DISTRIBUTION AND PRODUCTIVITY OF *Terminalia chebula* Retz. IN JAMMU REGION

By

VINOD KUMAR SHARMA

(J-15-M-428)

Thesis submitted to Faculty of Postgraduate Studies

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE

IN

FORESTRY

Division of Agroforestry

Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu,

Main Campus, Chatha, Jammu- 180 009

2017

CERTIFICATE-I

This is to certify that the thesis entitled **"Distribution and Productivity of *Terminalia chebula* Retz. in Jammu Region"** submitted in partial fulfilment of the requirements for the degree of **Master of Science in Forestry** to the Faculty of Post-Graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, is a record of bonafide research, carried out by **Mr. Vinod Kumar Sharma** (Registration Number **J-15-M-428**) under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma. It is further certified that help and assistance received during the course of investigation have been duly acknowledged.

Dr. N. S. Raina
(Major Advisor)

Place: Jammu

Date: 2-11-2017

Endorsed:

Head
Division of Agroforestry

Date: 02-11-2018

CERTIFICATE-II

We, the members of the Advisory Committee of **Mr. Vinod Kumar Sharma** (Registration Number **J-15-M-428)** a candidate for the degree of Master of Science in Forestry, have gone through the manuscript of the thesis entitled **"Distribution and Productivity of *Terminalia chebula* Retz. in Jammu Region"** and recommend that it may be submitted by the student in partial fulfilment of the requirements for the degree.

Dr. N. S. Raina
Associate Professor
Division of Agroforestry
(Major Advisor and Chairman
Advisory Committee)

Place: Jammu
Date : 02-11-2017

Advisory Committee Members:

Dr. L.M. Gupta, Associate Professor
(Division of Agroforestry)

Dr. N. P. Thakur, Sr. Scientist
(Soil Science, Farming System Research)

Dr. Rajinder Peshin, Associate Professor
(Division of Agricultural Extension Education)

CERTIFICATE-III

This is to certify that the thesis entitled **"Distribution and Productivity of *Terminalia chebula* Retz. in Jammu Region"** submitted by **Mr. Vinod Kumar Sharma (Registration No. J-15-M-428)** to the Faculty of Post-Graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, in partial fulfilment of the requirement for the degree of **Master of Science in Forestry** was examined and approved by the Advisory Committee and External Examiner(s) on 24.01.2018

24.01.2018

External Examiner

(HARMEET SINGH SARALCH)
Professor of Forestry
Deptt of Forestry & NR
PAU, Ludhiana (PB)
141 004

Dr. N. S. Raina
Associate Professor
Division of Agroforestry
(Major Advisor)

07/2/18

Dr. S. K. Gupta
Professor & Head
Division of Agroforestry

Dr. D. P. Abrol
Dean, Faculty of Agriculture

ACKNOWLEDGEMENT

I bow, here, in adulation before the supreme authority of Almighty, The Sovereign, The Merciful and Compassionate for having endowed upon me the motivation and strength to accomplish this gargantuan task.

It is my profound privilege to express my sincere and heartfelt deep sense of unbound gratitude to my major advisor, ***Dr. N. S. Raina*** *Associate Professor Agro-forestry, for his most enthusiastic, altruistic and proficient guidance, carping critical appraisal and affectionate appreciation which imbued me during entire period of this study and laugh off the hitches, I so often encountered. My heartily thanks to him for his persistent and meticulous attitude, valuable teaching and selfless help during the course of investigation.*

I feel great elation in expressing profound thanks and venerations to ***Dr. S.K.Gupta*** *Professor and head of the Agro forestry Division, for his continued supportive guidance and for being extremely approachable and providing all the possible facilities and timely help throughout the period of study. I am immensely benefitted by his experience, scientific skill, critical depth and analytical bent.*

Indeed words at my command are inadequate to acknowledge my gratitude to Members of Advisory Committee viz ***Dr. L.M.Gupta, Dr. R.Peshin, Dr. N. P. Thakur*** *for their valuable advice and help related to the project studies. . It goes without saying that this work has been accomplished by his benevolence and generosity.*

My fastidious thanks and gratitude goes to the staff of the division particularly ***Dr. S. K. Gupta, Dr. Sandeep Seghal, Mrs. Meenakshi Gupta*** *and the non teaching staff especially* ***Mr. R. K. Dhar*** *and* ***Mr. Sunil.***

I seize this opportunity to express my utmost regards to ***Dr. D. P. Abrol,***

Dean, Faculty of Agriculture, Who have been kind and affectionate in every form of assistance, advice and constructive criticism.

I have no words to express my venerations towards my parents ***Shri Kuldeep Raj Sharma*** *and* ***Smt. Kamla Devi,*** *my ever replenishing source of strength and encouragement, and my brother* ***Viyay Kumar Sharma,*** *sister* ***Sushma Devi*** *and* ***family members*** *for their silent prayers, selfless sacrifices and loving emotions during my entire life.*

I m very thankful to my seniors ***Zubair Ahmed, Raj Kumar Gupta, Lalit Upadhyay , Fayaz Ahmed , Sunil Kumar*** *and* ***Friends Pushkar Khare, Amit Kumar, Akshay Kumar, Qurat-ul-Ain, Amreena Akthar*** *for their unflagging love and support throughout my study.*

I shall fail in my duty if I don't thank the Peon ***Mr. Des Raj,*** *and* ***Pushaj Raj*** *who were contributed help during my experimental trial and academic period.*

I am extremely grateful to ***Mr. Rohan Kashyap (Global Village Internet Cyber Cafe)*** *who deserves special thanks for extending his never ever tiring hands, expertise and dedication for meticulous typing and designing of this manuscript and for his all time co-operation.*

I am also indebted to other persons whose names I could not mention here for their instant help, moral support and good wishes.

Sharma

Place : Jammu
Date: 02-11-2017

Vinod Kumar Sharma

ABSTRACT

Title of Thesis	:	**"Distribution and Productivity of *Terminalia chebula* Retz. in Jammu Region"**
Name of the student	:	**Vinod Kumar Sharma**
Registration Number	:	**J-15-M-428**
Name and Designation of Major Advisor	:	**Dr. N. S. Raina, Associate professor (Agroforestry)**
Degree to be Awarded	:	**M.Sc. Forestry**
Year of Award of Degree	:	**2017**
Name of University	:	**Sher-e-Kashmir University of Agricultural Sciences and Technology- Jammu**

ABSTRACT

A survey was conducted in 2015-16 to study the distribution, fruit and tree parameters, productivity and marketing of harad *Terminalia chebula* in the Jammu region. In forests, the scattered harad trees were found in four forest divisions namely Jammu, Reasi, Udhampur and Ramnagar. Plantations of harad were present in Mathwar, Manwal and Ranjan villages of Jammu district. With the advancement of age, tree parameters increased significantly in various growth and development parameters. Diameter at breast height (17.3 cm), height (7.5 m) and crown spread (7.3 m) were maximum in non-grafted harad having age group 15-20 years and minimum was observed in grafted trees in the age group of 5-10 years. Fruits of grafted harad showed a significant increase in quality parameters like fruit length (77.92 mm), fruit breadth (32.77 mm), fresh fruit weight (42.82 g), fresh pulp weight (33.38 g), dry fruit weight (21.08 g) fruit yield (16.76 kg) and productivity (1676 kg ha^{-1}) than non- grafted harad.

Marketing of harad follow one channel: producer- pre-harvesting contractor-forwarding agent-wholeseller. The price received by the farmer was ₹4500.00 q^{-1} by selling of grafted harad fruits whereas non-grafted harad fruits fetched only ₹500.00 q^{-1}. Total marketing cost, total marketing margin and price spread was higher at ₹9196.00 q^{-1}, ₹4804.00 q^{-1} and ₹14000.00 q^{-1}, respectively in grafted harad than non- grafted harad which was ₹96.00 q^{-1}, ₹704q^{-1}, and ₹800 q^{-1}, respectively. The producer share in consumer's rupee (%) and index of marketing efficiency was higher in non-grafted harad 38.46 and 0.64, respectively than grafted harad which was 24.32 and 0.32.

Keywords: Harad, marketing, productivity, grafted, non-grafted

Signature of Major Advisor

Signature of the Student

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

g	Gram
kg	Kilogram
cm	Centimeter
m	Meter
mm	Millimeter
ha	Hactare
^{o}C	Degree Celsius
RBD	Randomized Block Design
$CD_{0.05}$	Critical difference at 5% level of significance
$\pm SE_{m}$	Standard error of mean
amsl	Above mean sea level
q	Quintal
Yr	Year
DBH	Diameter at breast height
₹	Rupee

ACKNOWLEDGEMENT

I bow, here, in adulation before the supreme authority of Almighty, The Sovereign, The Merciful and Compassionate for having endowed upon me the motivation and strength to accomplish this gargantuan task.

It is my profound privilege to express my sincere and heartfelt deep sense of unbound gratitude to my major advisor, ***Dr. N. S. Raina*** *Associate Professor Agro-forestry, for his most enthusiastic, altruistic and proficient guidance, carping critical appraisal and affectionate appreciation which imbued me during entire period of this study and laugh off the hitches, I so often encountered. My heartily thanks to him for his persistent and meticulous attitude, valuable teaching and selfless help during the course of investigation.*

I feel great elation in expressing profound thanks and venerations to ***Dr. S.K.Gupta*** *Professor and head of the Agro forestry Division, for his continued supportive guidance and for being extremely approachable and providing all the possible facilities and timely help throughout the period of study. I am immensely benefitted by his experience, scientific skill, critical depth and analytical bent.*

Indeed words at my command are inadequate to acknowledge my gratitude to Members of Advisory Committee viz ***Dr. L.M.Gupta, Dr. R.Peshin, Dr. N. P. Thakur*** *for their valuable advice and help related to the project studies. . It goes without saying that this work has been accomplished by his benevolence and generosity.*

My fastidious thanks and gratitude goes to the staff of the division particularly ***Dr. S. K. Gupta, Dr. Sandeep Seghal, Mrs. Meenakshi Gupta*** *and the non teaching staff especially* ***Mr. R. K. Dhar*** *and* ***Mr. Sunil.***

I seize this opportunity to express my utmost regards to ***Dr. D. P. Abrol,***

Dean, Faculty of Agriculture, Who have been kind and affectionate in every form

of assistance, advice and constructive criticism.

I have no words to express my venerations towards my parents ***Shri Kuldeep Raj Sharma*** *and* ***Smt. Kamla Devi****, my ever replenishing source of strength and encouragement, and my brother* ***Viyay Kumar Sharma,*** *sister* ***Sushma Devi*** *and* ***family members*** *for their silent prayers, selfless sacrifices and loving emotions during my entire life.*

I m very thankful to my seniors ***Zubair Ahmed, Raj Kumar Gupta, Lalit Upadhyay , Fayaz Ahmed , Sunil Kumar*** *and* ***Friends Pushkar Khare, Amit Kumar, Akshay Kumar, Qurat-ul-Ain, Amreena Akthar*** *for their unflagging love and support throughout my study.*

I shall fail in my duty if I don't thank the Peon ***Mr. Des Raj****, and* ***Pushaj Raj*** *who were contributed help during my experimental trial and academic period.*

I am extremely grateful to ***Mr.Anil Sawhney (Mahavir Computer)*** *who deserves special thanks for extending his never ever tiring hands, expertise and dedication for meticulous typing and designing of this manuscript and for his all time co-operation.*

I am also indebted to other persons whose names I could not mention here for their instant help, moral support and good wishes.

