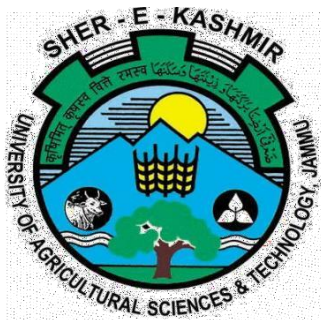


STATUS AND DIGITAL DOCUMENTATION OF PULSE CROPS IN THE TEMPERATE AREA OF JAMMU REGION

**By
Gurshaminder Singh
(J-17-D-298-A)**

Thesis submitted to Faculty of Agriculture
in partial fulfillment of the requisition
for the degree of

**DOCTOR OF PHILOSOPHY
IN
AGRICULTURAL EXTENSION AND COMMUNICATION**



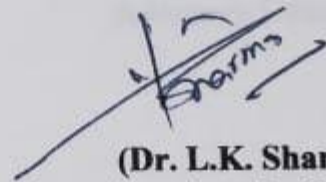
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This is to certify that the thesis entitled "**Status and digital documentation of pulse crops in the temperate area of Jammu region**" submitted in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Agriculture (Agricultural Extension Education and Communication)** to the Faculty of Post-Graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, is original work and has similarities with published work not more than minor similarities as per UGC norms of 2018 adopted by the University. Further the level of minor similarities has been declared after checking the manuscript with **Urkund** software provided by the University.

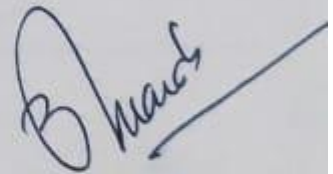
The work has been carried out by **Mr. Gurshaminder singh** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma. It is further certified that help and assistance received during the course of thesis investigation have been duly acknowledged.



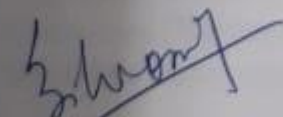
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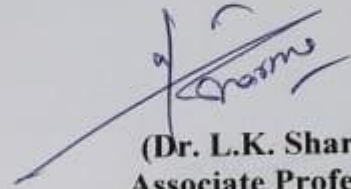
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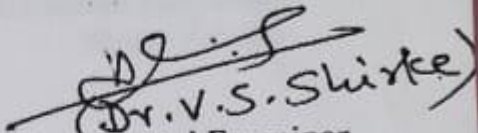


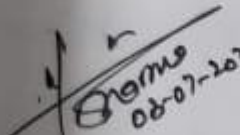
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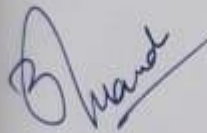


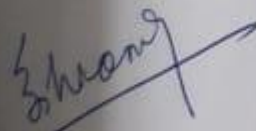
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External Examiner

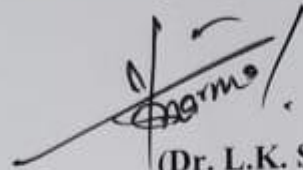

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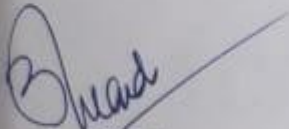
Certified that all necessary corrections as suggested by the external examiner and advisory committee have been duly incorporated in the thesis entitled "Status and digital documentation of pulse crops in the temperate area of Jammu region" submitted by Mr. Gurshaminder Singh, Registration No. J-17-D-298-A.



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Head of the Division



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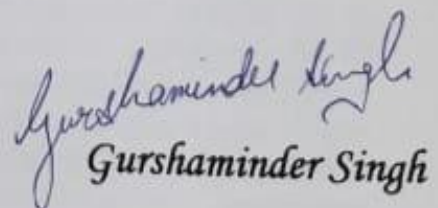
From the profundity of my inner heart, I take the privilege to express my everlasting regards, affection, deep humility and devotion to my parents S. Gursewak Singh and Parkash Kaur for their love, affection, unstained faith and confidence on me, unrelenting support and inspiration to move on the right path, which helped me to sail my ship of ambitions and anchor it in a harbor of success. I owe everything of my life to them and without their blessings it would have been impossible for me to complete this panorama.

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Gurshaminder Singh

Date: 16/7/21

Title of the thesis	:	Status and digital documentation of pulse crops in the temperate area of Jammu region
Name of the student	:	Gurshaminder Singh
Registration No.	:	J-17-D-298-A
Name and designation of Major advisor	:	Dr. LK Sharma, Associate Professor
Major subject	:	Extension Education
Degree to be awarded	:	Ph.D. Agricultural Extension and Communication
Name of the University	:	Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

ABSTRACT

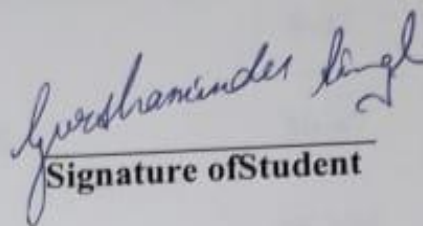
Pulse crops have been an important component of agriculture since ancient times. The world's major pulses producing countries, which together account for half of the global production are India, Canada, China, Myanmar and Brazil. India is the largest producer of pulses, accounting for 25 per cent of global pulses production. In the past decade, pulse production increased by 36.5 per cent mostly contributed by chick pea, mung bean and urd bean. However, India needs to increase pulses production from 19 Mt/mt to anywhere between 25.4 and 36.9 Mt to meet its deficit. The total pulse crop area of the Jammu and Kashmir state was 18,893 hectares. In Jammu region and Kashmir region it was reported 12,955 ha and 5938 ha respectively (DSE 2018). The present study entitled "**Status and digital documentation of pulse crops in the temperate area of Jammu region**" was undertaken. The Jammu division comprises of ten districts. The present study was conducted in four districts namely Doda, Kishtwar, Udhampur and Kathua in temperate area of Jammu region. The study was carried out in temperate area of Doda, Kishtwar, Udhampur and Kathua districts of Jammu division purposively because maximum acreage of pulse crop in these four districts. The study conducted in four district found that the average productivity of rajma was 2.64 q/ha while that of black gram was 2.47 q/ha. The productivity of green gram, red lentil, horse gram and French bean was 2.02 q/ha, 1.37q/ha, 3.34q/ha and 2.71 q/ha respectively. The results shows that all the respondents use FYM for cultivation but the dosage of application varies between different areas and under different crops and all the respondents use manual method for weed management. The overall C:B ratio of rajma, black gram, green gram, red lentil, horse gram and French bean was **1.53:1, 1.17:1, 1.02:1, 0.95:1, 2.15:1 and 2.16:1** respectively . Among all the factors age (p= .000), land holding (p= .002), fragmentation (p= .000), farming experience (p= .000), on farm income (p= .000), off farm income (p= .001), extension contact (p= .003) and productivity (p= .004) significantly affected the per cent of income from pulse crop of the respondent. By using the GPS coordinates in different locations of studied areas a digital map was generated which can help to easily find the pulse growing areas for future references. The digital database is also generated which shows the information and status of different pulse crops grown in different areas of study and further these digital database can be accessed by visiting a newly created online platform. There were many problems being faced by the farmers regarding the cultivation of pulse crops as 83 per cent of total respondents expressed lack of irrigation as constraint, the 64 percent of total respondents expressed poor extension linkage as a constraint, the 75 per cent of respondents expressed lack of awareness as constraint, the 49 per cent of respondents expressed inputs not available at right time as a constraint, the 26 per cent of total respondents expressed wild animal destroy the crop as a constraint and 17 per cent of total respondents expressed shattering problem during harvesting time as a constraint. There were also some suggestions given by the farmers as the respondents give suggestion that proper awareness regarding pulse crop cultivation should be provided, organic cultivation

of pulse crop should be promoted, irrigation facilities need to be strengthened. Marketing linkages should be promoted, the 18 per cent of the respondents thought that more research should be done on developing rain fed varieties and storage facilities need to be developed. The study founded that most of the farmers were using organic way of production and they also want that this should be promoted as more as possible, this is encouraging outcome of the study that farmers preferring organic way of cultivation that conventional way of farming.

Keywords: Organic farming, digital database and digital map.



Signature of Major Advisor



Signature of Student

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LIST OF ABBREVIATIONS AND TERMS

%	:	Per cent
<i>et. al</i>	:	et alibi (and elsewhere)
etc.	:	Etcetera
Fig.	:	Figure
GDP	:	Gross Domestic Product
Ha	:	Hectare
i.e.	:	that is
J&K	:	Jammu and Kashmir
Kg	:	Kilogram
Km	:	Kilometer
MOA	:	Ministry of Agriculture
q/ha	:	Quintals per Hectare
S. No.	:	Serial Number
SPSS	:	Statistical Package for Social Sciences
Ltd.	:	Limited
FYM	:	Farm Yard Manure
DAP	:	Diammonium Phosphate
C:B ratio	:	Cost Benefit ratio
KVK	:	Krishi Vigyan Kendra
SKUAST	:	Sher-e-Kashmir University of Agricultural Sciences and Technology
₹	:	Rupee
AEO	:	Agriculture Extension Officer
JAEO	:	Junior Agriculture Extension Officer
Gm	:	Grams
IPM	:	Integrated Pest Management
TOT	:	Transfer of Technology
vis-à-vis	:	Face-to-face
m ha	:	Million hectares
PC	:	Principal Component

Chapter-1

Introduction

CHAPTER I

INTRODUCTION

The growth of Indian agriculture over last few decades has helped the country in achieving food security at National level. The next big challenge faced by the country in general and Indian agriculture in particular is to sustain this growth and achieve nutritional security as well. Pulses are environment friendly, a major source of protein and are also complementing cereals both in production and consumption have a vital role to play under the circumstances. In the production process, pulses improve soil fertility, requires less water than cereals and their rotation with cereals help in controlling diseases and pests. Pulses are rich source of protein which is available at economical price. Pulses contain carbohydrates 55 to 60 per cent, rich in calcium and iron. (Joshi and Saxena, 2002)

Pulse crops have been an important component of agriculture since ancient times. The world's major pulses producing countries, which together account for half of the global production are India, Canada, China, Myanmar and Brazil. India is the largest producer of pulses, accounting for 25 per cent of global pulses production. Pulses play an important role in Indian diet also (Ali and Gupta, 2012). In India, pulses are the cheapest and concentrated source of dietary amino acids, where protein demand of vegetarian population is fulfilled through pulses, so it is also considered as "A poor man's meat". Pulses occupy a unique position in the world of agriculture by virtue of its high protein content, which is almost double than that of cereals. In addition to protein, pulses also contain good quality lysine, tryptophan, ascorbic acid and riboflavin. Pulses are suitable for people with diabetes, also for coronary heart disease and anemia, as they regulate the cholesterol. The presence of bioactive compounds i.e. phytochemicals and antioxidants, build up anti-cancer properties in pulses.

Other than their suitability for human health, pulses are also good for environment. All pulses play a key role in enhancing of soil fertility through biological nitrogen fixation with the help of Rhizobium bacteria found their root nodules pulses and it is used by subsequent crops. Increase in the yield of subsequent crops of about 20-40 per cent has been recorded (Singh *et al.*, 2016).

Table 1.1: Nutritive value of Pulse

Constituents	Magnitudes
Protein	>20-%
Carbohydrate	55 – 60%
Fat	>1.0%
Fibre	3.2%
Phosphorus	300-500 mg/100 g
Iron	7-10mg/100 g
Vitamin C	10-15 mg/100 g
Calcium	69 -75mg/100g
Calorific value	343
Vitamin A	430-489 IU

(Singh *et al.*, 2013)

The crop is resistant to adverse climatic conditions. In India, owing to its diverse agro-climatic conditions, pulses are grown throughout the year and play an important role in crop rotation, mixed and inter-cropping, maintaining soil fertility through nitrogen fixation, release of soil-bound phosphorus and thus contribute significantly to sustainability of the farming systems. In the production process, pulses require less water than cereals. The genotypes of pulses have inbuilt potential to provide relatively good production even in stress conditions i.e. drought, frost and water logging. Major pulses grown in India include chick pea, pigeon pea, lentil, black gram, mung bean, lablab bean, moth bean, horse gram, pea, grass pea or khesari, cowpea, and broad bean or fababean. More popular among these are chick pea, pigeon pea, mung bean, urd bean and lentil. Among various pulse crops, chickpea dominates with over 40 per cent share of total pulse production followed by pigeon pea (18-20%), mung bean (11 %), urd bean (10-12 %), lentil (8-9 %) and other legumes (20 %) (Anonymous, 2013).

In the world, major markets from where India is importing the pulses are 1) Small chickpea: Burma, Tanzania, Australia, China, UAE, 2) Pigeonpea: Burma, China and Tanzania, 3) Blackgram: Burma, Singapore and Thailand; 4) Mungbean: Burma, Singapore, China and Australia; 5) Green and yellow peas: Canada, Australia, Hungary, Tanzania and US, 6) Lentil: Netherland, Syria, Canada, Turkey, China and

7) Large Chickpea or Kabuli: Australia, Canada, Turkey, Iran and Burma. The prominent markets for export of pulses from India are Bangladesh, Sri Lanka and UAE and minor USA, Nepal, Saudi Arabia, Kuwait, UK, Egypt, Malaysia, Canada, Spain, Italy, Pakistan, Yemen Republic, Algeria and Bahrain. India accounts for over one third of the total world area and over twenty per cent of total world production. (Sahadev, 2015).

As per World Bank indicator, the total geographical area of world under pulses was 81.61 million hectare and 55.10 million metric tonne of production. India is producing 14.76 million tons of pulses from an area of 23.63 million hectare and is one of the largest pulses producing country in the world. However, about 2-3 million tons of pulses are imported annually to meet the domestic consumption requirement (Anonymous 2016). Pulses are important component of Indian agricultural economy next to food grains oilseeds in terms of acreage, production economic value (Choudhary, 2009). India is largest producer consumer of pulses in the world, accounting for about 25% of global production, 27% of consumption 34% of food use (F.A.O.). In India, pulses output is seen at 24.42 MT, up from 23.03 MT in 2019-20 crop year. Between 2017 and 2019, pulse production in India increased by 23 per cent. India is targeting an output of 32 million tonnes by 2030 from the current level of around 24 million tonnes. The potential of pulses to help address future global food security, nutrition and environmental sustainability needs has been acknowledged through the UN declaration of the 2016 International Year of Pulses. Pulses are a Smart Food as these are critical for food basket (dal-roti, dal-chawal), important source of plant protein and help address obesity, diabetes etc.

About 80% of global pigeon pea (*Cajanus cajan*), 65% of chick pea (*Cicer arietinum*), 37% of lentil (*Lens culinaris*) and more than 65% of mungbean (*Vigna radiata*) and urd bean (*Vigna mungo*) are produced in India. In the past decade, pulse production increased by 36.5% mostly contributed by chick pea, mung bean and urd bean. However, India needs to increase pulses production from 19 Mt/mt to anywhere between 25.4 and 36.9 Mt to meet its deficit. The production of pulses in the country has been quite encouraging, increasing from 14.7 Mt in 2009-10 to 18.2 Mt in 2010-11 and highest ever 19.8 Mt in 2013-14 with an all-time high production achieved in chickpea (9.53 Mt) (Reddy 2015).

The total pulse crop area of the Jammu and Kashmir UT was 18,893 hectares.

In Jammu region and Kashmir region it was reported as 12,955 ha and 5938 ha respectively (DSE 2018). Some important pulse crops like Green gram (*Vigna radita*), Red lentil (*Lens culinaris*), Red gram (*Cajanus cajan*), Black gram (*Vigna mungo*), chickpea (*Cicer arietinum*), Cowpea (*Vigna unguiculata*), Pea (*Pisum sativum*), French bean (*Phaseolus vulgaris*), Moth bean (*Vigna sativum*), etc. The main pulses found in J&K are Rajma, Black gram, Green gram, Red lentil, Horse gram, French gram, etc.

Pulses occupy an important place in human diet, as they are rich source of protein and constitute 10-15 percent of food diet of Indians. Major portion of Indian population belong to vegetarian group and every person, on an average requires 70-80 g of pulses every day in order to maintain good health. There is high mismatch between demand and supply of pulses. These staple crops have been an integral part of human diet for millennia and today are an important crop not only for food security, but also for combating malnutrition, alleviating poverty, improving human health and enhancing agricultural sustainability. Between 1961 and 2015, the advances of the Green Revolution led to massive gains in both yield and production of many basic foodstuffs through the industrialization of farming. During this period maize, wheat, rice and soya all saw cumulative production gains somewhere between 200 per cent and 800 per cent, while pulses expanded by only 59 per cent over the same time frame, Global per capita consumption of pulses is around 7kg/person/year. In order to narrow down the demand supply gap of pulse, total requirement of the pulses in the country is projected at 39 million tonnes by the year 2050 which necessitates an annual growth rate of 2.2 per cent (Anonymous, 2015). This requires a paradigm shift in research, technology generation and dissemination regarding pulses production (Rajasekaran, *et al.*2011). At macro level a number of factors are responsible for sluggishness in the growth of area and yield of pulse crops. Low level of area under irrigation, non-availability of improved seeds and lack of improved production technology, price variability, lack of market information, subsistence farming, etc. are some constraints influencing production of pulses. Although several promotion strategies such as National Pulses Development Programme (NPDP), National Food Security Mission (NFSM), Integrated Scheme of Oilseeds, Pulses, Oil palm and Maize (ISOPOM) have been introduced to increase the production of pulses since the Third Five year plan, there is hardly any significant technological breakthrough that has positively impacted the production of pulses. In spite of the

efforts made by government, the production of pulses is not increasing significantly. One major cause for this may be the insufficient pulse marketing network that works against the farmers. So there is a urgent need for creating strategies for efficient marketing of pulses so as to improve marketing efficiency.

An amalgamation of modern and indigenous agricultural practices offers an environment friendly and market oriented solution to the farmers' problems. This is especially of great significance for marginal and small farmers who have always been resource poor. The farmers in the hills of Uttarakhand are mostly marginal farmers practicing low external input based production system. Since the topography of Jammu and Kashmir (J&K) is almost similar to the Uttarakhand, so this fact is also applicable here and it may be a blessing in disguise as the ill effects of synthetic chemical based agriculture are very limited here, the soil has not been polluted and the environment is clean and green with abundant bio-diversity. J&K has huge potential for organic farming as a large area in the state is already under semi-organic cultivation in hilly districts of the state due to the lack of availability of chemical fertilizers in these areas and the farmers of these areas hardly apply the chemical fertilizers. Farming is already semi-organic by default in large tracts of cultivable lands across the Jammu, especially higher reaches of Kishtwar, Udhampur, Doda, Kathua, Reasi, Ramban, Poonch and Jammu districts. Though, a large number of crops are grown there without or with little use of chemical pesticides and fertilizers in view of the temperate climate, the agricultural yield so produced needs certification, officials point out (Sharma 2012). So the marketable surplus of the produce from these areas can be sold as an organic or semi-organic crop. The farmers of Jammu & Kashmir can tap the opportunity of growing demand of organic products. Organic agriculture is generally environment friendly maintains soil health and enhance biodiversity. Already large numbers of farmers of the state are growing pulses, spices, basmati rice, walnuts, herbs etc. organically. There is need to introduce organic farming commercially, scientifically and in a systematized way so that the farmers can get rich dividends and farming can become sustainable (Lal and Sharma 2018).

The present study entitled **“Status and digital documentation of pulse crops in the temperate area of Jammu region”** was undertaken with the following specific objectives.

Objectives

- (i) To identify the different pulse crops grown and inputs used for their cultivation in temperate area of Jammu region.
- (ii) To study the economics of identified pulse crops.
- (iii) To delineate the factors driving the dependence of households on pulse crop for livelihood security
- (iv) To generate digital database and mapping of pulse crop.

Scope of the Study

This study will help future researchers to find production status of pulses crops in temperate area of Jammu region. This study will also help researcher to find ways to improve the productivity of pulse crops and also help the government to formulate the policy which can solve location specific problems of famers based on the suggestions of the farmers. The study found that the farmers are preferring the organic way of farming which can encourage government and researchers to find ways to improve productivity of the organic farming. The digital database and digital map generated will help future researchers easily locate the pulses growing area of Jammu region and will also help to find the information related to pulse crops. This study shows that still there is low C:B ratio of different pulse crops which can be improved and still there are lot of constraints being faced by the farmers which needs to be addressed .

Limitations of the Study

The limitations of the study are:

- The findings of the study are based on verbal expression of opinion or responses on recall mechanism of the respondent farmers.
- Due to limited time, researcher could not include more independent variables for better assessment of their contribution towards extent and level of adoption and factors affecting productivity of Basmati rice.
- Owing to time and resource constraints to research scholar, limited sample size (240 farmers) was taken. A larger sample size would definitely tend to improve the generalization.
- The data was collected by personal interview method. There must be some discrepancies in actual information and expressed responses.

- The study was confined to temperate area of Jammu region due to limitations of time and other resources at the disposal of researcher. Hence, the results are largely applicable to those areas only where similar conditions prevail. However, considerable care and thought was exercised in making the study as scientific, systematic and objective as possible.

Presentation of the study

For analytical convenience and clear exposition of the results of the present study, the thesis has been presented into six chapters. The Chapter-1 encompasses the introduction, objectives, significance, scope and limitations of the study. Chapter-2 deals with the review of literature related to the topic under study. Chapter-3 presents the methodology adopted including description of the study area, sampling frame, nature and sources of the data and the analytical techniques employed in the study. The results of the study are presented in Chapter-4 while Chapter-5 attempts to discuss these results. Chapter-6 provides a brief summary of the whole study and also suggests the policy implications from the findings of the study. At the end, important references have been listed related to the present study.

Chapter-2

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

The review of literature is an important part of the scientific approach and is carried out in all areas of scientific research. It provides the means of getting knowledge to the frontier in particular field of knowledge. It gives answers to the questions like what others have done and what still remains to be done in that area of study. Thus, the review of literature forms the foundation upon which all future research works must be built. In this chapter our purpose is to convey what knowledge and ideas have been established on a topic and what their strengths and weaknesses are. It provides an insight and understanding to the researchers on various horizon and dimensions of their investigations. The review of literature was undertaken keeping in view the specific objectives of the study. The available and relevant literature has been reviewed and presented under the following heads:

- **Identification of different pulse crops grown in temperate area and inputs used for their cultivation.**
 - **Economics of identified pulse crops.**
 - **Factors driving the dependency of households on pulse crop for livelihood security.**
 - **Digital database and mapping of pulse crop.**
- (i) **Identification of different pulse crops grown in temperate area and inputs used for their cultivation.**

Brahmaprakash *et al.* (2004) in their study on pulses production claims that the pulses were not as low in their yield performance as was generally projected and that this perception of lower yield was due to a set of confusing issues. It shows that pulses were poor in harvesting the solar energy and in converting it to biological yield. It presents the reasons for this inefficiency and identifies that the inputs supplied to pulses was one of the major factors limiting the pulse yields. The impact of breeding protocols, production system and policy building for pulses cultivation were also mentioned.

Singh *et al.* (2007) in one of their studies on agronomic practices of organic farming in India observed that management of soil organic matter is critical to maintain a productive organic farming system. No one source of nutrient usually

suffices to maintain productivity and quality control in organic system. In addition, the inputs to supplement nutrient availability are often not uniform presenting additional challenges in meeting the nutrient requirement of crops in organic systems. With this concept, a field experiment was conducted at the research farm of Indian Agricultural Research Institute (IARI), New Delhi, during 2003-06 in rice-wheat-green gram cropping system. An interesting observation recorded was that there was no serious attack of any insect pest or disease in organically grown crop. Soil microbial population enhanced due to the application of organic amendments in comparison to absolute control as well as recommended fertilizer application that in turn resulted in a notable enhancement in soil dehydrogenase and phosphatase enzyme activity. However, to meet the ever-growing food-grain demands of the country, which is estimated at 294 million tonnes per annum by 2020, the mainstream of Indian agriculture has to depend on modern agricultural inputs, such as chemical fertilizer and pesticides. Nevertheless, their restrained and efficient use is important. As regards plant nutrient needs in modern agriculture, integrated nutrient supply is the key for sustainable Indian agriculture.

Ashfaq *et al.* (2008) in their study reported that 1 percent increase in land preparation cost, wheat gross income increased by 0.045 percent, and it is significant at 99% confidence level. The reason was that better preparation of seed bed improves the efficiency of seed to germinate and ultimately yield increases. The results also showed that fertilizer and chemicals were two important factors adding to the total revenue from the wheat crop. One percent increase in fertilizer cost increased the wheat cost revenue by 0.29%. This result also showed that farmers of the area were not using the balanced dosage of fertilizers and fertilizers are underutilized in the area.

Posner *et al.* (2008) in their study observed that during the last half-century, agriculture in the upper U.S. Midwest has changed from limited-input, integrated grain–livestock systems to primarily high-input specialized livestock or grain systems. This trend has spawned a debate regarding which of cropping systems is more sustainable and led to the question: “can the diverse, low-input cropping systems like organic systems be as productive as the conventional systems?” To answer this question, they compared six cropping systems ranging from diverse, organic systems to less diverse conventional systems at two sites in southern Wisconsin. The results of their 13 years study at one location and eight years study in another showed that: (i) organic forage crops can yield both as much dry matter as their conventional

counterparts and with quality, sufficient to produce as much milk; and (ii) Several crops can produce 90 per cent as well as their conventionally managed counterparts. Combining with other controlled data, they found that weed control was a problem, resulting in lower yields. Finally, their findings indicate that diverse, low-input cropping systems can be as productive per unit of land as conventional systems.

Avasthe (2016) reported that pulses are mostly grown in rainfed areas that do not witness high use of chemical inputs where adoption of organic farming may be the option to enhance the sustainability of the ecosystem. Organic production systems maintain and improve the soil health through stimulating the activity of soil microorganisms and are also helpful in alleviating the increasing incidence or deficiency of secondary and micronutrients and are capable of sustaining crop productivity. Application of organic inputs in sufficient amounts for various purposes at regular intervals not only meet the requirements of crops but also result in higher crop yield with improved soil fertility and minimization of the incidence of insect-pests and diseases especially in pulses. The real potential of organic farming lies in growing pulses especially under rainfed condition.

Pooniya *et al.* (2015) conducted a study on pulse crops and reported that improved cultivation practices, such as seed replacement with improved varieties, raised bed planting method, use of biofertilizers, foliar application of fertilizers at critical stages in rainfed areas, application of secondary and micro-nutrients and adoption of appropriate modules for integrated weed and pest management, etc. had great potential in gearing-up pulses productivity. Thus, there is a great challenge for policy makers, farm scientists and farming community to enhance pulse productivity using improved farm technology to meet-out the national and local pulse requirements. This study presented a critical review on capacity of various improved crop management practices to scale-up pulses productivity on one hand and highlight future research priorities on the other with the prime objective of sustaining pulse production in India.

Rimal *et al.* (2015) analyzed the patterns and sources of growth in pulses production in India and also examined their implications for future growth of pulses production. The study has observed an increasing trend in pulses production, driven mainly by yield improvements. The contributions of area expansion and prices to pulses growth have been erratic, suggesting that these can not be the sustainable sources of growth in pulses. Further, farmers' area allocation decisions to pulses are

not price-dependent, but depend on non-price factors, mainly rainfall. These findings imply that in the short-run, to boost pulses production, the policy should address the non-price constraints such as irrigation, access to credit and input supply. However, the growth in pulses production in the long-run must come from technological changes.

Shah and Anbuvel (2016) conducted a study to report the changes in the cropping pattern in the region, where the circumstances was paving way for specialization rather than diversification. Chi- Square test had been used to check the association of various socioeconomic variables to change in production of paddy and apple over the last seven years. The primary data was supplemented with the secondary data from various sources to represent the changes in the cropping pattern over the years

Suresh and Reddy (2016) had explored the role of technology change in improving pulse productivity by studying the case of chickpea in Andhra Pradesh. The findings of study showed that per capita consumption of pulses has declined over the years. The consumption of pulses is far less by the lowest income group vis-a-vis the highest income group households. The yield of pulses in general has stagnated over the years. Among the pulses studied, only chickpea and green gram have exhibited improvement in Total Factor Productivity. The study has revealed that pulses are the cheapest source of proteins among all foods and therefore, have a significant place in improving nutrition at individual level as well as country level. It is the development of short-duration and heat-tolerant varieties and better management that have helped in yield improvement. The case study on chickpea in Andhra Pradesh has shown that productivity improvement is directly related to the share of improved varieties adoption. The study has concluded that the development of affordable technologies suitable for marginal environments and emerging cropping patterns would help improve the productivity of pulses in India, thereby may contribute in addressing the under-consumption of protein.

Sanjeev *et al.* (2018) a study to measure resource use efficiency in rajmash production in Bharderwah and Bhalla blocks of Doda district of J&K state. The input-output data was taken from the sample of 100 rajmash growing farmers and Cobb-Douglas type of production function was used to work out the efficiency of different resources. The results revealed that human labour, seed, manure & fertilizers and plant protection chemicals had the elasticities of 0.105, -0.388, 0.013 and 0.062,

respectively and were statistically significant. The marginal value productivity were (MVP) in respect of manure & fertilizers (8.981) and plant protection chemicals (11.344) was more than unity level and for human labour (0.872) it was less than unity level. In case of machine labour (-2.275) and seed (-9.772), MVP values were found to be negative, indicated more than optimum use of these two resources.

From the above studies it can be concluded that imbalance use of different inputs is major reason for low productivity of pulse crops not only in plane sub-tropical areas but also in temperate hilly areas where farmers are always in their need of different inputs required for pulse production especially plant protection chemicals.

(ii) Economics of identified pulse crops

Tomar (1994) reported that a large gap existed between on farm and research station yields. Front line demonstrations were carried out on cultivar's field in Tikamgarh district during 1991-92, 1992-93 to test research finding on farmer's fields and to disseminate suitable improved varieties, better agronomic practices and improved plant protection measures compared with local practices. The demonstration plots provided return of ₹4180, ₹9945, ₹9448 and ₹9662 per hectare for summer moong bean, chickpeas mustard and soybean, respectively, compare with ₹1376, ₹3940, ₹4471 and ₹4180 per ha, respectively, for the plots with indigenous practices. The percentage increased in the cost benefit ratios were observed to be 90 per cent for summer moong bean and mustard, 75 per cent for chick pea and 56 per cent for soybean demonstration plots.

Tiwari *et al.* (1998) examined that the economic analysis of kharif crops and it revealed that paddy and maize can be grown profitably using improved practices. Pulse crop and oilseed crop (soybean) were profitable under both traditional and improved practices. The potential exists for increasing productivity and net profit of other pulses and oilseed crop. It was concluded that paddy, maize, arhar, soybean and sesamum crop could be grown economically in the kharif season using improved practices under northern hill zone of Shahdol district of Madhya Pradesh.

Suresh (2001) studied the performance of organic farming in Shimoga district in two major irrigated crops- paddy and sugarcane. The organic farms produced higher yields both in paddy (21.93%) and sugarcane (18.10%) over the inorganic farms. The average cost of cultivation per acre of paddy and sugarcane on organic farms were ₹8509.52 and ₹18487.97 against ₹8784.72 and ₹19493.31 on inorganic

farms. The returns per rupee spent in paddy and sugarcane productions were 2.06 and 2.04 on organic farms and 1.61 and 1.71 on inorganic farms. The mean technical efficiency of inorganic farmers was less (85%) than that of organic farmers (89%) in paddy production and also in sugarcane production (84% and 88% respectively).

