)	222.71	231.37	237.99	231.97
6	Input output ratio	1:3.18	1:3.02	1:2.94	1:3.02

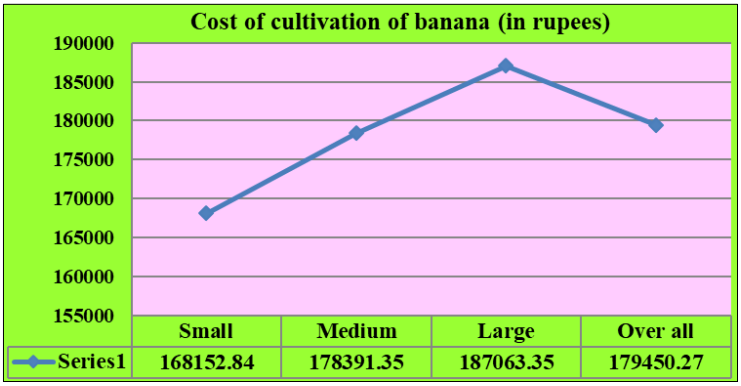

Fig 1: Cost of cultivation of banana on the sample farms (Rs./ha.)

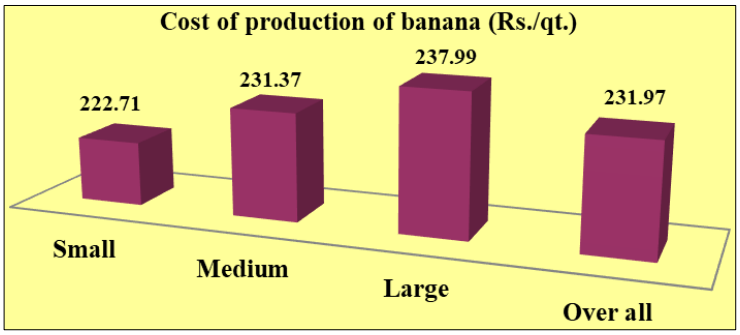

Fig 2: Cost of production of banana on the sample farms" (Rs./ha.)

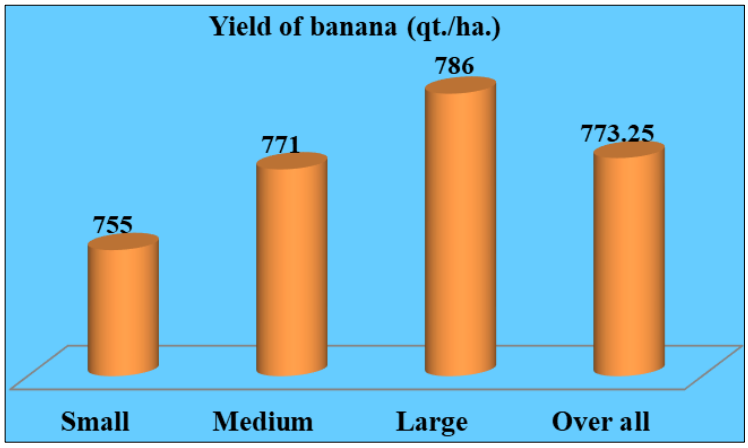

Fig 3: Yield of banana (qt./ha.)

Measures of farm profit

The values of net income, family labour income and farm business the per hectare the sample farms of different size groups have been worked out in the table 3 and figure 4. The table indicates that, on an average the value of net average family labour income and farm business income per hectare came Rs.40,7001.67 and Rs.38,1445.39, respectively, on the sample farms of different sizes. Overall on an average the input-output ratio of" banana came to 1:3.02 "on the sample farms."

Table 3: Cost and return of banana on the sample farm for different groups of farm (Rs./ha.)

S. No	Particulars	Farm size			
		Small	Medium	Large	Overall
1.	Input cost	168152.84	178391.35	187063.35	179450.27
2.	Output cost	536223.65	540178.02	550781.64	543585.43
3.	Net income	368070.81	361786.67	363718.29	364135.16
4.	Family labour income	400218.29	405380.55	412383.34	407001.67
5.	Farm business income	376919.61	379638.76	385632.36	381445.39
6.	Farm investment income	391369.49	387528.46	390469.27	389691.44

Cost and returns on the basis of cost concept"

The cost and returns on the basis of cost concept in the production of" banana "have been presented in the table 4 and figure 5 that, the per hectare cost-A_1, A_2, cost-B_1, B_2, and cost-C_1, C_2, C_3 at the overall level were Rs.14,4322.97, 14,4322.97, Rs.14,6706.50, 16,9879.15, and Rs. 15,3620.36, 17,9450.19, 19,7395.21 per hectare, respectively on the sample farms. The average income per hectare over cost - A_1, A_2, cost-B_1, B_2 and cost-C_1, C_2, C_3 were worked out to Rs.39,9262.12, 39,9262.12 Rs.39,6878.93, 37,3706.15 and Rs.38,9965.07, 36,4135.24, 34,6190.22, respectively. The income over different costs also increased with the increase in the farms size because of higher output in relation to total input cost."