Place : ***Vinod Kumar Sharma***

Date:

CHAPTER-1

INTRODUCTION

Ayurveda is a 5000 years old healing tradition rooted in ancient Indian culture. This vast body of healing knowledge referred to as "Mother of all healing" has recently come to the attention of western medical researchers on seeking novel therapeutic compounds due to concerns over more invasive, expensive and potentially toxic main stream practices (Bag *et al*., 2013). According to World Health Organization (WHO) about 80 % of world population rely chiefly on plant based traditional medicine for their primary healthcare need (WHO, 2002). Traditional healing system around the world that utilizes herbal remedies is an important resource for the discovery of modern drugs (Koehn and Carter, 2005). While screening a number of medicinal plants, scientist discovered harad (*Terminalia chebula* Retz.) as one of the most revered medicinal plant i.e. which exhibits a number of medicinal activities due to the presence of a large number of different types of phytoconstituents. The fruit of the tree possesses diverse health benefits and has been used as traditional medicine for household remedy against various human ailments (Khare, 2007).

Terminalia chebula commonly known as harad having a trade name of chebulic myrobalans, belongs to family Combretaceae and is indigenous to India and Southeast Asia (Dymock *et al*., 1976). In India, it is distributed throughout the greater part except arid zone (Troup, 1921). In the sub-Himalayan tract, it extends from Ravi eastwards to West Bengal and Assam, ascending upto an altitude of 1500 m amsl in the outer Himalayas and upto 900 m amsl on dry slopes in the Western Ghats (Luna, 2005). In India, it is mainly found in Himachal Pradesh, Kerala, Karnataka, Maharashtra, Uttar Pradesh, Haryana, Uttrakhand, North-eastern states, Gujarat, Assam and Jammu and Kashmir (Chander and Chauhan, 2014). In Jammu and Kashmir, it is found in sub-tropical forests ranging from 300 m amsl to 1630 m amsl (Sharma *et al*., 2015). It is capable of growing in a variety of soils, clayey as well as sandy and in areas having an annual rainfall 100-150 cm and temperature 0-17°C (Gupta, 2012).

Harad is a medium to large size deciduous tree with a height upto 30 m and diameter upto 1-1.5 m. It has round crown and spreading branches. The bark is dark

brown with some longitudinal cracks. Leaves are 10-30 cm long elliptical with an acute tip and cordate base with 6-8 pairs of veins. Flowers are yellowish white in terminal spikes and it flowers from the end of March to June in general; where as in north India flowering of harad commences from first week of May. Two flowering flush have been observed, first beginning from May and second from August and ripening of fruits till April (Troup, 1921).

Terminalia chebula is one of the multipurpose and medicinal agroforestry tree species. It plays an important role in the livelihoods of rural people. The fruits are rich in tannin and used in leather industry for tanning. The tree is lopped for leaves to feed the livestock during winter when other green fodder is very scarce in this region. The leaves contain 1.73 per cent nitrogen (equivalent to 10.80 % protein content) and 2.75 per cent calcium (Singh, 1982). The wood is used as timber due to its resistance to termites.

As far as the medicinal properties are concerned, fruits are an important constituent of 'Triphala' (a medicinal digestive stew) in Indian system of medicine and used in many Ayurvedic medicine to treat flatulence, dyspepsia, liver and spleen disorders, constipation, cancer, and cardio-vascular diseases like ulcers, leprosy, arthritis, gout and epilepsy (Suryaprakash *et al*., 2012). It has been reported as antioxidant, antidiabetic, antibacterial, antiviral, antifungal, anticancerous, antiulcer and antimutagenic (Kim *et al*., 2001; Rao and Nammi, 2006; Kannan *et al*., 2009; Suchalata and Devi, 2009).

In India, production is estimated to be 1,00,000 tonnes of which 20% is exported to countries like Europe and USA (World Agroforestry Centre n.d, 2017). In Jammu and Kashmir State, the annual production of harad fruit is about 500 tonnes (as per conversation with local trader of Jammu). Before 2007-2008, the harad fruits of this region were being sold in Majeetha Mandi, Amritsar. Now it is being sold to Pakistan and Arab countries through Slamabad in Uri sector and Chakan-da-Bagh in Poonch sector under Line of Control Trade agreement between India and Pakistan.

Variation in fruit characteristic of *Terminalia chebula* has been reported by many researchers (Saleem *et al*., 2014 and Sharma *et al*., 2016). Large size fruits fetch more price than smaller ones and thus farmers have shown preference for large sized fruit trees on their crop land. In Jammu and Kashmir State, few plantations of grafted harad (with large size fruit size) have been undertaken by the farmers in different areas in sub-tropics of Jammu. However, the data on distribution, productivity and marketing of harad is scanty. Keeping in view its medicinal value and diverse use, the present investigation was carried out with the following objectives:

i. To study the distribution of *Terminalia chebula* in Jammu region.
ii. To estimate the productivity of *Terminalia chebula* in Jammu region.
iii. To study marketing of *Terminalia chebula* in Jammu region.
    - Marketing channel
    - Price spread

CHAPTER-2

REVIEW OF LITERATURE

The literature pertaining to the present study "Distribution and productivity of *Terminalia chebula* Retz. in Jammu region" of J&K have been reviewed under the following heads.

2.1 Distribution of harad.

2.2 Growth and yield parameters of harad.

2.3 Marketing channels of harad.

2.1 Distribution of Harad

Sundriyal *et al.* (1998) studied distribution of *Terminalia chebula* in Sikkim Himalaya and found that it occurred at two elevation ranges i.e. low hills (upto 900 m amsl) and mid hills (900–2000 m amsl).

Sahu *et al*. (2012) studied tree species diversity, distribution and population structure in a tropical dry deciduous forest of malyagiri hill ranges, Eastern Ghats, India. Their result showed that *Terminalia chebula* having frequency (3.3%), density (1.3 ha^{-1}), basal area (0.02 m^2 ha^{-1}), importance value index (0.02) and distribution (0.87) and distribution (contiguous).

Sanjeewa *et al*. (2013) studied distribution of *Terminalia chebula* in Srilanka. It was found that harad trees are naturally distributed only in the intermediate zone of Sri Lanka and plantation can be seen in all agro-climatic zones at an elevation ranges from 187 m amsl to 856 m amsl and planted trees range varies from 7 m to 486 m amsl. The GPS coordinates latitudes and longitudes varies from 6.7°N to 7.5°N and 80.7°E to 81.10°E for natural trees and planted trees varies from 6.9°N to 8.3°N and 79.8°E to 80.59°E.

Chander and Chauhan (2014) conducted survey in entire shiwalik belt of Haryana with emphasis on Morni area and adjoining Jamun Ki Ser area of Himachal Pradesh to studying the distribution of harad. They found that it grows upto an altitude of about 1200

m amsl and out of 2000 harad trees existing in Haryana, three-fourth are on farmer's fields and only one-fourth trees exist in forest. Both in the forest and in the fields, harad never exists in pure stands. It was found mixed with other tree species like Beul (*Grewia optiva*), Behra (*Terminalia bellerica)* and Sain (*Terminalia elliptica).* About 90 per cent of these trees exist in and around Raj Tikri, Hathiya and Thandog village of Panchkula district and adjoining Sirmour district in Himachal. Trees existing on farmers land are commercially utilized by the farmers. They also concluded that the trees existing in forest are inaccessible due to thick undergrowth of *Lantana camera* growth which makes human movement difficult and does not allow young seedlings to come up in forest.

Sharma and Kant (2014) conducted study on sub-tropical forests of kandi shiwaliks of Jammu and Kashmir, India. The kandi belt have distinct vertical zonation of three forest types i.e., northern dry mixed deciduous forests ($5B/C_2$), himalayan sub-tropical scrub forest ($9/C_1/DS_I$) and himalayan subtropical pine forest ($9/C_1a$) in an altitudinal range of 300 m amsl to 990 m amsl. They concluded that more density (8.37 trees ha^{-1}), basal area ($6.82m^2$) and SIV (5.20%) of *Terminalia chebula* is found in northern dry mixed deciduous forests than himalayan sub-tropical dry deciduous scrub and himalayan sub-tropical pine forest.

Jyoti *et al*. (2014) studied the altitudinal range of *Terminalia chebula* in Nadaun block of Hamirpur district, Himanchal Pradesh and found altitudinal range of *Terminalia chebula* from 700 m amsl-1000 m amsl.

Sharma *et al*. (2015) studied ethno-medicinal uses of floristic diversity of sub-tropical forests of Jammu, Jammu and Kashmir. They observed that *Terminalia chebula* occured at altitudinal range of 300 m amsl to 1,675 m amsl and were found abundant in Mathwar, Nandani beyond tunnel.

Sharma and Thakur (2015) conducted a survey to study ecological variation among three natural populations Rakkar, Bachhwain and Praur of *Terminalia chebula* distributed in Kangra district of Himachal Pradesh. They revealed that among trees, *Terminalia chebula* was dominant species in Rakkar population with density 67 trees ha^{-1}, abundance of 6 AB, basal area of 4.97 m^2ha^{-1}, frequency of 400% and importance value index of 300. Bachhwain population contains density of 49 trees ha^{-1}, abundance of 4.4 AB, basal area of 4.93 m^2ha^{-1}, per cent frequency of 520 and importance value index (300). Praur

population contains density 71 of trees ha^{-1}, abundance of 6.4 AB, basal area of 4.24 m^2 ha^{-1}, per cent frequency of 500 and importance value index (300).

Sharma and Thakur (2016) conducted a studied in two natural populations of *Terminalia chebula* distributed in Sirmour and Una districts of Himachal Pradesh. They draw 5 quadrats of 30 m x 30 m size and found that *Terminalia chebula* was dominant tree species in Jamun Ki Sair and with density of 78 trees ha^{-1}, abundance of 7AB, basal area of 7.32 m^2ha^{-1}, and frequency of 100% and importance value index of 109.01. Ganu population contains density of 69 trees ha^{-1}, abundance of 6.2 AB, basal area of 6.87 m^2 ha^{-1}, frequency of 100% and importance value index of 78.36. They also reported altitudinal range of *Terminalia chebula* in Sirmour district and Una district with values of 1050 m amsl and 509 m amsl, respectively.

2.2 Growth and yield parameters of Harad.

Thakur *et al*. (2008) assessed the harad growing areas in district Sirmour of Himachal Pradesh and Himachal Pradesh and district Panchkula of Haryana, to study the natural variation in fruit and seed characters and screened out the elite genotypes among the populations. This survey revealed that there was significant variation in fruit size, weight and seed/pulp ratio. Fruit diameter showed significant and positive correlation with green fruit weight, which is the most important character from market point of view. Further correlation revealed that selection for fruit diameter also result in selection for fruit green weight. On the basis of fruit length (6.18 cm), fruit diameter (3.45 cm), green seed weight (39.50 cm), dry fruit weight (16.29 g), fruit diameter (3.45 cm), green fruit weight (39.50 g), dry fruit weight (16.29 g), and seed length (3.06 cm), seed diameter (1.79 cm), green seed/pulp ratio (0.19) and seed/pulp ratio (0.53) respectively, was found to be best in accession Paluhri (T_{11}) for fruit and seed characteristic which is followed by Paluhri (T_{12}) and Morni (T_{14}) accessions.

Thakur *et al*. (2008) conducted a study to characterize the variation in morphological characters in fruit samples of 15 different collections of *Terminalia chebula* in Himachal Pradesh. The study revealed that variation in their shape, colour and physical dimensions. The higher fresh fruit weight (39.53 g) along with high values of fresh pulp/kernel (16.04) and dry pulp/kernel ratio (6.85) in the fruits from the Paragpur 1.