Vangelis *et al.* (2001) using the recent advances in the stochastic production frontier framework, presented an empirical analysis of technical, allocative and economic efficiency of a sample of organic and conventional cotton farms located in Greece, and suggested that both farm types in the sample examined are technically, allocatively and economically inefficient. Farmer's age, education and farm size were found to be important factors in explaining differentials in efficiency estimates. In comparative terms, organic farms exhibited lower efficiency scores *vis-à-vis* their conventional counterparts in terms of technical and economic efficiency; regarding allocative efficiency both farm types are almost equally inefficient. Low efficiency scores in both types of farming may be attributed to the respective intervention policies of the last 20 years.

Mali *et al.* (2004) conducted the study on economics of production and marketing of banana in Jalgaon district of Maharashtra during the year 2000-01 and observed that the total cost of cultivation of banana was ₹120539.12 per hectare. The yield per hectare worked out to be 533.14 quintals with gross returns amounting to ₹214867.24. The per quintal cost of production were found to be ₹220.06. The per hectare net profit was ₹79640.11.

Nandal and Punia (2004) in their study on economics of major fruit cops in western zone of Haryana during 2002-03 found that the total cost of cultivation of guava increased from ₹9185.90 per acre in the first year to ₹14976.74 in the seventh year and onwards and the yield increased from 2.50 quintal per acre in the third year to 109.50 quintal per acre during the seventh year and onwards with gross to be ₹60225 per acre. The total cost of per cultivation increased from ₹7400.14 per acre in the first year to ₹9399.49 in the seventh year onwards and gross returns ₹34347.22 with a production of 64.20 quintal per acre which was found increasing from 1.25 quintal per acre in the third year to 64.20 quintal per acre in the seventh year.

David (2005) concluded that organic farming offers real advantages for crops such as corn and soybean and analyzed the environmental, energy and economic costs and benefits of growing soybeans and corn organically versus conventionally. This

study is a review of the Rodale Institute Farming Systems Trial, the longest running comparison of organic vs. conventional farming in the United States.

Savadatti (2007) in his research effort on econometric analysis of demand and response of pulse in India made an attempt to undertake the task of verifying various factors influencing the supply of pulses and to develop appropriate demand relations. It focused on two important pulses grown in the country namely Chickpea and Tur (pigeon pea). Used Nerlove's adjustment lag model as the basic framework, supply aspects had been studied at the regional and national level, based on the time series data cover the period 1965-66 to 1998-99. Acreage response results showing that in rain fed areas farm harvest prices and good weather conditions positively influenced the area allocation decision of the farmers.

Chand *et al.* (2008) examined and worked out the cost of cultivation of major arable crops in arid Kachchh district of Gujarat. The study was conducted with 60 farmers having assured irrigation facilities. In Kachchh district farmers were cultivating pearl millet, groundnut, sesame, cotton, castor and vegetables in kharif season and wheat, mustard and coriander in rabi season. Except wheat and pearl millet all other crops were cultivated for market purpose. Farmers incurred highest cost in cultivation of cotton and coriander crop per ha in kharif and rabi season, respectively. The farmers were getting highest net returns of ₹44,408 with B:C ratio of 2.32 from cultivation of cotton followed by groundnut and castor among kharif season crops while wheat followed by coriander recorded highest net returns in rabi crops. It was concluded that production of all the major crops found place in the cropping pattern of Kachchh district and was economically viable having B:C ratio more than unity. The farmers were allotting more area to those crops which were giving higher net returns with high B:C ratio and vice-versa. It implies that farmers in Kachchh region are well aware of limited agriculture resources and invested in them to get the maximum returns. But in the fragile agro-ecosystem of Kachchh district where ground water is depleting at an alarming rate cultivation of arable crops on sustainable basis requires adoption of modern efficient irrigation methods, viz., drip irrigation system and micro sprinkler and sprinkler irrigation system, etc.

Sharma *et al.* (2008) conducted a study entitled economic feasibility of sprinkler irrigation system vis-à-vis surface irrigation for major crops of rabi and kharif season in Bikaner district of Rajasthan. Thirty farmers using sprinkler irrigation system and thirty farmers using surface irrigation method (through canal) were

selected using multi-stage random sampling technique and in kharif season groundnut crop and in rabi season gram crop was selected for the study. The study observed that the total cost of cultivation of selected crops was marginally higher on sprinkler irrigated farms than on surface irrigated farms. The gross returns, farm business income, returns to labour, net returns, benefit-cost ratio, cropping intensity and per cent area irrigated of total land holdings were higher on sprinkler irrigated farms than on surface irrigated farms for all the selected crops and in all the selected size groups under study.

Asmatoddin *et al.* (2009) conducted a study entitled “Arrivals and price behaviour in APMC market Parbhani” during the year 2004-05 to determine price index fluctuations for important pulse crops. The data on monthly arrivals and prices were collected for nine year (1996-97 to 2004-05) from record of APMC, Parbhani. The result revealed that peak arrivals of green gram were in the month of October and the highest price index recorded was in the month of March. The price index touched to the lowest 83 per cent and to the peak value of 105 price index. In case of Pigeon pea, the arrival index was the highest in the month of January whereas, the price index was lowest in the month of September. The range of price index varies from 93 to 107 per cent.

Asmatoddin *et al.* (2009) studied the economic analysis of pulse on medium farms and revealed that, in case of soybean per hectare cost of cultivation was ₹11355.60 and net profit was ₹4761.86 and in case of pigeon pea and green gram per hectare cost of cultivation was ₹12632.42 and ₹8935.48, and net profit was ₹2012.16 and ₹3292.80, respectively.

Banerjee and Palke (2010) worked on economics of pulses production and processing of India. This paper looks at the economics of pulses production and processing in India based on a compilation of commodity study reports of five states, namely, Odisha, Andhra Pradesh, Uttar Pradesh, Haryana and Karnataka. They also studied different aspect of marketing and international trade in pulses. Finally, constraints in production, processing, marketing and international trade in pulses were deliberated and possible policy strategies were also suggested in this study.

Bhajan (2010) in his study on economics of production and marketing of flowers in Wardha district of Maharashtra found that per hectare cost of cultivation of rose, tuberose, marigold, jasmine and chrysanthemum were ₹124515.79, ₹57073.06,

₹83068.24, ₹67625.86 and ₹78408.28, respectively and input output ratio was calculated to be 1:2.10, 1:1.76, 1:1.13, 1:6.35 and 1:2.24, respectively.

Charyulu and Biswas (2010) in their study focused mainly on the issues like economics and efficiency of organic farming *vis-à-vis* conventional farming in India. Four states of Gujarat, Maharashtra, Punjab and U.P were purposively selected for the study. Similarly, four major crops i.e., cotton, sugarcane, paddy and wheat were chosen for the comparison. A Model based nonparametric Data Envelopment Analysis (DEA) was used for analyzing the efficiency of the farming systems. The results showed a mixed response. Overall, it is concluded that the unit cost of production is lower in organic farming in case of cotton and sugarcane, whereas the same is lower in conventional farming for paddy and wheat. The DEA efficiency analysis conducted on four different crops indicated that the efficiency levels are lower in organic farming compared to conventional farming, relative to their production frontiers. The results concluded that there is ample scope for increasing the efficiency under organic farms.

Kachroo *et al.* (2010) worked out the costs and returns in ber cultivation in Jammu district of Jammu and Kashmir state. The study reported that the per acre total establishment cost of ber were ₹9137, ₹7700 and ₹8441 in the case of marginal, small and medium orchards with an average of ₹9123 per acre. Similarly, the per acre returns per year from ber orchards were ₹5854, ₹4962 and ₹5040 for marginal, small and medium orchards with an average of ₹5769 per acre.

Manoj (2010) in his study on economic analysis of production and marketing of marigold in Pune district found that the average total cost of cultivation per hectare for marigold was ₹38038.86 at overall level. The major items of cost of cultivation were family human labour, rental value of land, seeds and hired human labour. The average production of marigold was 21.63 q/ha and the gross income was found to be ₹41286.19. The estimated production function revealed that human labour, manures and nitrogen application had significant influence on the productivity of marigold flower.

Dwivedi, *et al.* (2011) carried out an economic analysis of Basmati rice production in three villages namely Chakroi, Gharana and Gharani of Community Development Block of R.S. Pura district Jammu. The study indicated that the per hectare cost of cultivation worked out to ₹20914.02 on small farms, ₹20960 on

medium farms, ₹18825 on large farms and ₹20233 at overall level. Also, the net income from Basmati rice per hectare was ₹32451 on small farms, ₹29888 on medium farms, ₹29505.78 on large farms and ₹30608.06 at overall level.

Islam *et al.* (2011) in their study revealed that mung bean production was found profitable. The benefit cost ratio (BCR) was 2.22 on full cost basis. The estimated results showed that the average level of technical efficiency among the sample farmers was 89%. This implies that given the existing technology and level of inputs, the output could be increased by 11 percent. Farmer's education and experience had positive significant effect on mung bean production. Fifty nine percent farmers produced outputs to the maximum frontier output level. Farmers in the study area mentioned some constraints like high price of fertilizer, insecticides, severe attack of insects, etc. to the production of mung bean at farm level.

Kumar and Baurai (2012) made an effort to find out the economics, benefit, and constraints of pulse production in the state of Uttarakhand. This study has revealed that the rotation of chickpea and pigeon pea reduces the use of chemical fertilizers and also enhances the output of paddy and wheat significantly.

Hedge *et al.* (2013) estimated the cost of cultivation of black gram at ₹27671. It increased with the size of holding from ₹27044 for small farmers to ₹28307 for large farmers. It was observed that the operational costs accounted for a major share in the total costs on all the categories of farms. The total operational cost was ₹22972, ₹24057 and ₹23493 for small farmers, large farmers and the sample as a whole respectively. Higher operational cost of large farmers was due to hiring more human labour and tractor services and incurring more cost on manures and fertilizers and plant protection chemicals.

Ahirwar *et al.* (2015) revealed that the cost of cultivation was found to be highest on large farm (₹29379.88/ ha) as compared to medium farm (₹26155.99/ha) and small farm (₹21942.80/ ha). The gross income received from wheat cultivation was ₹50166.54 per hectare on overall farms, while gross income was found to be maximum in case of large farm (₹55817.55/ ha) followed by medium farm (₹50191.20/ha) and small farm (₹44490.87/ ha). The net income, farm business income, family labour income and farm investment income was found to be ₹24340.32, ₹35779.93, ₹27969.70 and ₹34498.43 per hectare, respectively on overall farms. The cost benefit ratio was found to be highest on small farm (1: 2.027) as

compared to medium (1: 1.918) and large farm (1: 1.899).

Pal *et al.* (2016) in their study showed that average land holding size of pigeonpea seed farmers was higher in comparison to grain farmers. The study illustrates a ratio of 32:68 towards fixed and variable costs in pigeon pea certified seed production with a total cost of ₹39436 and the gross and net returns were ₹73300 and ₹33864 per hectare, respectively. The total cost of cultivation, gross return, and net return in pigeon pea seed production were higher by around 23, 32, and 44 percent than grain production, respectively. Hence, production of certified seed has resulted in a win-win situation for the farmers with higher yield and increased returns. The decision of the farmer on adoption of seed production technology was positively influenced by his education, age, land holding, irrigated land, number of crops grown, and extension contacts while family size was influencing negatively. Higher yield and profitability associated with seed production can be effectively popularized among farmers, resulting in increased certified seed production.

Abbas *et al.* (2017) conducted a study at Social Sciences Research Institute (PARC), AARI, Faisalabad during the year 2015. The objective was to calculate chickpea cost of production in Bhakkar and Layyah districts of low intensity zone and also to investigate the factors responsible for low chickpea yield in selected districts. A sample of 80 farmers was selected through purposive sampling technique. Chickpea cost of production was estimated at ₹13688 with the gross returns ₹19958. Net income received by the farmers was noted as ₹6270 showing cost benefit ratio of 1:1.50. The results of the regression model indicated that farming experience, seed cost, ploughing and harvesting cost show significant effect on chickpea yield. The coefficient for experience, seed cost, ploughing cost and harvesting cost showed positive impact on yield indicated that 1 percent increase in these variables will bring 0.03, 0.44 and 0.85 percent increase in chickpea yield. The study concluded that use of improved and high yielding varieties along with better management practices like proper land preparation, weeding, etc. can help to increase the per acre yield of chickpea in low intensity zone.

Kumar *et al.* (2017) carried out an economics analysis of rajmash crop of marginal, small and medium farmers in Bhaderwah and Bhalla blocks of Doda district of Jammu & Kashmir state during 2015–16. The results revealed that per hectare cost of cultivation of rajmash was ₹33176 on marginal farms, ₹36301 on small farms

and ₹37931 on medium farms, respectively with an overall average of ₹35354. Net income of rajmash cultivation varied from ₹37761 on marginal farms to ₹32533 on medium farms with an overall average of ₹35634. The cost benefit ratio was calculated as 2.12, 1.94 and 1.86 on marginal, small and medium farms, respectively. Overall, the cost benefit ratio of rajmash was worked out to be 2.01.

Kumari *et al.* (2017) studied to appraise the existing situation of major pulse production and consumption with adoption of technologies and its impact on crop productivity, income, and other socio-economic issues. The average productivity of improved variety of chickpea in adopted villages was estimated at 9.5 quintal/ha and for local variety it was 8.5 q/ha. For pigeon pea the productivity was 18 to 19 quintal/ha. The per capita income in the adopted village was more than that of control village which included 54% of income from the crop enterprises and from pulses its share was estimated only 10 to 12 percent of total farm income.

Singh *et al.* (2017) studied changing scenario of pulses in India: An analysis of its growth and instability in eastern States. Liberalized and subsidized import of pulses of India helps to meet demand-supply gaps, which have occurred because of stagnation in the area under cultivation, very slow growth in yield, poor increase in production and speedy increase in population. Ban on export and re-export of pulses make the closure of Indian pulses processing units. Problems of pulses economy can be solved with the increase the sources of production. Effective and continuous efforts are needed to increase the area under cultivation with better technological and logistic support.

Thakar *et al.* (2017) attended research pursuit to study the growth and instability in area, production, productivity and also price, arrival seasonality with reference to North Gujarat. Overall, North Gujarat was observed positive growth in yield (3.77%), but it is not substantial to increase the production (-2.55%) of cluster bean over the study period. Except, Patan all other districts of North Gujarat observed positive growth in yield resultant it increased production of cluster bean at regional level with 1.41 percent per annum. The growth (4.78%) performance of production of green gram during the study period had been satisfactory because yield increase (4.65%) favoured this crop even small decline in area (-0.74%). The growth (-5.21%) performance of moth bean production during the study period had been extremely poor even yield increased with 8.26 per cent but growth in area decrease was substantial (-13.1%). Growth performance of tur crop during the study period had

been marginalized even yield increased with 9.45 percent in North Gujarat because acreage decrease (-10.09) was more prominent phenomena. Growth performance of urd crop during the study period had been guided by the yield increase and marginal acreage increase as compared to any other major pulses in North Gujarat. Being an industrial crop and there is no spoilage, so price fluctuation was very low in cluster bean as compared to other pulse crops. The seasonal price of green gram was higher in the month of April, May and June in most of the selected markets. In summer season, there is a scarce of vegetables and green gram supplements it, so the prices were higher during April to June months. Tur prices were higher in month of April to July. The seasonal arrival indices of urd were higher in the month of October, November and December in the selected market of study area. In moth bean, there was no relationship between market arrivals and prices during study period.

All the viewers presented in above section underlines the importance of pulse cultivation in household income of all categories of farmers. These studies indicated that C:B ratio of pulse crops is higher than grain crops and adoption of recommended technology could help in better return from cultivation of pulse crops.

(iii) Factors driving the dependency of households on pulse crop for livelihood security

Tripathi (1998) study was based on the survey data of 100 farmers in different agro-ecological situations of Uttarakhand region. It deals with the cost structure, gross/net returns and profitability of urd, soyabean, french bean, horse, gram, rajma, and arhar in Uttarakhand. The production function analysis was used to estimate the relationship between dependent and independent variables. The gross returns of pulse crops depended on cost of human labour, bullock labour, cost of seed and manure, size of operational holding and number of family workers. It was observed that the marketing surplus of pulses was very low in this region. The author recommended that popularizing improved variety seeds, water management and plant protection measures can provide immediate results in terms of increased pulse production. The importance of lifesaving irrigation to pulse crops especially in rabi season was highlighted and the author emphasized the need to tap, conserve and recycle scarce run off water for increasing and stabilizing production of pulses in the area. The marketing infrastructure was inadequate and ineffective. The malpractices, illegal charges, higher taxes and high rate of whole seller's commission in regulated markets resulted in lower share of the producer. The effective and honest supervision,

development of transportation and communication could help in boosting pulse production in Uttarakhand region.

Hossain *et al.* (2006) examined that movement in and out of poverty was caused by several demographic, economic and natural factors that were within and outside the control of the household. This chapter used primary data collected from a sample survey to understand the major factors behind changes in economic conditions in a coastal province in South Vietnam. The survey was conducted in 2001 in five purposively selected villages to: (i) understand the livelihood systems in the Vietnam coastal area; and (ii) analyse the impact of government intervention (construction of embankments and sluices to prevent saltwater intrusion) for water management on rural livelihoods. A comparative analysis of costs and returns of intensified rice farming, rice–shrimp farming and semi-intensive shrimp farming was conducted to study the effect of the change from the brackish-water to the freshwater system on the productivity of land, the most important asset possessed by rural households. An income determination function was estimated to analyse the effect of the endowment of various capital items on household income. Farmers were asked to report changes in economic conditions over the last 10 years and the reasons behind the changes. These qualitative data were related to the endowment of capital at the household level to analyse the factors contributing to the poverty dynamics in the region.

Luttrell (2006) examined the effects of aquaculture development on the livelihoods of households in two historically and geographically distinct coastal communities in north and south Vietnam. It was shown that the importance of open-access resources for livelihoods increases in line with the poverty and vulnerability of the social group. This increase had occurred at the same time as a decrease in the availability of open-access products because of the privatization of resources associated with aquaculture. Many open access resources were accessed illegally or with unofficial access rights and this had implications for livelihood security, since open-access resources have uncertain rights and legislative status, a status that was open to change and frequently subject to privatization. The high capital investment required and the loans necessary to raise that capital were also increasing the vulnerability of the wealthier households involved in aquaculture.

According to IFPRI (2011) there has been substantial growth in cereals, in terms of area cultivated, yields and production since 2000, but yields are low by international standards and overall production is highly susceptible to weather shocks,

particularly droughts. Thus, both raising production levels and reducing its vulnerability are essential aspects of improving food security in Ethiopia, both to help ensure adequate food availability, as well as to increase household incomes.

Barbier (2006) examined that from 1961 to 1996, Thailand lost 50–60% of its mangrove forests, mainly because of conversion to shrimp aquaculture. The speed and scale of deforestation had affected many coastal communities. This paper highlighted the importance of mangroves to four case study villages. Households depended directly on mangrove forests for fish and wood collection and/or benefit indirectly from the mangrove's support to coastal fisheries. Mangrove loss therefore affected the decision of households to look for outside employment. In response to deforestation, female household members allocated more hours to employment relative to mangrove-dependent activities, whereas males allocated fewer hours to outside work. Awareness of community conservation efforts and of the environmental damage imposed by shrimp farms also motivated households to participate in replanting activities. Efforts to control mangrove deforestation and promote community-based management of remaining mangrove forests, as well as replanting, would help to mitigate some of the worst impacts on coastal villages. By developing institutions to support local community management, the government of Thailand could help avoid excessive mangrove deforestation and conflicts over uses. Such a framework could also provide important lessons in coastal resource management for other countries in South-east Asia and elsewhere.

Kumar and Upadhyay (2008) analyzed the case of goat based integrated farming system evolved by farmers as a coping strategy under water scarcity and changing resource situations in arid region of Rajasthan. It had also quantified the magnitude of linkages amongst different components of the farming system. The study was conducted in Nagaur district in arid Rajasthan. The primary data were collected from randomly selected 60 goat-keeping households and 25 farm households without goats for the year 2004- 2005. The static input-output model was used to quantify the linkages. Instead of opting for transhumance system, the farmers were innovative to evolve a farming system that allowed sustainable production of grains for family as well as feed and fodder for maintaining their small ruminants. Three farming systems, namely, I-Rainfed goat based farming system, II-Partially irrigated goat based farming system and III-Rainfed crop based farming system were delineated. In response to the emerging resource and environmental conditions, goat

farmers utilised the potential synergy of linkages among different components of the farming system. On rainfed farms, the maximum area in kharif season was occupied by crops, but farmers kept about 20 per cent of their land fallow for grazing the animals. During this period farmers sold their restricted flocks due to lack of grazing resources. It was revealed that crop and livestock- especially small ruminants – enterprises were integrated components of the farming systems in the study area. Grazing on common and own fallow lands and lopping from trees on owned and common land was a major source of fodder for the small ruminants and other livestock. The small ruminants with long daily hours of grazing provided nutrients to the current fallow and common lands through their droppings and dung. Goat rearing contributed the major share of the total farm income in both the goat based farming systems and provided livelihood security to the farm family in the poorly endowed arid region. Per hectare net returns of rainfed goat based farming system were 60 per cent higher than the crop based farming system. Diversification and strengthened linkages among different components of the farming system had a synergistic effect on the functioning of the entire farming system and resulted in higher income. However, the farmers of the existing goat production need to be finely tuned with the modern goat rearing practices. The innovative idea of farmers of keeping part of their land fallow for grazing their goats and sheep during the lean season needs to be used as an opportunity to encourage the farmers to develop this fallow land as pasture with recommended legume and non-legume grasses. Moreover, provision of market information, enhancing competition in milk and live animal market through organised efforts, access to improved technologies, critical inputs like vaccines, improved fodder seeds, and easy institutional finance were identified as the crucial factors for strengthening the goat based farming systems in the study area.

Singh *et al.* (2008) a study was conducted for assessing the impact of watershed development project in Bardh village of district Jalaun in Uttar Pradesh on improvement in income and employment surrounding the project area. The project was launched in the year 2000 and observations were made during the year 2005-06. For the purpose of study 60 farm households were selected from the Vardh village under the watershed project command area. The study observed that the average net cultivated area was 108.50 ha and 182.50 ha and 182.12 ha before and after implementation of the watershed project. This programme had increased 75 per cent cropping intensity and an increase through improved irrigation facilities had been

observed on the farms. Livestock population shows a positive change in number before and after project implementation. The total livestock population in the village increased from 265 total livestock before project period to 554 after project period. Due to improved cropped area, irrigation facility and more raw material was easily available on farms. The effect of watershed project on the productivity of the crops grown on farms showed an increasing trend in productivity under wheat crops during post project period. It was concluded that implementation of watershed development project has resulted in area expansion, increase in net cultivated area, increase in livestock population, improvement in crop productivity and employment days. Besides the watershed project could help arrest degradation of both arable and non-arable lands. All these had enhanced the farmer's income and employment opportunities at the local level and small holders have benefited more and has improved livelihood.

Rajarithinam *et al.* (2010) the investigation was carried out to study area, production and productivity trends and growth rates of tobacco (*Nicotiana tabacum*) crop grown in Anand region of Gujarat state, India for the period 1949-50 to 2007-08 based on parametric and nonparametric regression models. In parametric models different linear, non-linear and time-series models were employed. The statistically most suited parametric models were selected on the basis of adjusted R^2 , significant regression co-efficients and co-efficient of determination (R^2). Appropriate time-series models were fitted after judging the data for stationarity. The statistically appropriate model was selected on the basis of various goodness of fit criteria viz., Akaike's information criterion, Bayesian information criterion, Root mean square error, Mean absolute error, assumptions of normality and independence of residuals. In nonparametric regression optimum bandwidth was computed by cross-validation method. *Epanechnikov-kernel* was used as the weight function. Nonparametric estimates of underlying growth function were computed at each and every time point. Residual analysis was carried out to test the randomness. Relative growth rates of area, production and productivity were estimated based on the best fitted trend function. None of the parametric model was found suitable to fit the trends in area, production and productivity of the tobacco crop. The Nonparametric regression was finally selected as the best fitted trend function for the area, production and productivity of tobacco crop based on lower values of root mean square and mean absolute errors. Tobacco production had increased at a rate of 1.40% which was due

to combined effect of increase in area and productivity at a rate of 0.02 and 1.39% per annum, respectively.

Rao (2010) found on performance of pulses during pre and post-WTO period in Andhra Pradesh, district wise study and attempted to cluster the districts based on different criterion, assessing the patterns of growth and magnitude of instability, and assessing the explanatory variable's effects on pulses production in Andhra Pradesh. Decomposition analysis shown that area effect was marginally higher than the productivity effect on the production differential. Therefore, growth in production should mainly come from area assigning factors like assured supply of farm inputs and provision of remunerative prices.

Reddy (2010) tried to analyse the consumption and production pattern, marketed surplus of different pulse crops and potential for future expansion of production of pulse crops in different regions. There were large differences in both consumption and production of pulse crops across regions. There is a need for regional and crop specific strategies for enhancing the production of pulse crops to meet the growing domestic demand and to reduce imports and exploit export possibilities. There should be greater emphasis on the adoption of improved package of practices as the existing improved pulse production technology was having potential to increase yield by about 30 per cent

Ayoola *et al.* (2011) presented the results of multiple regression of the double log form testing the effects of socio-economic variables: age, farming experience, educational level, land, marital status, and total variable cost on rice production by male and female farmers. The coefficient of determination indicated that 89.6% of the total variation in rice production by men was explained by the estimated variables and 77.8% in case of the women. Among all the explanatory variables, land, level of variable inputs used, experience and age were significantly implying that these variables would greatly influence productivity of rice among the male farmers in the area. While age would influence rice production negatively, implying that the older the farmers, the less the vigour for farming; all the other variables influence rice production positively implying that rice production could be increased by increasing the use of land and variable inputs such as fertilizers, herbicides and labour. While results indicated generally low level of input's use. The level of inputs used by female farmers was generally less than that of the male farmers

Obiero (2013) in his study on socio-economic factors affecting farm yield in

Siaya district, Siaya County, Kenya and found that there was a positive relationship between family labour and farm yield. More than half of the households derive their human labour for the farm work from the family. There is a negative relationship between the farmer's experience and farm yield. The study also showed that there is negative relationship between the farmer's education and the farm yield. There was a positive and significant relationship between the farmer's income and farm yield. This shows that sufficient investments in the farming sector would give better yields.

Mfikwa and Kilima (2014) investigated factors underlying market participation and its consumption to inform policy and chain actors about ideal means to address the challenge. A two-step model following the double hurdle specification was adopted to identify factors underlying the decision to consume pulses and its extent of consumption. Model results revealed that household sizes and education levels of the decision makers residing in rural areas had significant effect on the decision to consume pulses while the extent of consumption was influenced by their education levels, household sizes, household's total expenditure on food and non-food and prices of pulses and meat. Household sizes, levels of education and sex of the main decision makers were found to have significant effects on the decision to consume pulses whereas the age and education levels, household sizes and household's total expenditure were the main factors that influenced the extent of consumption in urban areas.

Basavaraj *et al.* (2016) revealed that the nature, extent and determinants of crop diversification had been analysed in the Gadag district of Karnataka over space and time. The area under vegetables, fruits and pulse crops has registered a higher (7-11%) growth compared to cereals, oilseeds, fibre and other crop groups (<1%). Over the years, the share of cereal crop groups had decreased significantly from 32.53 per cent to 28.81 per cent and that of fruits and vegetables had increased considerably from 0.10 per cent to 0.25 per cent for fruits and from 4.66 per cent to 7.80 per cent for vegetable crops. The transition probability matrix had indicated that over the years, horticultural crop groups had retained a higher share (92%) in terms of area under crops. The Northern Dry Zone (Gadag taluk) had been found to be more diversified with Entropy index of 0.99 and household crop richness of 3.20 compared to 0.55 and 1.90 in the Northern Transitional Zone (Shirahatti taluk), respectively. The major factors influencing crop diversification had been identified as size of landholding, gross irrigated area, and net return realised per farm.

Harishkumar *et al.* (2016) studied to assess the outcomes of livelihood security like Economic security, Food security, Educational security, Health security, Habitat security and Social network security. Four farming systems viz. Crop+Dairy, Crop+Sericulture, Crop+Dairy+Sericulture and Crop+Sheep were identified as major farming systems based on preliminary survey and previous studies in the area. The study based on the primary data from 120 farmers covering equal samples under major farming systems was elicited through survey method for the period 2010-11. The data was analyzed using Garrett ranking technique, Gini co-efficient and conventional economic and simple statistical tools like ratios, percentage and indices etc. The result revealed that net annual income realized by a household was highest in C+D+S (₹3,58,880/-) farming system of which 43.78 per cent was from sericulture enterprise alone and least in C+Sh (₹46,281/-) farming system of which 59.95 per cent was from non-farm activities. When compared to Farm households of rainfed based farming systems (Crop+Sheep) irrigation based farming system (Crop+Dairy, Crop+Sericulture, Crop+Dairy+Sericulture) households are on par with Indian Council of Medical Research (ICMR) norms in cereal consumption. Public Distribution System (PDS) playing an important role in food security of farm households of rainfed farming systems through supplying food grains at cheaper prices. The overall livelihood security is high in case of C+D+S farm households.

Makate *et al.* (2016) demonstrated how crop diversification impacts on two outcomes of climate smart agriculture; increased productivity (legume and cereal crop productivity) and enhanced resilience (household income, food security, and nutrition) in rural Zimbabwe. Using data from over 500 smallholder farmers, they jointly estimated crop diversification and each of the outcome variables within a conditional (recursive) mixed process framework that corrects for selectivity bias arising due to the voluntary nature of crop diversification. They found that crop diversification depends on the land size, farming experience, asset wealth, location, access to agricultural extension services, information on output prices, low transportation costs and general information access. Results also indicated that an increase in the rate of adoption improves crop productivity, income, food security and nutrition at household level. Overall, results were indicative of the importance of crop diversification as a viable climate smart agriculture practice that significantly enhances crop productivity and consequently resilience in rural smallholder farming systems. We, therefore, recommended wider adoption of diversified cropping systems

notably those currently less diversified for greater adaptation to the ever-changing climate.

Sellam and Poovammal (2016) analyzed the environmental parameters like Area under Cultivation (AUC), Annual Rainfall (AR) and Food Price Index (FPI) that influences the yield of crop and to establish a relationship among these parameters. In this research, Regression Analysis (RA) is used to analyze the environmental factors and their infliction on crop yield. RA is a multivariate analysis technique which analyzes the factors groups them into explanatory and response variables and helps to obtain a decision. A sample of environmental factors like AR, AUC, FPI are considered for a period of 10 years from 1990-2000. Linear Regression (LR) is used to establish relationship between explanatory variables (AR, AUC, FPI) and the crop yield as response variable. R² value clearly shows that yield is mainly dependent on AR. AUC and FPI are the other two factors influencing the crop yield. This research can be extended by considering other factors like Minimum Support Price (MSP), Cost Price Index (CPI), Wholesale Price Index (WPI) etc. and their relationship with crop yield.