Table 4: Per hectare yield value of output and cost of production per quintal of banana.

S. No.	Cost/category	Small	Medium	Large	Overall
A.	**Break-up cost**				
1.	Cost A_1 (all actual expenses)	129529.82	143435.42	153881.24	144322.97
2.	Cost A_2=Cost A_1+Rent paid for leased in land	129529.82	143435.42	153881.24	144322.97
3.	Cost B_1=Cost A_1+Interest on value of owned fixed capital	131687.63	145835.79	156385.61	146706.50
4.	Cost B_2=Cost B_1+Rental value of owned land and rent paid for leased inland	152828.05	169177.21	180632.22	169879.15
5.	Cost C_1=Cost B_1+Imputed value of family labour	147011.97	155053.02	156385.61	153620.36
6.	Cost C_2=Cost B_2+Imputed value of family labour	168152.39	178391.44	187063.35	179450.19
7.	Cost C_3=Cost B_2+10% of cost C_2 on account of managerial function performed by farmer	184967.62	196230.58	205769.68	197395.21
B.	**Income over different cost**				
	I.O.D.C. A_1	406693.83	396742.06	396900.04	399262.12
	I.O.D.C A_2	406693.83	396742.06	396900.04	399262.12
	I.O.D.C. B_1	404536.02	394342.23	394396.03	396878.93
	I.O.D.C. B_2	383395.06	371000.81	370149.42	373706.15
	I.O.D.C. C_1	389211.68	385125.00	394396.03	389965.07
	I.O.D.C. C_2	368071.26	361786.58	363718.29	364135.24
	I.O.D.C. C_3	351256.03	343947.44	345011.96	346190.22
C.	**Gross income**	**536223.65**	**540178.02**	**550781.68**	**543585.43**
D.	**Input output ratio**	**1:3.18**	**1:3.02**	**1:2.94**	**1:3.02**

Note: Figures in parentheses indicates in total percentage

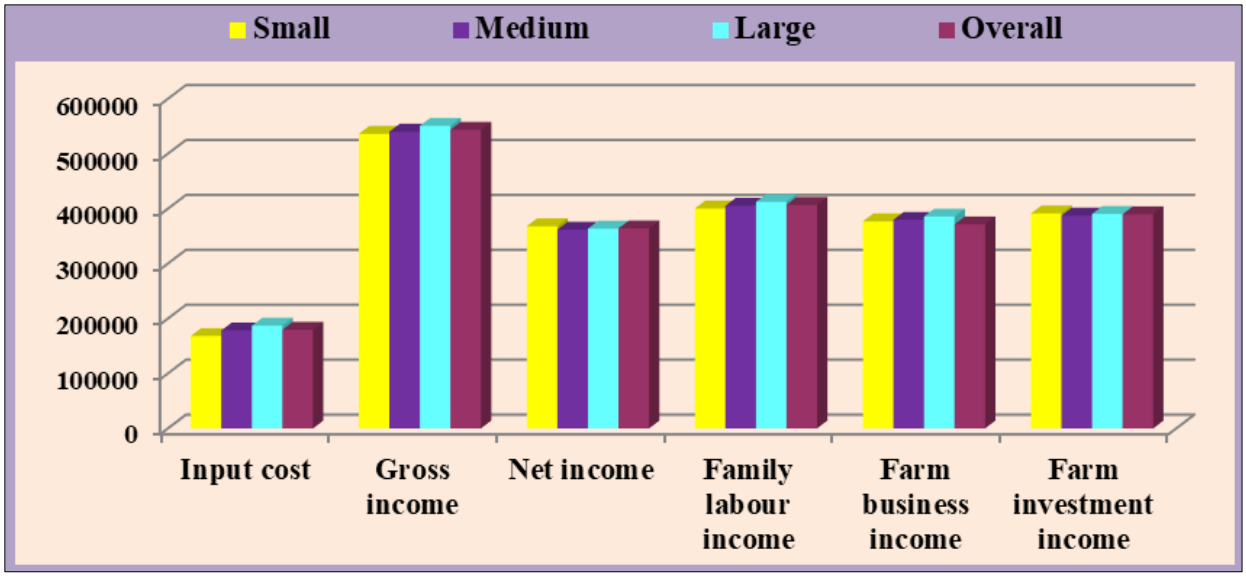

Fig 4: Cost and return of banana on the sample farm for different groups of farms (Rs./ha.)