Navhale *et al*. (2011) conducted a survey in fourty genotype from the area of Dapoli, Burondi, Wakawali, Murud and Anjarla during January to December 2008 to

study the genetic variability and selection of candidate plus trees in *Terminalia chebula*. They observed six morphological characters of trees and found variation ranges from 3.50 m to 15 m in height, 3.20 m to 10 m in canopy diameter, 44 cm to 126 cm in diameter breast height, 65 cm to 180 cm in girth at breast height, and 65 cm to 180 cm in girth at base.

Navhale *et al*. (2011) reported significant variation in fruit parameters ranges from 6.32 g to 10.42 g in fresh fruit weight, 0.98 cm to 1.84 cm in fruit diameter, 1.82 to 3.54 cm in fruit length, 3.58 to 7.32 in fruit pulp weight and 2.60 g to 5.28 g in dry fruit weight. These variations were due to phenotypic, genotypic and environment differences and ranges from 0.03 to 270.96, 0.02 to 85.72 and 0.02 to 185.24, respectively.

Sharma *et al*. (2012) conducted an experiment in order to check the propagation technique of *Terminalia chebula* in short period of time. They soaked kernels in bavistin solution and kept in germinator and germinated seeds put in polybags for further growth and development. After completion of four months, they observed 14.4 cm height, 3 branches, 3.1 cm spike length, and 57 flowers. Before them, many authors have been working for the last two decades on various aspects like propagation and development of promising strains of harad and grafting/budding techniques have been standardized to produce true to type precocious plants which bear flower in two to three years.

Khobragade *et al*. (2013) studied height (m), clear bole height (cm), girth (cm), crown volume (m^3), crown diameter (m), number of fruit kg^{-1}, and fruit weight (kg) for selection of candidate plus trees of *Terminalia chebula* and *Terminalia bellerica* grown in natural forests and plantation in Maharashtra and Madhya Pradesh. They found significant positive correlation between yield of fruit weight and all other characters except clear bole height and crown volume, girth and crown bole height given importance to select candidate plus tree. In *Terminalia bellarica* relation between fruit weight, crown diameter, crown volume and fruit number was positive and highly significant correlation at genetic level.

Sanjeewa *et al*. (2013) conducted a survey in different agro-ecological regions of Srilanka to studied morphological variation in *Terminalia chebula*. They observed that within tree variations for fruit characters was not significant ($p>0.01$), while between

trees variation was significant ($p>0.01$) for fruit size and fruit shape. Both between and within-tree variations were significant ($p>0.01$) for leaf character.

Saleem *et al*. (2014) studied variation in fruit characteristics of *Terminalia chebula* collected from different areas of Jammu and Himachal Pradesh province. They observed that fresh fruit weight (44.6 g), dry fruit weight (21.75 g), fruit length (7.9 cm) and fresh pulp weight (34.78 g) of mother tree present in Mathwar village was significantly higher than all other mother trees of Jammu and Himachal Pradesh region. Due to superiority of a majority of fruit characteristics of this mother tree the same was selected for taking scion material for grafting experiment and is locally called "Raj Harad" i.e. "King of this species" owing to the superiority of its fruit characteristics.

Sharma *et al.* (2016) studied fruit size, fruit weight and pulp weight of *Terminalia chebula* among five natural populations distributed in three districts Sirmour, Kangra and Una of Himanchal Pradesh. They observed that fresh fruit weight (15.44±2.02 g) and dry fruit weight (6.57±0.93 g) was maximum in the Praur population, whereas, minimum fresh weight (12.78±3.93 g) and dry fruit (5.47±1.03 g) was observed in Rakkar population. Maximum length was found in (46.33±3.75 mm) in Bachhwain population followed by Praur (46.19±4.25) and smallest in Sirmour (36.43±5.52) population. Maximum fruit diameter (24.39±1.22 mm) was found in Praur population and minimum (23.31±2.37 mm) in Rakkar population. Fresh pulp weight was maximum (13.46±2.02 g) in Bachhwain population followed by Praur (13.27±1.87 g) and minimum (11.02±3.65 g) in Jamun Ki Sair population. Maximum dry pulp (5.24±0.86 g) was found in Praur population, which was significantly at par with Bachhwain (5.12±0.89 g). They concluded that the variation in phenotype of fruit and pulp character were highly attributed due to mother tree. Mother tree variance was higher as compared to the population and error variance for all the fruit and pulp characters of mother tree.

Srivastava (2017) conducted a study for the formation of clonal bank of *Terminalia chebula*. They revealed that natural regeneration of seed was poor due to hard mesocarp, thick shell, poor formation of kernel and cleft grafting made successful in getting good graft plant in good time. This new technology will help farmers in obtaining sustained income gains.

2.3 Marketing channels of Harad

The literature pertaining to marketing channels of harad is very scanty, so the review of other crops can be incorporated:

Sundriyal *et al.* (1998) studied marketing of wild *Terminalia chebula* in Sikkim Himalaya. They reported that marketing price was 20 per 100 fruits and in Gangtok marketing price was ₹20-30 per 100 fruits. They studied quantity and prices of Harad fruit at different stages during marketing. They concluded that collector sold 41.5 ton of fruit to stakeholder at a ₹14.6 kg^{-1} and this stakeholder sold same quantity of fruit to other at a ₹19.3 kg^{-1}.

Murthy *et al*. (2009) studied marketing channels of mango and banana in Andhra Pradesh and Karnataka. They found that 85 % of mango was traded by four channels viz., channel I. Farmers → post harvest contractor → distant wholesaler → retailer → consumer, channel II. Farmer → post harvest contractor → local wholesaler → distant wholesaler → consumer, channel III. Farmer → post-harvest contractor → local wholesaler → retailer → consumer and channel IV. Farmer → distant wholesaler → retailer → consumer and 70 per cent of banana was traded mainly by two channels viz., Farmer → wholesaler → retailer → consumer and Farmer → farmers co-operative society → consumer.

Singh and Sharma (2010) studied price and size of three market samples of *Terminalia chebula* to compare with standard data of *Terminalia chebula* in Udaipur district of Rajasthan. The price of sample-1 was ₹200 kg^{-1}, sample-2 was ₹100 kg^{-1} and sample-3 was ₹100 kg^{-1}. The length and width of three samples were (4.2 cm and 1.5 cm, 4 cm and 2 cm and 3.3 and 1.9 cm) and the standard value was 3.5 cm- 4 cm and 1.5- 2 cm.

Piya *et al*. (2011) studied marketing channels of Non timber forest products in Shaktihor of Chitwan district in Nepal. They found that collectors sold 0.6 % products to consumers 2.0 % to national processors and 97.4 % to stakeholder.

Thamizhselvan and Murugan (2012) studied marketing channels and price spread of grapes in Theni district of Tamil nadu. They identified that grape reached grower to consumer through three marketing channels viz., channel 1. Producer → pre harvesting contractor → commission Agent → wholesaler → retailers → consumer, channel II.

Producer → commission agent → wholesaler → retailer → consumer and channel III. Producer → wholesaler → retailer → consumer. They studied that 28 % of the grapes growers sell their produce directly to commission agents and 50 % of grapes growers prefer the sale to pre harvest contractors, who make advance payment a few months before the harvest on condition that the entire produce should be sold to them at the price prevailing at the time of harvest. The share of the producer in the price paid by the consumer is 50.20 %, 58.32 % and 58.73 % in channels I, II and III, respectively. It was found that share of producer was highest in channel III when compared to channels I and II.

Chander and Chauhan (2014) reported that Khari Bawali (New Delhi) was the market for the sale and purchase of harad fruit in the country. Besides, Majeetha in Amritsar is the trade hub for medicinal plants in the country. They reported that due to perishibility of fruit and marketing monopoly, contractors sold the produce at the prices, ranging from ₹25 to ₹50 kg^{-1}. They also reported on site price of one kg of harad ranged between ₹12 to ₹35 depending upon size and quality of fruit.

Bhat *et al.* (2015) studied three marketing channels viz., channel I. Producer ⟶ commission agent → retailer → consumer channel II. Producer → retailer → consumer channel III. Producer → consumer to find out marketing costs and price spread of citrus fruit in Samba district of Jammu division, Jammu and Kashmir. They concluded that, average marketing cost at producer's level is ₹438.65, ₹264.00 and ₹226.67 per quintal for channel I, II and III, respectively and per quintal net price received by the producer were ₹945.90, 1 ₹036.00 and ₹1073.33 which was 44.00 %, 51.29 % and 82.56 % of the price paid by the consumer for channel I, II and III, respectively.

Bansal *et al*. (2015) studied marketing cost, price spread and marketing efficiency of potato in middle Gujarat. They concluded that 60 % of marketed surplus moved through marketing channel viz., Producer → wholesaler cum-commission agent → retailer → consumer. The total marketing cost incurred by growers amounted to ₹29.22 q^{-1}, average cost of production was ₹281.84 q^{-1}, and average price was ₹370.07 q^{-1} and net return received by farmer and ₹59.0 q^{-1}. Per quintal cost and margins in potato marketing recorded to ₹188.19 (26.28 %) and ₹187.10 (26.12 %), respectively. Thus, the producer's share in consumer's rupee was only 47.60 %, which was lower due to lack of storage facilities and presence of unorganized markets.

Khobarkar *et al*. (2016) studied marketing channel and price spread of Muskmelon in Akola district of Maharastra.They found two marketing channels viz., channel I. Producer → consumer, channel II.Producer → wholesaler → retailer → consumer. The producers share in consumer's rupee in channel-II was 73.31 per cent, and in channel I was 95.00 per cent. It showed that if share of various intermediates decrease the producers share in consumers rupee increases. Per quintal gross price received by producer price received was ₹522.49 q^{-1} selling price of wholesaler was ₹600.80 q^{-1} and retailers selling price was ₹712.65 q^{-1}. They concluded that channel-I was most profitable than channel-II.

Kumar *et al*. (2016) studied marketing channels and price spread of onion in Ambala district of Haryana during year 2014-15. They found three channels viz., channel I. Producer → wholesaler-cum commission agent → retailer → consumer, channel II. Producer → retailer → consumer and channel III: Producer → consumer. The highest share of producer in consumer's rupee was in channel-III (97.63 %) and followed by channel-II (70.13 %). Share of producer in consumer rupee was found lowest in channel-I which was accounted 54.39 %. This was because of non existence of intermediaries between producer and consumer in channel-III and large number of middlemen in between the producers and ultimate consumer in channel-I. Marketing cost incurred by the producer was highest in channel-I ₹52.50 q^{-1} and lowest in channel-III ₹32.00 q^{-1} whereas, the margin of intermediaries was highest in channel I i.e., ₹ 419.20 followed by channel II. In absolute terms, the producer received the highest net sale price in channel III ₹1318.00 q^{-1} followed by channel-II ₹1016.90 q^{-1}.

Pundir and Patel (2016) conducted a research on Marketing of Pomegranate in Middle Gujarat. The result showed that among three major marketing channels, channel I. Producer → wholesaler was found most popular among the farmers as about 72.39 % of total pomegranate production was marketed through this channel.

CHAPTER-3

MATERIAL AND METHODS

The present investigation entitled "Distribution and productivity of *Terminalia chebula* Retz. in Jammu region" of J&K state was carried out during 2015-16. The sampling procedure and techniques adopted during the course of investigation have been described in this chapter.