Ahmed *et al.* (2017) investigated the status of small farming household's food security, and its determinants including the role of market accessibility factors in enhancing food security at household level. In addition, this study also determines the household's perception about different kinds of livelihoods risks. This study is based on a household survey of 576 households conducted through face-to-face interviews using structured interviews in Punjab, Pakistan. Food security status is calculated using dietary intake method. The study findings show that one-fourth of the households are food insecure. The study findings reveal that farm households perceive increase in food prices, crop diseases, lack of irrigation water and increase in health expenses as major livelihood risks. Further, the results of logistic regression show that family size, monthly income, food prices, health expenses and debt are main factors influencing the food security status of rural households. Furthermore, the market accessibility factors (road distance and transportation cost) do significantly affect the small farming household food security. The results suggest that local food security can be enhanced by creating off-farm employment opportunities, improved transportation facilities and road infrastructure.

Basantaray and Nancharaiah (2017) examined the extent and pattern of crop diversification and its impact on farm income across all the districts of Odisha. The

determinants of crop diversification have been identified. Using the NSSO data, the study has found three districts, namely Anugul, Jharsuguda, and Balangir, to be highly diversified districts and the average farm income in these districts is significantly higher than in both moderately and least diversified districts. The medium farmers are the most diversified category of farmers in two out of the three highly diversified districts. The marginal farmers are the most diversified category of farmers in one highly diversified district. On the basis of regression analysis, the study has found that SC households in Odisha are less diversified in comparison to other households and higher the extent of irrigated land, lower is the extent of crop diversification.

Esham *et al.* (2017) conducted a study for assessing the impact of climate change, variability and extreme weather events on food production, food security and livelihoods. The link between climate change and food security has been mostly explored in relation to impact on crop production or food availability aspects of food security, with little focus on other key dimensions, namely food access and food utilization. This review, based on available literature, adopted a food system approach to gain a wider perspective on food security issues in Sri Lanka. It points to several climate-induced issues posing challenges for food security. These issues include declining agriculture productivity, food loss along supply chains, low livelihood resilience of the rural poor and prevalence of high levels of undernourishment and child malnutrition. Our review suggests that achieving food security necessitates action beyond building climate resilient food production systems to a holistic approach that is able to ensure climate resilience of the entire food system while addressing nutritional concerns arising from impacts of climate change. Therefore, there is a pressing need to work towards a climate-smart agriculture system that will address all dimensions of food security. With the exception of productivity of a few crop species, our review demonstrates the dearth of research into climate change impacts on Sri Lanka's food system.

Kumari *et al.* (2017) this study was to appraise the existing situation of major pulse production and consumption with adoption of technologies and its impact on crop productivity, income, and other socio-economic issues. The average productivity of improved variety of chickpea in adopted villages was estimated at 9.5 quintal/ha & for local variety it was 8.5 q/ha. For pigeon pea the productivity was 18 to 19 quintal/ha. The per capita income in the adopted village was more than that of control village accounted 54 per cent of income from the crop enterprises and from pulses its

share was estimated only 10 to 12 per cent of total farm income. Human labor accounted highest cost in pulse cultivation (farm family contributed about 52 per cent of total labor). Comparative cost and benefit analysis indicated that pulse crop were more remunerative in Bihar. Constraints analysis indicates that the non-availability of seeds of high-yielding varieties in the desired quantities was perhaps one of the major constraints followed by moisture stress, high pod borer incidence, and shortage of labor during harvesting and threshing and some of variety found not suitable in flood affected area etc in pulse production. The share of consumption expenditure on pulses was only 15.60 percent of total food expenditure/household. It is suggested that major future expansion of area under pulse crops may take place in rice fallows, (1.2 million ha) where there is no other crop to compete with. Steps to reduce the temporal and spatial variation in price of pulses will definitely help in sustaining as well as enhancing the farmer's interest in pulses production. The government has never treated the MSP as an effective tool for increasing pulses production; High volatility in prices for long periods, low productivity, and stagnation in production technology has acted as disincentives for pulses production.

Yamba *et al.* (2017) ascertained the alternative livelihood options of smallholder farmers against climate variability and change in the Bosomtwe District. Using a cross-sectional survey, 152 smallholder farmers were sampled from 12 communities using a multistage sampling procedure. The quantitative data collected were subjected to binary logistic regression analysis, contingency tables, frequencies, and Nagelkerke tests of association, embedded in the statistical package for social sciences (SPSS) v.17. The results indicate that farmers are resorting to alternative livelihood activities that are less capital intensive and require less skill in order to secure income and household food supply. Significant determinants of farmer's alternative livelihood are age, household size, and household food supply, which were significant at $p < .030$, $p < .019$, and $p < .012$ respectively. At a 95% confidence interval (CI), these variables had lower to upper CIs for each of the EXP (B), respectively, at CI = 1.134–12.524, CI = 1.359–30.224, and CI = 1.781–104.561, respectively. The paper recommends that government institutes policies that will create opportunities and draw on various local/grassroots opportunities and resources to expand farmer's asset base for sustainable livelihood strategies.

Ahmed *et al* (2018) carried a study to investigate the patterns and extent of livelihood diversification in rural Bangladesh. It also identified the major factors

affecting extent of livelihood diversification. The study drew a random sample of 500 rural farm households in Bangladesh through a multi-stage sampling technique. The primary data were collected using semi-structured questionnaires, and analyzed using descriptive statistics and statistical techniques. The results showed that remittance contributed the highest to the household income followed by petty business and rice farming. The estimated values of Simpson Index of Diversification (SID) showed that majority of the rural households had “medium” and “high” level diversified livelihood activities. Tobit regression analysis found that gender of the household head, household size and amount of credit had positive and significant effects; and number of migrant household member, dependency ratio, household assets, education of the household head and amount of savings had negative but significant effects on the extent of livelihood diversification. The small and medium landholding households were more likely to diversify their livelihoods compared to the functionally landless and large landholding households. The study recommended that non-farm employment opportunities should be expanded to combat poor household’s vulnerability to shocks and income fluctuations. Functionally landless households should be given more attention to increase and diversify their incomes.

Lopez-Ridaura *et al.* (2018) examined the food security status and livelihood activities of 269 smallholder farm households (HHs) in Bihar, India. Proceeding with a four-step analysis, they first applied a multivariate statistical methodology to differentiate five primary farming system types. They next applied an indicator of food security in the form of HH potential food availability (PFA), and examined the contribution of crop, livestock, and on- and off-farm income generation to PFA within each farm HH type. Lastly, they applied scenario analysis to examine the potential impact of the adoption of ‘climate smart’ agricultural (CSA) practices in the form of conservation agriculture (CA) and improved livestock husbandry, and environmental shocks on HH PFA. Results indicate that compared to livestock interventions, CA may hold considerable potential to boost HH PFA, though primarily for wealthier and medium-scale cereal farmers. These farm HH types were however considerably more vulnerable to food insecurity risks resulting from simulated drought, while part-time farmers and resource-poor agricultural laborers generating income from off-farm pursuits were comparatively less vulnerable, due in part to their more diversified income sources and potential to migrate in search of work. Results underscore the importance of prior planning for development initiatives

aimed at increasing smallholder food security while maintaining social equity, while providing a robust methodology to vet the implications of agricultural interventions on an *ex ante* basis.

Acharya et al. (2019) this study had been conducted in Manbazar-1 and Purulia-1 blocks of Purulia district and data were collected from 75 respondents who are mainly small and marginal farmers. The selection of the respondents had followed the random sampling method by using an exhaustive list of pulse growers from selected locale. Higher marketable surplus and higher size of homestead land had got the most importance. The study had offered a unique micro level policy implication at a time when the entire Nation is trying to boost up pulse productivity and cultivation throughout the length and breadth of geography of India.

Khakbazan *et al.* (2020) this study was conducted from 2010 to 2014 at three locations in western Canada to evaluate the effects of rotating a cereal crop with a range of PC at different frequencies and sequences on the economic returns and risk of both the entire rotation and each individual crop. Crops in rotation included spring wheat (*Triticum aestivum* L.) (W), field pea (*Pisum sativum* L.) (P), chickpea (*Cicer arietinum* L.) (C), lentil (*Lens culinaris* Medik) (L), and Oriental mustard (*Brassica juncea* L.) (M). Thirteen 4-yr-cycle crop rotation treatments, along with a continuous wheat treatment as a baseline, were included. Treatments were arranged in a randomized complete block design with four replicates at each site-year. The net revenue (NR) was defined as the income remaining after paying all monetary, land and ownership, and labor costs. Crop rotation had a significant effect on average annual NR. The most profitable rotations were L–L–L–W and P–M–L–W. These rotations provided CAN\$330 and \$235 yr⁻¹ ha⁻¹ higher NR, respectively, than the baseline, and were most preferable by risk-averse producers. The economic ranking of the rotations remained the same with different crop price scenarios. Preceding PC also had a positive impact on the succeeding wheat crop NR.

To sum up, all the findings of research studies presented in this section show that there are certain factors which are very crucial for driving the dependency of households on pulse crops for livelihood security such as size of land holding, market price, household size, availability of inputs, etc.

(iv) Digital database and mapping of pulse crop

Gumma *et al.* (2011) investigated that while mapping the rice areas of six South Asian countries using Moderate Resolution Imaging Spectroradiometer (MODIS) time-series data for the time period 2000 to 2001. South Asia accounts for almost 40% of the world's harvested rice area and is also home to 74% of the population that lives on less than \$2.00 a day. The population of the region is growing faster than its ability to produce rice. Thus, accurate and timely assessment of where and how rice is cultivated is important to craft food security and poverty alleviation strategies. We used a time series of eight-day, 500-m spatial resolution composite images from the MODIS sensor to produce rice maps and rice characteristics (e.g., intensity of cropping, cropping calendar) taking data for the years 2000 to 2001 and by adopting a suite of methods that include spectral matching techniques, decision trees, and ideal temporal profile data banks to rapidly identify and classify rice areas over large spatial extents

Bronson (2016) in his study revealed that farming is undergoing a digital revolution. Our existing review of current Big Data applications in the agri-food sector has revealed several collection and analytics tools that may have implications for relationships of power between players in the food system (e.g. between farmers and large corporations). For example, Who retains ownership of the data generated by applications like Monsanto Corporation's Weed I.D. "app"? Are there privacy implications with the data gathered by John Deere's precision agricultural equipment? Systematically tracing the digital revolution in agriculture, and charting the affordances as well as the limitations of Big Data applied to food and agriculture, should be a broad research goal for Big Data scholarship. Such a goal brings data scholarship into conversation with food studies and it allows for a focus on the material consequences of big data in society.

Mico (2016) in his study aimed to build a web based system for smart farming. In addition, the proponents will be using temperature and humidity sensors and soil moisture sensors as inputs to the system. This secured web-based system was built with usernames and passwords for a user account. With the use of PHP, the updates on the information about the farm will be updated whenever the user wants to know about the plant environment. The information to be collected was monitored in different parameters such as Temperature and Humidity and Soil Moisture. The design of the system was such a user-friendly GUI which can be easily understood by

the users. There will be a menu categorized by separate parameters which the users can decide on whatever they want to monitor. There will be a button for monitoring in every category in order to make it understandable for the users. The sense data will be stored in a database and with the use of crystal report, it will be outputted in control charts. This system will use microcontroller, which will be connected and interfaced on the web using PHP for effective Internet based monitoring and data management system.

Aniket (2017) introduced a new web portal system based on agriculture market which will be helpful for farmers and market traders to sell and buy agriculture products easily and efficiently. The system intended to provide reliable and efficient communication and interaction platform between different stakeholders of market like farmers, traders and government officials. System will provide timely updates about weather information, market prices and minimum support prices of different crops. System focused on making use of advantages of ICT to bring transparency and accuracy in Agriculture Produce Market Committee (APMC) and making Indian farmers ready to compete with farmers of developed countries in globalised market.

Gray (2018) in his study revealed that more than 500 million smallholder farms worldwide play a significant role in food production and the genetic diversity of the food supply. Until now, it has been difficult to get information to or from smallholder farmers, compounding basic infrastructural problems such as access to inputs, markets, financing, and training. The spread of mobile technology, remote-sensing data, and distributed computing and storage capabilities are opening new opportunities to integrate smallholder farmers into the broader agri-food system. The scale of these changes holds out the potential for another agricultural revolution.

Gumma *et al.* (2018) conducted a study to use remote sensing methods to identify croplands in Myanmar and cropland fallow areas in two important agro-ecological regions, delta and coastal region and the dry zone. The study used moderate-resolution imaging spectroradiometer (MODIS) 250-m, 16-day normalized difference vegetation index (NDVI) maximum value composite (MVC), and land surface water index (LSWI) for one 1 year (1 June 2012–31 May 2013) along with seasonal field-plot level information and spectral matching techniques to derive croplands versus cropland fallows for each of the three seasons: the monsoon period between June and October; winter period between November and February; and

summer period between March and May.

Nikola *et al* (2019) in their study revealed that the rise of digital agriculture could be the most transformative and disruptive of all the industries, because digital agriculture not only will change how farmers farm their farms, but also will transform fundamentally every part of the agri food value chain. Digital agriculture will affect the behavior of farmers, and also affect the way that input providers, processing and retail companies market, price and sell their products. It can be applied to all aspects of agri food systems and reflects a change in generalized management of resources towards highly optimized, individualized, intelligent and anticipatory management, in real time, hyper connected and driven by data. For example, rather than treating all fields, crops and value chains uniformly, each could receive their own highly optimized management prescriptions and animals could be monitored and managed individually. Value chains could have traceability and coordination at the lowest level of granularity. The desired results of digital agriculture are systems of higher productivity, which are safe, anticipatory and adapted to the consequences of climate change, to offer greater food security, profitability and sustainability.

From the above reviewers it can be concluded that digitalization of agricultural is must for inclusive growth digitalization will transform the way of farming because it will enhance the availability of markets, inputs information etc. Digitalization will find out new hot spot of different agricultural crops.

Chapter-3

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The previous chapter showed how the literature has been conceptualized in this study and provided a visual explanation of the emerged frame of reference. This chapter will cover the methodology used in this research. The selection of methodology is based on the research problem and stated research questions. The methods employed are elaborated under the following heads.

Research design

Locale of the study

Sampling technique

Selection of districts

Selection of respondents

Variables and their measurement

Operational Definitions

Tools and Techniques of Data Collection

Pre-testing of the research instrument

Data collection

Statistical Analysis

Research Design

Non-experimental descriptive research design was put forth for the study. In non-experimental research, the independent variables are not manipulated by the researchers. The researcher study the aspects, what naturally occur or have already occurred, and in addition, also study how variables are related. Descriptive research design is a design in which the major emphasis is on studying the field study of a particular situation.

Locale of the study

The Jammu division comprises of ten districts. The present study was conducted in four districts namely Doda, Kishtwar, Udhampur and Kathua in temperate area of Jammu region as maximum pulse area is in these districts.

Profile of the Study Area

Jammu is located 74 degree 24' and 75 degree 18', East longitude and 32 degree 50' and 33 degree 30' North latitude. It is approximately 600 Kms away from National Capital, New Delhi and is linked with a National Highway. The UT of Jammu and Kashmir has two provinces namely Jammu province and The Kashmir Valley

offering a rich diversity in landscapes, region and people. The average altitude of the state, above mean sea level, varies from less than 300 meters to about 9400 meters. The total geographical area of the Jammu and Kashmir state is 101387sq. kilometers (2.42 m ha) (excluding the area under the unlawful occupation of Pakistan and China) which is 3.08 per cent of the total geographical area of India. Out of which 0.742m ha (30.38per cent) is the net sown area, 0.658 m ha (27.24per cent) is under forests, 0.073 m ha (3.02per cent) is fallow, 0.293 m ha (12.13per cent) under non- agricultural use, 0.289 m ha (11.96per cent) are barren plus uncultivable and 0.361 m ha (14.94per cent) under cultivable waste, permanent pastures and other grazing land etc. Out of total net area of 0.742 m ha, 0.378 m ha (51.90per cent) is double cropped and 0.309 m ha (41.70per cent) is irrigated (Anonymous, 2019). The Division has three agro-climatic zones. The zones, an area falling under these zones and suitable fruit crops is illustrated below:-

Sub-tropical Zone: It constitutes the areas falling between 300m-1000m above MSL and covers Jammu and Samba districts as whole, parts of District Kathua, Udhampur, Reasi and Rajouri. Normal summer monsoon ranges 1200-1500mm from mid June to mid September. This zone is further divided into two sub-zones: Irrigated sub- tropical and Unirrigated sub-tropical.

Intermediate Zone: This is located between an altitude of 1000 metres- 1500 above MSL. It comprises parts of Basoli, Billawar, Lohi Malhar, Surankote, Balakote, Mendhar, Rajouri, Dhoongi, Darhal, Budhal, Triyath, Ramnagar, Udhampur, Ghordi, Reasi, Pouni, Arnas, Mahore, Doda, Thathri, Assar, Bhagwa, Ramban, Ramsou Blocks/ Zones.

Temperate zone: Jammu division comprises of 10 districts and all the districts except Jammu and Samba districts are bestowed with temperate areas under their jurisdiction. This zone includes areas above 1500 met. above MSL and comprises parts of Bani, Basoli, Billawar, Lohai Malhar, Poonch, Mendhar, Manjakot, Rajouri, Budhal, Darhal, Thanamandi, Dungi, Arnas, Mahore, Latti, Dudu Basantgarh, Chenani, Mongri, Panchari, Ramnagar, Gool, Banihal, Ramban, Assar, Doda, Bhagwa, Dessa, Thathri, Bhalessa, Bheaderwah, Inderwal, Chattroo, Kishtwar, Marwah, Paddar Blocks/ Zones.

Kathua district:-The district is situated 32° 17' to 32° 55' North Latitude and 75° 70' to 76° 16' East longitude. The District is surrounded by Punjab in the South-East, Himachal Pradesh in North-East, Doda and Udhampur in North and North-West, Jammu in the West and Pakistan in the South-West with an area of 2502 SqKms

(Census 2011), population of 6.16 Lacs, 5 Assembly Constituencies & 11 Tehsils; Kathua, Bani, Basohli, Billawar, Hiranagar, Nagri, Marheen, DingaAmb, Lohai-Malhar, Mahanpur, Ramkote.

It is also divided into 19 blocks: Bani, Basohli, Baggan, Kathua, Billawar, Hiranagar, Nagri, Barnoti, Marheen, DingaAmb, Duggain, Duggan, Lohai-Malhar, Mahanpur, Mandli, NagrotaGujroo, Bhoond, DharMahanpur, KeerianKandyal, & has approximately 512 villages. The traditional language of Kathua is Dogri. The Pahari languages are prevalent in the mountainous area of the east. The principal media of education are English, Hindi, and Urdu.

Udhampur Distict: Udhampur district lies in the southern side of the State. The district is constituted of four tehsils; namely; Udhampur, Ramnagar, Chenani and Majalta. For development planning, these tehsils have been further divided into seven Community Development Blocks, namely; Udhampur, Chenani, Dudu Basant Garh Ghordi, Ramnagar, Panchari and Majalta. The rural part is constituted of 331 villages out of which 6 are uninhabited. Its urban sector is comprised of four towns viz. Chenani, Udhampur, Majalta and Ramnagar. The administrative headquarter is located at Udhampur which is at a distance of 66 kms. from Jammu on the Jammu-Srinagar National Highway.

The district has returned a population of 5,54,985 which is 4.43 per cent of the total population of the State. Amazingly, among all the districts of the State. Udhampur ranks 10th in terms of population. Sex ratio viz, number of females per 1,000 males is 870 which is lower as compared to the State's ratio of 889. The rural part of the district spread over an area of 2593.28 Sq. km and that of urban part is 43.72 Sq. Km.

Doda District: Doda district lies in the outer Himalayan range in Jammu & Kashmir State. District Doda is located about 175 Km from Jammu and about 200 Km from Srinagar. It is comprised of 4 tehsils; namely; Doda, Thathri, Bhalessa (Gandoh) and Bhaderwah. Of all these 4 tehsils, Doda is the largest. For efficient administration these tehsils have been further divided into 8 Community Development Blocks- Bhaderwah, Ghat (Doda), Thathri, Gandoh, Bhagwah, Assar, Marmat and Gundana. The rural part of the district is constituted of 406 villages encompassing an area of 8892.25 SqKms, whereas its urban sector spread over an area of 19.75 Sq.Km, is made up of 2 towns namely, Doda (MC) and Bhaderwah (MC).

As per 2011 Census, the district has recorded a population of 409,936 comprising 3.27 per cent of the total population of the State, thereby it ranks 13th

among all the districts of the State. The number of males and females in the district is of the order of 213,641 and 196,295 respectively. Sex ratio i.e number of females per 1,000 males is 919 which is higher than the corresponding ratio of the State (889) as well as for 2001 Census (913) of the district.

Kishtwar District: The district derives its name from its district headquarter, town Kishtwar. It is comprised of 4 tehsils; namely; Marwah, Chhatroo, Kishtwar and Atholi. For efficient administration these tehsils have been further divided into 7 Community Development Blocks viz; Warwan, Dachhan, Chhatroo, Kishtwar, Nagseni, Drabshalla and Paddar. The rural part of the district is constituted of 157 villages included two un-inhabited village, encompassing an area of 1643.65 SqKms, whereas its urban sector spread over an area of 0.63 Sq.Km, is made up of only 1 towns namely, Kishtwar.

As per 2011 Census, the district has recorded a population of 230,696, comprising 1.84 percent of the total population of the State, thereby it ranks 19th among all the districts of the State. The number of males and females in the district is of the order of 12,0165 and 11,0531 respectively. Sex ratio i.e. number of females per 1000 males is 920 which is higher than the corresponding ratio of the State (889).

Sampling technique

Multistage random sampling technique was employed in the present study. Personal interview technique was used for data collection

Selection of Districts

The study was carried out in temperate area of Doda, Kishtwar, Udhampur and Kathua districts of Jammu division purposively because maximum acreage of pulse crop in these four districts as given in the below table 3.1

Table 3.1: District wise area sown under pulse crop in temperate region of Jammu 2016-17

		Area (Hectare)
S.No.	District	Pulses
1	Doda	1488
2	Kishtwar	1170
3	Kathua	2403
4	Rajouri	307
5	Poonch	28
6	Reasi	352
7	Udhampur	1576

(DSE 2018)

Selection of Respondents

Jammu division comprises of 10 districts and all the districts except Jammu and Samba districts are bestowed with temperate areas under their jurisdiction. From 8 temperate districts, Kathua, Doda, Kishtwar and Udhampur districts were selected purposely because of maximum acreage under pulses in these districts. A list of temperate sub-divisions with area under pulse crop was prepared for each district. One sub-division from each district was selected randomly. Thus four sub-divisions, one each from sub-division were selected. A list of villages where pulses are grown was prepared for each sub-division. From the list prepared, six villages were selected from each sub-division by using random sampling technique. Thus a total of 24 villages from four sub-divisions were selected. A list of pulse growing farmers was prepared for each village and from each such list prepared, ten farmers were randomly selected as respondents for the study. Thus a total of 240 farmers involved in pulse crop production were selected as final sample size for the study.

Table 3.2: Sampling plan of pulse crop growers

S. No.	Name of district	Selected sub-division	Number of villages covered	Number of respondents from each villages	Number of respondents from selected villages
1	Doda	Pranoo	Bigota Masari Shekpura Bathoh Tantla Thilroo	10	60
2	Kishtwar	Mughal Maidan	Bhata Moolchatar Seeri Sigdi Markhar Bankari Dahayan	10	60
3	Kathua	Machedi	Machedi Badnota Nangala Dull Bijohi Najot Kindli	10	60
4	Udhampur	Pancheri	Kulyar Upper Meer Lower Meer Gailote Sadhota Suman	10	60
					N- 240

Variables and their Measurement

Two types of variables were studied for the purpose of the study, independent and dependent variables.

Table 3.3: Coding and measurement of dependent and independent variables

Dependent Variable

Variable	Code	Measurement
Pulse crop income to household income	Y1	Percentage

Independent variables

Variable	Code	Measurement
Age	X1	Chronological age of the respondent.
Education	X2	Number of years of formal schooling
Family size	X3	Number of members in the family
Family Type	X4	Joint/nuclear
Experience in pulse crop cultivation	X5	No. in Years
Land holding	X6	Area in ha
Irrigated/un irrigated	X7	1 for irrigated 0 for unirrigated
Extension contacts	X8	1 for contact 0 for no contact
Occupation	X9	1=Farming and 0 for off farm activities
Source of information	X10	1= yes 0= no
Social participation	X11	1= yes 0= no
Number of livestock	X12	In numbers
On-farm Income	X13	In Rupees
Off-farm Income	X14	In Rupees
Income from pulse crop	X15	In Rupees

Operational definitions

There are in general two types of operational definitions: measured and experimental. A measured operational definition describes how a variable will be measured and an experimental operational definition spells out the details of researcher's manipulation of a variable (Kerlinger, 1973).

Age

Age was operationalized as the chronological age of respondents expressed in completed years at the time of investigation. Categorization of respondents on the basis of their age as per average mean and standard deviation.

Category Age group

Young 22 to 35 years

Middle 36 to 59 years

Old Above 59 years

Education

It was measured in terms of the number of formal education completed by the pulse crop growers and non-growers at the time of interview and categorized into illiterate, below primary, primary, middle, matriculate, 10+2, graduate and above.

Nuclear family and joint family

Nuclear family was considered as the type consisting members in a family from one generation sharing resources of home and land separately and joint family consists of one or more than one generation of a family sharing resources together.

Occupation

The main source of livelihood was considered as the occupation of the respondents. The respondents were categorized into six categories based on their frequency in each of the six occupations.

The seven categories were:

- Category 1 Agriculture only
- Category 2 Agriculture + Govt. service
- Category 3 Agriculture + Retired from govt.service
- Category 4 Agriculture + Business
- Category 5 Agriculture + Labour
- Category 6 Agriculture + Private job only
- Category 7 Agriculture + Shop

Operational land holding

It refers to the number of hectares of land owned by the pulse crop growers including leased in and excluding leased out. Operational land holding = Area owned + Area leased in- Area leased out.

Family Size

It refers as total number of members in the family. Three categories of respondents were made on the basis of Singh cube root method of categorization (1975).

2-4 members
5-7 members
Above 7

Extension Contact

It refers to contacts of the pulse crop growers with different extension personnel. It was measured by awarding 1 score for extension contact and 0 for no extension contact.

Social participation

The term social participation in this study refers to the degree of involvement of the respondents in formal/informal organizations as member or executive/office bearer or both. It was measured by awarding 1 score for involvement and 0 for no involvement.

Livestock possession

It is considered as the actual number of animals/livestock possessed by the respondents at the time of enquiry. It was measured in terms of number of animals/livestock possessed by the respondents.

Farm income

Farm income in this study includes income from agricultural crops and livestock. In calculating agricultural crop income, all incomes generated from farming are accounted. The quantity of crop yields was obtained from individual households through face to face interviews and reported price of each products by household itself are used in calculation. Reported prices for each seasonal product are same as they sold their products in the local markets almost at the same time. Agricultural income is calculated by multiplying the crop yields with respective prices of the products. The common livestock found in the study area are cow, buffalo, oxen, sheep

and poultry. In order to calculate the annual income stream from livestock, milk yield and sale of animals was calculated.

Off- farm income

Off- farm income include all income generated from the wage labour, business, private job, private shops and permanent employment such as pension, government staff etc.

Experience in pulse crop cultivation

It was measured in terms of number of years a farmer practicing pulse crop cultivation.

Distance from the pulse market

It was total distance from home to pulse market measured in kilometers.

Distance from Agriculture office

It was total distance from home to agriculture office measured in kilometers.

Distance from forest office

It was total distance from home to forest office measured in kilometers.

Distance from maid road

It was total distance from home to main road measured in kilometers.

Information utilization pattern

This refers to different sources utilized by the farmers in obtaining the information regarding different aspects of pulse crop production and other than pulse crop production technology and was measured in terms of percentage of farmers reporting the different sources.

Constraints

It is a measure of limitations faced by the pulse crop growers in the production recommendations of pulse crop cultivation and was measured in terms of percentage of farmers reporting the different sources.

Suggestions

Respondents were asked to give their valuable suggestions to overcome the problems faced by them in cultivation, storage, processing and marketing of pulse crop. The suggestions offered were summarized on the basis of number and per cent of respondents.

Construction of research tool

Interview schedule was constructed for the collection of the data and it was constructed while keeping the objectives of the study in mind. It consisted of three parts:

Part 1: Socio personal profile of pulse crop growers

Part 2: Regarding pulse crop cultivation practices.

Part 3: Constraints and suggestion.

Pre-testing of the research instrument

Before the collection of actual data, the research instrument was pre-tested on 20 non-sampled farmers of Udhampur district. The pre-testing of research instrument was done with the objectives to find out the weaknesses and ambiguity in any part of the schedule, to remove the difficulties which were likely to come up during the actual data collection, to see how it worked in respect of clarity and understanding by the respondents and to see how much time was taken to interview a respondent. These 20 respondents were not included in the final sample of 240 respondents. On the basis of information obtained through pre-testing, necessary modifications were made in research schedule to make it easy for recording the data and to remove ambiguity if any. This helped a great deal in getting correct response from the pulse crop growers under investigation.

Data collection

Data were collected from the selected respondents with the help of semi-structured interview schedule by using the personal interview method. The respondents were interviewed at their home, at community places or in their fields and their responses were recorded on the spot. The secondary data were collected from the Department of agriculture, Jammu Government of Jammu and Kashmir.

Statistical Analysis of data

After the collection of data from the respondents, the data were classified, quantified and tabulated. In order to yield the relevant information in consistent with the objectives of the study, the data were analyzed with the help of suitable statistical measures such as frequencies, percentages, mean and standard deviation.

Percentage

Simple comparisons were made on the basis of percentage.

Arithmetic mean

It was obtained by dividing sum of values of observations by total number of observations.

$$\bar{X} = \frac{\sum X}{n}$$

Where, \bar{X} = Arithmetic mean

$$\Sigma X = \bar{X}_1 + X_2 + X_3 + \dots + X_n$$

n = Total number of observations

Standard deviation:

It is a statistics that measures the dispersion of a set of observations relative to its mean and is calculated as the square root of variance. It is denoted by σ

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$$

Where,

σ = sampled standard deviation n = no. of observations

x_i = the observed values of a sample item \bar{x} = the mean values of the observations

Categorization of group data

Singh (1975) gave a method to categorize group data into various categories known as 'Singh's cube root method' and gave a formula:

$$S_1 = L_1 + \frac{\frac{iN}{3} - C_{i-1}}{f_1} \times h$$

Where,

i = indicate category number (i=1, 2, 3.....n)

S_1 = segment (e.g. I, II, III)

L_1 = Lower limit of the quartile class

C_{i-1} = Cumulative frequency of the class preceding to the quartile class f = frequency

h = width of the quartile class

N = Total cumulative cube root of frequencies

Linear regression model

Linear regression model was applied to identify the independent variables influencing the dependent variables. The result of this type of regression can be expressed as follows:

$$y = b_0 + b_{1x_1} + b_{2x_2} + \dots + b_{kx_k}$$

where,

Y = the continuous dependent variables whose values are being modeled

b_0 = y-intercept

x_i (i=1,2,3,.....,k) represents k independent variables.

Stepwise regression analysis computes a sequence of multiple linear regression in a stepwise manner. One variable is added to the regression equation at each step. The added variable is one which includes the greatest reduction in the error sum of square. It was also the variables which had the highest partial correlation with the dependent variables for fixed values of those variables already added. The importance of various factors (prediction) in the model was judged on the basis of standard regression coefficients. The adjusted R^2 was used as measure of determination of variation caused by the predictors. The significance of model indicates that all independent variables in the model jointly caused significant variation in dependent variables.