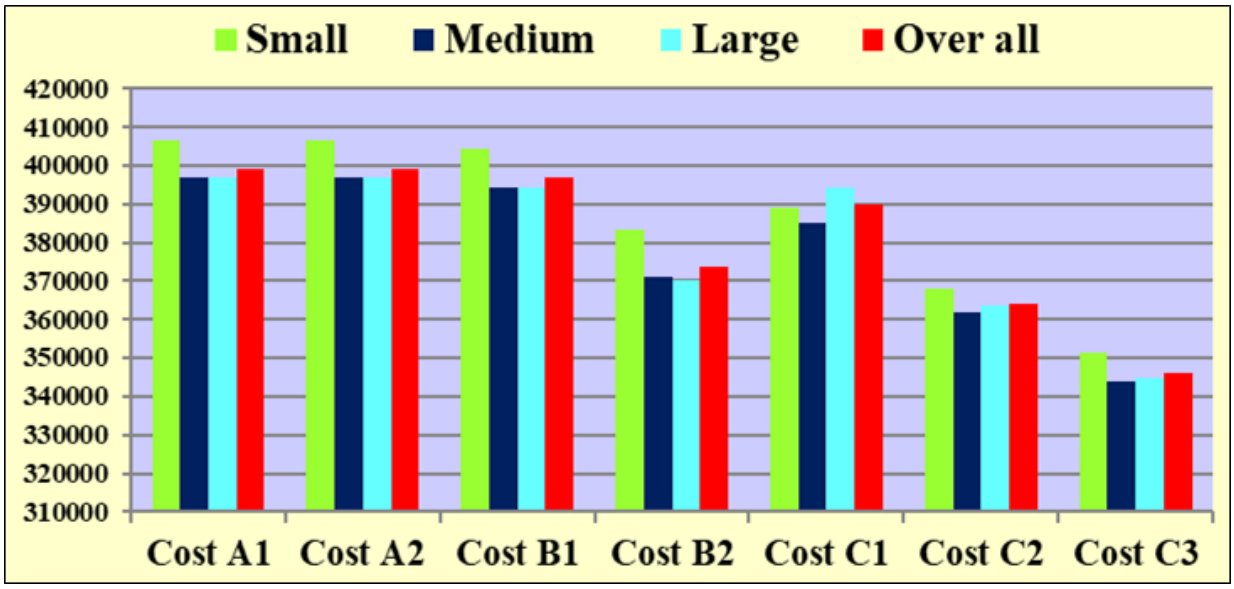

Fig 5: Cost concept of banana on the sample farms (Rs./ha.)

Post-harvest losses in banana at market level

The estimated post-harvest losses per quintal of banana handled at different stages at market level are presented in table 5. Post-harvest losses in banana at market level were estimated at wholesaler and retailer level. It has been reported that total post-harvest losses at market level was found 5.27 kilogram per quintal out of which contribution of losses at wholesaler and retailer level was 3.04 and 2.23 kilogram per quintal respectively. Maximum share of losses among different operations of marketing was found in transportation (wholesaler level) being 20.68 per cent to the total losses at market level. Contribution of losses in selling was found maximum among different operations at retailer level being 13.66 per cent to the total losses at market level

Table 5: Post-harvest losses of banana at market level

S. No.	Stage	Losses (Kg./qt.)	Percentage
1	**Losses at wholesaler level**		
	(a) Sorting & grading	0.43	8.15
	(b) Packaging	0.56	10.62
	(c) Storage	0.70	13.28
	(d) Transportation	1.09	20.68
	Sub total	3.04	57.66
2	**Losses at retailer level**		
	(a) Transportation	0.66	12.52
	(b) Sorting Grading	0.60	11.38
	(c) Selling	0.72	13.66
	Sub total	2.23	42.03
	Total	5.27	100.00

Summary and Conclusion

Growing fruits gives better returns to farmers as compared to cereals so beside health benefits vegetables can increase the income of Indian farmers. Export quality fruits fetch good price in international markets and contribute strengthening economy of the nation. Outputs of all agricultural commodities produced in the field have to undergo a series of operations such as"harvesting, transportation, processing, storage and exchange before they reach the consumer, and there are appreciable losses of outputs during these stages of their handling. The sum quantity of outputs lost in these operations at all of these stages is referred to as" "post-harvest losses". Losses of horticultural produce are a major problem in the post-harvest chain. The total post-harvest losses in banana was 17.58, kilogram per quintal. Maximum share of losses was at farmer level in 12.31 kilogram per quintal.

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