3.1 EXPERIMENTAL SITE

3.1.1 Location

The present study was confined to Jammu district of Jammu region as the maximum numbers of harad growers are present in this district. The information regarding the distribution of harad was collected from divisional forest offices of Jammu, Kathua, Samba and Udhampur. Three villages of Jammu district namely Manwal, Ranjan and Mathwar were selected and trees were divided into different age groups: 5-10 years, 10-15 years and 15 years and above (maximum age was upto 20 years). From each age group, ten trees were selected and analyzed for different parameters.

3.1.2 Climate

The experimental site falls under sub-tropical zone of Jammu division of Jammu and Kashmir state, with hot dry summers, hot humid rainy and cold winter months. The average annual rainfall at the site is about 1000-1200 mm, 75-80 percent of which is received during July to September and rest 20-25 per cent during winter months of December to January. The maximum temperature rises upto 45°C in May and June and minimum falls to 1°C during winter.

3.1.3 Collection of data

The data on tree parameters and fruit parameters were collected from each selected age group of harad plantation and mentioned as under:

Site/Villages	Age-group	Type of plantation
Manwal	5-10 years	Grafted
Ranjan	10-15 years	Grafted
Mathwar	15-20 years	Non-grafted

For the selection of trees in each site the total numbers of trees were counted and with the help of random number table, 10 trees were marked for data collection. The

information regarding marketing and productivity was done by visiting the fields of farmers and contacting them during study period.

3.2 TREE PARAMETERS

3.2.1 Age (years)

The age of tree was recorded based on plantation date of harad plants of the concerned farmers in site.

3.2.2 Height (m)

Angle of slope was calculated with Abney's level from observation taken at 10m distance. After that tangent method was applied, and is given below, to estimate final height of trees.

$$\tan\theta = \frac{\text{Perpendicular}}{\text{Base}}$$

a. Perpendicular = height of tree

b. Base = distance between observer and tree

c. θ= angle of slope

3.2.3 DBH (cm)

Diameter at breast height (DBH) over bark of trees at 1.37 m from the ground level was measured with the help of calliper in two directions at right angle to each other and the average of two measurements was computed and reported as mean diameter.

3.2.4 Crown spread (m)

It is the maximum spread of the crown along its widest diameter. The value of this variable indicates the growing space occupied by the tree. It was measured in East-West and North-South direction of the tree trunk. It was measured with the help of a graduated wooden rod and average value for crown spread then calculated.

3.3 FRUIT PARAMETERS

The trees were marked and a sample of 10 fruits were collected randomly in December, 2016. The fruit parameters were measured in the laboratory of Division of Agroforestry of Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu at Chatha.

3.3.1 Fruit size

3.3.1.1 Fruit length (mm)

A sample of 10 randomly selected fruit per tree was taken and length between the two ends of fruit was recorded in millimetre using digital verniers calliper and reported as mean.

3.3.1.2 Fruit diameter (mm)

The diameter at the centre of 10 randomly selected fruits was recorded at two right angles in millimetre and averaged.

3.3.2 Fresh fruit weight (g)

A sample of 10 randomly selected fruits per tree was taken and weighted with the help of weighing balance. An average fresh weight was worked out and reported as mean.

3.3.3 Fresh pulp weight (g)

The pulp of 10 fresh fruits was removed mechanically and weighted to obtain the fresh pulp weight of respective sample.

3.3.4 Dry fruit weight (g)

The pulp content and seeds (left after removing the pulp) of 10 fruits per tree were dried separately in oven at 80°C for 48 hours. The dry pulp weight and seeds for each sample was determined by weighing these dried samples. The dry pulp weight and dry seed weight of each sample was added to get the dry fruit weight of the respective sample and reported as mean.

3.3.5 Pulp fruit ratio

It is the ratio of pulp weight and fresh weight of each fruit obtained by weighing in electronic balance and average value was calculated.

3.3.6 Fruit yield (kg)

The fruits were removed from each tree at the time of harvesting and weighted in kilograms using electronic balance separately for each tree and average value was calculated as fruit yield per tree.

3.3.7 Fruit productivity (kg ha^{-1} yr^{-1})

The productivity of fruit was estimated by multiply fruit yield per tree in each site with number of tree per hectare.

3.4 MARKETING

3.4.1 Collection of primary data

The data regarding marketing of harad were collected by survey method by interviewing the farmers as well as different market functionaries directly. Relevant

primary as well as secondary data were collected with the help of a pre-tested, well designed interview schedule and is presented in Appendix-1.

3.4.2 Collection of secondary data

The required secondary data/information was collected from different marketing/scientific sources/agencies. Both primary and secondary data were used as per requirement of the study.

3.4.3 Quantification of the variables

Marketing cost, marketing margin and price spread was calculated on per quintal basis. Producer's share in consumer rupee and marketing efficiency was calculated by using following formula:

(1) Producer's share in consumer rupee (PS)

$$PS = \frac{\text{Price received by producer}}{\text{Price paid by consumer}} \times 100$$

(2) Index of marketing efficiency

For estimation of index of marketing efficiency, Acharya approach was used as per the suitability of data.

The modified method of marketing efficiency (MME) formula is given below.

MME= (RP/ (MC+MM)-1

MME=Index of marketing efficiency

RP=Price paid by consumer

MC=Total marketing costs

MM=Net marketing margins

3.5 Statistical analysis

The data, generated from the present investigations were analysed statistically using OPSTAT statistical programme.

CHAPTER-4

EXPERIMENTAL RESULTS

The results obtained during the present investigation on **Distribution and productivity of *Terminalia chebula* Retz. in Jammu region** are described under following heads:

4.1 Distribution of *Terminalia chebula* in Jammu region

4.2 Tree parameters of *Terminalia chebula*

4.3 Fruit parameters of *Terminalia chebula*

4.4 Marketing channels of *Terminalia chebula*

4.1 Distribution of *Terminalia chebula* in Jammu region

The information on distribution pattern of harad in different forest divisions of Jammu division is presented Fig 1 in Table 1 and described as under:

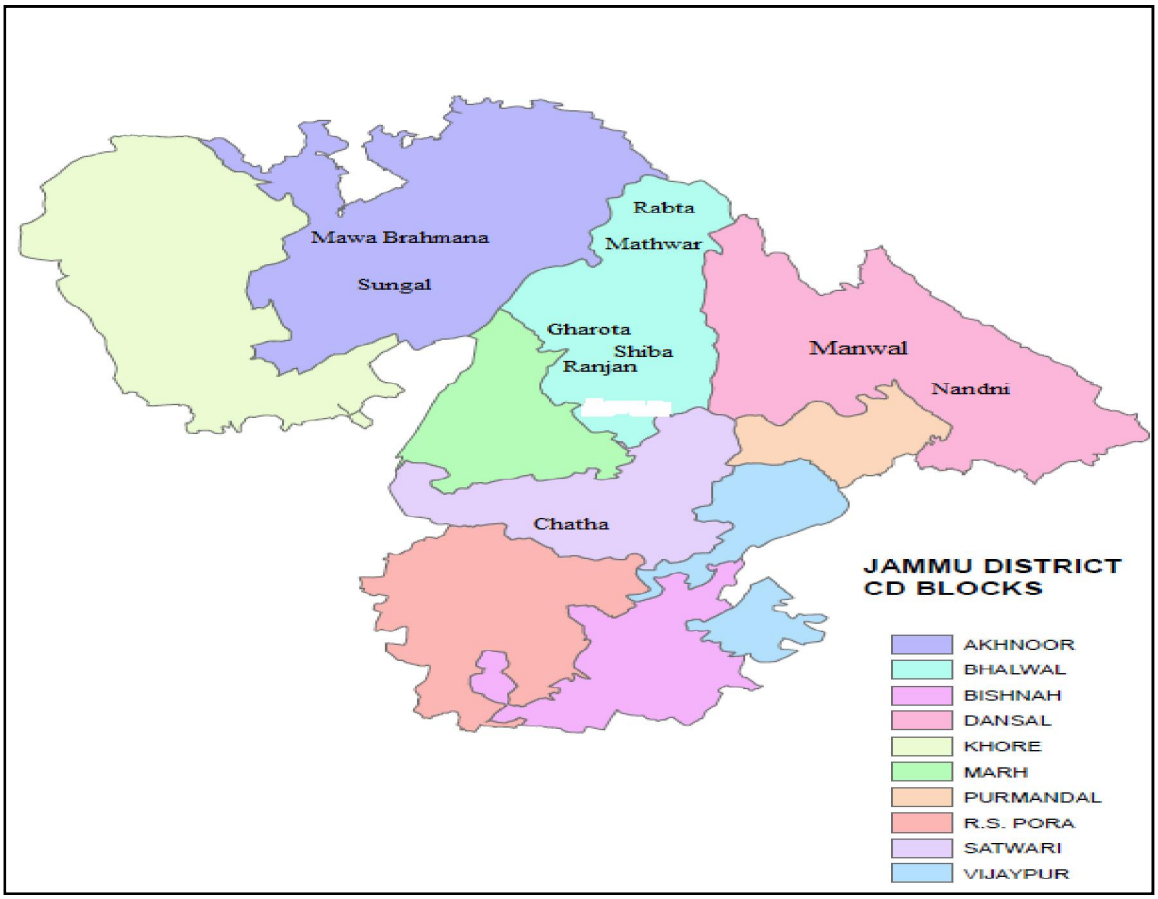

Fig1. Distribution of *Terminalia chebula* in Jammu region

In Jammu forest division, few scattered trees of *Terminalia chebula* along with other broadleaved tree species and dense scrub were found in Mansar block of Jindrah

range and Ramnagar rakh block of Jammu range in an area of 12879 ha which represent 18.32 per cent of the total area. In Jammu forest division, pure crop of *Terminalia chebula* was absent. On the basis of classification made in the revised survey of forest types of India by Champion and Seth, *Terminalia chebula* occurs only in forest type $5B/C_2$ - northern dry mixed deciduous forests having density 8.37 trees per ha^{-1} along with broad leaved associates which covered 16 % of the total area of the division. Whereas, it was absent in forest type $9C_1$/DS- Himalayan subtropical dry scrub type 9 / C_1 - Himalayan subtropical pine forest.

In Ramnagar Forest Division, *Terminalia chebula* occurred along with other broad leaved plant species in three ranges namely Ramnagar South, Ramnagar North and Basantgarh at an elevation upto 1700 m amsl. Scattered trees of *Terminalia chebula* are in lower Shivalik Chir Pine forest - $9/C_1A$ in all the three ranges on shivalik rock types along nallas, depressions and on cooler aspects.

In Udhampur Forest Division, few trees of *Terminalia chebula* were found along with other broad leaved tree species at an elevation ranges from 500 m amsl to 1700 m amsl in Udhampur , Pancheri and Dudu ranges of Chir Pine (*Pinus roxburghii*) forests.

In Reasi Forest Division, few trees of *Terminalia chebula* are managed for medicinal purpose in northern dry mixed deciduous forest type -$5B/C_2$ which comes under Reasi, Katra and Thakrakot ranges.