Principal Component Analysis

Principal components analysis determines those a_i weights that maximize the variance of variable Z . Since the variance may tend to infinity for values of weights conveniently chosen, the method determines only the weights subject to the restriction according to which the vector \mathbf{a} is normalized, i.e. $\sum_{i=1} a_i^2 = 1$

Weights \mathbf{a} once calculated, the variable Z is called the **first principal component**. Denoting by \mathbf{C} the matrix of covariance (correlation) of variables \mathbf{X} , in fact by converting the analysis data in principal components $\mathbf{C} = \mathbf{X}'\mathbf{X}$, it results that dispersion of Z is $\mathbf{a}'\mathbf{C}\mathbf{a}$ (where \mathbf{X}' is the matrix transpose of \mathbf{X}). One seeks to maximize the variance of Z with the restriction $\mathbf{a}'\mathbf{a} = 1$. Thus one reaches at the general problem, namely: $\max \mathbf{a}'\mathbf{X}'\mathbf{X}\mathbf{a}$ with restriction $\mathbf{a}'\mathbf{a} = 1$.

By means of the Lagrange multiplier method one will seek for the maximum of function $F(\mathbf{a}) = \mathbf{a}'\mathbf{C}\mathbf{a} - \lambda(\mathbf{a}'\mathbf{a} - 1)$ hence, in the general method, that \mathbf{a} is the eigenvector of matrix \mathbf{C} corresponding to its eigenvalue λ and $\mathbf{a}'\mathbf{C}\mathbf{a} = \lambda$. Since $\text{Var}(Z) = \mathbf{a}'\mathbf{C}\mathbf{a}$ it results that $\text{Var}(Z) = \lambda$, i.e. \mathbf{a} is the eigenvector corresponding to the highest eigenvalue λ .

The second principal component is defined as a linear combination of variables \mathbf{X} with the next highest variance: $Z_2 = a_{12}X_1 + a_{22}X_2 + \dots + a_{n2}X_n$.

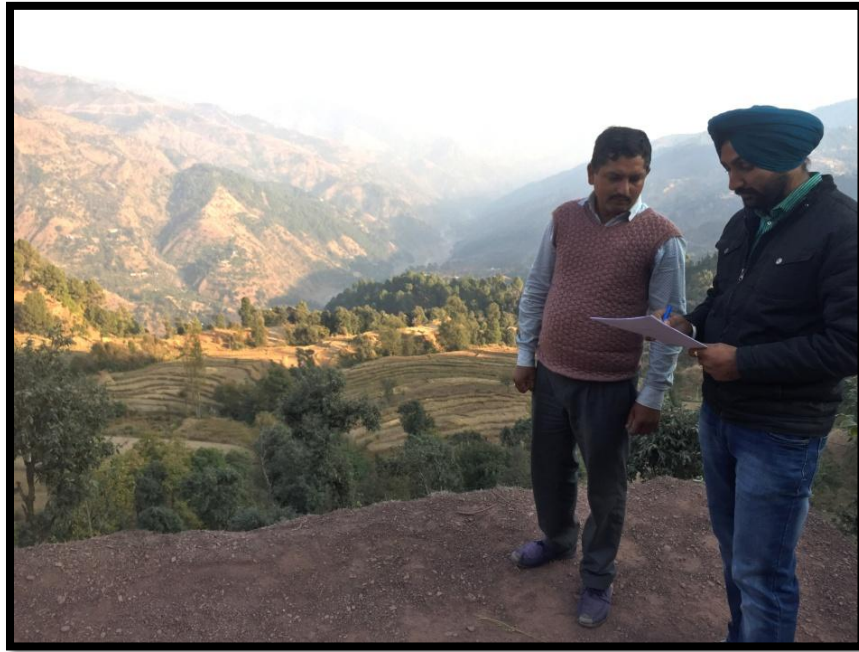
Thus one reaches at the second highest eigenvalue, etc. One should note that a_{ij} is the weight of variable i in the number j principal component.



1. Pulse growers of Kishtwar district



2. Pulse growers of Doda district



3. Pulse growers of Udhampur district



4. Pulse growers of Kathua district

Chapter-4

Results

CHAPTER IV

RESULTS

This chapter pertains to the results which were obtained and interpreted after collection, analysis and tabulation of data in the light of research objectives of the study. The results are presented under the following main headings:

Socio-personal description of respondent pulse crop grower.

Distribution of respondent farmers on the basis of farming details of major crop (other than pulse crop).

Identification of different pulse crops grown and input use pattern in the cultivation of pulse crop in temperate area.

Economics of identified pulse crops.

Factors driving the dependence of households on pulse crop for livelihood security.

Digital database and mapping of pulse crop.

Constraints faced by farmers in cultivation of pulse crop.

Suggestions put forth by respondents for improving the productivity of pulse crop

Socio-personal description of pulse crop growers

Age and Education

Table 4.1 explains that overall mean age of respondent pulse crop growers was 47 years Majority (69%) of the respondent farmers fall in 36-59 age group category followed by 20 per cent, who fall in above 59 age group category and remaining 18 per cent each fall in 22-35 age group category. Regarding educational status Table 4.1 shows that in Doda district 10.00 per cent of the respondents were illiterate, 20.00 per cent were middle pass and 43.00 per cent were high school pass outs, 19.00 per cent were educated upto higher secondary and only 8.00 per cent were having qualification of graduate level and above. In case of Kishtwar district 28.00 per cent of respondents were illiterate, 32.00 per cent were middle pass, 27.00 per cent were high school pass outs, 8.00 per cent were educated upto higher secondary and only 5.00 per cent were having qualification of graduate level and above. In Kathua district 47.00 per cent of the respondents were illiterate, 8.00 per cent were educated upto primary, 15.00 per cent were middle pass, 10.00 per cent were high school pass outs , 10.00 per cent were educated upto higher secondary and 10.00 per cent were having qualification of graduate level and above. In Udhampur district 43.00 per cent of the respondents were illiterate, 5.00 per cent were educated upto primary, 20.00 per cent were middle pass,

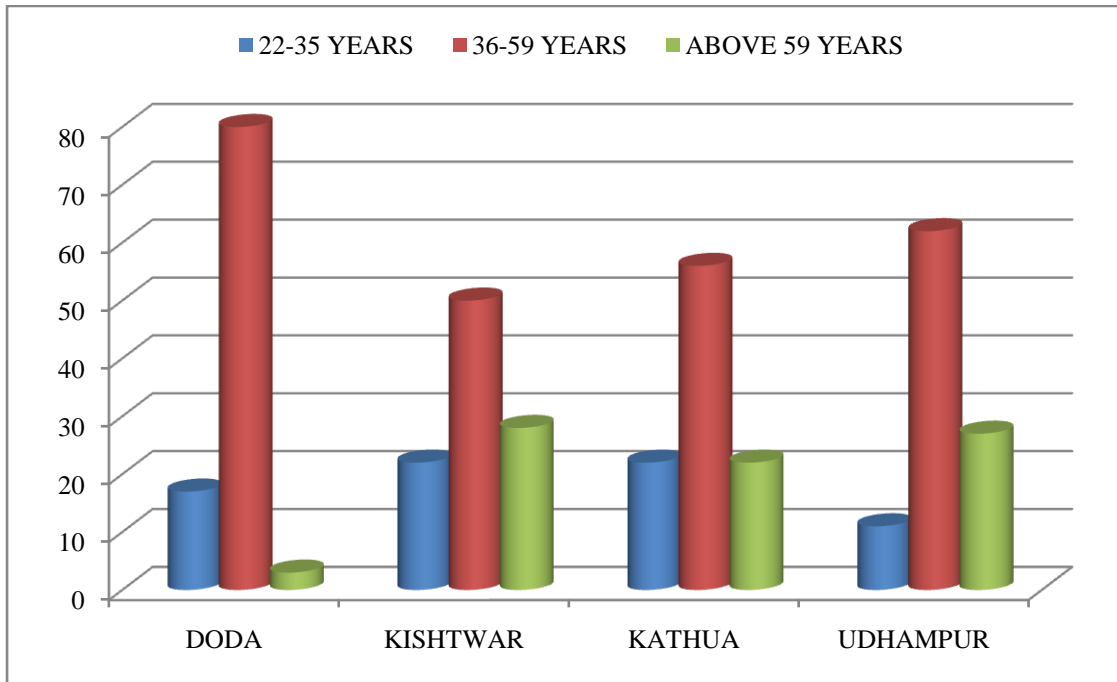


Figure 4.1: Categories of age

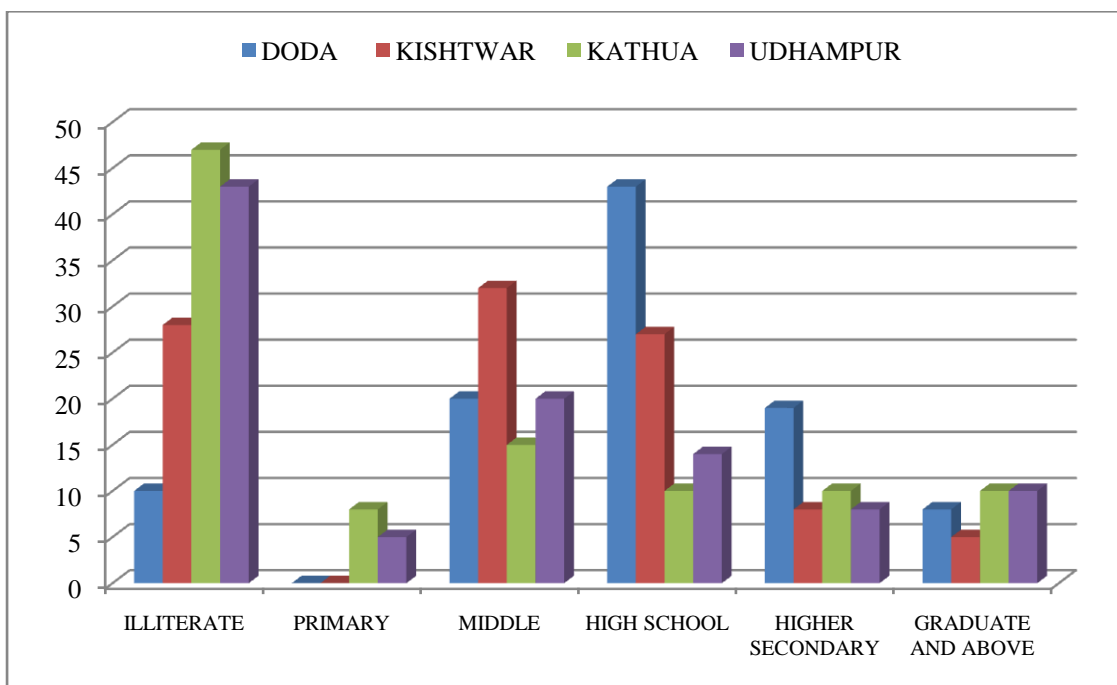


Figure 4.2: Categories of education

14.00 per cent were high school pass outs, 8.00 per cent were educated upto higher secondary and 10.00 per cent were having qualification of graduate level and above. Overall in four districts 32.00 per cent were illiterate, 3.00 per cent were educated upto primary, 22.00 per cent were middle pass, 23.00 per cent were high school pass outs, 12.00 per cent were educated upto higher secondary and 8.00 per cent were having qualification of graduate level and above. The average formal education in Doda district was 9.00 years (± 3.84), in Kishtwar district 7 years (± 4.78), in Kathua district 5 years (± 5.89) and 6 years (± 5.83) years in Udhampur. The average overall formal education was 7 years (± 5.32).

Type of house

Data presented in table 4.1 regarding type of house shows that overall 49 per cent of farmers had pakka house followed by 26 per cent which had kacha house while 25 per cent of farmers had semi-kacha house .

Table 4.1: Descriptive Statistics of the respondents

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Mean age(years) \pm S.D.	45 \pm 9.30	47 \pm 13.29	47 \pm 12.42	49 \pm 12.3	47 \pm 12.08
Age category (% farmers)					
22-35 years	10(17)	13(22)	13(22)	7(11)	43(18)
36-59 years	48(80)	30(50)	34(56)	37(62)	149(62)
Above 59 years	2(3)	17(28)	13(22)	16(27)	48(20)
Education					
Mean Education (formal no. of schooling years completed) \pm S.D.	9 \pm 3.84	7 \pm 4.78	5 \pm 4.89	6 \pm 5.83	7 \pm 5.32
Illiterate (% farmers)	6(10)	17(28)	28(47)	26(43)	77(32)
Primary (% farmers)	0	0	5(8)	3(5)	8(3)
Middle (% farmers)	12(20)	19(32)	9(15)	12(20)	52(22)
High school (% farmers)	26(43)	16(27)	6(10)	8(14)	56(23)
HigherSecondary (% farmers)	11(19)	5(8)	6(10)	5(8)	27(12)
Graduate andAbove (% farmers)	5(8)	3(5)	6(10)	6(10)	20(8)
Average farming Experience (years) \pm SD	24 \pm 10.92	24 \pm 11.36	26 \pm 13.96	28 \pm 14.52	25 \pm 12.69
Type of house (% farmers)					
Kacha	8(13)	5(8)	20(33)	25(42)	63(26)
Pakka	38(63)	39(65)	25(42)	18(30)	117(49)
Semi-kacha	13(22)	16(27)	15(25)	17(28)	61(25)

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Type of family

The result in table 4.2 revealed that in Kathua district 68 per cent respondents had nuclear families followed by 55 per cent in Udhampur, 53 per cent in Doda district and 47 per cent in Kishtwar district. Overall 56 per cent lived in nuclear family, where rest lived in joint family.

Family size

With regard to family size, the average family size of Doda district was 5.78 (± 1.49) followed by 5.68 (± 1.04) in Kishtwar district, 5.43 (± 1.68) in Kathua district and 5.30 (± 1.78) in Udhampur district. The overall average family size was 5.55 (± 1.53) as depicted in table 4.2.

With respect to categorization of family size done by 'Singh's Cube root method (1975) overall 62 per cent of the respondents had a family size of 5 to 7 members followed by 24 per cent who had family size of 2 to 4 members and only 14 per cent had family size of above 7 members per family.

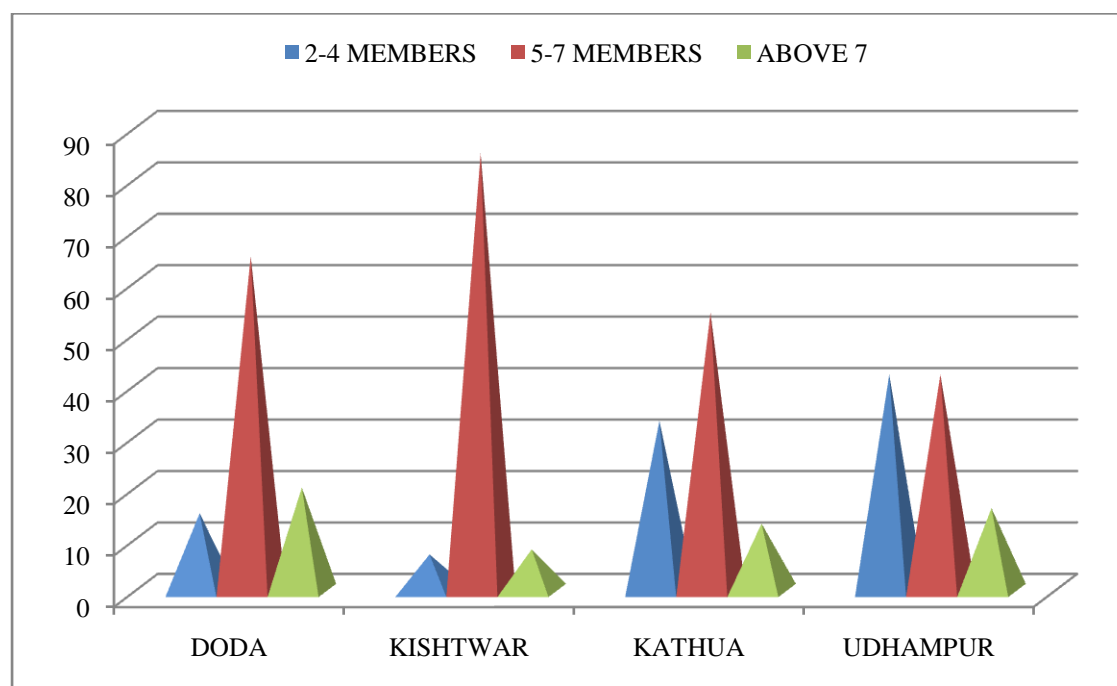


Figure 4.3: Categories of Family size

Data regarding head of families of respondent given in Table 4.2 shows that overall 90 per cent respondents were head of families where as in the remaining households the head of the family was other than the respondent.

Table 4.2: Family composition of respondent farmers' household

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Family type (% farmers)					
Joint	28(47)	32(53)	19(32)	27(45)	106(44)
Nuclear	32(53)	28(47)	41(68)	33(55)	134(56)
Total no. of family members	347	341	326	318	1332
Average family Size (No.) ±SD	5.78 ± 1.49	5.68 ± 1.04	5.43 ± 1.68	5.3 ± 1.78	5.55 ± 1.53
Size of farm households (% farmers)					
2-4 members	9(15)	4(7)	20(33)	25(42)	58(24)
5-7 members	39(65)	51(85)	32(54)	25(42)	147(62)
Above 7	12(20)	5(8)	8(13)	10(16)	35(14)
Head of family (% farmers)					
Self	55(92)	47(78)	56(93)	57(95)	215(90)
Others	5(8)	13(22)	4(7)	3(5)	25(10)

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Landholding

Data given in table 4.3 revealed that the total land holding of the respondent farmers of the Udhampur district was 51 ha followed by 50 ha in Kishtwar district, 49 ha in Kathua district and 45 ha in Doda district. The overall total land holding of all the respondent farmers was 195 ha. The average operational land holding of the respondent farmers in Doda, Kishtwar, Kathua and Udhampur districts were 0.76 (± 0.53), 0.83 (± 0.56), 0.82 (± 0.98) and 0.85 (± 0.98) hectares, respectively. Overall average operational land holding of the respondent farmers in the study area was 0.81 (± 0.79) hectares. The overall total irrigated and unirrigated land of the respondent farmers in the study area was 21 and 176 hectares. 95 per cent of the respondent farmers of the Doda district had fragmented land holdings followed by Kishtwar district (83%), Kathua district (50%) and Udhampur district (48%). On the cumulative basis for all these four district, 69 per cent of the respondent farmers had fragmented land holdings. Further, it was evident from the study that overall average fragmented

and non-fragmented land was 0.93 (± 0.83) and 0.54 (± 0.61) respectively. The overall average size of largest and smallest land fragment of the respondents in the study area was 0.34 (± 0.35) and 0.15 (± 0.16) hectares.

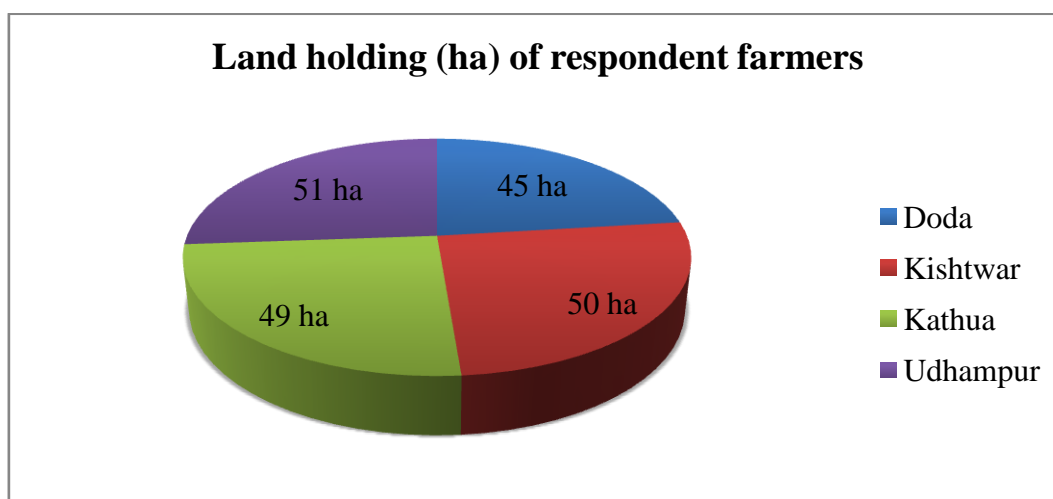


Figure 4.4: Categories of Land holding

Table 4.3: Land holding and land fragmentation (in ha) details of respondent farmers

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Total land holding(ha)	45	50	49	51	195
Average land holding (ha) \pm S.D.	0.76 \pm 0.53	0.83 \pm 0.56	0.82 \pm 0.68	0.85 \pm 0.68	0.81 \pm 0.79
Total irrigated land (ha)	5	7	5	4	21
Total unirrigated land (ha)	40	43	46	47	176
Land fragmentation (% farmers)	57(95)	50(83)	30(50)	29(48)	166(69)
Average of fragmented land \pm SD	0.76 \pm 0.55	0.92 \pm 0.57	1.11 \pm 1.05	1.13 \pm 1.08	0.93 \pm 0.83
Average of non-fragmented land \pm SD	0.7 \pm 0.55	0.41 \pm 0.13	0.53 \pm 0.49	0.58 \pm 0.56	0.54 \pm 0.51
Average size of largest land fragment \pm SD	0.38 \pm 0.20	0.53 \pm 0.25	0.31 \pm 0.41	0.28 \pm 0.42	0.34 \pm 0.35
Average size of smallest land fragment \pm SD	0.16 \pm 0.10	0.23 \pm 0.12	0.14 \pm 0.12	0.12 \pm 0.10	0.15 \pm 0.10

**Categorization of farmers as per MOA notification (2011)*

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Distance of respondent farmer's house from different places of agricultural importance

Data presented in Table 4.4 regarding distance show that the overall average distance of the Agriculture office, Forest office, main road, Market and selling point

of pulse crop was 8km, 14km, 1km, 12km and 7km respectively from their (respondents) place of residence.

Table 4.4: Average distance of respondent farmers' house from different places of agricultural importance

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Distance (km)					
Agri office	8	15	4	5	8
Forest office	11	16	12	16	14
Main road	2	1	1	1	1
Market	4	16	12	16	12
Selling point of pulse	4	15	3	3	7

Social participation and Extension contacts

A close look at Table 4.5 indicates that overall only 8 per cent respondent pulse crop growers were panchayat member followed by farmer club member (2 per cent) and 1 per cent were numberdar of the village. With regard to extension contacts of the respondent farmers, overall 90 per cent pulse growers had contact with Department of Agriculture, 50 per cent farmers had contact with private agencies, 21 per cent had contact with District Forest Officer, 4 per cent had contact with Krishi Vigyan Kendra and only 2 per cent had contact with State Agricultural University.

Table 4.5: Social participation and Extension contacts

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Panchayat Member	4(7)	6(10)	4(7)	4(7)	18(8)
Numberdar	0	0	2(3)	0	2(1)
Farmer club	4(7)	1(2)	0	0	5(2)
Any other	0	0	2(3)	2(3)	4(2)
Extension Contact					
SAU	4(7)	0	0	0	4(2)
DFO	17(28)	19(32)	6(10)	9(15)	51(21)
DOA	52(87)	50(83)	56(93)	55(92)	215(90)
KVK	9(15)	1(2)	0	0	10(4)
Private Agencies	39(65)	33(55)	23(38)	26(43)	121(50)

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Source of Information

Table 4.6 reveals the respondents behavior of farmers getting the information related to farming practices from different sources. Overall 75 per cent respondent farmers collected information from progressive farmers followed by 69 per cent from friends/relatives, 56 per cent from Television, 36 per cent from Input dealers, 12 per cent from Radio, 6 per cent from Newspaper, 3 per cent from Training and Kisan mela and 2 per cent from Group meeting and Demonstrations.

Table 4.6: Contact of respondent farmers with various information sources of agricultural importance

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Input Dealer	29(48)	11(18)	22(37)	24(40)	86(36)
Progressive Farmers	46(77)	44(73)	50(83)	38(63)	180(75)
Friends/ Relatives	43(72)	47(78)	40(67)	33(55)	165(69)
Radio	10(17)	7(12)	4(7)	7(12)	28(12)
Television	44(73)	36(60)	28(47)	25(42)	135(56)
Newspaper	12(20)	3(5)	0	0	15(6)
Training	3(5)	2(3)	1(2)	0	6(3)
Group Meeting	2(3)	2(3)	0	0	4(2)
Field visits/ Tour	3(8)	1(2)	0	0	4(3)
Demonstrations	3(5)	1(2)	0	0	4(2)
Kisan Mela	3(5)	2(3)	1(2)	1(2)	7(3)

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Existing status of respondent enrollment in different government scheme for agriculture and rural development

The data presented in table 4.7 revealed that 100 per cent respondent farmers had Aadhar card and Ration card followed by 80 per cent had MGNREGA card, 70 per cent had Toilets, 49 per cent had Kisan credit card, 27 per cent had Ayushman health card and only 1 per cent had Soil health card.

Table 4.7: Existing status of respondent enrollment in different government scheme for agriculture and rural development

Extension Participation	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240*)
Kisan credit card	30(50)	44(73)	22(37)	19(32)	117(49)
MGNERGA	56(93)	57(95)	42(70)	37(62)	193(80)
Soil health card	2(3)	1(2)	0	0	3(1)
Toilet	57(95)	59(98)	28(47)	24(40)	168(70)
Aadhar card	60(100)	60(100)	60(100)	60(100)	240(100)
Ayushman health card	3(5)	3(5)	14(23)	16(27)	36(15)
Ration card	60(100)	60(100)	60(100)	60(100)	240(100)

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Occupational status of pulse crop growers

The results presented in Table 4.8 revealed that the average monthly income of respondent farmers was 11516 rupees in Kathua district followed by 11000 rupees in Udhampur district, 9733 rupees in Kishtwar and 8150 rupees in Doda district. The overall average income of respondent farmers was 10100 rupees. Overall 63 per cent sampled pulse crop growers had agriculture as their main occupation and as such were exclusively dependent on agriculture for their livelihood. The results further revealed that 37 per cent of respondents had other source of income which includes 9 per cent each from Private Jobs as well as own shop, 7 per cent each from Government service as well as labourers, 3 per cent were having Business and 1 per cent was retired from govt. services.

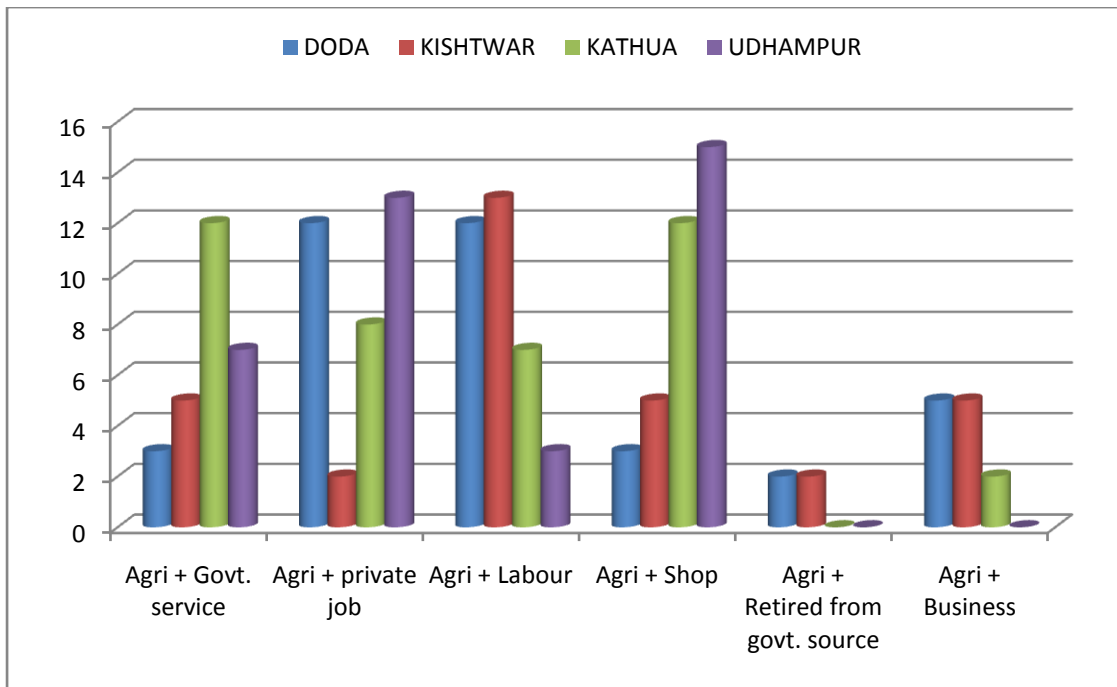


Figure 4.5: Categories of On-farm and Off-farm Occupation status

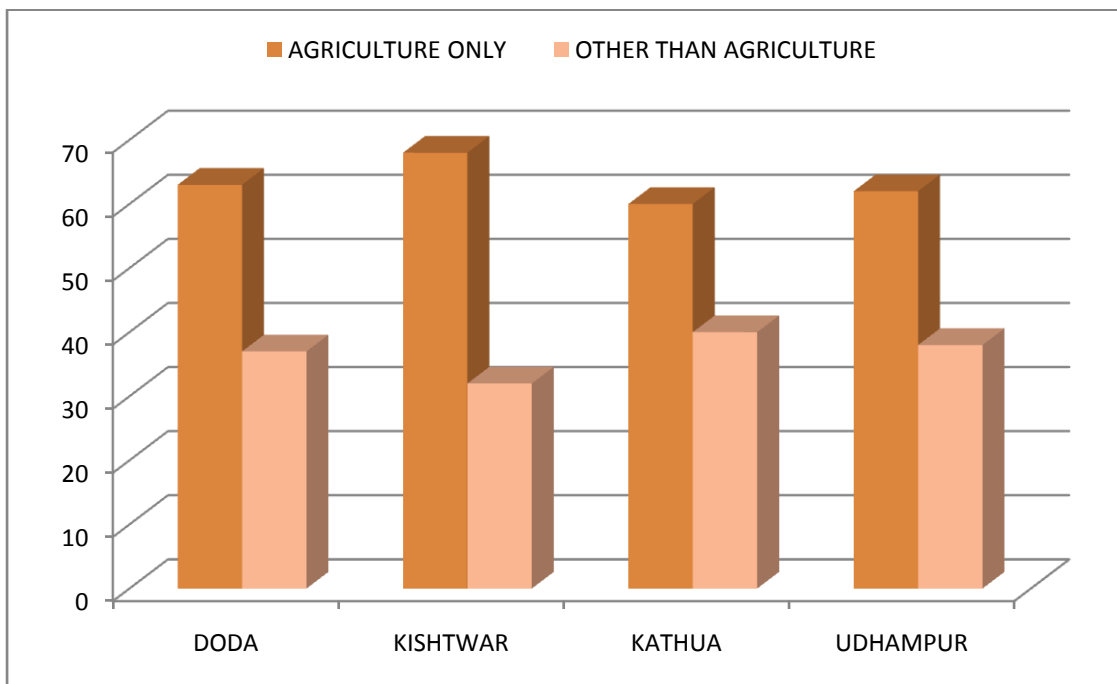


Figure 4.6: Categories of Occupation status

Table 4.8: Occupation status of respondent

Respondent's main Occupation	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
On-farm and Off-farm source of income of respondents					
Agri + Govt. service	2(3)	3(5)	7(12)	4(7)	16(7)
Agri + private job	7(12)	1(2)	5(8)	8(13)	21(9)
Agri + labour	7(12)	8(13)	4(7)	2(3)	21(7)
Agri + shop	2(3)	3(5)	7(12)	9(15)	21(9)
Agri + retired from govt. source	1(2)	1(2)	0	0	2(1)
Agri + business	3(5)	3(5)	1(2)	0	7(3)
Average monthly income (rupees)±SD	8150±933 1.6	9733±101 37.8	11516±13 423.3	11000±12 790.3	10100±11 551.1
Solely depend on Agriculture (%farmers)	38(63)	41(68)	36(60)	37(62)	152(63)
Having other economic Activities (% farmers)	22(37)	19(32)	24(40)	23(38)	88(37)

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Occupational status of farm families

The results presented in Table 4.9 revealed that the average monthly income of respondent farmer families was 22475 rupees in Kishtwar district followed by 18370 rupees in Kathua district, 16516 rupees in Doda district and 9733 rupees in Udhampur district. The overall average income of respondent farmer families was 18831 rupees. Overall only 13 per cent sampled pulse crop grower families had agriculture as their main occupation and so they were exclusively dependent on agriculture for their source of livelihood. The results further clear that 87 per cent households had other source of income.