Table 1 Distribution of *Terminalia chebula* in Jammu region

Forest Division	Forest Range	Forest Type	Source of Information
Jammu	Jindrah, Jammu	Northern Dry Mixed Deciduous Forests (5B/ C_2)	Working Plan Jammu 2014-2024
Ramnagar	Ramnagar South, Ramnagar North, Basantgarh	Chir Pine Forests ($9/C_1$)	Working Plan Ramnagar 2014-2024
Udhampur	Udhampur, Pancheri, Dudu	Chir Pine Forests ($9/C_1$)	Working Plan Udhampur 2014-2024
Reasi	Reasi, Katra, Thakrakot	Northern Dry Mixed Deciduous Forests (5B/ C_2)	Working Plan Reasi 2014-2024

Terminalia chebula has been adopted as agroforestry tree species by the farmers in different location of Jammu district. However, sizable plantations exist in Manwal, Ranjan and Mathwar villages. In Ranjan, farmers have planted *Terminalia chebula* in lines at a spacing of 10 m×10 m whereas, farmers of Manwal have planted at boundary of the field. In Mathwar village, plantations of both grafted and non-grafted plants exist on the farmers field.

4.2 Tree parameters of *Terminalia chebula*

The results obtained after analysis of variance for various tree parameters in different age groups are presented in Table 2, and were significant for all characters. The various observations studied were diameter at breast-height (DBH), height and crown spread.

4.2.1 Height (m)

Height of tree was significantly influenced by age group of trees. Maximum height of 7.5 m was obtained in age group of 15-20 years followed by 5.6 m in age group of 10-15 years. Age group, 5-10 years recorded minimum tree height of 4.6 m.

4.2.2 DBH (cm)

Perusal of the data revealed that the DBH was also significantly affected by different age groups. Maximum DBH of 17.3 cm was recorded in age group of 15-20 years followed by 15.7 cm in age group of 10-15 years. Minimum tree height of 11.5 cm was recorded in 5-10 years age group.

4.2.3 Crown spread (m)

The observations recorded on crown spread of *Terminalia chebula* in different age groups indicated that age group has significant influence on this parameter. Maximum crown spread of 7.3 m was recorded in age group 15-20 years followed by 6.1m in the age group of 10-15 years. Minimum crown spread of 4.8 m was recorded in the age group of 5-10 years.

Table 2. Tree parameters as affected by age of plantation in *Terminalia chebula*

Age group (years)	DBH (cm)	Height (m)	Crown spread (m)
5-10 (grafted)	11.5	4.6	4.8
10-15 (grafted)	15.7	5.6	6.1
15-20 (non-grafted)	17.3	7.5	7.3
$CD_{0.05}$	1.5	0.4	0.4
±SE(m)	0.5	0.1	0.1

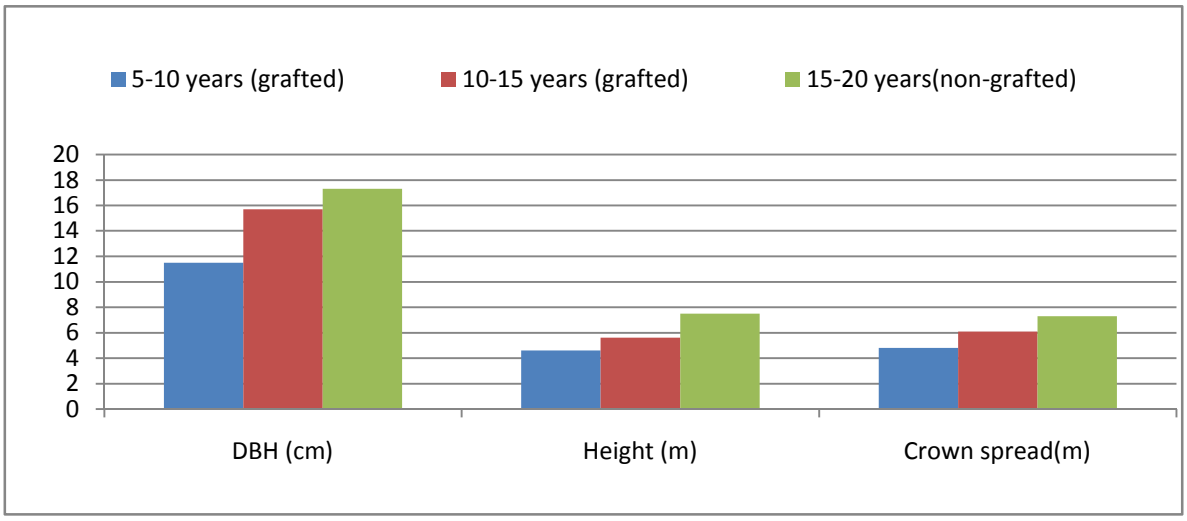

Fig 2.Tree parameters as affected by age of plantation in *Terminalia chebula*

4.3 Fruit parameters of *Terminalia chebula*

The data pertaining to the fruit parameters of *Terminalia chebula* grafted and non-grafted in three age groups viz. 5-10 years, 10-15 years and 15-20 years were recorded in order to compare market value of fruit. Fruit parameters such as length (mm), diameter (mm), fresh fruit weight (g), fresh pulp weight (g), dry fruit weight (g), pulp seed ratio, fruit yield per tree (kg) and productivity (ha^{-1}) were studied and are presented in Table 3.

4.3.1 Fruit length (mm)

The mean data recorded for fruit length showed significant variation between grafted and non- grafted harad. Maximum fruit length of 77.92 mm was recorded in grafted harad having age group 5-10 years which was at par with grafted tree in the age

group 10-15 years (77.77 mm) whereas, the minimum length (42.83 mm) was recorded in non-grafted trees in the age group of 15-20 years.

4.3.2 Fruit diameter (mm)

From the perusal of data it was clear that maximum fruit breadth of 32.77mm observed in grafted trees in the age group of 5-10 years was at par with grafted trees in the age group of 10-15 years (32.45 mm). Minimum fruit breadth of 24.75 mm was recorded in non-grafted trees in the age group 15-20 years.

4.3.3 Fresh fruit weight (g)

Fresh fruit weight (g) varied significantly among age groups, and between grafted and non-grafted harad. Maximum fresh fruit weight of 42.82 g was recorded in grafted trees of age group 5-10 years followed by grafted trees in the age group 10-15 years (42.57 g). However, both were statistically alike. Minimum fresh weight of 17.02 g was observed in non-grafted trees having age group of 15-20 years.

4.3.4 Fresh pulp weight (g)

A critical analysis of data showed that fresh pulp weight of grafted and non-grafted harad showed significant variation among different age groups. Maximum pulp weight (33.38 g) was recorded in grafted trees in the age group of 5-10 years which was at par with 10-15 years grafted trees (33.14 g). Significant minimum pulp 12.44g weight was observed in non-grafted trees in the age group 15-20 years.

4.3.5 Dry fruit weight

Among the various age groups, 5-10 year age group grafted trees attained significantly highest dry fruit weight (21.08 g) which was statistically at par with grafted trees 20.93 g having age group of 10-15 years. The lowest dry fruit weight of 8.14 g was recorded in non- grafted trees in the age group 15-20 years.

4.3.6 Pulp fruit ratio

Pulp fruit ratio varied significantly among age group and in between grafted and non-grafted harad. Maximum pulp fruit ratio (0.79) was recorded in non-grafted grafted trees in the age group 15-20 years followed by grafted trees in the age group 5-10 years (0.78) was statistically at par grafted trees in the age group of 10-15 years.

4.3.7 Fruit yield tree^{-1} (kg)

The mean data recorded for fruit yield per tree showed significant variation between grafted and non-grafted harad. Maximum fruit yield per tree (16.76 kg) was recorded in grafted trees in the age group of 10-15 years followed by grafted tree having

age group 5-10 years (14.14 kg), whereas, the minimum was recorded in non-grafted trees having age group of 15-20 years (11.52 kg).

4.3.8 Productivity per hectare

Estimated productivity was maximum (1676 kg $ha^{-1}yr^{-1}$) in grafted trees (Fig 2) in the age group 10-15 years followed by grafted trees in the age group of 5-10 years (1414 kg $ha^{-1}yr^{-1}$). It was least (1152 kg $ha^{-1}yr^{-1}$) in non-grafted trees having age group 15-20 years.

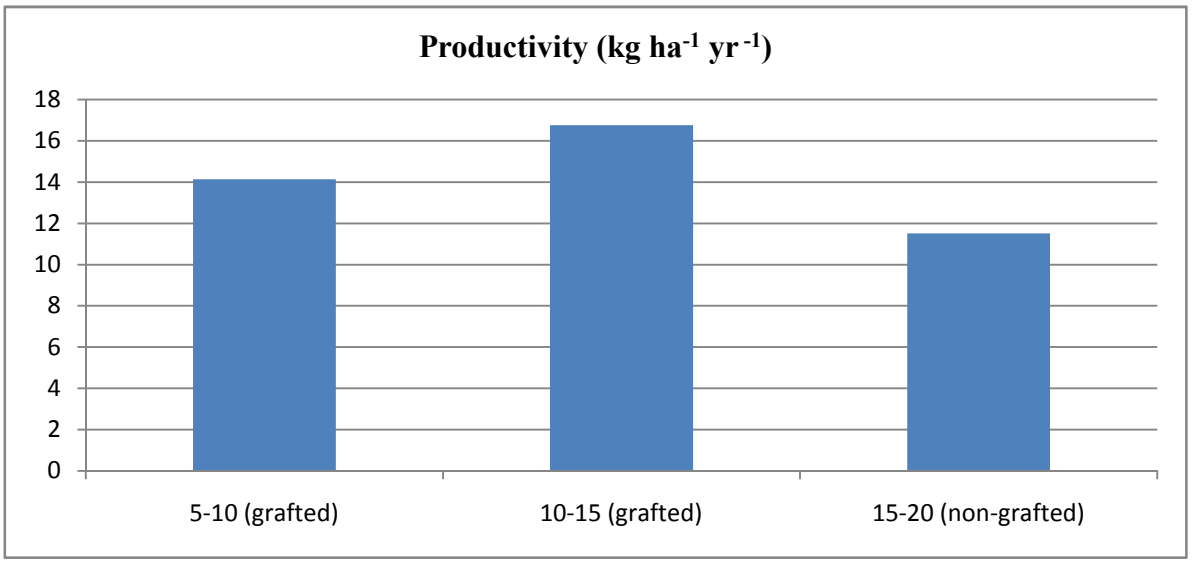

Fig 3. Productivity as affected by age of plantation in *Terminalia chebula*

Table 3 Fruit parameters as affected by age of plantation in *Terminalia chebula*

Age group (years)	Fruit size (mm)		Fruit weight (g)		Fresh pulp weight (g)	Pulp fruit Ratio	Fruit yield(kg tree^{-1})	Estimated productivity (kg ha^{-1}yr^{-1})
	Length	Breadth	Fresh	Dry				
5-10 (grafted)	77.92	32.77	42.82	21.08	33.38	0.78	14.14	1414
10-15 (grafted)	77.77	32.45	42.57	20.93	33.14	0.78	16.76	1676
15-20 (non-grafted)	42.83	24.75	17.02	8.14	12.44	0.79	11.52	1152
$CD_{0.05}$	1.29	0.83	0.94	0.43	1.22	0.73	0.95	224.35
±SE (m)	0.43	0.28	0.31	0.14	0.41	0.60	0.32	74.93

4.4. Marketing Channels of *Terminalia chebula*

The perishable nature of forestry produce makes its marketing an important aspect of study. Marketing of forestry produce involves various intermediaries' channels. In case of *Terminalia chebula*, being a medicinal fruit tree and involvement of various quality parameters like size, weight, pulp fruit ratio, etc, it needs special care in grading and marketing of produce. Therefore, different aspects of marketing namely marketing channels, total marketing cost, margins, and price spread were studied.

Marketing of *Terminalia chebula* follows one channel before reaching to the ultimate consumer. In the study area only one channel was identified (Fig.3). This channel was: producer - pre -harvesting contractor - forwarding agent - wholeseller/market. In this channel *Terminalia chebula* grower sold his produce to the pre -harvesting contractor who acted as a bridge between producer and forwarding agent. This product is channelized to market through forwarding agent.

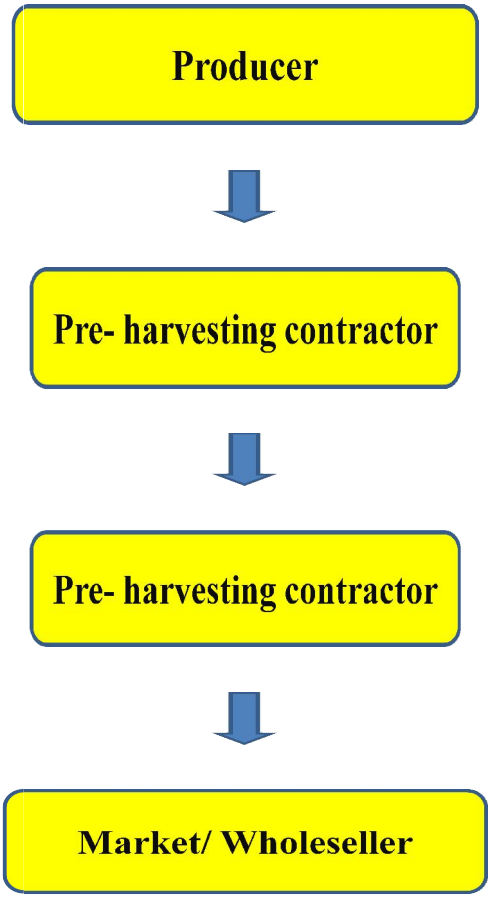

Fig. 3. Marketing Channels of *Terminalia chebula*

4.4.1Total marketing cost, margins and price spread of non-grafted harad

The details of marketing cost, margins and producers share in consumers rupee for the sample as a whole for fruit of non-grafted harad is depicted in Table 4. The results showed that the average price received by the farmers was ₹500 q^{-1}, which account for (38.46%) of the consumer price whereas, the total expenses incurred by harad farmers was nil. The total expenses incurred by pre-harvesting contractor were ₹46 q^{-1} which account for (3.54%) of consumers rupee. Among the various expenses incurred by pre-harvesting contractor, highest was picking cost (1.54%), followed by transportation cost (0.85%), gunny bag cost (0.77%) and loading and unloading cost (0.38%). The net margin received after selling was ₹254 q^{-1} which account for (19.54%) of consumer rupee. The forwarding agent purchased at ₹800 q^{-1} and total expenses incurred were ₹50q^{-1} which accounted for (3.85%) of consumers rupee. The net margins received after selling was ₹450 q^{-1} which accounted for (34.61%) of the consumers rupee. The wholeseller purchased at ₹1300 q^{-1}. Total marketing cost and marketing margins amounted to ₹96 and ₹704 q^{-1}, respectively. The price spread which included total marketing cost incurred in whole marketing channel namely from farmer to wholeseller/market and total marketing margins earned by intermediaries amounted to ` 800 (61.54%). Further, it was found that producer share in consumers rupee was (38.46%) and net income was (41.52%) at producer level, (21.09%) at pre-harvesting contractor level and (37.37%) at forwarding agent level (Fig 4). The marketing efficiency index was worked out to be 0.64.

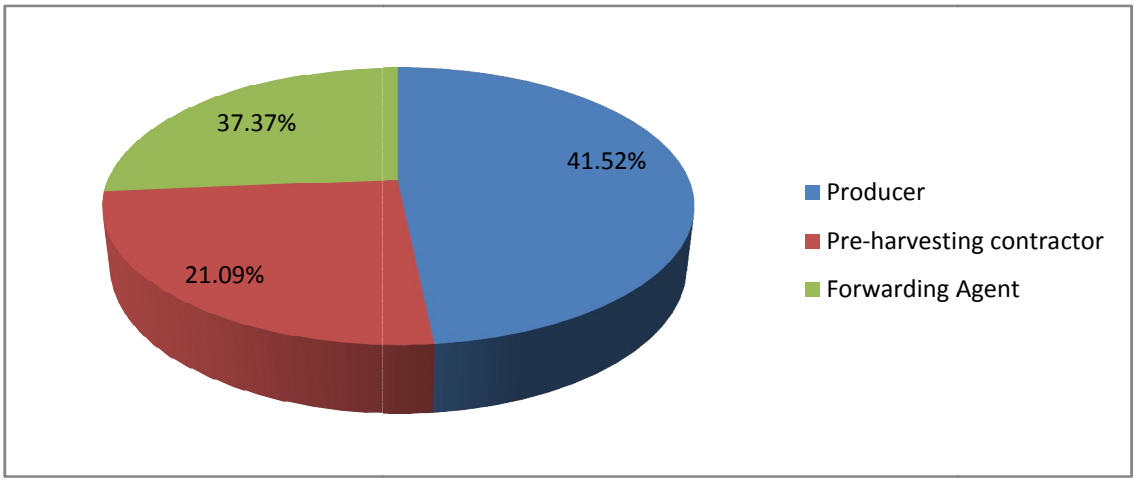

Fig.4. Net income of different stakeholder in marketing of non-grafted harad

Table 4 Price spread and marketing efficiency in non-grafted harad

Particulars	Cost (₹/q)	Percentage to consumers rupee
Farmers level		
Price received	500.00	38.46
Expenses incurred	Nil	-------
Net price received	500.00	38.46
Pre-harvesting contractor level		
Purchase price	500.00	38.46
Expenses incurred		
Picking cost	20.00	1.54
Gunny bag cost	10.00	0.77
Transportation cost	11.00	0.85
Loading and unloading cost	5.00	0.38
Total expenses	46.00	3.54
Net margins	254.00	19.54
Forwarding agent level		
Purchase price	800.00	61.54
Expenses incurred		
Transportation cost	50.00	3.85
Total expenses	50.00	3.85
Net margins	450.00	34.61
Wholesellers level		
Purchase price	1300.00	100
Total marketing cost	96.00	7.38
Total marketing margins	704.00	54.15
Price spread	800.00	61.54
Producer share in consumers rupees	38.46	
Index of marketing efficiency	0.64	

4.4.2 Total marketing cost, margins and price spread of grafted harad

The details of marketing cost, margins and producers share in consumer's rupee for the fruits of grafted harad is depicted in Table 5. The results showed that the average price

received by the farmers was ₹4500 q^{-1}, which account for (24.32%) of the consumer price whereas, the total expenses incurred by harad farmers was nil. The total expenses incurred by pre-harvesting contractor were ₹9146 q^{-1} which account for (49.44%) of consumers rupee. Among the various expenses incurred by pre-harvesting contractor, highest cost was reduced weight cost ₹9000 (48.65%), followed by labour charges ₹100 (0.54), picking cost ₹20 (0.11%), transportation ₹11 (0.06%), gunny bag cost ₹10 (0.05%) and loading and unloading cost ₹5 (0.03%). The net margin received after selling was ₹2354 q^{-1} which accounted for (12.72%) of consumer rupee. The forwarding agent purchased at `1600 q^{-1} and total expenses incurred were ₹50 q^{-1} which account for (0.27%) of consumers rupee. The net margins received after selling was ₹2450 q^{-1} which accounted for (13.24%) of the consumers rupee. The wholeseller purchased at ₹18500 q^{-1}, in which the total marketing cost and marketing margins amounted to ₹9196 and 480 ₹4 q^{-1}, respectively. The price spread which included total marketing cost incurred in whole marketing channel viz, from farmer to wholeseller/market and total marketing margins earned by intermediaries amounted to ₹14000.00 (75.67%). Further, it was found that producer share in consumers rupee was (24.32%) and net income was (48.36%) at producer level, (25.30%) at pre-harvesting contractor level and (26.33%) at forwarding agent level (Fig 5). The marketing efficieny index was worked out to be 0.32.

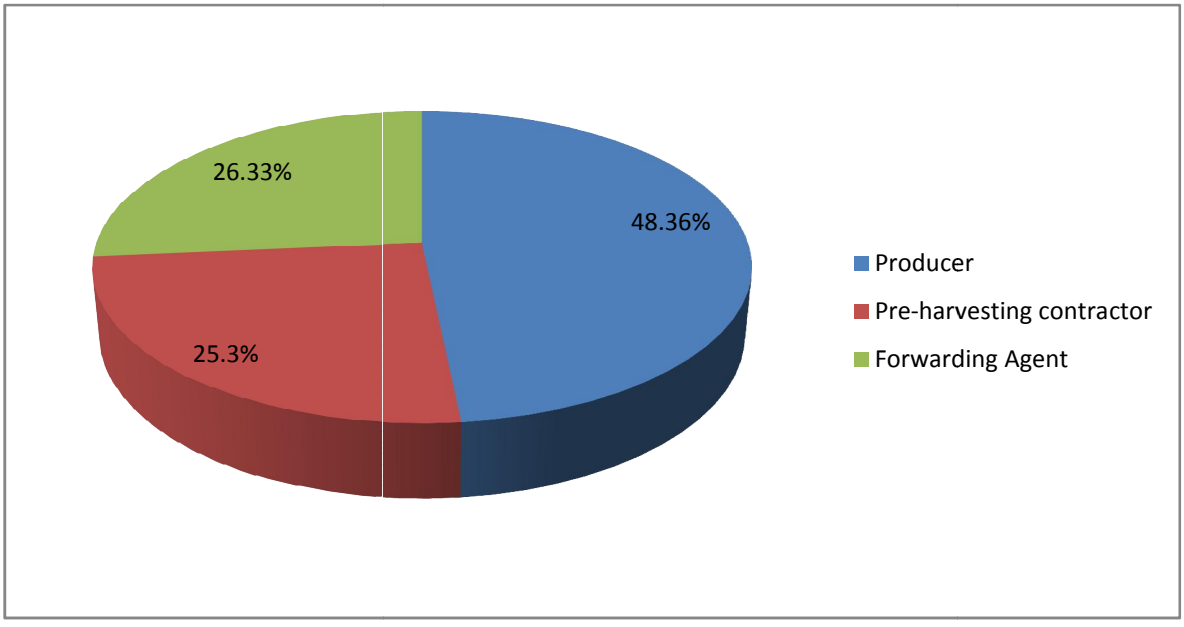

Fig.5. Net income of different stakeholder in marketing of grafted harad

Table 5 Price spread and marketing efficiency in grafted harad

Particulars	Cost (₹/q)	Percentage to consumers rupee
Farmers level		
Price received	4500.00	24.32
Expenses incurred	Nil	-------
Net price received	4500.00	24.32
Pre-harvesting contractor level		
Purchase price	4500.00	24.32
Expenses incurred		
Picking cost	20.00	0.11
Gunny bag cost	10.00	0.05
Transportation cost	11.00	0.06
Loading and unloading cost	5.00	0.03
Reduced weight cost	9000.00	48.65
Labour charges	100.00	0.54
Total expenses	9146.00	49.44
Net margins	2354.00	12.72
Forwarding agent level		
Purchase price	16000.00	86.45
Expenses incurred		
Transportation cost	50.00	0.27
Total expenses	50.00	0.27
Net margins	2450.00	13.24
Wholesellers level		
Purchase price	18500.00	100
Total marketing cost	9196.00	
Total marketing margins	4804.00	25.97
Price spread	14000.00	75.67
Producer share in consumers rupee	24.32	
Index of marketing efficiency	0.32	