Table 4.9: Occupation status of farm families (Per cent household)

Respondent's main Occupation	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Average monthly income of family (₹) ± SD	16516 ± 13272.5	22475 ± 20830.9	18370 ± 17112.5	17556 ± 17437.3	18831 ± 17663.4
Solely depend on Agriculture	19(32)	1(2)	10(17)	1(2)	31(13)
Having other economic Activities	41(68)	59(98)	50(83)	59(98)	209(87)

Figures in parenthesis are per centages

Figures in decimals rounded off to nearest whole number

Mobile connectivity

With regards to mobile connectivity, 97 per cent of the respondent farmers had mobile phone connectivity in Udhampur district out of which 55 per cent had smartphones, followed by Doda district in which 95 per cent had mobile phone connectivity out of which 60 per cent had smartphones, Kishtwar district in which 93 per cent had mobile phone connectivity out of which 50 per cent had smartphones and Kathua district where 83 per cent had mobile phone connectivity out of which 58 per cent had smartphones. Overall 92 per cent of the respondent farmers had mobile connectivity out of which 56 per cent of them had smartphones. (Table 4.10)

Table 4.10: Mobile connectivity status of respondent farmers

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Mobile availability	57(95)	56(93)	50(83)	58(97)	221(92)
Smart phone	34(60)	28(50)	29(58)	32(55)	123(56)
Non-smart phones	23(40)	28(50)	21(42)	26(45)	98(44)
Internet connectivity	34(57)	28(47)	29(48)	32(53)	123(51)

Livestock possession

The figures of the table 4.11 revealed that the livestock possession of respondent farmers was 100 per cent in Udhampur and Kathua district followed by 95 per cent in Kishtwar and 88 per cent in Doda district. Overall 96 per cent of the respondent farmers had livestock which includes 90 per cent of the respondent farmers had cows with an average of 2 cows per household and average milk yield was 4.46 (±2.55) kg/

household/day and 40 per cent had buffalo with an average of 1 buffalos per household and average milk yield of 4.01 (± 1.68) kg/household/day. Overall total number of cow and buffalo in study area of respondent farmers was 390 and 96.

Table 4.11: Livestock possession details of respondent farmers

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Livestock possession	53(88)	57(95)	60(100)	60(100)	230(96)
Cattle					
Possessing	53(88)	57(95)	52(87)	51(85)	215(90)
Total number of cattle	90	109	97	90	390
Average number of cattle(per family)	1.7	1.9	2	1.8	1.85
Total production of milk (litre per day)	288	276	204	184	960
Average production per household (litre) \pm SD	5.43 \pm 2.29	4.84 \pm 1.82	3.92 \pm 2.80	3.60 \pm 2.90	4.46 \pm 2.55
Quantity sale (litre/day)	96	46	45	46	233
Average quantity sale per family per day (litre)	2	1	1.5	1.2	1.42
Sale price of milk (₹/l)	38	40	30	30	36
Buffalo					
Possessing	0	0	42(70)	54(90)	96(40)
Total number of buffaloes	0	0	42	54	96
Average number of buffalo (per family)	0	0	1	1	1
Total production of milk (litre per day)	0	0	131	158	289
Average production per household	0	0	4.2 \pm 1.62	3.85 \pm 1.72	4.01 \pm 1.68
Quantity sale (litre/day)	0	0	27	26	53
Average quantity per family per day (litre)	0	0	1.5	1.2	1.35
Sale price of milk (₹/l)	0	0	40	40	40

Livestock possession (other than dairy animal)

The results presented in Table 4.12 indicate that 40 per cent of respondent farmers of Kishtwar district had oxen followed by 37 per cent in Doda district, 30 per cent in Udhampur district and 27 per cent in Kathua. Overall 33 per cent of respondent farmers had oxen. 52 per cent of respondent farmers of Doda district had sheep with an

average number of 5 per family followed by 50 per cent each in Udhampur and Kishtwar district with an average number of 4 per family and 42 per cent in Kathua district with an average number of 3 per family. Overall 144 number of sheep were sold by respondent farmers with the average sale price of rupees 4320 each. Seventy three per cent of respondent farmers of Doda district had poultry with an average number of 5 per family followed by 68 per cent in Udhampur district with an average of 4 per family, 65 per cent in Kathua district with an average of 3 per family and 50 per cent in Kishtwar district with an average of 5 per family. Overall 355 numbers of poultry were sold by respondent farmers with an average sale price of rupees 180 each.

Table 4.12: Livestock possession (other than dairy animal) details of respondent farmers

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Oxen possession (%farmers)	22(37)	24(40)	16(27)	18(30)	80(33)
Sheep possession (%farmers)	31(52)	30(50)	25(42)	30(50)	116(48)
Average number of sheep per family	5	4	3	4	4
Number sold (last year)	62	45	17	20	144
Sale price (rupee)	4461	3869	4800	4285	4320
Poultry possession (%farmers)	44(73)	30(50)	39(65)	41(68)	154(64)
Average number per family	5	5	3	4	4
Number sold (last year)	90	112	80	73	355
Sale price (rupee)	100	100	300	300	180

Distribution of respondent farmers on the basis of farming details of major crop (other than pulse crop).

Maize crop

Table 4.13 revealed that in case of Maize crop, the average area under maize crop of respondent farmers was 0.66 ha (± 1.28) in Kishtwar district followed by 0.54 ha (± 0.50) in Udhampur district, 0.50 ha (± 0.47) in Kathua district and 0.48 (± 0.44) hectares in Doda district. The overall average area of maize crop of respondent farmers was 0.545(± 0.76) hectares. 85 per cent of respondent farmers used owned saved seed in Kishtwar, followed by 58 per cent in Kathua and 48 per cent each in Udhampur and

Doda district. Improved variety seed used by respondent farmers in Doda and Udhampur district was 52 per cent followed by 42 percent in Kathua and 15 percent in Kishtwar district. The Overall 60 percent of a respondent farmers used owned saved seed and 40 percent used improved variety seed. The overall source of improved variety seed was 78 per cent from department and 22 per cent from private shop. The results further revealed that the average expenditure in terms of rupees incurred on maize crop was found to be highest i.e. ₹5223.3 (± 4985.55) in Udhampur district with an overall average expenditure of ₹4941.25 (± 4254.06). The total quantity sold by the respondent farmers was found to be highest i.e. 244 q from Doda district and overall total quantity sold was 856.5 q. Whereas, the average quantity sold was found to be highest from maize crop i.e. 4 q (± 5.11) from Doda district with sale price of 1470 (₹/q) with an overall average of 3.5 q (± 4.45) with a sale price of 1480 (₹/Qtls.).

Table 4.13: Distribution of respondent farmers on the basis of farming details of maize crop

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Average area (ha) \pm SD	0.489 \pm 0.44	0.667 \pm 0.28	0.502 \pm 0.47	0.54 \pm 0.50	0.545 \pm 0.76
Variety					
Owned saved seed	29(48)	51(85)	35(58)	29(48)	144(60)
Improved variety	31(52)	9(15)	25(42)	31(52)	96(40)
Source of improved variety (% farmers)					
Department	17(55)	7(78)	22(88)	26(84)	75(78)
Private shop	14(45)	2(22)	3(12)	5(16)	21(22)
Average expenditure \pm SD	5216.66 \pm 3870.10	4550 \pm 3354.35	4808.33 \pm 4666.58	5223.3 \pm 4985.55	4941.25 \pm 4254.06
Total quantity sold (q)	244	165	220	227.5	856.5
Average quantity sold (q) \pm SD	4 \pm 5.11	2.7 \pm 4.26	3.6 \pm 4.43	3.8 \pm 4.08	3.5 \pm 4.45
Sale price (₹/q)	1470	1500	1480	1480	1480

Wheat crop

Table 4.14 revealed that in case of Wheat crop, the wheat crop growers was 82 per cent in Udhampur district followed by 73 per cent in Kathua district, 63 per cent in Doda district, 58 per cent in Kishtwar and overall 70 per cent. The average area under

wheat crop of respondent farmers was 0.43 ha (± 0.45) in Kishtwar district followed by 0.39 ha (± 0.48) in Doda district, 0.31ha (± 0.17) in Kathua district and 0.30 ha (± 0.44) in Udhampur district. The overall average area of wheat crop of respondent farmers was 0.35 (± 0.33) hectares. 100 percent of respondent farmers used owned saved seed in Kishtwar, followed by 94 per cent in Udhampur and 93 percent in Kathua and 68 per cent in Doda district .Improved variety used by respondent farmers in Doda district was 32 per cent followed by 7 percent in Kathua and 6 percent in Udhampur district. The Overall 89 percent of a respondent farmers used owned saved seed and 11 per cent used improved variety. The overall source of improved variety seed was 89 per cent of department seed and 11 per cent of private shop. The results further revealed that the average expenditure in terms of rupees incurred on wheat crop was found to be highest i.e. ₹3505.2 (± 4090.39) in Doda district with an overall average expenditure of ₹3117.96 (± 2755.26). The total quantity sold by the respondent farmers was found to be highest i.e. 105 q from Udhampur district and overall total quantity sold was 348 q. Whereas, the average quantity sold was found to be highest from wheat crop i.e. 2.14 q (± 1.37) from Udhampur district with sale price of 1300 (₹/q) with an overall average of 2.08 q (± 1.99) with a sale price of 1370 (₹/q).

Table 4.14: Distribution of respondent farmers on the basis of farming details of wheat crop

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Wheat crop growers	38(63)	35(58)	44(73)	49(82)	167(70)
Average area (ha) \pmSD	0.392 ± 0.48	0.431 ± 0.45	0.317 ± 0.17	0.305 ± 0.15	0.355 ± 0.33
Variety					
Owned saved seed	26(68)	35(100)	41(93)	46(94)	149(89)
Improved variety	12(32)	0	3(7)	3(6)	18(11)
Source of improved variety (% farmers)					
Department	10(83)	0	3(100)	3(100)	16(89)
Private shop	2(17)	0	0	0	2(11)
Average expenditure \pm SD	3505.2 \pm 4090.39	3116.6 \pm 3387.24	3018.1 \pm 1634.83	2959.1 \pm 1567.36	3117.96 \pm 2755.26
Total quantity sold(q)	81	72	90	105	348
Average quantity sold	2.13 \pm 2.06	2 \pm 2.98	2.03 \pm 1.52	2.14 \pm 1.37	2.08 \pm 1.99
Sale price (₹/q)	1700	1750	1300	1300	1370

Mustard crop

Table 4.15 revealed that in case of Mustard crop, the mustard crop growers was 44 per cent in Udhampur district followed by 38 per cent in Kathua district, 10 per cent in Doda district and overall 23 per cent. The average area under mustard crop of respondent farmers was 0.2 ha (± 0.07) in Doda district followed by 0.18 ha (± 0.14) in Udhampur district and 0.18 ha (± 0.14) in Kathua district. The overall average area of mustard crop of respondent farmers was 0.17 (± 0.10) hectares. 100 percent of respondent farmers used owned saved seed in Doda district, followed by 96 per cent in Udhampur district and 91 percent each in Kathua district. Improved variety used by respondent farmers was 9 per cent in Kathua and 4 per cent in Udhampur district. The Overall 96 per cent of respondent farmers used owned saved seed and 4 per cent used improved variety seed. The overall source of improved variety seed was 100 per cent from department. The results further revealed that the average expenditure in terms of rupees incurred on mustard crop was found to be highest i.e. ₹1478.3 (± 2433.04) in Kathua district with an overall average expenditure of ₹1223.28 (± 1667.60). The total quantity sold by the respondent farmers was found to be highest i.e. 5.8 q from Udhampur district and overall total quantity sold was 11.4 q. Whereas, the average quantity sold was found to be highest from mustard crop i.e. .25 q (± 0.60) from Kathua district with a sale price of 3000 (₹/q) with an overall average 0.21 q (± 0.54) with a sale price of 2900 (₹/q).

Table 4.15: Distribution of respondent farmers on the basis of farming details of mustard crop

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Mustard crop growers	6(10)	0	23(38)	26(44)	55(23)
Average area (ha) \pm SD	0.2 \pm 0.07	0	0.18 \pm 0.14	0.16 \pm 0.06	0.17 \pm 0.10
Variety					
Owned saved seed	6(100)	0	21(91)	25(96)	53(96)
Improved variety	0	0	1(9)	1(4)	2(4)
Source of improved variety (% farmers)					
Department	0	0	1(100)	1(100)	2(100)
Average expenditure \pm SD	833.3 \pm 258.19	0	1478.3 \pm 1433.04	1115.4 \pm 875.20	1223.28 \pm 1167.60
Total quantity sold (q)	0	0	5.6	5.8	11.4
Average quantity sold	0	0	0.25 \pm 0.6	0.23 \pm 0.57	0.21 \pm 0.54
Sale price (₹/q)			3000	2800	2900

Barley crop

Table 4.16 revealed that in case of Barley crop, the barley crop growers was 43 per cent in Udhampur district followed by 35 per cent in Kathua district and overall 20 per cent. The average area under barley crop of respondent farmers was 0.2 ha (± 0.09) in Kathua district and 0.18 ha (± 0.08) in Udhampur district. The overall average area of barley crop of respondent farmers was 0.19 (± 0.08) hectares. The Overall 100 percent of a respondent farmers used owned saved seed. The results further revealed that the average expenditure in terms of rupees incurred on barley crop was found to be highest i.e. 1761.90 (± 956.80) in Kathua district with an overall average expenditure of 1652.08 (± 783.87). The total quantity sold by the respondent farmers was found to be highest i.e. 22 q from Udhampur district and overall total quantity sold was 43.5 q. Whereas, the average quantity sold was found to be highest from barley crop i.e. 1.02 q (± 1.42) from Kathua district with a sale price of 3500 ($\text{₹}/\text{q}$) with an overall average of 0.90 q (± 1.33) with a sale price of 3750 ($\text{₹}/\text{q}$).

Table 4.16: Distribution of respondent farmers on the basis of farming details of barley crop

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Barley crop growers	0	0	21(35)	26(43)	48(20)
Average area (ha) \pmSD	0	0	0.2 \pm 0.09	0.18 \pm 0.08	0.19 \pm 0.08
Source of seed					
Own saved seed	0	0	21(100)	26(100)	48(100)
Average expenditure \pm SD	0	0	1761.90 \pm 956.80	1596.15 \pm 616.75	1652.08 \pm 783.87
Total quantity sold (q)	0	0	21.5	22	43.5
Average quantity sold	0	0	1.02 \pm 1.42	0.84 \pm 1.3	0.90 \pm 1.33
Sale price ($\text{₹}/\text{q}$)			3500	4000	3750

Paddy crop

Table 4.17 revealed that in case of Paddy crop, the paddy crop growers was 35 per cent in Kishtwar district followed by 27 per cent in Doda district and overall 15 per cent. The average area under paddy crop of respondent farmers was 0.24 ha (± 0.13) in Kishtwar district and 0.15 ha (± 0.08) in Doda district. The overall average area of paddy crop of respondent farmers was 0.22 (± 0.12) hectares. 35 percent of respondent farmers used owned saved seed in Kishtwar and 22 per cent in Doda. Improved variety used by respondent farmers in Doda district was 5 per cent. The Overall 92 percent of a respondent farmers used owned saved seed and 8 per cent used improved variety. The overall source of improved variety seed was 100 per cent from private shop. The results further revealed that the average expenditure in terms of rupees incurred on paddy crop was found to be highest i.e. ₹2086.9 (± 900.15) in Kishtwar district with an overall average expenditure was found to be ₹1897.4 (± 762.43). The total quantity sold by the respondent farmers was found to be highest i.e. 24 q from Kishtwar district and overall total quantity sold was 38 q. Whereas, the average quantity sold was found to be highest from paddy crop i.e. 1.04 q (± 1.29) from Kishtwar district with a sale price of 4000 (₹/q) for desi variety with an overall average of 0.97 q (± 1.18) with a sale price of 3900 (₹/q) for desi variety and 2000 for improved variety.

Table 4.17: Distribution of respondent farmers on the basis of farming details of paddy crop

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Paddy crop growers	16(27)	21(35)	0	0	37(15)
Average area (ha) \pm SD	0.15 \pm 0.08	0.24 \pm 0.13	0	0	0.22 \pm 0.12
Variety					
Owned saved seed	13(81)	21(100)	0	0	34(92)
Improved variety	3(19)	0	0	0	3(8)
Source of improved variety (% farmers)					
Private shop	3(100)	0	0	0	3(100)
Average expenditure \pmSD	1812.5 \pm 512.34	2086.9 \pm 900.15	0	0	1897.4 \pm 762.43
Total sold quantity (q)	14	24	0	0	38
Average sold quantity (q)	0.8 \pm 1.02	1.04 \pm 1.29	0	0	0.97 \pm 1.18
Sale price of desi (₹/q)	3800	4000			3900
Sale price of hybrid(₹/q)	2000	0			2000

Vegetable

Table 4.18 revealed that in case of Vegetables, the vegetable growers was 30 per cent in Doda district followed by 18 per cent in Udhampur district, 17 per cent in Kathua district, 8 per cent in Kishtwar with an overall 18 per cent. The average area under vegetable of respondent farmers was 0.73 ha (± 1.3) in Kathua district followed by 0.38 ha (± 0.94) in Udhampur district, 0.20 ha (± 0.09) in Doda district and 0.18 ha (± 0.06) in Kishtwar district. The overall average area under vegetable of respondent farmers was 0.36 (± 0.77) hectares. The overall source of seed was 7 per cent of department seed and 93 per cent of private shop. The results further revealed that the average expenditure in terms of rupees incurred on wheat crop was found to be highest i.e. ₹12105 (± 12050.33) in Doda district with an overall average expenditure was found to be ₹10088 (± 10194.3). The total quantity sold by the respondent farmers was found to be highest i.e. 68 q from Doda district and overall total quantity sold was 218 q. Whereas, the average quantity sold was found to be highest from wheat crop i.e. 12.3 q (± 11.7) from Doda district with a sale price of 1530 (₹/q) and overall 8.5 q (± 13.1) with a sale price of 1580 (₹/q).

Table 4.18: Distribution of respondent farmers on the basis of farming details of vegetable

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Vegetable growers	18(30)	5(8)	10(17)	11(18)	44(18)
Average area (ha)	0.20 \pm 0.09	0.18 \pm 0.06	0.73 \pm 1.3	0.38 \pm 0.94	0.36 \pm 0.77
Vegetable name: Pea, Tomato, Cabbage, Cauli flower					
Source of seed (% farmers)					
Department	0	0	2(30)	1(9)	3(7)
Private shop	18(100)	5(100)	7(70)	10(91)	41(93)
Average expenditure \pm SD	12105 \pm 12050.33	11300 \pm 11076.38	8500 \pm 6900.08	7636.36 \pm 5477.64	10088 \pm 9194.3
Total sold quantity (q)	68	34.5	51.5	64	218
Average sold quantity (q)	12.3 \pm 11.7	6.9 \pm 5.1	5.15 \pm 4.46	5.8 \pm 4.45	8.5 \pm 7.1
Average Sale price (₹/q)	1530	1240	1700	1720	1580

Other crop

Table 4.19 revealed that in case of other crops (Jowar, Oats), the other crop growers was 23 per cent in Doda district followed by 18 per cent in Kishtwar district, 7 per cent in Udhampur district, 5 per cent in Kathua with an overall 13 per cent. The average area under other crops of respondent farmers was 0.34 (± 0.32) in Kishtwar district followed by 0.26 (± 0.27) in Doda district, 0.19 (± 0.05) in Udhampur district and 0.18 (± 0.06) hectares in Kathua district. The overall average area under vegetable of respondent farmers was 0.27 (± 0.26) hectares. The overall source of seed was 59 per cent of owned saved seed followed by 41 per cent of department seed and 3 per cent of private shop. The results further revealed that the average expenditure in terms of rupees incurred on wheat crop was found to be highest i.e. ₹3006.66 (± 3186.23) in Kishtwar district with an overall average expenditure of ₹2660.97 (± 2976.64). The total quantity sold by the respondent farmers was found to be highest i.e. 19 q from Doda district and overall total quantity sold was 33 q. Whereas, the average quantity sold was found to be highest from other crops i.e. 1.18 q (± 2.12) from Doda district and overall 0.8 q (± 1.6).

Table 4.19: Distribution of respondent farmers on the basis of farming details of other crop

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Other crops growers (% farmers)	14(23)	11(18)	3(5)	4(7)	32(13)
Average area (ha) \pm SD	0.26 \pm 0.27	0.34 \pm 0.32	0.18 \pm 0.06	0.19 \pm 0.05	0.27 \pm 0.26
Name of other crops: Jowar, Oats					
Source of seed (% farmers)					
Department	9(64)	4(36)	0	0	13(41)
Owned saved	6(43)	7(64)	3(100)	4(100)	19(59)
Private shop	1(7)	0	0	0	1(3)
Average expenditure \pm SD	2968.7 \pm 3480.75	3006.66 \pm 3186.23	1250 \pm 866.02	1300 \pm 758.28	2660.97 \pm 2976.64
Total sold quantity(q)	19	10	2	2	33
Average sold quantity(q)	1.18 \pm 2.12	0.71 \pm 1.25	0.5 \pm 1	0.4 \pm 0.89	0.8 \pm 1.6

Distribution of respondents on the basis of pulse crop grown

Pulse crop

The results presented in Table 4.20 revealed that the total number of farmers of **Rajma** (*Phaseolus vulgaris*) in study area was 100 per cent in Kathua district followed by 98 per cent in Kishtwar district and 97 per cent each in Udhampur and Doda district with an overall of 98 per cent. The total number of farmers of **Black gram** (*Vigna mungo*) in study area was 82 per cent in Kathua and Doda district followed by 77 per cent in Kishtwar and Udhampur district with an overall of 79 per cent. The total number of farmers of **Green gram** (*Vigna radiata*) in study area was 77 per cent in Kishtwar district followed by 73 per cent in Doda district, 72 per cent in Kathua, 68 per cent in Udhampur district with an overall of 76 per cent. The total number of farmers of **Red lentil** (*Lens culinaris*) in study area was 60 per cent in Kishtwar district with an overall of 15 per cent. The total number of farmers of **Green gram** (*Vigna radiata*) in study area was 77 per cent in Kishtwar district followed by 73 per cent in Doda district, 72 per cent in Kathua, 68 per cent in Udhampur district with an overall of 76 per cent. The total number of farmers of **Horse gram** (*Macrotyloma uniflorum*) in study area was 57 per cent in Doda district followed by 27 per cent in Kathua district with an overall of 21 per cent. The total number of farmers of **French bean** (*Phaseolus vulgaris*) in study area was 32 per cent in Doda district followed by 25 per cent in Kathua district, 20 per cent in Udhampur with an overall of 21 per cent respectively.

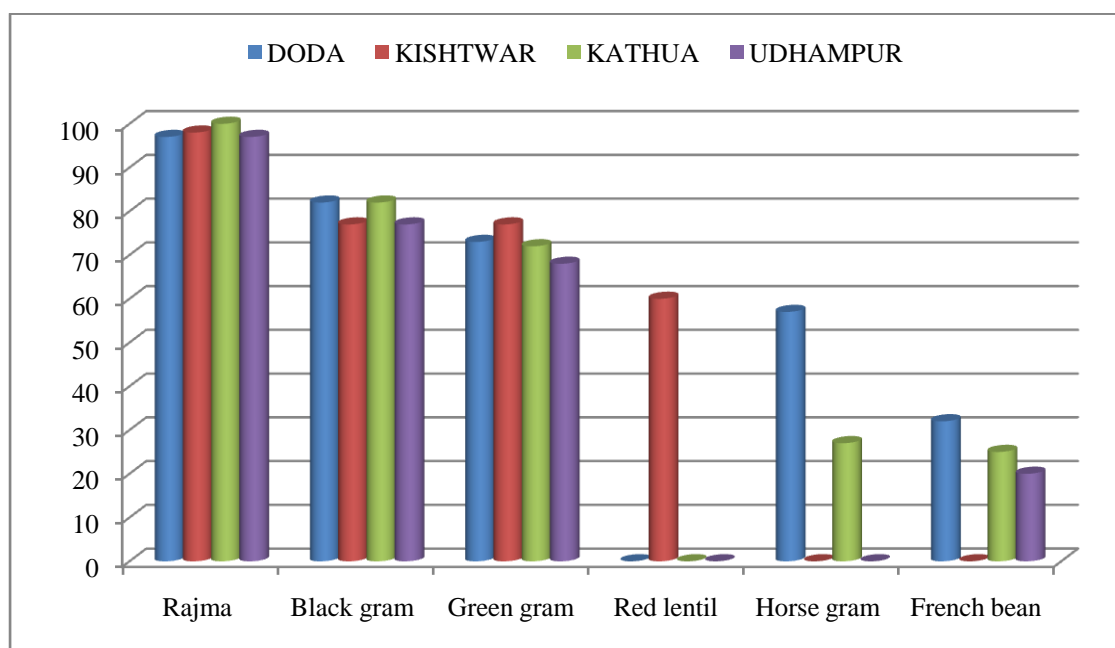


Figure 4.7: Categories of Pulse crop grown

Table 4.20: Distribution of respondents on the basis of pulse crop grown

Parameter	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Rajma (<i>Phaseolus vulgaris</i>)					
Number of farmer (% farmers)	58(97)	59(98)	60(100)	58(97)	235(98)
Black gram (<i>Vigna mungo</i>)					
Number of farmer (% farmers)	49(82)	46(77)	49(82)	45(77)	189(79)
Green gram (<i>Vigna radiata</i>)					
Number of farmer (% farmers)	44(73)	46(77)	43(72)	41(68)	174(76)
Red lentil (<i>Lens culinaris</i>)					
Number of farmer (% farmers)	0	36(60)	0	0	36(15)
Horse gram (<i>Macrotyloma uniflorum</i>)					
Number of farmer (% farmers)	34(57)	0	16(27)	0	50(21)
French bean (<i>Phaseolus vulgaris</i>)					
Number of farmer (% farmers)	19(32)	0	15(25)	12(20)	46(19)

Rajma (*Phaseolus vulgaris*)

The data in table 4.21 revealed that in case of Rajma crop, the total area was 24 ha in Kishtwar district followed by 16.6 ha in Doda district, 11.7 ha in Kathua district and 11.6 ha in Udhampur district with an overall 63.9 ha in study area. The results further revealed that average area of rajma crop of respondent farmers was 0.40 ha (± 0.46) in Kishtwar district followed by 0.28 ha (± 0.21) in Doda district, 0.20 ha (± 0.15) in Udhampur district and 0.19 ha (± 0.16) in Kathua district. The overall average area of rajma crop of respondent farmers was 0.27 hectares (± 0.29). 100 per cent area under rajma crop was unirrigated. The average seed rate used by the respondent farmers was 20.49 kg/ha (± 3.28) in Kathua district followed by 17.53 kg/ha (± 2.79) in Udhampur district, 15.63 kg/ha (± 3.75) in Doda district, 14 kg/ha (± 3.32) in Kishtwar district with an overall average of 16.47 kg/ha (± 4.28) in study area. 98 per cent of the rajma growers used owned saved seed and 2 per cent who used improved variety seed. The overall average time period since the farmers were cultivating these varieties was

25.5 years. 100 per cent of the respondent farmers reported that rajma was sown in month of March-April. 100 per cent of the respondent farmers have sown rajma by broadcasting method and as mixed cropping system.

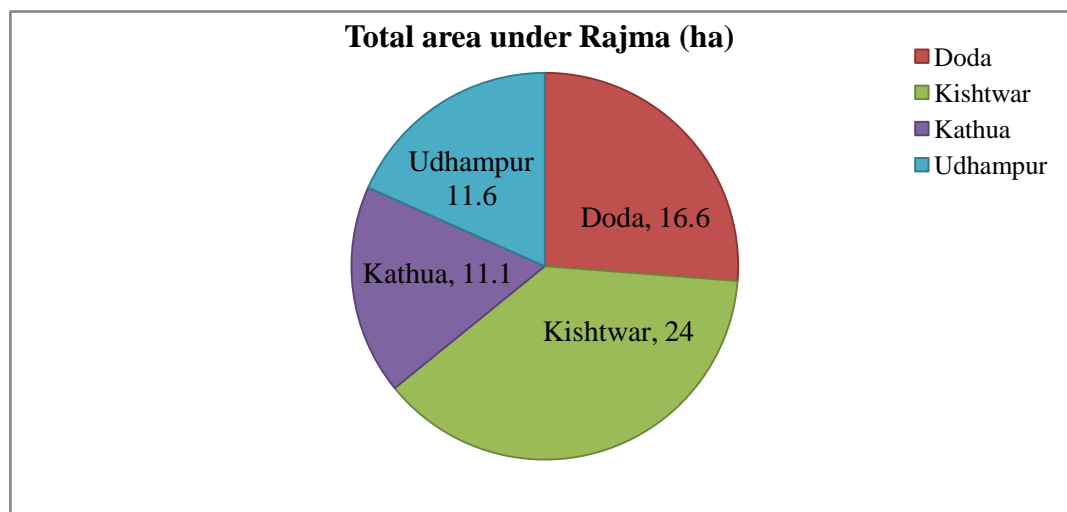


Figure 4.8: Categories of area under Rajma crop

Table 4.21: Area and other cultivation practices of Rajma (*Phaseolus vulgaris*) as adopted by respondents

Parameter	Doda (n=58)	Kishtwar (n=59)	Kathua (n=60)	Udhampur (n=58)	Overall (N=235)
Total area (ha)	16.6	24	11.7	11.6	63.9
Average area(ha)±SD	0.28 ±0.21	0.4±0.46	0.19 ±0.16	0.2 ±0.15	0.27 ± 0.29
Unirrigated area under Rajma(ha)	16.6 (100)	24 (100)	11.7 (100)	11.6 (100)	63.9 (100)
Seed rate					
Average seed rate (kg/ha)±SD	15.63 ±3.75	14 ±3.32	20.49 ±3.28	17.53±2.79	16.47 ±4.28
Source of seed (% farmers)					
Owned saved seed	58(100)	55(97)	60(100)	58(100)	231(98)
Private dealers	0	4(7)	0	0	4(2)
Average time period cultivating these varieties (years)	23	24	27	28	25.5
Time of sowing (% farmers)					
March-April	58(100)	59(100)	60(100)	58(100)	235(100)
Method of sowing (% farmers)					
Broadcasting	58(100)	59(100)	60(100)	58(100)	235(100)
Cropping system (% farmers)					
Mixed cropping	58(100)	59(100)	60(100)	58(100)	235(100)

Black gram (*Vigna mungo*)

The data in table 4.22 revealed that in case of Black gram, the total area was 13.8 ha in Kishtwar district followed by 9.95 ha in Kathua district, 9.3 ha in Doda district, 7.5 ha in Udhampur district with an overall of 40.55 ha in study area. The results further revealed that average area of black gram crop of respondent farmers was 0.29 ha (± 0.39) in Kishtwar district followed by 0.18 ha (± 0.11) in Doda district, 0.18 ha (± 0.11) hectares in Kathua district and 0.16 ha (± 0.13) in Udhampur district. The overall average area in terms of hectares of black gram crop of respondent farmers was 0.20 (± 0.23) hectares. 100 per cent area under black gram crop was unirrigated. The average seed rate (kg/ha) used by the respondent farmers was 17.45 (± 7.48) in Udhampur district followed by 11.06 (± 6.59) in Kathua district, 10.68 (± 6.71) in Kishtwar district, 9.86 (± 4.54) in Doda district and 12.09 (± 6.95) in overall study area. 100 per ce

nt of the growers used owned saved seed. The overall average time period since the farmers were cultivating these varieties was 25 years. 100 per cent of the respondent farmers reported that black gram was sown in month of March-May. 100 per cent of the respondent farmers have sown black gram by broadcasting method and as sole cropping system.

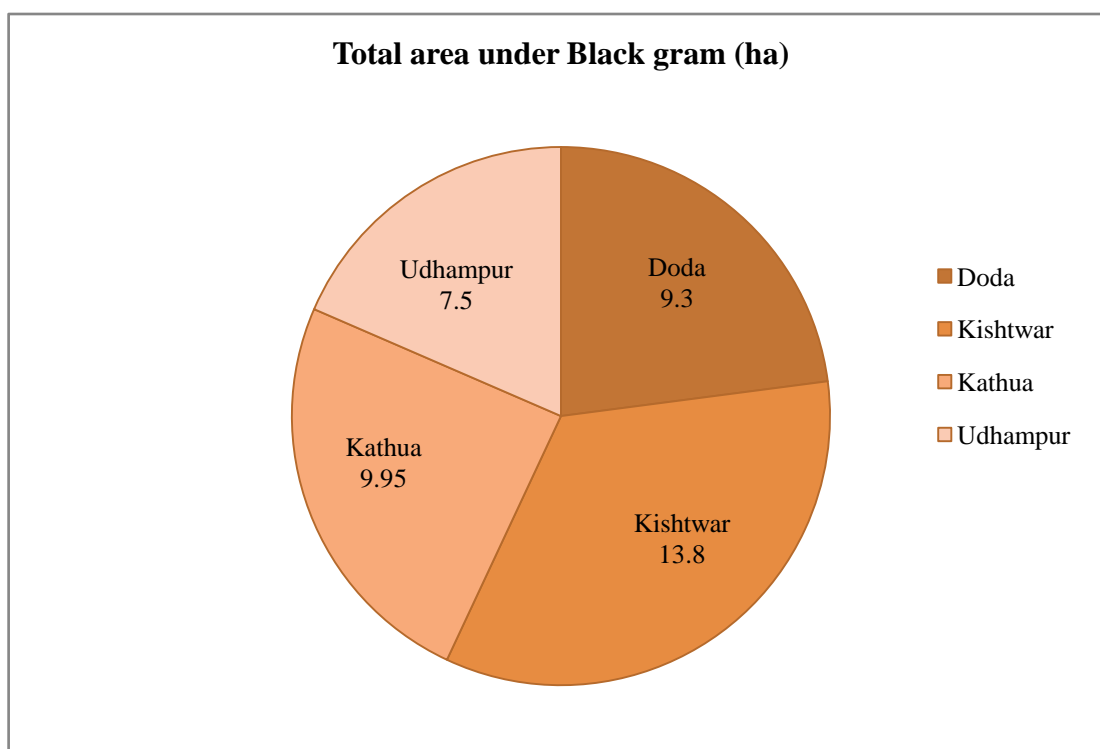


Figure 4.9: Categories of area under Black gram

Table 4.22: Area and other cultivation practices of Black gram (*Vigna mungo*) as adopted by respondents

Parameter	Doda (n=49)	Kishtwar (n=46)	Kathua (n=49)	Udhampur (n=45)	Overall (N=189)
Total area (ha)	9.3	13.8	9.95	7.5	40.55
Average area (ha) ± SD	0.18 ± 0.11	0.29 ± 0.39	0.18 ± 0.17	0.16 ± 0.13	0.20 ± 0.23
Unirrigated area (ha)	9.3 (100)	13.8 (100)	9.95 (100)	7.50 (100)	40.55 (100)
Seed rate					
Average seed rate (kg/ha) ± SD	9.86 ± 4.54	10.68 ± 6.71	11.06 ± 6.59	17.45 ± 7.48	12.09 ± 6.95
Source of seed (% farmers)					
Owned saved seed	49(100)	46(100)	49(100)	45(100)	189(100)
Average time period cultivating these varieties (years)	24	24	26	27	25
Time of sowing (% farmers)					
March-May month	49(100)	46(100)	49(100)	45(100)	189(100)
Method of sowing (% farmers)					
Broadcasting	49(100)	46(100)	49(100)	45(100)	189(100)
Cropping system (% farmers)					
Sole cropping	49(100)	46(100)	49(100)	45(100)	189(100)

Green gram (*Vigna radiata*)

The data in table 4.23 indicates that in case of Green gram, the total area was 10.8 ha in Kishtwar district followed by 6.65 ha in Udhampur district, 6.2 ha in Doda district, 6.15 ha in Kathua district with an overall of 29.8 ha in study area. The results further revealed that average area of green gram crop of respondent farmers was 0.29 ha (± 0.39) in Kishtwar district followed by 0.15 ha (± 0.12) in Kathua district, 0.14 ha (± 0.08) in Doda district and 0.13 (± 0.10) hectares in Udhampur district. The overall average area in terms of hectares of green gram crop of respondent farmers was 0.18 (± 0.23) hectares. 100 per cent area under green gram crop was unirrigated. The average seed rate used by the respondent farmers was 20.19 (± 0.08) in Doda district followed by 17.20 kg/ha (± 6.99) in Kathua district, 17.00 kg/ha (± 6.75) in Kishtwar district, 16.35 kg/ha (± 7.20) in Udhampur district with an overall of 17.77 kg/ha (± 7.02) in study area. 100 per cent of growers used owned saved seed. The overall average time period since the farmers were cultivating these varieties was 23.5

years.100 per cent of the respondent farmers reported that green gram was sown in month of October-November. 100 per cent of the respondent farmers have sown black gram by broadcasting method and as sole cropping system.

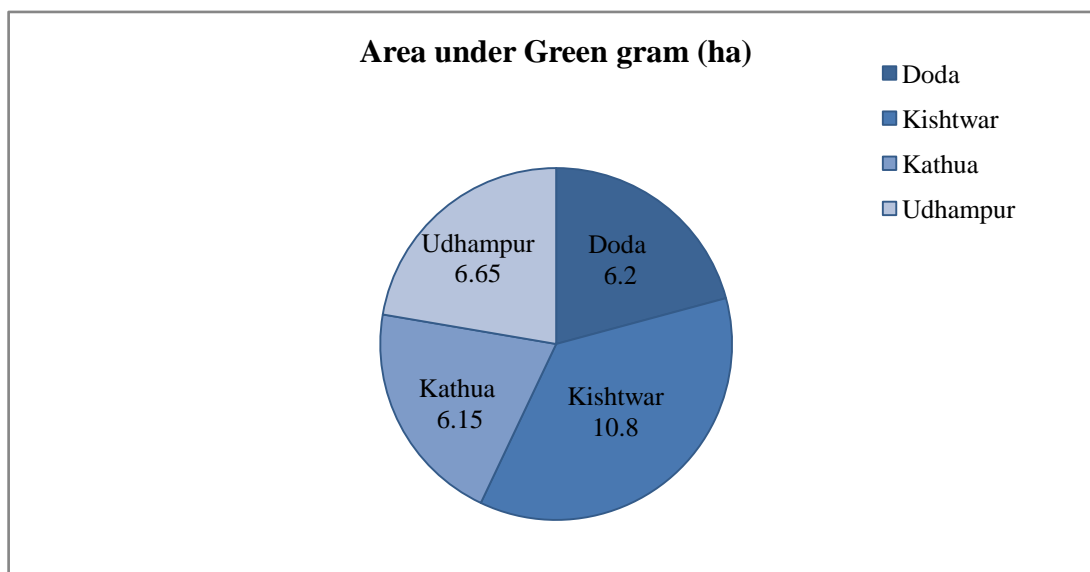


Figure 4.10: Categories of area under Green gram

Table 4.23: Area and other cultivation practices of Green gram (*Vigna radiata*) as adopted by respondents

Parameter	Doda (n=44)	Kishtwar (n=46)	Kathua (n=43)	Udhampur (n=41)	Overall (N=174)
Total area (ha)	6.2	10.8	6.15	6.65	29.8
Average area (ha)±SD	0.14 ±0.08	0.29 ±0.39	0.15 ±0.12	0.13 ±0.10	0.18±0.23
Unirrigated area (ha)	6.2 (100)	10.8(100)	6.15(100)	6.65(100)	29.8(100)
Seed rate					
Average seed rate (kg/ha) ± SD	20.19 ±0.08	17.00 ±6.75	17.20 ±6.99	16.35 ±7.20	17.77 ±7.02
Source of seed (% farmers)					
Owned saved seed	44(100)	46(100)	43(100)	41(100)	174(100)
Average time period cultivating these varieties (in years)	18	25	25	26	23.5
Time of sowing (% farmers)					
October-November month	44(100)	46(100)	43(100)	41(100)	174(100)
Method of sowing (% farmers)					
Broadcasting	44(100)	46(100)	43(100)	41(100)	174(100)
Cropping system (% farmers)					
Sole cropping	44(100)	46(100)	43(100)	41(100)	174(100)

Red lentil (*Lens culinaris*)

The Red lentil (*Lens culinaris*) was found to be cultivated only in Kishtwar district and the results from table 4.24 revealed that the total area was 3.65 ha and all this area was unirrigated. The average seed rate used by the respondent farmers was 36.95 kg/ha (± 9.35). All the respondents used owned saved seed from last 25 years. All the respondent farmers reported that red lentil was sown in month of March-April and was grown by broadcasting method and as a sole crop.

Table 4.24: Area and other cultivation practices of Red lentil (*Lens culinaris*) as adopted by respondents

Parameter	Doda (n=0)	Kishtwar (n=36)	Kathua (n=0)	Udhampur (n=0)	Overall (N=36)
Total area (ha)		3.65			3.65
Average area (ha) \pm SD		0.10 \pm 0.06			0.10 \pm 0.06
Unirrigated area (ha)		3.65(100)			3.65(100)
Seed rate					
Average seed rate (kg/ha) \pm SD		36.95 \pm 9.35			36.95 \pm 9.35
Source of seed (% farmers)					
Owned saved seed		36(100)			36(100)
Average time period cultivating these varieties (years)		25			25
Time of sowing (% farmers)					
March-April month		36(100)			36(100)
Method of sowing (% farmers)					
Broadcasting		36(100)			36(100)
Cropping system (% farmers)					
Sole cropping		36(100)			36(100)

Horse gram (*Macrotyloma uniflorum*)

The data in table 4.25 revealed that in case of Horse gram, the total area was 3.55 ha in Kathua district followed by 2.25 ha in Doda district with an overall of 5.8 ha in study area. The results further revealed that average area of horse gram crop of respondent farmers was 0.22 ha (± 0.16) in Kathua district and 0.03 ha (± 0.04) in Doda district. The overall average area in terms of hectares of horse gram crop of respondent farmers was 0.07 (± 0.11) hectares. 100 per cent area under horse gram crop was unirrigated. The average seed rate used by the respondent farmers was 19.12 kg/ha (± 1.02) in Kathua district followed by 16.67 kg/ha (± 2.87) in Doda district with an overall average of 17.46 kg/ha (± 2.68) in study area. 100 per cent of the growers used owned saved seed. The overall average time period since the farmers were cultivating these varieties was 24 years. 100 per cent of the respondent farmers reported that horse gram was sown in month of March-April. 100 per cent respondent farmers have sown horse gram by broadcasting method and as sole cropping system.

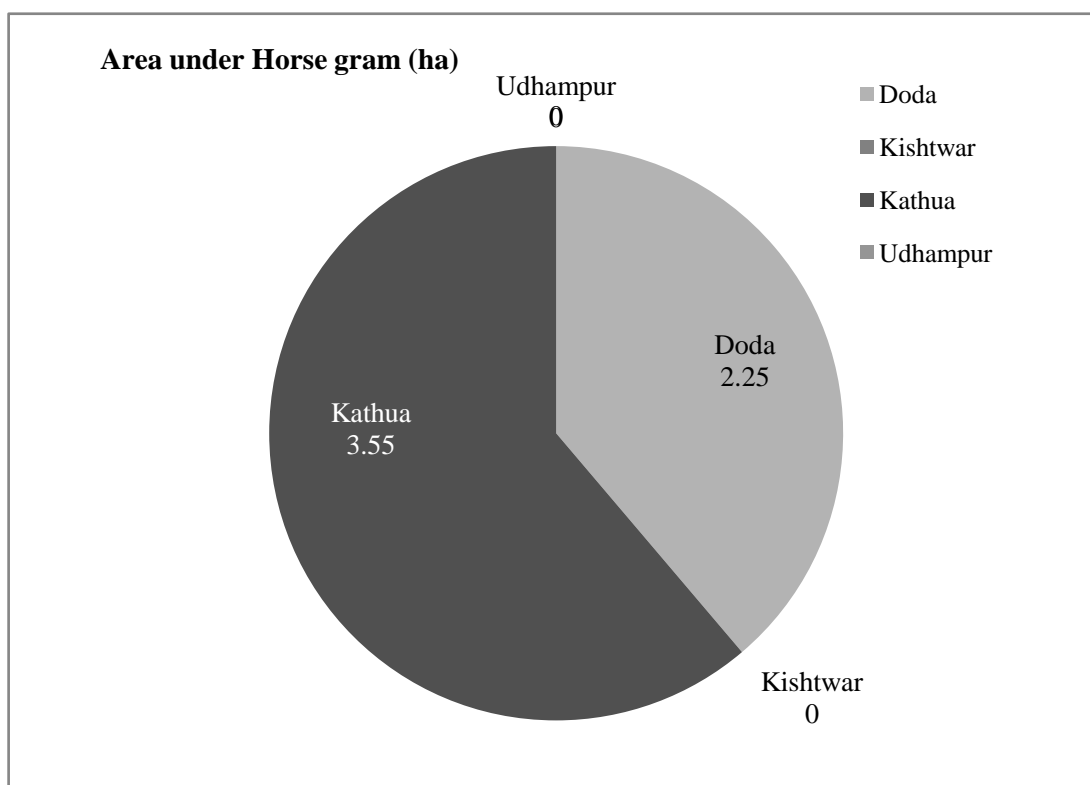


Figure 4.11: Categories of area under Horse gram

Table 4.25: Area and other cultivation practices of Horse gram (*Macrotyloma uniflorum*) as adopted by respondents

Parameter	Doda (n=34)	Kishtwar (n=0)	Kathua (n=16)	Udhampur (n=0)	Overall (N=50)
Total area (ha)	2.25	0	3.55	0	5.8
Average area (ha) \pm SD	0.03 \pm 0.04	0	0.22 \pm 0.16	0	0.07 \pm 0.11
Unirrigated area(ha)	34(100)	0	16(100)	0	50(100)
Seed rate					
Average seed rate (kg/ha) \pm SD	16.67 \pm 2.87	0	19.12 \pm 1.02	0	17.46 \pm 2.68
Source of seed (% farmers)					
Owned saved seed	34(100)	0	16(100)	0	50(100)
Since when you are cultivating these varieties	25	0	23	0	24
Time of sowing (% farmers)					
March-April month	34(100)	0	16(100)	0	50(100)
Method of sowing (% farmers)					
Broadcasting	34(100)	0	16(100)	0	50(100)
Cropping system (% farmers)					
Sole cropping	34(100)	0	16(100)	0	50(100)

French bean (*Phaseolus vulgaris*)

The data in table 4.26 revealed that in case of French bean, the total area was 1.6 ha in Doda district followed by 1.35 ha in Kishtwar district, 1.1 ha in Udhampur district with an overall of 4.05 ha in study area. The results further revealed that average area of french bean crop of respondent farmers was 0.08 (\pm 0.04) in Doda district followed by 0.08 (\pm 0.03) in Kishtwar district and 0.07 (\pm 0.03) in Udhampur district. The overall average area in terms of hectares of french bean crop of respondent farmers was 0.08 (\pm 0.03) hectares. 100 per cent area under green gram crop was unirrigated. The average seed rate used by the respondent farmers was 62.14 kg/ha (\pm 16.55) in Doda district followed by 48.33 kg/ha (\pm 23.80) in Kathua district, 42.00 kg/ha (\pm 31.04) in Udhampur district with an overall of 55.11 kg/ha (\pm 22.80) in study area. 100 per cent of the growers used owned saved seed. The overall average time period since the farmers were cultivating these varieties was 25 years 100 per cent of the respondent farmers reported that french bean was sown in month of

October-November. 100 per cent respondent farmers have sown french bean by broadcasting method and as sole cropping system.

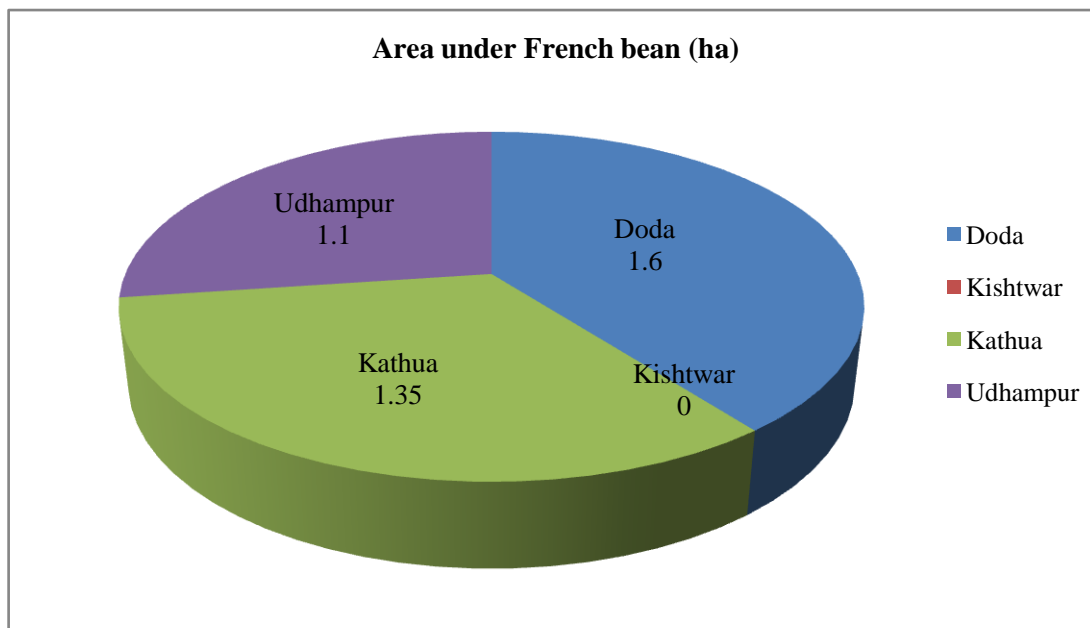


Figure 4.12: Categories of area under French bean

Table 4.26: Area and other cultivation practices of French bean (*Phaseolus vulgaris*) as adopted by respondents

Parameter	Doda (n=19)	Kishtwar (n=0)	Kathua (n=15)	Udhampur (n=12)	Overall (N=46)
Total area (ha)	1.6		1.35	1.1	4.05
Average area (ha) ± SD	0.08 ± 0.04		0.08± 0.03	0.07±0.03	0.08 ± 0.03
Unirrigated area (ha)	1.6(100)		1.35(100)	1.1(100)	4.05(100)
Seed rate					
Average seed rate (kg/ha) ± SD	62.14 ±16.55		48.33 ±23.80	42.00 ±31.04	55.11 ±22.80
Source of seed (% farmers)					
Owned saved seed	19(100)		15(100)	12(100)	46(100)
Average time period of cultivating these varieties (years)	24		25	27	25
Time of sowing (% farmers)					
October-November month	19(100)		15(100)	12(100)	46(100)
Method of sowing (% farmers)					
Broadcasting	19(100)		15(100)	12(100)	46(100)
Cropping system (% farmers)					
Sole cropping	19(100)		15(100)	12(100)	46(100)

Land Preparation practices followed by respondents for pulse crops

The result in the table 4.27 shows that bullock was used for land preparation in **Rajma** (*Phaseolus vulgaris*) by 72 per cent respondents in Doda district, followed by 68 per cent in Kishtwar district, 67 per cent in Udhampur district, 58 per cent in Kathua and overall 66 per cent of the respondents used bullock for land preparation, where rest of respondent farmers used tillers for land preparation. The overall average number of ploughing in rajma was 2.02 times (± 0.35). The land preparation practices in **Black gram** (*Vigna mungo*) through bullocks was done by 71 per cent of respondents in Kathua district, followed by 65 per cent in Kishtwar district, 64 per cent in Doda district, 51 per cent in Doda and overall 63 per cent of respondents used bullocks for ploughing the land, where as rest of respondent farmers done land preparation with tillers. The overall average number of ploughing was 2.06 times (± 0.32). The land preparation practices in **Green gram** (*Vigna radiata*) through bullocks was done by 83 per cent of respondents in Udhampur district, followed by 80 per cent in Kishtwar district, 77 per cent in Kathua district, 66 per cent in Doda and overall 76 per cent of respondents used bullocks for ploughing the land, where as rest of respondent farmers done land preparation with tillers. The overall average number of ploughing was 2.04 times (± 0.37). The land preparation practice in **Red lentil** (*Lens culinaris*) through bullocks was done by 72 per cent of respondents in Kishtwar district, where as rest of respondent farmers done land preparation with tillers. The overall average number of ploughing was 1.91 times (± 0.5). The land preparation practice in **Horse gram** (*Macrotyloma uniflorum*) through bullocks was done 74 per cent in Doda district followed by 62 per cent in Kathua district and overall 70 per cent of respondents used bullocks for ploughing the land, where rest of respondent farmers done land preparation with tillers. The overall average number of ploughing was 1.96 times (± 0.28). The land preparation practice in **French bean** (*Phaseolus vulgaris*) through bullocks was done 75 per cent in Udhampur district followed by 63 per cent in Doda district, 60 per cent in Kathua district and overall 65 per cent of respondents used bullocks for ploughing the land,, where rest of respondent farmers done land preparation with tillers. The overall average number of ploughing was 2.00 times (± 0.47).

Table 4.27: Land preparation practice followed by respondent for identified pulse crops

Parameter	Doda	Kishtwar	Kathua	Udhampur	Overall
Rajma (<i>Phaseolus vulgaris</i>)	(n=58)	(n=59)	(n=60)	(n=58)	(N=235)
Bullock (% farmers)	42(72)	40(68)	35(58)	39(67)	156(66)
Tillers (% farmers)	16(28)	19(32)	25(42)	19(33)	79(34)
Average number of ploughing \pm SD	2.01 \pm 0.35	1.96 \pm 0.31	2.06 \pm 0.36	2.06 \pm 0.36	2.02 \pm 0.35
Black gram (<i>Vigna mungo</i>)	(n=49)	(n=46)	(n=49)	(n=45)	(N=189)
Bullock (% farmers)	25(51)	30(65)	35(71)	29(64)	119(63)
Tillers (% farmers)	24(49)	16(35)	14(29)	16(36)	70(37)
Average number of ploughing \pm SD	2.10 \pm 0.30	2.06 \pm 0.31	2.04 \pm 0.34	2.04 \pm 0.36	2.06 \pm 0.32
Green gram (<i>Vigna radiata</i>)	(n=44)	(n=46)	(n=43)	(n=41)	(N=174)
Bullock (% farmers)	29(66)	37(80)	33(77)	34(83)	133(76)
Tillers (% farmers)	15(34)	9(20)	10(23)	7(17)	41(24)
Average number of ploughing \pm SD	2.04 \pm 0.47	2.10 \pm 0.31	2.00 \pm 0.33	2.00 \pm 0.32	2.04 \pm 0.37
Red lentil (<i>Lens culinaris</i>)	(n=0)	(n=36)	(n=0)	(n=0)	(N=36)
Bullock (% farmers)		26(72)			26(72)
Tillers (% farmers)		10(28)			10(28)
Average number of ploughing \pm SD		1.91 \pm 0.5			1.91 \pm 0.5
Horse gram (<i>Macrotyloma uniflorum</i>)	(n=34)	(n=0)	(n=16)	(n=0)	(N=50)
Bullock (% farmers)	25(74)		10(62)		35(70)
Tillers (% farmers)	9(26)		6(38)		15(30)
Average number of ploughing \pm SD	1.97 \pm 0.30		1.93 \pm 0.25		1.96 \pm 0.28
French bean (<i>Phaseolus vulgaris</i>)	(n=19)	(n=0)	(n=15)	(n=12)	(N=46)
Bullock (% farmers)	12(63)		9(60)	9(75)	30(65)
Tillers (% farmers)	7(37)		6(40)	3(25)	16(35)
Average number of ploughing \pm SD	2.05 \pm 0.22		2.00 \pm 0.36	2.00 \pm 0.60	2.00 \pm 0.47

Distribution of respondents on the basis of applied manures and fertilizers in Rajma (*Phaseolus vulgaris*)

The result in the table 4.28 shows the distribution of the respondents on the basis of applied manures and fertilizers in Rajma (*Phaseolus vulgaris*). The results revealed that 9 per cent of the respondent farmers applied urea in Doda district and all the respondents applied it as top dressing .The average applied dose of urea was 0.88 ± 0.10 kg/ha in Doda district while in Kishtwar district 27 per cent of the respondents applied urea and all of them applied it as top dressing. The average dose of top dressing in Kishtwar district was 2.07 ± 2.34 kg/ha. In Kathua 8 per cent of the respondents applied urea and all of them applied it as top dressing. The average dose of top dressed urea in Kathua was 0.92 ± 0.10 kg/ha. In Udhampur district, 9 per cent of the respondents applied urea and all of them applied it as top dressing. The average dose of top dressed urea in Udhampur district was 0.88 ± 0.10 kg/ha. Overall results showed that 13 per cent of the total respondents applied urea and all of them applied it as top dressing with an average applied dose of 1.50 ± 1.76 kg/ha. The results further showed that 9 per cent of the respondents in Doda district applied DAP and average quantity applied was 0.64 ± 0.21 kg/ha. 20 per cent of the respondents in Kishtwar district applied DAP and average quantity applied was 0.48 ± 0.15 kg/ha. 8 per cent of the respondents in Kathua district applied DAP and average quantity used was 0.68 ± 0.26 kg/ha. 9 per cent of the respondents in Udhampur district applied DAP and the average quantity used was 0.64 ± 0.21 kg/ha. Overall 11per cent of respondents applied DAP and the average quantity applied was 0.57 ± 0.21 kg/ha. When it comes to the results of the FYM, all the respondents of Doda district applied FYM and the average dose used was 31.46 (± 12.70) q/ha, in Kishtwar district also all the respondents applied FYM and average dose used was 30.05 ± 13.07 . Same results were found in Kathua and Udhampur district as all the respondents applied FYM and average dose was 32.50 ± 12.40 and 32.24 ± 12.43 q/ha respectively. Overall, it was found that average quantity of FYM applied was $31.56 (\pm 12.61)$ q/ha.

Table 4.28: Distribution of respondents on the basis of applied manures and fertilizers in Rajma (*Phaseolus vulgaris*)

Parameter	Doda (n=58)	Kishtwar (n=59)	Kathua (n=60)	Udhampur (n=58)	Overall (N=235)
UREA					
Number of farmers applied (% farmers)	5(9)	16(27)	5(8)	5(9)	31(13)
Number of farmer applied top dressing (% farmers)	5(9)	16(27)	5(8)	5(9)	31(13)
Average top dressing dose (kg/ha)	0.88 ± 0.10	2.07 ± 2.34	0.92 ± 0.10	0.88 ± 0.10	1.50 ± 1.76
DAP					
Number of farmers applied (% farmers)	5(9)	12(20)	5(8)	5(9)	27(11)
Average quantity used (kg/ha)	0.64 ± 0.21	0.48 ± 0.15	0.68 ± 0.26	0.64 ± 0.21	0.57 ± 0.21
FYM					
Number of farmers applied (% farmers)	58(100)	59(100)	60(100)	58(100)	235(100)
Average dosage (q) ± SD	31.46 ± 12.70	30.05 ± 13.07	32.50 ± 12.40	32.24 ± 12.43	31.56 ± 12.61

Distribution of respondents on the basis of applied manures and fertilizers in Black gram (*Vigna mungo*)

The result in the table 4.29 shows that the distribution of respondents on the basis of applied manures and fertilizers in Black gram (*Vigna mungo*). The results revealed that 10 per cent of the respondents farmers applied urea in Doda district and all the respondents applied it as top dressing .The average applied dose of top dressing urea in Doda district was 0.72 ± 0.10 kg/ha while in Kishtwar district 22 per cent of the respondents applied urea and all of them applied it as top dressing. The average dose of top dressing in Kishtwar district was 0.60 ±0.16kg/ha. 10 per cent of the respondents applied urea in Kathua district and all of them applied urea as top dressing. The average dose of top dressed urea in Kathua district was 0.76 ± 0.16 kg/ha. 11 per cent of the respondents applied urea in Udhampur district and all of them applied it as top dressing. The average applied dose of top dressing urea in Udhampur district was 0.72 ±0.10kg/ha. Overall results showed that 11 per cent of the total respondents applied

urea and all of them applied it as top dressing with an average dose of 0.69 ± 0.15 kg/ha. The results showed that 10 per cent of the respondents in Doda district applied DAP and average quantity applied was 0.72 ± 0.10 kg/ha. 22 per cent of the respondents in Kishtwar district applied DAP and average quantity applied was 0.48 ± 0.15 kg/ha. 10 per cent of the respondents in Kathua district applied DAP and the average quantity applied was 0.72 ± 0.10 kg/ha. 11 per cent of the respondents in Udhampur district applied DAP and the average quantity applied was 0.72 ± 0.10 kg/ha. Overall 11 per cent of respondents applied DAP and the average quantity applied was 0.67 ± 0.14 kg/ha. When it comes to the results of the FYM, all the respondents of Doda district applied FYM and the average dose applied was 29.89 ± 13.24 q/ha, in Kishtwar district also all the respondents applied FYM and average dose applied was 29.64 ± 13.45 q/ha. Same results were found in Kathua and Udhampur district as all the respondents applied FYM with an average dose of $30.81 (\pm 13.16)$ and $30.22 (\pm 13.39)$ q/ha respectively. Overall, it was found that average quantity of FYM applied by all the respondents was $30.14 (\pm 13.21)$ q/ha.