CHAPTER- 5

DISCUSSION

The finding of the present investigation entitled **"Distribution and Productivity of *Terminalia chebula* Retz. in Jammu Region"** of J&K are discussed in this chapter with suitable and reasonable explanation in the light of available literature. Efforts were made during the present investigation to explore natural habitat and plantations of harad in Jammu region. In addition to this, the aim of present study was to compare fruit parameters, productivity and price spread of non-grafted and grafted harad trees grown in Jammu region. This information was essential to make this species more popular on farmland. The findings of the present investigation are discussed under the following heads:

5.1 Distribution of harad in Jammu region

5.2 Growth and yield parameters

5.3 Marketing channels of harad

5.1 Distribution of harad in Jammu region

This species mostly occurred in kandi belt of sub-tropical area of Jammu region at an altitude ranges from 300 m amsl to 990 m amsl. The scattered trees were found in Jammu, Ramnagar, Udhampur and Reasi forest divisions in northern dry mixed deciduous forests ($5B/C_2$) and chir pine forests (Kalsi, 2017; Iqbal, 2017; Chaudhary, 2017 and Khan, 2017). Most extensive damages to the crop of these forests are caused by man and animals. The uncontrollable increase in human and bovine population has resulted in excessive biotic pressure in these areas. The major injuries that are caused by man and animals are lopping of trees, forest fires, grazing, grass cutting, illicit damages and encroachments. This species is found as single tree which is observed from the survey conduct and also reported in the working plans of all the divisions. This may be due to the many reasons such as unavailability of fruits on the forest floor due to its collection for use in the pharmaceuticals industry, the premature fruit drop as a result of attack of fruit borers, insect and leaf rust causes yellow spot on the leaves that reduces photosynthetic activity. Other reasons may be infestation of forest floor with *Lantana camara*, poor regeneration due to dormancy and non-formation of kernals, hard mesocarp, etc. Srivastava (2017) also reported poor natural regeneration of harad due to its hard mesocarp, thick shell and poor formation of kernel. Chander and Chouhan (2014) found that *Lantana camara* forms thick mat on forest floor and seeds don't get proper conditions and space for germination and hence, natural regeneration

of harad in Shiwalik belt of Haryana and Himachal Pradesh is less. Similar observations have been reported by Sharma and Kant (2014) in sub-tropical kandi Shiwaliks of Jammu. Wherein, regeneration of harad has been effected by heavily infestation of dense patches of *Lantana camara* weed. Sahu *et al*. (2012) found contagious behaviour of harad in tropical deciduous forest of Malyagiri hill ranges, Eastern Ghats, India with a density of $1.3ha^{-1}$.

5.2 Growth and yield parameters

For the farmers, juvenility is the important factor for the adoption of any fruit species in their field to get maximum benefits. Most of the plants growing in fields have long juvenile period and farmers have to wait for a period of 10-15 years. Multiplication of these plants by sexual reproduction through (seeds) cannot be maintained true-to-type plants. To overcome this difficulty, researchers used vegetative propagation method to multiply plants. Picking and harvesting of fruits becomes easy due to early age fruiting. In the present investigation vegetative propagated plants (grafted) and sexually reproduced plants were compared to estimate the growth and yield parameters. For this purpose, we took three age groups namely 5-10 years (grafted), 10-15 years (grafted) and 15-20 years (non-grafted). DBH, height and crown spread was highest in non-grafted harad having age-group 15-20 years and fruit size, fruit weight, pulp weight, yield and productivity per hectare is lowest compared to grafted plants of lower age-group. Non-grafted plants due to larger size (DBH 17.3cm, height 7.5m and crown spread 7.3m) are not preferred by the farmers (Fig 1) because of their shading effect on the crops with less fruit yield per tree compared to grafted plants with smaller in size and higher fruit yield. In case of grafted plants, the scion is taken from superior mother tree "Raj Harad" so the quality of the fruit is better in grafted than non-grafted. Fruit parameters of both the grafted plantation were similar to each other as well as to the mother tree. Maximum productivity per hectare is observed in grafted plants of 10-15 years age-group followed by grafted trees of 5-10 years age-group. This variation may be due to age difference in both the plantations. Minimum productivity was observed in non-grafted plants of 15-20 years age-group.

Saleem *et al*. (2014) also reported significant variation in fresh fruit weight, dry fruit weight, fruit length and fresh pulp weight in candidate plus trees in different locations of Himachal Pradesh and Jammu and Kashmir. Khobragade *et al*. (2013) also observed variation in tree and fruit yield in natural populations and plantations of *Terminalia chebula* in Maharashtra and Madhya Pradesh. They reported that crown volume, girth and clear bole height must be considered for selection of candidate plus tree for higher fruit yield in harad.

Navale *et al*. (2011) studied the variation in forty-eight candidate plus trees (CPTs) selected in Dapoli, Burondi, Wakawali, Murud and Anjarla in Maharashtra. They took six characters of tree and twelve physical parameters of fruit and recorded significant variation among them. Four CPTs were analyzed based on parameters like non-reducing sugar per cent, weight of fresh fruit, weight of seed, weight of fruit pulp, moisture per cent and weight of dry fruit as these characters were under genotypic control. Improvement in fruit productivity and fruit yield by grafting in different rootstock has also been reported by Lavat *et al*. (1995) in Avocado and Mango

5.3 Marketing channels of harad

The objectives of economic analysis is to verify the price received by the farmer's, price spread at various intermediately level, producer share in consumer rupee and index of marketing efficiency by selling grafted and non-grafted harad, as the size of fruit determine its value in marketing and also find out the best marketing channel in order to get farmer maximum benefit. Marketing of harad followed one marketing channel namely producer-pre-harvesting contractor- forwarding agent- whole seller/industries in Jammu region.The price received by farmer from marketing of grafted harad fruit was higher (₹4500 q^{-1}) as compare to non-grafted harad fruit (₹500 q^{-1}). This is attributed due to bigger size, high pulp content and large fruit weight. Chander and Chauhan (2014) reported that on site farmer get price ranging from ₹1200 q^{-1} to ₹3500 q^{-1}. This flucation of price is mainly due to size of fruit. Producer share in consumer's rupee was higher (38.46) in non-grafted harad fruit than grafted fruit (32.24). This is due to difference in price received by farmer and price paid by wholeseller. Similar study was reported in pomegranate in middle Gujarat by Pundir and Patel (2016). The price spread was higher in grafted harad while index of marketing efficiency and producers share in consumer rupee was higher in non-grafted harad. Similar study is well supported by the finding of Srikala *et al*. (2016) in marketing of chillies, Gunwat *et al*. (2013), Kumar *et al*. (2016) in marketing of Onion and Kobarkar *et al*. (2016) in marketing of Muskmelon.

CHAPTER – 6

SUMMARY AND CONCLUSION

The present investigation entitled **"Distribution and Productivity of *Terminalia chebula* Retz. in Jammu Region"** was conducted during the year 2015-16.The basic purpose of the study was to find the distribution of harad in Jammu region and to compare the different morphological parameters, fruit characters and productivity of grafted and non grafted harad trees. The three age-groups viz. 5-10 years (grafted), 10-15 years (grafted) and 15-20 years (non-grafted) were selected for the investigation. Two experiments were conducted under Randomized Block Design with ten replications in each. Price spread and marketing channels of harad fruits were also studied. The salient features of the investigation are summarized as below.

The scattered trees of harad were present in Jammu, Ramnagar, Udhampur and Reasi forest divisions with maximum trees in Bhalwal block of tehsil Akhnoor. A few of the farmers adopted harad as agroforestry tree species at Mathwar, Rabta, Ranjan and Manwal villages of Jammu district. Scattered trees were also found at Raya, Rabta, Sarore, and Nandini villages of sub-tropical areas of kandi shiwaliks of Jammu region.

Tree parameters like DBH, height and crown spread were affected by age. Maximum DBH (17.3cm), height (7.5m) and crown spread (7.3m) were recorded in non-grafted plants having age-group of 15-20 years followed by 10-15years age-group of grafted plants. Minimum DBH (11.5m), height (4.6m) and crown spread (4.8m) were recorded in grafted harad having age-group of 5-10 years.

Higher values of fruit parameters viz, fruit length (77.92mm), fruit breadth (32.77mm), fresh fruit weight (42.82g), dry fruit weight (21.08g), fresh pulp weight (33.38g), fruit yield (14.14kg^{-1}) were recorded in grafted plants having age group 5-10 years and are significantly at par with 10-15 years grafted harad. These fruit quality contributing characters recorded lowest value in non-grafted harad having age group 15-20 years.

The price received by grower in the marketing of harad fruit was higher (₹4500q^{-1}) as compare to non-grafted harad fruits (₹500q^{-1}). The total marketing cost (₹9196.00), marketing margins (₹4804.00) and price spread (₹14000) were higher in grafted harad fruits than in non-grafted, while producer share in consumer rupee (24.32) and index of marketing efficiency (0.32) was lowest in grafted harad than in non grafted.

Conclusions

Scattered trees of harad were found in Jammu, Udhampur, Ramnagar and Reasi forest divisions of Jammu region and few farmers adopted as an agroforestry tree species at Mathwar, Ranjan and Manwal villages of Jammu district. Fruit size, fruit weight, pulp weight, fruit yield per tree and productivity was higher in grafted harad compared to non-grafted. Producer share in consumer's rupees and index of marketing efficiency was higher in non-grafted harad while price spread was higher in grafted.

REFERENCES

Bag, A., Bhattacharyya, S.K. and Chattopadhyay, R. S. 2013. Development of *Terminalia chebula* in clinical research. *Asian Pacific Journal of Tropical Biomedicine*, **3** (3):244-252.

Bansal., R.K., Zala, Y.C and Parmar, D. J. 2015. An economic analysis of marketing cost, price spread and marketing efficiency of potato in middle Gujrat. *International Journal of Humanities and Social Sciences,* **4** (3):21-26.

Bhat, A., Kachroo, J., Singh, S.P. and Sharma, R. 2015. Marketing costs and price spread analysis for citrus in Samba district of Jammu region. *International Journal of Agro-Economist*, **2** (1):39-44.

Chander, J. and Chauhan, S.K. 2014. Current status of management of *Terminalia chebula* in Shivalik Hills. *Journal of Krishi Vigyan*, **3** (1):13-17.

Chaudhary, S. 2017. Working plan for Udhampur Forest Division 2015-16 to 2025-26. http://www.jkforest.gov.in/wplans/UDH_WP_Part1.pdf (accessed on 10-02-2017).

Dymock, M., Warden, C.J.H and Hopper, D. 1976. A history of the principal drugs of vegetable origin, met within British India. *Pharmacographica indica*, **6** (1):140-146.

Gunwant, V., Raturi, M., Hussain, M., Khan, S.F.A and Rana, D. 2013. Marketing of sweet orange (Malta) in India. *International Journal of Emerging Research in Management &Technology*, **2** (3):45-49.

Gupta, P. C. 2012. Biological and pharmacological properties of *Terminalia chebula*. *International Journal of Pharmacy and Pharmaceutical Sciences*, **4** (3): 62-68.

Iqbal, F. 2017. Working plan for Ramnagar Forest Division 2013-2014 to 2023-2024. http://www.jkforest.gov.in/wplans/Ramnagar_Part1.pdf (accessed on 05-02-2017).

Jyoti, S., Samant, S., Kishor, K., Upreti, B.M., Bharti, M., Bohra, N., Sharma, P and Tewari, L.M. 2014. Diversity, distribution, indigenous uses and conservation prioritization of the economically important floristic diversity in Nadaun Block of Hamirpur District, Himachal Pradesh. *International Journal of Biodiversity and Conservation*, **6** (7):522-540.