Table 4.29: Distribution of respondents on the basis of applied manures and fertilizers in Black gram (*Vigna mungo*)

Parameter	Doda (n=49)	Kishtwar (n=46)	Kathua (n=49)	Udhampur (n=45)	Overall (N=189)
UREA					
Number of farmers applied (% farmers)	5(10)	10(22)	5(10)	5(11)	20(11)
Number of farmer applied top dressing (% farmers)	5(10)	10(22)	5(10)	5(11)	20(11)
Average top dressing dose (kg/ha)	0.72 ± 0.10	0.64 ± 0.18	0.76 ± 0.16	0.72 ± 0.10	0.69 ± 0.15
DAP					
Number of farmers applied(% farmers)	5(10)	10(22)	5(10)	5(11)	20(11)
Average quantity used(kg/ha)	0.72 ± 0.10	0.60 ± 0.16	0.72 ± 0.10	0.72 ± 0.10	0.67 ± 0.14
FYM					
Number of farmers applied(% farmers)	49(100)	46(100)	49(100)	45(100)	189(100)
Average dosage (q) \pm SD	29.89 ± 13.24	29.64 ± 13.45	30.81 ± 13.16	30.22 ± 13.39	30.14 ± 13.21

Distribution of respondents on the basis of applied manures and fertilizers in Green gram (*Vigna radiata*)

The result in the table 4.30 shows the distribution of respondents on the basis of applied manures and fertilizers in Green gram (*Vigna radiata*). The results revealed that 11 per cent of the respondents farmers applied urea in Doda district and all the respondents applied it as top dressing .The average dose of top dressing urea in Doda district was 0.72 ± 0.10 kg/ha while in Kishtwar district 15 per cent of the respondents applied urea and all of them applied it as top dressing. The average dose of top dressed in Kishtwar district was 0.57 ± 0.07 kg/ha. 12 per cent of the respondents applied urea in Kathua district and all of them applied urea as top dressing. The average dose of top dressed urea in Kathua district was 0.68 ± 0.10 kg/ha. 12 per cent of the respondents applied urea in Udhampur district, and all of them applied it as top dressing. The average dose of top dressed urea in Udhampur district was 0.72 ± 0.10 kg/ha. Overall, the results showed that 13 per cent of the total respondents applied the urea and all of them applied it as top dressing with an average dose of 0.66 ± 0.11 kg/ha. The results revealed showed that 11`per cent of the respondents in Doda district applied DAP and average quantity applied was 0.72 ± 0.10 kg/ha. 15 per cent of the respondents in Kishtwar district applied DAP and average quantity applied was 0.48 ± 0.10 kg/ha. 12 per cent of the respondents in Kathua district applied DAP and the average quantity applied was 0.68 ± 0.10 kg/ha. 12 per cent of the respondents in Udhampur district applied DAP and the average quantity applied was 0.72 ± 0.10 kg/ha. Overall 13 per cent of respondents applied DAP and the average quantity applied was 0.63 ± 0.14 kg/ha. When it comes to the results of the FYM, all the respondents of Doda district applied FYM and the average dose applied was 29.65 ± 13.90 q/ha, in Kishtwar district also all the respondents applied FYM and average dose applied was 29.80 ± 13.41 q/ha. Same results were found in Kathua and Udhampur district as all the respondents applied FYM with an average dose of $29.72 (\pm 14.38)$ and $30.52 (\pm 14.13)$ q/ha respectively. Overall, it was found that average quantity of FYM applied by all the respondents was $29.91 (\pm 13.80)$ q/ha.

Table 4.30: Distribution of respondents on the basis of applied manures and fertilizers in Green gram (*Vigna radiata*)

Parameter	Doda (n=44)	Kishtwar (n=46)	Kathua (n=43)	Udhampur (n=41)	Overall (N=174)
UREA					
Number of Farmers applied (% farmers)	5(11)	7(15)	5(12)	5(12)	22(13)
Number of farmer applied top dressing (% farmers)	5(11)	7(15)	5(12)	5(12)	22(13)
Average top dressing dose (kg/ha)	0.72 ± 0.10	0.57 ± 0.07	0.68 ± 0.10	0.72 ± 0.10	0.66 ± 0.11
DAP					
Number of Farmers applied (% farmers)	5(11)	7(15)	5(12)	5(12)	22(13)
Average Quantity used (kg/ha)	0.72 ± 0.10	0.48 ± 0.10	0.68 ± 0.10	0.72 ± 0.10	0.63 ± 0.14
FYM					
Number of Farmers applied (% farmers)	44(100)	46(100)	43(100)	41(100)	174(100)
Average dosage (q) ± SD	29.65 ± 13.90	29.80 ± 13.41	29.72 ± 14.38	30.52 ± 14.13	29.91 ± 13.80

Distribution of respondents on the basis of applied manures and fertilizers in Red lentil (*Lens culinaris*)

The result in the table 4.31 shows the distribution of respondents on the basis of applied manures and fertilizers in Red lentil (*Lens culinaris*). The results revealed that Urea, DAP and FYM was applied by only the respondents of the Kishtwar district. 28 per cent of the respondents in Kishtwar district applied urea and all of them applied it as top dressing, while average quantity applied as top dressing was 0.56 ± 0.08 kg/ha. 28 per cent of the respondents in Kishtwar district applied DAP

and average quantity applied was 0.46 (± 0.09) kg/ha. When it comes to FYM, all the respondents applied FYM and the average dose was 29.11 (± 13.59) q/ha.

Table 4.31: Distribution of respondents on the basis of applied manures and fertilizers in Red lentil (*Lens culinaris*)

Parameter	Doda (n=0)	Kishtwar (n=36)	Kathua (n=0)	Udhampur (n=0)	Overall (N=36)
UREA					
Number of Farmers applied (% farmers)	0	10(28)	0	0	10(28)
Number of farmer applied top dressing (% farmers)		10(28)			10(28)
Average top dressing dose (kg/ha)		0.56 \pm 0.08			0.56 \pm 0.08
DAP					
Number of Farmers applied (% farmers)	0	10(28)	0	0	10(28)
Average Quantity used (kg/ha)		0.46 \pm 0.09			0.46 \pm 0.09
FYM					
Number of Farmers applied (% farmers)	0	36(100)	0	0	36(100)
Average dosage (q) \pm SD		29.11 \pm 13.59			29.11 \pm 13.59

Distribution of respondents on the basis of applied manures in Horse gram (*Macrotyloma uniflorum*)

The result in the table 4.32 shows that distribution of respondents on the basis of applied manures in Horse gram (*Macrotyloma uniflorum*). The results revealed that all the respondents of Doda and Kathua district applied FYM and the average dose applied was 29.85 (± 14.16) and 33.43 (± 12.20) q/ha respectively. When we combine the figures it showed that average quantity applied by respondents of Doda and Kathua district were 31.00 (± 13.55) q/ha.

Table 4.32: Distribution of respondents on the basis of applied manures in Horse gram (*Macrotyloma uniflorum*)

Parameter	Doda (n=34)	Kishtwar (n=0)	Kathua (n=16)	Udhampur (n=0)	Overall (N=50)
FYM					
Number of Farmers applied (per cent farmers)	34(100)	0	16(100)	0	50(100)
Average dosage (q) ± SD	29.85 ± 14.16		33.43 ± 12.20		31.00 ± 13.55

Distribution of respondents on the basis of applied manures in French bean (*Phaseolus vulgaris*)

The results shown in table 4.33 showed the Distribution of respondents on the basis of applied manures in French bean (*Phaseolus vulgaris*). The results revealed that all the respondents of Doda, Kathua and Udhampur district applied FYM and the average dose applied was 26.57 ± 14.91 , 36.66 ± 8.16 and 35.83 ± 9.00 q/ha respectively. Overall, it showed that average quantity applied by respondents of Doda, Kathua and Udhampur district was $32.28 (\pm 12.36)$ q/ha.

Table 4.33: Distribution of respondents on the basis of applied manure in French bean (*Phaseolus vulgaris*)

Parameter	Doda (n=19)	Kishtwar (n=0)	Kathua (n=15)	Udhampur (n=12)	Overall (N=46)
FYM					
Number of Farmers applied (% farmers)	19(100)	0	15(100)	12(100)	46(100)
Average dosage (q) ± SD	26.57 ± 14.91		36.66 ± 8.16	35.83 ± 9.00	32.28 ± 12.36

Sources of information about fertilizers as expressed by respondents

The result in table 4.34 shows the distribution of farmers on the basis of sources of information about fertilizers as expressed by respondents. 3 per cent of respondents in Doda district, 10 per cent of respondents in Kishtwar district, 5 per cent of respondents in Kathua district and 5 per cent of respondents in Udhampur district expressed from fellow farmers as their source of information. 5 per cent of respondents in Doda district, 12 per cent of respondents in Kishtwar district, 3 per cent of respondents in Kathua district expressed private dealers as source of information. Overall, only 5 per cent of respondents get information from private dealer. Only 5 per

cent of respondents from Kishtwar district and 3 per cent of respondents from Udhampur district gets information from department of agriculture. Overall only 2 per cent of respondents got information from department of agriculture.

The results shows that 92 per cent of respondents from Doda district did not apply fertilizers. 12 per cent of respondents reported no knowledge of applying fertilizers as reason while 58 per cent of respondents expressed that fertilizers are not available in local market and 73 per cent of respondents expressed that there is no need to apply fertilizers. 73 per cent of respondents from Kishtwar district did not apply fertilizers. 7 per cent, 50 per cent and 62 per cent of respondents from Kishtwar district expressed no knowledge, not available in local market and no need respectively as reason for not applying fertilizers. 92 per cent of respondents from Kathua district did not apply any fertilizers. 13 per cent, 52 per cent and 32 per cent of respondents from Kathua district expressed no knowledge, not available in local market and no need respectively as reason for not applying fertilizers. 92 per cent of respondents from Udhampur district did not apply fertilizers. 17 per cent, 25 per cent and 63 per cent of the respondents from Udhampur district expressed no knowledge, not available in local market and no need respectively as reason for not applying fertilizers. Overall 87 per cent of the total respondents did not apply fertilizer. 12 per cent, 46 per cent and 57 per cent of total respondents expressed no knowledge, fertilizers not available in local market and no need, respectively as reason for not applying fertilizers.

Table 4.34: Sources and constraints in fertilizers application as expressed by respondents

Parameter (% farmers)	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Source of information					
Fellow farmers	2(3)	6(10)	3(5)	3(5)	14(6)
Private dealers	3(5)	7(12)	2(3)	0	12(5)
Department of agriculture	0	3(5)	0	2(3)	5(2)
Not applying	55(92)	44(73)	55(92)	55(92)	209(87)
Reason for not applying fertilizers*					
No knowledge	7(12)	4(7)	8(13)	10(17)	29(12)
Not available in local market	35(58)	30(50)	31(52)	15(25)	111(46)
No need of applying	44(73)	37(62)	18(30)	38(63)	137(57)

*Multiple response

Weed management practices adopted by Rajma (*Phaseolus vulgaris*) growers

The results in table 4.35 shows weed management practices adopted by Rajma (*Phaseolus vulgaris*) growers. The results showed all the respondents from Doda, Kishtwar, Kathua and Udhampur district used manual methods for weed management. 20 per cent of respondents from Kishtwar district, 30 per cent of respondents from Kathua district and 29 per cent of respondents from Udhampur district did only one hoeing. 20 per cent of the all the respondents did only one hoeing. The results showed that 100 per cent of respondents from Doda district, 80 per cent of respondents from Kishtwar district, 70 per cent of the respondents from Kathua district and 71 per cent of respondents from Udhampur district did two hoeing. Overall 80 per cent of the total respondents did two hoeing. All the respondents from Doda, Kishtwar, Kathua and Udhampur district did first hoeing after a month of sowing. 74 per cent, 51 per cent, 58 per cent and 66 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively did second hoeing after 20-25 days from first hoeing. 62 per cent of the total respondents did second hoeing after 20-25 days from first hoeing. 26 per cent, 29 per cent, 12 per cent and 5 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively did second hoeing after a month from first hoeing. 18 per cent of the total respondents did second hoeing after a month from first hoeing. The all the respondents from Doda, Kishtwar, Kathua and Udhampur district reported that average time taken by person for hoeing a kanal area took around 3 days. The average rate of hoeing per person (₹/day) was ₹400 in all districts.

Table 4.35: Weed management practices adopted by Rajma (*Phaseolus vulgaris*) growers

Weed control	Doda (n=58)	Kishtwar (n=59)	Kathua (n=60)	Udhampur (n=58)	Overall (N=235)
Manual (% farmers)	58(100)	59(100)	60(100)	58(100)	235(100)
No. of hoeing done (% farmers)					
One	0	12(20)	18(30)	17(29)	47(20)
Two	58(100)	47(80)	42(70)	41(71)	188(80)
First hoeing done (% farmers)					
After a month	58(100)	59(100)	60(100)	58(100)	235(100)
Second hoeing (% farmers)					
After 20-25 days	43(74)	30(51)	35(58)	38(66)	146(62)
After a month	15(26)	17(29)	7(12)	3(5)	42(18)
Average time in hoeing (Man day/ha)	3	3	3	3	3
Average rate of hoeing per person (₹/day)	400	400	400	400	400

Weed management practices of Black gram (*Vigna mungo*)

The table 4.38 shows weed management practices of black gram (*Vigna mungo*). The results showed all the respondents from Doda, Kishtwar, Kathua and Udhampur district used manual methods for weed management. 37 per cent of respondents from Doda district, 24 per cent of respondents from Kishtwar district, 35 per cent of respondents from Kathua district and 24 per cent of respondents from Udhampur did only one hoeing. 30 per cent of the all the respondents did only one hoeing. The results showed that 63 per cent of respondents from Doda district, 76 per cent of respondents from Kishtwar district, 65 per cent of the respondents from Kathua district and 76 per cent of respondents from Udhampur district did two hoeing. Overall 70 per cent of the total respondents did two hoeing. All the respondents from Doda, Kishtwar, Kathua and Udhampur district did first hoeing after a month of sowing. 45 per cent, 61 per cent, 41 per cent and 47 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively did second hoeing after 20-25 days from first hoeing. Overall 48 per cent of the total respondents did second hoeing after 20-25 days from first hoeing. 18 per cent, 15per cent, 24 per cent and 29 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively did second hoeing after a month from first hoeing. 22 per cent of the total respondents did second hoeing after a month from first hoeing. The all the respondents from Doda, Kishtwar, Kathua and Udhampur district reported that average time taken by person for hoeing a kanal area took around 3 days. The average rate of hoeing per person (₹/day) was ₹400 in all districts.

Table 4.38: Weed management practices of Black gram (*Vigna mungo*)

Weed control	Doda (n=49)	Kishtwar (n=46)	Kathua (n=49)	Udhampur (n=45)	Overall (N=189)
Manual (% farmers)	49(100)	46(100)	49(100)	45(100)	189(100)
No. of hoeing done (% farmers)					
One	18(37)	11(24)	17(35)	11(24)	57(30)
Two	31(63)	35(76)	32(65)	34(76)	132(70)
First hoeing done (% farmers)					
After a month	49(100)	46(100)	49(100)	45(100)	189(100)
Second hoeing (% farmers)					
After 20-25 days	22(45)	28(61)	20(41)	21(47)	91(48)
After a month	9(18)	7(15)	12(24)	13(29)	41(22)
Average time in hoeing (Man day/ ha)	3	3	3	3	3
Average rate of hoeing per person (₹/day)	400	400	400	400	400

Weed management practices of Green gram (*Vigna radiata*)

The table 4.37 shows weed management practices of Green gram (*Vigna radiata*). The results showed all the respondents from Doda, Kishtwar, Kathua and Udhampur district used manual methods for weed management. 3 per cent of respondents from Doda district, 35 per cent of respondents from Kishtwar district, 23 per cent of respondents from Kathua district and 15 per cent of respondents from Udhampur district did only one hoeing. 26 per cent of the all the respondents did only one hoeing. The results showed that 70 per cent of respondents from Doda, 65 per cent of respondents from Kishtwar district, 77 per cent of the respondents from Kathua district and 85 per cent of respondents from Udhampur district did two hoeing. Overall 74 per cent of the total respondents did two hoeing. All the respondents from Doda, Kishtwar, Kathua and Udhampur district did first hoeing after a month of sowing. 57 per cent, 48 per cent, 53 per cent and 56 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively did second hoeing after 20-25 days from first hoeing. 53 per cent of the total respondents did second hoeing after 20-25 days from first hoeing. 14 per cent, 17 per cent, 23 per cent and 29 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively did second hoeing after a month from first hoeing. 21 per cent of the total respondents did second hoeing after a month from first hoeing. All the respondents from Kishtwar, Kathua and Udhampur district reported that average time taken by person for hoeing a kanal area took around 3 days while the respondents of Doda reported that average time taken by person for hoeing a kanal area took around 2.59 days. The average rate of hoeing per person (₹/day) was ₹400 in all districts.

Table 4.37: Weed management practices of Green gram (*Vigna radiata*)

Weed control	Doda (n=44)	Kishtwar (n=46)	Kathua (n=43)	Udhampur (n=41)	Overall (N=174)
Manual (% farmers)	44(100)	46(100)	43(100)	41(100)	174(100)
No. of hoeing done (% farmers)					
One	13(3)	16(35)	10(23)	6(15)	45(26)
Two	31(70)	30(65)	33(77)	35(85)	129(74)
First hoeing done (% farmers)					
After a month	44(100)	46(100)	43(100)	41(100)	174(100)
Second hoeing (% farmers)					
After 20-25 days	25(57)	22(48)	23(53)	23(56)	93(53)
After a month	6(14)	8(17)	10(23)	12(29)	36(21)
Average time in hoeing (Man day/ ha)	2.59	3	3	2.59	2.79
Average rate of hoeing per person (₹/day)	400	400	400	400	400

Weed management practices of Horse gram (*Macrotyloma uniflorum*)

The results in table 4.38 shows weed management practices of horse gram (*Macrotyloma uniflorum*). The results showed all the respondents from Doda and Kathua district used manual method for weed management. 31 per cent of respondents from Kathua district did only one hoeing. 100 per cent and 69 per cent of respondents from Doda and Kathua district respectively did two hoeing. The results showed 90 per cent of total respondents did two hoeing. All the respondents from Doda and Kathua district did first hoeing after a month of sowing. 88 per cent of the respondents from Doda district and 50 per cent of the respondents from Kathua district did second hoeing after 20-25 days from first hoeing. Overall 76 per cent of the respondents did second hoeing after 20-25 days of first hoeing. 12 per cent of respondents from Doda district and 19 per cent of respondents from Kathua district did second hoeing after a month of first hoeing. 14 per cent of total respondents from Doda and Kathua district did second hoeing after month of first hoeing. All the respondents from Doda and Kathua reported that average time taken by person for hoeing a kanal area took around 2 days .The average rate of hoeing per person (₹/day) was ₹400 in Doda and Kathua district.

Table 4.38: Weed management practices of Horse gram (*Macrotyloma uniflorum*)

Weed control	Doda (n=34)	Kishtwar (n=0)	Kathua (n=16)	Udhampur (n=0)	Overall (N=50)
Manual (% farmers)	34(100)	0	16(100)	0	50(100)
No. of hoeing done (% farmers)					
One	0		5(31)		5(10)
Two	34(100)		11(69)		45(90)
First hoeing done (% farmers)					
After a month	34(100)		16(100)		50(100)
Second hoeing (% farmers)					
After 20-25 days	30(88)		8(50)		38(76)
After a month	4(12)		3(19)		7(14)
Average time in hoeing (Man day/ ha)	2		2		2
Average rate of hoeing per person (₹/day)	400		400		400

Weed management practices of French bean (*Phaseolus vulgaris*).

The results in table 4.39 shows weed management practices of French bean (*Phaseolus vulgaris*).The results showed all the respondents form Doda, Kathua and

Udhampur district used manual methods for weed management. 26 per cent of respondents from Doda district, 33 per cent of respondents from Kathua district and 42 per cent of respondents from Udhampur district did only one hoeing. 33 per cent of all the respondents from Doda, Kathua and Udhampur district did only one hoeing. The results showed that 74 per cent of respondents from Doda, 67 per cent of the respondents from Kathua district and 58 per cent of respondents from Udhampur district did two hoeing. Overall 67 per cent of the total respondents from Doda, Kathua and Udhampur district did two hoeing. All the respondents from Doda, Kathua and Udhampur district did first hoeing after a month of sowing. 47 per cent, 47 per cent and 50 per cent of the respondents from Doda, Kathua and Udhampur district respectively did second hoeing after 20-25 days from first hoeing. Overall 48 per cent of the total respondents did second hoeing after 20-25 days from first hoeing. 26 per cent, 20 per cent and 17 per cent of the respondents from Doda, Kathua and Udhampur district respectively did second hoeing after a month from first hoeing. 22 per cent of the total respondents from Doda, Kathua and Udhampur district did second hoeing after a month from first hoeing. The respondents from Doda, Kathua and Udhampur district reported that average time taken by person for hoeing a kanal area took around 2 days, 2 days and 2.9 days respectively. The average time taken by person for hoeing a kanal area was 2.3 days. The average rate of hoeing per person (₹/day) was ₹400 in Doda, Kathua and Udhampur district.

Table 4.39: Weed management practices of French bean (*Phaseolus vulgaris*)

Weed control	Doda (n=19)	Kishtwar (n=0)	Kathua (n=15)	Udhampur (n=12)	Overall (N=46)
Manual (% farmers)	19(100)	0	15(100)	12(100)	45(100)
No. of hoeing done (% farmers)					
One	5(26)		5(33)	5(42)	15(33)
Two	14(74)		10(67)	7(58)	31(67)
First hoeing done (% farmers)					
After a month	19(100)		15(100)	12(100)	46(100)
Second hoeing (% farmers)					
After 20-25 days	9(47)		7(47)	6(50)	22(48)
After a month	5(26)		3(20)	2(17)	10(22)
Average time in hoeing (Man day/ ha)	2		2	2.9	2.3
Average rate of hoeing per person (₹/day)	400		400	400	400

Harvesting practices

The result in table 4.40 shows distribution of farmers on the basis of harvesting practices. The results revealed that 74 per cent, 68 per cent, 67 per cent and 60 per cent of respondents of Doda, Kishtwar, Kathua and Udhampur district respectively harvested Rajma (*Phaseolus vulgaris*) when turns red colour. It means 67 per cent of total respondents harvested rajma when pods turn red colour. The remaining 26 per cent, 32 per cent, 33 per cent and 40 per cent of respondents in Doda, Kishtwar, Kathua and Udhampur district harvested rajma when its leaves start drying and shedding. Overall, the results showed that 33 per cent of the total respondents harvested rajma when its leaves start drying and shedding. In Black gram (*Vigna mungo*), results showed that 61 per cent, 59 per cent, 59 per cent and 33 per cent of respondents in Doda, Kishtwar, Kathua and Udhampur district harvest black gram when pod start cracking. The results further showed that 53 per cent of the black gram growers harvest crop when pod cracking start. The remaining 39 per cent, 41 per cent, 41 per cent and 67 per cent of black gram growers in Doda, Kishtwar, Kathua and Udhampur district respectively harvest crop when leaves start drying and shedding. Overall 47 per cent of the total black gram respondents harvest crop when leaves start drying and shedding. In Green gram (*Vigna radiata*), 45 per cent, 57 per cent, 23 per cent and 34 per cent of respondents in Doda, Kishtwar, Kathua and Udhampur district respectively harvest green gram when pod cracking started and remaining 55 per cent, 43 per cent, 77 per cent and 66 per cent of the green gram growers in Doda, Kishtwar, Kathua and Udhampur district respectively harvest crop when leaves started drying and shedding. Overall 60 per cent of the total green gram growers harvest green gram when leaves start drying and shedding. In Red lentils (*Lens culinaris*), 64 per cent of the red lentil respondents in Kishtwar district harvest crop when pod cracking started and 36 per cent of the red lentil respondents in Kishtwar district harvest crop when leaves started drying and shedding. In horse gram (*Macrotyloma uniflorum*), 29 per cent and 31 per cent of horse gram respondents in Doda and Udhampur district respectively harvested crop when pod cracking started while remaining 71 per cent and 69 per cent of horse gram growers in Doda and Udhampur district respectively harvested crop when leaves started drying and shedding. Overall 30 per cent and 70 per cent of total respondents harvested crop when pod cracking started and when leaves started drying and shedding respectively. In French bean (*Phaseolus vulgaris*), 21 per cent, 47 per cent and 33 per cent of the

respondents in Doda, Kathua and Udhampur district respectively harvested crop when pods turned whitish yellow. Overall 33 per cent of the total French bean respondents harvested crop when pods turned whitish yellow. The remaining 79 per cent, 53 per cent and 67 per cent of the French bean respondents in Doda, Kathua and Udhampur district harvested crop when leaves started drying and shedding respectively. Overall 67 per cent of the total French bean respondents harvested crop when leaves started drying and shedding.

Table 4.40: Harvesting practices of pulse crop

Symptoms of harvesting	Doda	Kishtwar	Kathua	Udhampur	Overall
Rajma (<i>Phaseolus vulgaris</i>)	(n=58)	(n=59)	(n=60)	(n=58)	(N=235)
Pod turn red color	43(74)	40(68)	40(67)	35(60)	158(67)
When leaves start drying and shedding	15(26)	19(32)	20(33)	23(40)	77(33)
Black gram (<i>Vigna mungo</i>)	(n=49)	(n=46)	(n=49)	(n=45)	(N=189)
Pod cracking start	30(61)	27(59)	29(59)	15(33)	101(53)
When leaves start drying and shedding	19(39)	19(41)	20(41)	30(67)	88(47)
Green gram (<i>Vigna radiata</i>)	(n=44)	(n=46)	(n=43)	(n=41)	(N=174)
Pod cracking start	20(45)	26(57)	10(23)	14(34)	70(40)
When leaves start drying and shedding	24(55)	20(43)	33(77)	27(66)	104(60)
Red lentil (<i>Lens culinaris</i>)	(n=0)	(n=36)	(n=0)	(n=0)	(N=36)
Pod cracking start		23(64)			23(64)
When leaves start drying and shedding		13(36)			13(36)
Horse gram (<i>Macrotyloma uniflorum</i>)	(n=34)	(n=0)	(n=16)	(n=0)	(N=50)
Pod cracking start	10(29)		5(31)		15(30)
When leaves start drying and shedding	24(71)		11(69)		35(70)
French bean (<i>Phaseolus vulgaris</i>)	(n=19)	(n=0)	(n=15)	(n=12)	(N=46)
Pods turn whitish yellow	4(21)		7(47)	4(33)	15(33)
When leaves start drying and shedding	15(79)		8(53)	8(67)	31(67)

Post-harvesting operations in pulse crop

The results in table 4.41 shows distribution of respondents on the basis of post-harvesting operations in pulse crop. The results showed 65 per cent, 63 per cent, 53 per cent and 72 per cent of respondents in Doda, Kishtwar, Kathua and Udhampur district respectively, used manual method of post-harvesting operations. Overall 63 per cent of the total respondents used manual method in post harvesting operations. Thresher was used by 18 per cent, 23 per cent, 15 per cent and 20 per cent of the total respondents in Doda, Kishtwar, Kathua and Udhampur district respectively for post harvest operations. Overall 19 per cent of the total respondents used thresher for post harvest operation. The remaining 17 per cent, 13 per cent, 32 per cent and 8 per cent of the respondents in Doda, Kishtwar, Kathua and Udhampur district respectively used bullocks for threshing. Overall 18 per cent of the total respondents used bullocks for threshing.

Table 4.41: Post-harvesting operations in pulse crop

Threshing	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Manual	39(65)	38(63)	32(53)	43(72)	152(63)
Thresher	11(18)	14(23)	9(15)	12(20)	46(19)
Bullocks (trampling)	10(17)	8(13)	19(32)	5(8)	42(18)

Yield of Rajma (*Phaseolus vulgaris*)

The results in table 4.42 shows yield of Rajma (*Phaseolus vulgaris*). The result shows all the respondents in Doda, Kishtwar, Kathua and Udhampur district have grown desi variety. The total area (ha) under rajma of respondents was 16.6, 24.05, 11.7 and 11.6 ha in Doda, Kishtwar, Kathua and Udhampur district, respectively, as reported by respondents of each district. The average area under the rajma of the respondents was 0.28 (± 0.21) ha, 0.40 (± 0.46) ha, 0.19 (± 0.16) and 0.20 (± 0.15) ha in Doda, Kishtwar, Kathua and Udhampur district respectively. Overall total average area under rajma was 0.27 (± 0.29) ha. The total production of the respondents of Doda, Kishtwar, Kathua and Udhampur district was 41.33 q, 57.72 q, 32.17 q and 34.22 q respectively. The overall production as reported by all the respondents was 168.82 q. The average productivity of rajma of the respondents was 2.49, 2.40, 2.75 and 2.95 q/ha in Doda, Kishtwar, Kathua and Udhampur district

respectively. Therefore total average productivity of the respondents was 2.64 q/ha. The average quantity sold by respondents of Doda, Kishtwar, Kathua and Udhampur district was 1.54, 1.25, 1.40 and 1.50 q/ha respectively. The overall average quantity sold by all the respondents was 1.42q/ha. The average sold price as reported by respondents of Doda, Kishtwar, Kathua and Udhampur district was 12000, 11000, 10500 and 11500 ₹/q respectively. The overall average sold price was 11250 ₹/q. The 16 per cent, 24 per cent, 35 per cent and 48 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively sold produce to fellow farmer and an overall total 31 per cent of the respondents sold produce to fellow farmers. The 12 per cent, 12 per cent, 22 per cent and 22 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively sold produce to pulse market. Overall a total 17 per cent of the respondents sold produce to pulse market.

Table 4.42: Yield of Rajma (*Phaseolus vulgaris*)

Parameter	Doda (n=58)	Kishtwar (n=59)	Kathua (n=60)	Udhampur (n=58)	Overall (N=235)
Variety					
Desi	58	59	60	58	235
Total area (ha)	16.6	24.05	11.7	11.6	63.95
Average area (ha) ± SD	0.28 ±0.21	0.40±0.46	0.19±0.16	0.20±0.15	0.27±0.29
Total production (q)	41.33	57.72	32.17	34.22	168.82
Productivity (q/ha)	2.49	2.40	2.75	2.95	2.64
Average quantity sold (q/h)	1.54	1.25	1.40	1.50	1.42
Average Sold price (₹/q)	12000	11000	10500	11500	11250
To whom sold					
Fellow farmer	9(16)	14(24)	21(35)	28(48)	72(31)
Pulse market	7(12)	7(12)	13(22)	13(22)	40(17)

Yield of Black gram (*Vigna mungo*)

The results in table 4.43 shows yield of Black gram (*Vigna mungo*). The result shows all the respondents in Doda, Kishtwar, Kathua and Udhampur district have grown desi variety. The total area (ha) under black gram was 9.3, 14, 9.3 and 7.5 ha in Doda, Kishtwar, Kathua and Udhampur district respectively, as reported by respondents of each district. The average area under the black gram of the respondents was 0.18 (±0.11) ha, 0.29 (±0.39) ha, 0.18 (±0.17) ha and 0.16 (±0.13) ha in Doda,

Kishtwar, Kathua and Udhampur district respectively. Overall total average area under black gram was 0.20 (± 0.23) ha. The total production of the respondents of Doda, Kishtwar, Kathua and Udhampur district was 24.08 q, 28.84 q, 20.36 q and 15.30 q respectively. The overall production as reported by all the respondents was 99.04 q. The average productivity of black gram of the respondents was 2.59, 2.06, 2.19 and 2.04 q/ha in Doda, Kishtwar, Kathua and Udhampur district respectively. Overall average productivity of the respondents was 2.47 q/ha. The average quantity sold by respondents of Doda, Kishtwar, Kathua and Udhampur district was 1.30, 1.00, 1.10 and 1.01 q/ha respectively. The total average quantity sold by all the respondents was 1.10q/ha. The average sold price as reported by respondents of Doda, Kishtwar, Kathua and Udhampur district was 11000, 10000, 10000 and 11500 ₹/q respectively. The overall average sold price was 10625 ₹/q. The 14 per cent, 28 per cent, 24 per cent and 36 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively sold produce to fellow farmer and an overall total 25 per cent of the respondents sold produce to fellow farmers. The 45 per cent, 24 per cent, 35 per cent and 16 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur district respectively sold produce to pulse market. Overall a total 30 per cent of the respondents sold produce to pulse market.