Kalsi, A.K. 2017. Working plan for Jammu Forest Division 2013-2014 to 2023-2024. http://www.jkforest.gov.in/wplans/JMU_WP_PART1.pdf (accessed on 01-01-2017).

Kannan, P., Ramadevi, S.R. and Hopper, W. 2009. Antibacterial activity of *Terminalia chebula* fruit extract. *Africian Journal of Microbiology Research*, **3** (4):180-184.

Khan, I.A. 2017. Working plan for Udhampur Forest Division 2015-16 to 2025-26. http://www.jkforest.gov.in/wplans/Part2_Reasi WP.pdf (accessed on 10-02-2017).

Khare, C.P 2007. *Indian medicinal plants*: pp. 652-653. An illustrated dictionary. Springer Verlag Berlin.

Khobarkar, V., Tale, N., Ingole, D.N. and Nage, G.V. 2016. Economics of marketing in Akola District. *Indian Journal of Economics and Development*, **12** (1a):151-153.

Khobragade, N.K., Prasad, H., Prabha, A.C. S and Mandal, A.K. 2013. Parameters for selection of candidate plus trees of *Terminalia chebula* and *Terminalia bellerica*. *Indian Forestor*, **139** (9):833-835.

Kim, T. G., Kang, S. Y., Jung, K.K., Kang, J.H., Lee, E., Han, H.M. and Kim, S.H. 2001. Antiviral activities of extracts isolated from *Terminalia chebula*, *Sanguisorba officinalis*, *Rubus palmatum* against Hepatitis B. *Phytotherapy Research*, **15** (8):718-720.

Koehn, F. K. and Carter, G.T. 2005. The evolving role of natural products in drug discovery. *Natural Revision Drug Discovery*, **4**:206-220.

Kumar, R., Bishnoi, D. K., Rathi. A and Prakash, S. 2016. Marketing and price behaviours of onion in Haryana. *Indian Journal of Economics and Development*, **12** (1a):7-11.

Lahav, V., Tomar, E., Gazit . S and Lavi, U. 1995. Performance of avocado (*Persea Americana*) and mango(*Mangifera indica*) seedlings compared with their grafted trees. *Journal of American Society of Horticulture Sciences,* **120** (2):265-269.

Luna, R.K. 2005. *Silviculture of Indian Trees*, pp. 274. International Book Depot, Dehradun.

Murthy, D.S., Gajanana, T., Sudha, M and Dakshinamoorthy,V. 2009. Marketing and post - harvest losses in fruits: Its implications on availability and economy. *Indian Journal of Agriculture Economics,* **64** (2):260-275.

Navhale, V.C., Sonone, N.G., Jangam, P.S., Jadhav,S.T and Bhave, S.G. (2011). Genetic variability and selection of candidate plus trees in chebulic myrobalan (*Terminalia chebula*). *Electronic Journal of Plant Breeding*, **2** (1)157:163.

Piya, L., Mahajan, K.L., Joshi, N.P and Dangol, D.R. 2011. Collection and marketing of non-timber forest products by the chepang community in Chitwan District of Nepal. *Munich Personal RePEc Archive*, **5**: 1-15.

Pundir, R.S and Patel, S.K. 2016. Marketing of pomegranate in Middle Gujrat. *Paripex-Indian Journal of Research*, **5** (6):55-58.

Rao, N. K and Nammi, S. 2006. Antidiabetic and renoprotective effects of the chloroform extract of *Terminalia chebula* seeds in streptozotocin-induced diabetic rats. *BMC Complement and Alternative Medicine*, **6**:17.

Sahu, S. C., Dhal, N. K. and Mohanty, R.C. 2012. Tree species diversity, distribution and population structure in a tropical dry deciduous forest of Malyagiri hill ranges, Eastern Ghats, India. *Tropical Ecology*, **53** (2):163-168.

Saleem, M., Sood, K.K., Gupta, S.K., Raina, N.S. and Gupta, L.M. 2014. Suitable agro-techniques for germination and vegetative propagation of superior germplasm of *Terminalia chebula* Retz. - A Multipurpose Agroforestry Tree. *Range Management and Agroforestry*, **35** (1): 121-127.

Sanjeewa, T. A.B.D., Pushpakumara, D.K.N.G. and Sangakkara, U. R. 2013. Morphological characterization of *Terminalia chebula* in Sri Lanka. *Tropical Agriculture Research*, **25** (1): 127-132.

Sharma, D. and Thakur, S. 2015. Ecological variation among natural populations of *Terminalia chebula* in Kangra Districts, Himachal Pradesh. *International Journal of Bio-resource and Stress Management*, **6** (6):754-758.

Sharma, D. and Thakur, S. 2016. Ecological variation among natural populations of *Terminalia chebula* in Sirmour and Una Districts, Himachal Pradesh. *International Journal of Farm Sciences*, **6** (1):140-147.

Sharma, D., Thakur, S. and Jha, S. K. 2016. Characterization of population variation for fruit and pulp in *Terminalia chebula*. *Agroforestry System*, **90**:361-369.

Sharma, K., Thakur, S., Sharma, S and Sharma, S.M. 2012. A new record on flowering in harad seedling. *American Journal of Plant Sciences*, **3**:693-695.

Sharma, N. and Kant, S. 2014. Vegetation structure, floristic composition and species diversity of woody plant communities in sub-tropical kandi shiwaliks of Jammu, J&K, India. *International Journal of Basic and Applied Sciences*, **3** (4):382-391.

Sharma, N., Sharma, Anu and Singh, D. 2015. Ethno- medicinal uses of floristic diversity of sub-tropical forests of Jammu. *International Journal of Development Sciences*, **5** (3):3945-3954.

Singh, M. P. and Sharma, C.S.2010. Pharmacognostical evaluation of *Terminalia chebula* on different market samples. *International Journal of ChemTech Research*, **2** (1):57-61.

Singh, R.V. 1982. Fodder trees of India. Oxford and IBH Publishing Co. Pvt., New Delhi.

Srikala., M., Devi, B., Subramanyam,V. and Ananda, T. 2016. Cost of cultivation and price spread in Guntur district of Andhra Pradesh. *International Journal of Agriculture, Environment and Biotechnology,* **9** (2):299-303.

Srivastava, R. K. (2017). Approach grafting- A new approach for the formation of clonal bank of *Terminalia chebula*. *Indian Forester*, **126** (6):300-304.

Suchalatha, S. and Devi, C.S. 2009. Antioxidant activity of ethanolic extract of *Terminalia chebula* fruit against isoproterenol-induced oxidative stress in rats. *Indian Journal of Biochemistry and Biophysics*, **42**:246 - 249.

Sundriyal, M., Sundriyal, R.C., Sharma, E. and Purohit, A.N. 1998. Wild edibles and other useful plants from the Sikkim himalaya, India. *Oecologia Montana*, **7**:43-54.

Suryaprakash, D.V., Sreesatya, N., Avanigadda, R. and Vangalapati, M. 2012. Parmacological review on *Terminalia chebula*. *International Journal of Research in Pharmaceutical and Biomedical Sciences*, **3** (2):679-683.

Thakur, S., Sharma, K and Gupta, A. 2008. Assesing natural variation in fruit and seed of harad (*Terminalia chebula*). *Indian Journal of Agroforestry*, **10** (2):66-70.

Thamizhselvan, K and Murugan, S.P. 2012. Marketing of grapes in Theni district of Tamil nadu. *International Journal of Marketing and Technology*, 2 **(9)**:96-110.

Troup, R.S. 1921. *Silviculture of Indian Trees*, pp.1195. International Book Depot, Dehradun.

WHO, 2002. *Traditional medicine growing needs and potential*, pp.1-7. WHO policy perspectives on medicine, Geneva.

World Agroforestry Centre. N.d. Agroforestry Tree Database. A Tree Species References and SelectionGuide.http:/www.worldagroforestry.org/sea/Products/AFDbases/af/asp/SpeciesInfo (accessed on 6/9/2017).

APPENDIX-1

Interview schedule of productivity and marketing of *Terminalia chebula* in Jammu region

Date of data collection	
Name of village	
Name of block	
Name of Tehsil	
Name of District	
Mobile number of the Respondent	

PART-1

1. Socio-demographic profile of the respondent

Name of the respondent	
Father's Name	
Age (years)	
Education	
In case of literate, the number of formal schooling (years completed)	
Whether land is owned by the respondent? If yes whether he/she has In case of joint ownership, name the owners of land	

2. Operational land holding (in acres):

S.NO	Land holding	Total	Irrigated	Un-irrigated	Topography
I	Owned				
II	Leased in				
III	Leased out				

3. Source of Irrigation: (In case the respondent has irrigated land)

Source	Number	Crop and area (acres) Irrigated
I. Canal		
II. Diesel pump set		
III. Electronic pump set		
IV. Seasonal river		
V. Perennial river		
VI. Any other		

4. Occupation of family members (Number) and main source of house hold income

Occupation	No.	Age
Agriculture		
Govt. Job		
Private job		
Retd. From		
Business/Shop		
Cattle rearing		
Student		

5. Main source of household income

5a. Subsidiary source of income

5b. Family income (Annual)

From agriculture (in Rs)	
Other source (in Rs)	

Part-II

6. Crop cultivated by the respondent

Crop	Area
Kharif	
Rabi	

7. Whether the harad planted on bunds/terraces (yes/no)

If yes, area of bunds.....

7a. Whether the respondent has planted harad (yes/no)

If yes, give the following details

Types of harad plantation	Area planted	No. of trees	Years of plantation/age	Production (q)
Desi				
Grafted\				

8. Does the farmers collect harad from wild plantation (yes/no)

If yes, give following details

Name of the area	No. of trees	Fruit collected (q)	Expenditure

Give the details about marketing

Fruit collected	Quantity (q)	Sale price (Rs/q)	Name of the buyer	Total income
Desi				
Grafted				

9. Distance of market from your place

10. Problems in marketing

1.

2.

3.

11. Marketing Pattern

Marketing cost incurred by intermediary..... (Rs/q)

Harad	Farmer	First intermediary	Second intermediary	Third intermediary	Fourth intermediary
Transportation cost					
Picking cost					
Cost of gunny bags					
Loading/unloading					
Weighing charges					
Any other costs					

VITA

Name of the student : **Mr. Vinod Kumar Sharma**

Father's name :**Sh. Kuldeep Raj Sharma**

Mother's name : **Smt. Kamla Devi**

Nationality :**Indian**

D.O.B :**05-01-1989**

Permanent home Address : **R/O Village Mondwah,**

Teh. Bhagwah

Distt. Doda (J&K)

Pincode: 182202

Email: vs9564960@gmail.com

EDUCATIONAL QUALIFICATION

Bachelors degree : **B.Sc. Forestry**

Sher-e-Kashmir University of Agricultural Sciences and Technology Wadura, Sopore (Kashmir) 2015

OGPA : **8.18 (ON 10 point scale)**

CERTIFICATE-IV

Certified that all the necessary corrections as suggested by the external examiner and the Advisory Committee have been duly incorporated in the thesis entitled **"Distribution and Productivity of *Terminalia chebula* Retz. in Jammu Region"** submitted by **Mr. Vinod Kumar Sharma** Registration No. **(J-15-M-428)**.

Dr. N. S. Raina
Major Advisor and Chairman
Advisory Committee

Place: Chatha, Jammu

Date: 06-02-2018

07/2/18
Head

Division of Agroforestry