Table 4.43: Yield of Black gram (*Vigna mungo*)

Parameter	Doda (n=49)	Kishtwar (n=46)	Kathua (n=49)	Udhampur (n=45)	Overall (N=189)
Variety					
Desi	49(100)	46(100)	49(100)	45(100)	189(100)
Total area (ha)	9.3	14	9.3	7.5	40.1
Average area (ha) \pm SD	0.18 \pm 0.11	0.29 \pm 0.39	0.18 \pm 0.17	0.16 \pm 0.13	0.20 \pm 0.23
Total production (q)	24.08	28.84	20.36	15.30	99.04
Productivity (q/ha)	2.59	2.06	2.19	2.04	2.47
Average quantity sold (q/ha)	1.30	1.00	1.10	1.01	1.10
Average Sold price (₹/q)	11000	10000	10000	11500	10625
To whom sold					
Fellow farmer	7(14)	13(28)	12(24)	16(36)	48(25)
Pulse market	22(45)	11(24)	17(35)	7(16)	57(30)

Yield of Green gram (*Vigna radiata*)

The results in table 4.44 shows yield of green gram (*Vigna radiata*). The result shows all the respondents in Doda, Kishtwar, Kathua and Udhampur district have grown desi variety. The total area (ha) under green gram was 6.2, 13.45, 5.45 and 5.0 ha in Doda, Kishtwar, Kathua and Udhampur district respectively, as reported by respondents of each district. The average area under the green gram as reported by respondents was 0.14 (± 0.08) ha, 0.29 (± 0.39) ha, 0.15 (± 0.12) ha and 0.13 (± 0.10) ha in Doda, Kishtwar, Kathua and Udhampur district respectively. Overall total average area under green gram was 0.18 (± 0.23) ha. The total production of the respondents of Doda, Kishtwar, Kathua and Udhampur district was 12.83q, 25.95q, 14.17q and 7.70q respectively. The overall production as reported by all the respondents was 60.80q. The average productivity of black gram of the respondents was 2.07, 1.93, 2.60 and 1.54 q/ha in Doda, Kishtwar, Kathua and Udhampur district respectively. Overall total average productivity of the respondents was 2.02 q/ha. The average quantity sold by respondents of Doda, Kishtwar, Kathua and Udhampur district was 1.2, 0.95, 1.5 and 0.75 q/ha respectively. The total average quantity sold by all the respondents was 1.10q/ha. The average sold price as reported by respondents of Doda, Kishtwar, Kathua and Udhampur district was 9795, 8450, 9000 and 10550 (₹/q) respectively. The overall average sold price was ₹9448.75 /q. The 5 per cent, 20 per cent, 19 per cent and 22 per cent respondents from Doda, Kishtwar, Kathua and Udhampur district respectively sold produce to fellow farmer and overall total 16 per cent of the respondents sold produce to fellow farmers. The 43 per cent, 26 per cent, 26 per cent and 15 per cent respondents from Doda, Kishtwar, Kathua and Udhampur district respectively sold produce to pulse market. Overall total of 28 per cent of the respondents sold produce to pulse market.

Table 4.44: Yield of Green gram (*Vigna radiata*)

Parameter	Doda (n=44)	Kishtwar (n=46)	Kathua (n=43)	Udhampur (n=41)	Overall (N=174)
Variety					
Desi	44(100)	46(100)	43(100)	41(100)	174(100)
Total area (ha)	6.2	13.45	5.45	5.00	30.10
Average area (ha) ± SD	0.14 ± 0.08	0.29 ± 0.39	0.15 ± 0.12	0.13 ± 0.10	0.18 ± 0.23
Total production (q)	12.83	25.95	14.17	7.70	60.80
Productivity (q/ha)	2.07	1.93	2.60	1.54	2.02
Average quantity sold (q/ha)	1.2	0.95	1.5	0.75	1.1
Average Sold price (₹/q)	9795	8450	9000	10550	9448.75
To whom sold					
Fellow farmer	2(5)	9(20)	8(19)	9(22)	28(16)
Pulse market	19(43)	12(26)	11(26)	6(15)	48(28)

Yield of Red lentil (*Lens culinaris*)

The table 4.45 shows the results of yield of red lentil (*Lens culinaris*). The results shows only respondents of Kishtwar district have grown red lentil. All the respondents from Kishtwar district have grown desi variety. The total area grown by respondents of Kishtwar district was 3.65 ha. The average area grown by respondents of Kishtwar district was 0.19 (± 0.06) ha. The total production of the respondents of the Kishtwar district was 5.00 q. The productivity of the respondents of Kishtwar district was 1.37 q/ha. The average quantity sold by the respondents of Kishtwar was 0.5 q/ha. The average selling price of red lentil of the respondents of Kishtwar district was ₹10000/q. The 11 per cent of the respondents from Kishtwar district sold produce to fellow farmer and 3 per cent of the respondents sold produce to market.

Table 4.45: Yield of Red lentil (*Lens culinaris*)

Parameter	Doda (n=0)	Kishtwar (n=36)	Kathua (n=0)	Udhampur (n=0)	Overall (N=36)
Variety					
Desi	0	36(100)	0	0	36(100)
Total area (ha)		3.65			3.65
Average area (ha) ± SD		0.1 ± 0.06			0.1 ± 0.06
Total production (q)		5.00			5.00
Productivity (q/ha)		1.37			1.37
Average quantity sold (q/ha)		0.5			0.5
Average Sold price (₹/q)		10000			10000
To whom sold					
Fellow farmer		4(11)			4(11)
Pulse market		1(3)			1(3)

Yield of Horse gram (*Macrotyloma uniflorum*)

The results in table 4.46 shows yield of Horse gram (*Macrotyloma uniflorum*). The result shows all the respondents in Doda and Kathua district have grown desi variety. The total area (ha) under horse gram was 2.75 and 3.4 ha in Doda and Kathua district respectively, as reported by respondents of each district. Overall total area under horse gram was 6.15 ha. The average area under the green gram of the respondents was 0.08 (±0.03) ha and 0.21 (±0.16) ha in Doda and Kathua district respectively. Overall total average area was 0.12 (±0.11) ha. The total production of the respondents of Doda and Kathua district was 8.28q and 12.47q respectively. The overall production as reported by all the respondents was 20.75 q. The average productivity of horse gram of the respondents was 3.07 and 3.67 q/ha in Doda and Kathua district respectively. Overall total average productivity of the respondents was 3.34 q/ha. The average quantity sold by respondents of Doda and Kathua was 1.75 and 1.90 q/ha respectively. The total average quantity sold by all the respondents of Doda and Kathua district was 1.82 q/ha. The average sold price as reported by respondents of Doda and Kathua district was 9500 and 10500 ₹/q respectively. The overall average sold price was 10000 ₹/q. The 35 per cent of the respondents from Doda district sold produce to fellow farmer. The 24 per cent and 100 per cent of the

respondents from Doda and Kathua district respectively sold produce to pulse market. Overall a total 48 per cent of the respondents sold produce to pulse market.

Table 4.46: Yield of Horse gram (*Macrotyloma uniflorum*)

Parameter	Doda (n=34)	Kishtwar (n=0)	Kathua (n=16)	Udhampur (n=0)	Overall (N=50)
Variety					
Desi	34(100)	0	16(100)	0	50(100)
Total area (ha)	2.75		3.4		6.15
Average area (ha) ± SD	0.08± 0.03		0.21± 0.16		0.12± 0.11
Total production (q)	8.28		12.47		20.75
Productivity (q/ha)	3.01		3.67		3.34
Total quantity sold (q)	4		15		19
Average quantity sold (q/ha)	1.75		1.90		1.82
Average Sold price (₹/q)	9500		10500		10000
To whom sold					
Fellow farmer	12(35)		0		12(24)
Pulse market	8(24)		16(100)		24(48)

Yield of French bean (*Phaseolus vulgaris*)

The results in table 4.47 shows yield of French bean (*Phaseolus vulgaris*). The result shows all the respondents in Doda, Kathua and Udhampur district have grown desi variety. The total area (ha) under French bean was 1.6, 1.3 and 0.95 ha in Doda, Kathua and Udhampur respectively, as reported by respondents of each district. The average area under the French bean of the respondents was 0.08 (±0.04) ha, 0.08 (±0.03) ha and 0.07 (±0.03) ha in Doda, Kathua and Udhampur district respectively. Overall total average area was 0.08 (±0.03) ha. The total production of the respondents of Doda, Kathua and Udhampur district was 4.46 q, 3.19 q and 2.72 q respectively. The overall production as reported by all the respondents of Doda, Kathua and Udhampur was 10.43 q. The average productivity of french bean of the

respondents was 2.79, 2.46 and 2.87 q/ha in Doda, Kathua and Udhampur district respectively. Overall total average productivity of the respondents of Doda, Kathua and Udhampur district was 2.71 q/ha. The average quantity sold by respondents of Doda, Kathua and Udhampur district was 0.2, 0.3 and 0.2 q/ha respectively. The total average quantity sold by all the respondents of Doda, Kathua and Udhampur district was 0.2 q/ha. The average sold price as reported by respondents of Doda, Kathua and Udhampur district was 11000, 10000 and 11000 ₹/q respectively. There overall average sold price was 10667.67 ₹/q. The 53 per cent, 33 per cent and 58 per cent of the respondents from Doda, Kathua and Udhampur district respectively sold produce to fellow farmer and Overall total of 48 per cent of the respondents sold produce to fellow farmers The 16 per cent, 67 per cent and 33 per cent respondents from Doda, Kathua and Udhampur district respectively sold produce to pulse market. Therefore total of 37 per cent of the respondents sold produce to pulse market.

Table 4.47: Yield of French bean (*Phaseolus vulgaris*)

Parameter	Doda (n=19)	Kishtwar (n=0)	Kathua (n=15)	Udhampur (n=12)	Overall (N=46)
Variety					
Desi	19(100)	0	15(100)	12(100)	46(100)
Total area (ha)	1.6		1.3	0.95	3.85
Average area (ha)±SD	0.08±0.04		0.08 ± 0.03	0.07 ± 0.03	0.08± 0.03
Total production (q)	4.46		3.19	2.72	10.43
Productivity (q/ha)	2.79		2.46	2.87	2.71
Total quantity sold (q)	3		4	2	9
Average quantity sold (q/ha)	0.2		0.3	0.2	0.2
Average Sold price (₹/q)	11000		10000	11000	10666.67
To whom sold					
Fellow farmer	10(53)		5(33)	7(58)	22(48)
Pulse market	3(16)		10(67)	4(33)	17(37)

Operation wise cost of cultivation, yield, income and C:B ratio of Rajma (*Phaseolus vulgaris*) and Maize crop (*Zea mays*)

Cost and return analysis of Rajma and maize crop is presented in Table 4.48. The table revealed that per hectare total cost of cultivation of Maize + Rajma was found to be highest (₹22599.10) in Kishtwar district followed by ₹219828.85, ₹21922.13, ₹21676.26 in Kathua, Udhampur and Doda districts, respectively with an overall average of ₹23380.56. The expenditure incurred for both the crops on preparation of land, use of farm yard manure, urea, DAP and hoeing was calculated combined and highest expenditure in all the districts was incurred on labour component for hoeing with an overall average of ₹4216.50 per hectare. For the purchase of seed, highest expenditure was incurred in case of Maize with an overall average of ₹1793.25 per hectare. The table further revealed that per hectare cost incurred for threshing of maize was higher as compare to Rajma and highest of ₹3160.00 was found both in Doda and Kishtwar district with an overall average of ₹3155.41.

Per hectare Yield of Rajma was found to be highest (2.95 quintals) in Udhampur district followed by 2.75 quintals, 2.49 quintals and 2.40 quintals in Kathua, Doda and Kishtwar districts, respectively with an overall average of 2.64 quintals. In case of maize, highest yield of 22.42 quintals per hectare was found in Kishtwar district with an overall average of 19.63 q/ha. Total Gross returns were found to be maximum (₹60260.00 per ha) in Kishtwar district with an overall average of ₹59164.44 per ha. However net returns were founded to be maximum of ₹38201.15 per ha in Kathua district with an overall value of ₹35783.88 per ha. Cost Benefit ratio was found to be highest (1:2.74) in Kathua district with an overall average of 1:2.53.

Table 4.48: Operation wise cost of cultivation, yield, income and C:B ratio of Rajma (*Phaseolus vulgaris*) and Maize crop (*Zea mays*)

Particular	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Seed (₹) ± SD					
Rajma	1563.79±31 6.61	1596.61±29 5.34	1290±219. 93	1437.93±301. 93	1471.06±308. 58
Maize	1791 ± 116.81	1791 ± 121.42	1690 ± 110.42	1794 ± 119.33	1793.25 ± 117.97
Land preparation (₹) ± SD	937.93±93.3 3	1025.42±27 7.04	940±92.42	941.37±91.83	961.27±163.5 2
FYM (₹) ± SD	3146.55±12 70.47	3005.08±13 07.85	3250±124 0.21	3224.13±1243 .13	3156.59±126 1.18
Urea (₹) ± SD	440 ± 54.77	1037.50±11 71.82	460.54±54 .77	440 ±54.77	750.61 ± 881.99
DAP (₹) ± SD	1600 ± 547.72	1208.33± 396.33	1700 ± 670.82	1600 ± 547.72	1444.44 ± 525.01
Hoeing (₹) ± SD	3700 ± 5662.42	4606.66±42 42.10	4280±389 9.97	4280 ± 3846.05	4216.5±4412. 63
Threshing (₹) ± SD					
Rajma	294.82±170. 05	266.10±153. 81	296.66±19 9.97	210.34±40.56	267.23±156.8 6
Maize	3160 ± 190.62	3160 ± 190.62	3153.33±1 92.63	3148.33 ± 179.91	3155.41 ± 187.39
Harvesting (₹) ± SD					
Rajma	2315.51±17 6.51	2185.74± 129.73	2146.66±8 1.23	2131.03±97.7 0	2194.04±144. 87
Maize	2726.66 ± 201.57	2716.66 ± 205.15	2721.66±2 03.43	2715 ± 199.85	2720± 201.29
Total Cost	21676.26	22599.1	21928.85	21922.13	23380.56
Yield (Qtls/ha)					
Rajma	2.49	2.40	2.75	2.95	2.64
Maize	18.81	22.42	21.04	16.58	19.63
Sale Price(₹/Qtls)					
Rajma	12000	11000	10500	11500	11250
Maize	1477.78	1507.14	1484.61	1487.5	1496.66
Gross return (₹) ± SD					
Rajma	29960 ± 13347.95	26460±1427 9.88	28880±1456 1.58	33972.41±249 5.03	29783.19± 12518.24
Maize	27782.26 ± 3487.50	33790.07±8 812.16	31236.19 ± 7144.09	24662.75 ± 3237.52	29379.43 ± 7023.23
Total gross return (Rajma+Maize)	57760	60260	60130	58647.41	59164.44
Net returns	36083.74	37660.9	38201.15	36725.28	35783.88
C:B ratio	1.66:1	1.67:1	1.74:1	1.67:1	1.53:1

Operation wise cost of cultivation, yield, income and C:B ratio of Black gram (*Vigna mungo*)

Cost and return analysis of Black gram is presented in Table 4.49. The table revealed that per hectare total cost of cultivation of Black gram was found to be highest (₹13411.2) in Doda district followed by ₹12016.54, ₹11702.37, ₹11462.21 in Kishtwar, Kathua and Udhampur districts, respectively with an overall average of ₹12148.08. The expenditure incurred for crop on preparation of land, use of farm yard manure, urea, DAP and hoeing was calculated and highest expenditure in all the districts was incurred on labour component for hoeing with an overall average of ₹3166.66 per hectare. For the purchase of seed, expenditure incurred with an overall average of ₹958.03 per hectare. The table further revealed that per hectare cost incurred for threshing of black gram was highest in Kathua with ₹318.36 and with an overall average of ₹282.19 in all districts.

Table 4.49: Operation wise cost of cultivation, yield, income and C:B ratio of Black gram (*Vigna mungo*)

Particular	Doda (n=49)	Kishtwar (n=47)	Kathua (n=49)	Udhampur (n=44)	Overall (N=189)
Seed (₹/ha) ± SD	994.48± 176.74	894.89± 141.13	923.77± 149.35	1023± 174.47	958.03± 167.79
Land preparation (₹/ha) ± SD	926.53± 97.41	995.83± 226.87	926.53± 97.41	924.44± 98.06	943.45± 143.80
FYM (₹/ha) ± SD	2989.79± 1324.80	2964.58± 1345.99	3081.63± 1316.35	3022.22± 1339.75	3014.66± 1321.71
Urea (₹/ha) ± SD	360 ± 54.77	320 ± 91.89	380 ± 83.66	360 ± 54.77	348 ± 77.02
DAP (₹/ha) ± SD	1800 ± 273.86	1500 ± 408.24	1800 ± 273.86	1800 ± 273.86	1680 ± 350
Hoeing (₹/ha) ± SD	3720 ± 3002.64	2893.33 ± 2201.22	3053 ± 2663.46	3000 ± 3354.32	3166.66 ± 2838.39
Threshing (₹/ha) ± SD	310.20± 180.56	281.25± 167.14	318.36± 215.70	213.33± 45.72	282.19± 170.44
Harvesting (₹/ha) ± SD	2310.20± 177.06	2166.66± 117.29	2142.85± 81.64	2142.22± 96.50	2191.62± 141.91
Total cost	13411.2	12016.54	11702.37	11462.21	12148.08
Yield (Qtls/ha)	2.59	2.7	2.43	2.24	2.49
Price per quintal	11000	10000	10000	11500	10625
Gross return (₹) ± SD	28523.40 ± 4895.17	27000.00 ± 5601.41	24300.00 ± 4188.43	25760 ± 5207.79	26456.25 ± 4973.20
Net returns (₹) ± SD	15112.2	14983.46	12597.63	14297.79	14247.77
C:B ratio	1.12:1	1.24:1	1.07:1	1.25:1	1.17:1

Per hectare Yield of Black gram was found to be highest (2.7 quintals) in Kishtwar district followed by 2.59 quintals, 2.43 quintals and 2.24 quintals in Doda, Kathua and Udhampur districts, respectively with an overall average of 2.49 quintals. Total Gross returns were found to be maximum (₹28523.40 per ha) in Doda district with an overall average of ₹26456.25 per ha. However net returns were founded to be maximum of ₹15112.2 per ha in Doda district with an overall value of ₹14247.77 per ha. Cost Benefit ratio was found to be highest (1.25:1) in Udhampur district with an overall average of 1.17:1.

Operation wise cost of cultivation, yield, income and C:B ratio of Green gram (*Vigna radiata*)

Cost and return analysis of Green gram is presented in Table 4.50. The table revealed that per hectare total cost of cultivation of Green gram was found to be highest (₹11474.29) in Doda district followed by ₹10996.25, ₹10975.69, ₹10810.04 in Kathua, Kishtwar and Udhampur districts, respectively with an overall average of ₹11070.55. The expenditure incurred for crop on preparation of land, use of farm yard manure, urea, DAP and hoeing was calculated and highest expenditure in all the districts was incurred on FYM with an overall average of ₹2991.46 per hectare. For the purchase of seed, expenditure incurred with an overall average of ₹657.21 per hectare. The table further revealed that per hectare cost incurred for threshing of green gram was highest in Doda with ₹322.72 and with an overall average of ₹268.90 in all districts.

Per hectare Yield of green gram was found to be highest (2.60 quintals) in Kathua district followed by 2.45 quintals, 2.35 quintals and 2.07 quintals in Udhampur, Kishtwar and Doda districts, respectively with an overall average of 2.37 quintals. Total Gross returns were found to be maximum (₹25847.50 per ha) in Udhampur district with an overall average of ₹22367.16 per ha. However net returns were founded to be maximum of ₹15037.46 per ha in Udhampur district with an overall value of ₹11296.61 per ha. Cost Benefit ratio was found to be highest (1.39:1) in Udhampur district with an overall average of 1.02:1.

Table 4.50: Operation wise cost of cultivation, yield, income and C:B ratio of Green gram (*Vigna radiata*)

Particular	Doda (n=44)	Kishtwar (n=44)	Kathua (n=36)	Udhampur (n=37)	Overall (N=161)
Seed (₹/ha) ± SD	649.77± 94.64	655.65± 99.23	675.55± 97.87	650.52± 93.31	657.21± 95.99
Land preparation (₹/ha) ± SD	920± 99.08	1000± 229.97	911.11± 100.79	915.78± 100.07	939.39± 151.69
FYM (₹/ha) ± SD	2965.90± 1390.99	2980.43± 1341.24	2972.22± 1438.97	3052.63± 1413.20	2991.46± 1380.64
Urea (₹/ha) ± SD	360 ± 54.77	285.71 ± 37.79	340 ± 54.77	361 ± 54.99	331.81 ± 56.79
DAP (₹/ha) ± SD	1800 ± 273.86	1214.28 ± 267.26	1700 ± 273.86	1846 ± 293.75	1590.90± 366.33
Hoeing (₹/ha) ± SD	2140 ± 1985.47	2398.33 ± 2144.01	1991.83 ± 1830.28	1655.17 ± 2055.30	2052.42 ± 2020.19
Threshing (₹/ha) ± SD	322.72± 186.60	271.73± 122.31	266.66± 163.88	205.26± 22.62	268.90± 144.66
Harvesting (₹/ha) ± SD	2315.90± 177.76	2169.56± 113.27	2138.88± 87.15	2123.68± 85.21	2191.46± 145.44
Total cost	11474.29	10975.69	10996.25	10810.04	11070.55
Yield (Qtls/ha)	2.07	2.35	2.60	2.45	2.37
Price per quintal	9795	8450	9000	10550	9448.75
Gross return (₹) ± SD	20363.64 ± 4319.18	19857.50 ± 4200.20	23400 ± 5626.38	25847.50 ± 4329.26	22367.16 ± 4618.75
Net returns (₹) ± SD	8889.35	8881.81	12403.75	15037.46	11296.61
C:B ratio	0.77:1	0.81:1	1.12:1	1.39:1	1.02:1

Operation wise cost of cultivation, yield, income and C:B ratio of Red lentil (*Lens culinaris*)

Cost and return analysis of Red lentil is presented in Table 4.51. The table revealed that per hectare total cost of cultivation of horse gram was found to be highest (₹9461.96) in Kishtwar district. The expenditure incurred for crop on preparation of land, use of farm yard manure, urea, DAP and hoeing was calculated and highest expenditure in all the districts was incurred on FYM with an overall average of ₹2540.33 per hectare. For the purchase of seed, expenditure incurred with an overall average of ₹1543.54 per hectare. The table further revealed that per hectare cost incurred for threshing of Red lentil with an overall average of ₹172.22.

Per hectare Yield of Red lentil was found (1.89 q/ha) in Kishtwar district. Total Gross returns were found (₹18900.00 per ha) in Kishtwar district. However net returns were founded ₹6438.04 per ha in Kishtwar district. Cost Benefit ratio was found (0.99:1) in Kishtwar district.

Table 4.51: Operation wise cost of cultivation, yield, income and C:B ratio of Red lentil (*Lens culinaris*)

Particular	Doda (n=0)	Kishtwar (n=36)	Kathua (n=0)	Udhampur (n=0)	Overall (N=36)
Seed (₹/ha) ± SD		1543.54 ± 183.00			1543.54 ± 183.00
Land preparation (₹/ha) ± SD		930.66± 253.54			930.66± 253.54
FYM (₹/ha) ± SD		2540.33 ± 115.47			2540.33 ± 115.47
Urea (₹/ha) ± SD		966.66 ± 250.00			966.66 ± 250.00
DAP (₹/ha) ± SD		940 ± 1628.89			940 ± 1628.89
Hoeing (₹/ha) ± SD		1015.78 ± 1636.61			1015.78 ± 1636.61
Threshing (₹/ha) ± SD		172.22± 123.31			172.22± 123.31
Harvesting (₹/ha) ± SD		1352.77± 105.52			1352.77± 105.52
Total cost		9461.96			9461.96
Yield (q/ha)		1.89			1.89
Price per quintal		10000			10000
Gross return (₹) ± SD		18900.00 ± 2513.95			18900.00 ± 2513.95
Net returns (₹) ± SD		6438.04			6438.04
C:B ratio		0.99:1			0.99:1

Operation wise cost of cultivation, yield, income and C:B ratio of Horse gram (*Macrotyloma uniflorum*)

Cost and return analysis of Horse gram is presented in Table 4.52. The table revealed that per hectare total cost of cultivation of horse gram was found to be highest (₹11346.25) in Kathua district followed by ₹10237.39 in Doda district with an overall average of ₹10590.89. The expenditure incurred for crop on preparation of land, use of farm yard manure, urea, DAP and hoeing was calculated and highest

expenditure in all the districts was incurred on FYM with an overall average of ₹3100 per hectare. For the purchase of seed, expenditure incurred with an overall average of ₹1587.6 per hectare. The table further revealed that per hectare cost incurred for threshing of horse gram was highest in Kathua with ₹468.75 and with an overall average of ₹391.83 in two districts.

Per hectare Yield of horse gram was found to be highest (3.67 quintals) in Kathua district followed by 3.01 quintals in Doda district with an overall average of 3.34 quintals. Total Gross returns were found to be maximum (₹38535.00 per ha) in Kathua district with an overall average of ₹33400 per ha. However net returns were founded to be maximum of ₹27188.75 per ha in Kathua district with an overall value of ₹22809.11 per ha. Cost Benefit ratio was found to be highest (2.39:1) in Kathua district with an overall average of 2.15:1.

Table 4.52: Operation wise cost of cultivation, yield, income and C:B ratio of Horse gram (*Macrotyloma uniflorum*)

Particular	Doda (n=34)	Kishtwar (n=0)	Kathua (n=16)	Udhampur (n=0)	Overall (N=50)
Seed (₹/ha) ± SD	1597.64± 154.58		1566.25 ± 157.30		1587.6 ± 154.55
Land preparation (₹/ha) ± SD	917.64± 99.91		937.5 ± 95.74		924 ± 98.06
FYM (₹/ha) ± SD	2985.29± 1416.81		3343.75 ± 1220.91		3100 ± 1355.26
Urea (₹/ha) ±SD	0		0		0
DAP (₹/ha) ±SD	0		0		0
Hoeing (₹/ha) ± SD	2055.81 ± 5036.68		2880 ± 2103.03		2317.46 ± 4323.17
Threshing (₹/ha) ± SD	354.54 ± 203.24		468.75 ± 275		391.83± 232.59
Harvesting (₹/ha) ± SD	2326.47± 178.05		2150 ± 81.64		2270± 174.08
Total cost	10237.39		11346.25		10590.89
Yield (Qtls/ha)	3.01		3.67		3.34
Price per quintal	9500		10500		10000
Gross return (₹) ± SD	28595.00 ± 6809.28		38535.00 ± 7254.79		33400 ± 7032.03
Net returns (₹) ± SD	18357.61		27188.75		22809.11
C:B ratio	1.79:1		2.39:1		2.15:1

**Operation wise cost of cultivation, yield, income and C:B ratio of French bean
(*Phaseolus vulgaris*)**

Cost and return analysis of French bean is presented in Table 4.53. The table revealed that per hectare total cost of cultivation of French bean was found to be highest (₹9461.32) in Kathua district followed by ₹9166.65 and ₹8812.61 in Udhampur and Doda districts, respectively with an overall average of ₹9146.86. The expenditure incurred for crop on preparation of land, use of farm yard manure, urea, DAP and hoeing was calculated and highest expenditure in all the districts was incurred on FYM with an overall average of ₹3228.26per hectare. For the purchase of seed, expenditure incurred with an overall average of ₹1833.04per hectare. The table further revealed that per hectare cost incurred for threshing of French bean was highest in Doda with ₹421.05 and with an overall average of ₹343.43 in three districts.

Table 4.53: Operation wise cost of cultivation, yield, income and C:B ratio of French bean (*Phaseolus vulgaris*)

Particular	Doda (n=19)	Kishtwar (n=0)	Kathua (n=15)	Udhampur (n=11)	Overall (N=45)
Seed (₹/ha) ± SD	1814.73± 188.66		1808± 193.13	1893.33± 164.77	1833.04± 183.84
Land preparation (₹/ha) ± SD	905.26± 102.59		986.66± 51.63	983.33± 57.73	952.17± 86.25
FYM (₹/ha) ± SD	2657.89± 1491.20		3666.66± 816.49	3583.33± 900.33	3228.26± 1236.96
Urea (₹/ha) ± SD	0		0	0	0
DAP (₹/ha) ± SD	0		0	0	0
Hoeing (₹/ha) ± SD	640 ± 1136.63		500 ± 944.92	373.33 ± 836.02	378.33 ± 876.77
Threshing (₹/ha) ± SD	421.05± 227.49		340± 255.79	225± 62.15	343.43± 219.74
Harvesting (₹/ha) ± SD	2373.68± 166.13		2160± 73.67	2108.33± 99.62	2234.78± 171.55
Total cost	8812.61		9461.32	9166.65	9146.86
Yield (Qtls/ha)	2.79		2.46	2.87	2.71
Price per quintal	11000		10000	11000	10666.67
Gross return (₹) ± SD	30690 ± 5159.03		24600.00 ± 3557.64	31570 ± 4083.16	28906.67 ± 19035.32
Net returns (₹) ± SD	21877.39		15138.68	22403.35	19759.81
C:B ratio	2.48:1		1.60:1	2.44:1	2.16:1

Per hectare Yield of French bean was found to be highest (2.87 quintals) in Udhampur district followed by 2.79 quintals and 2.46 quintals in Doda and Kathua districts, respectively with an overall average of 2.71 quintals. Total Gross returns were found to be maximum (₹31570 per ha) in Udhampur district with an overall average of ₹28906.67 per ha. However net returns were founded to be maximum of ₹22403.35 per ha in Udhampur district with an overall value of ₹19759.81 per ha. Cost Benefit ratio was found to be highest (2.48:1) in Doda district with an overall average of 2.16:1.

Storage methods of pulse crop grains

The table 4.54 shows results of storage methods of pulse crop grains. The results show store bin was used by 73, 68, 58 and 78 percent of respondents from Doda, Kishtwar, Kathua and Udhampur respectively. Overall, 70 percent of total respondents used store bin to store pulse grains. 27, 32, 42 and 22 percent of the respondents from Doda, Kishtwar, Kathua and Udhampur respectively used traditional bin to store pulse grain. It means overall 30 percent of the total respondents used traditional bin to store pulse grains.

Table 4.54: Storage methods of pulse crop grains

Storage	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Store bin	44(73)	41(68)	35(58)	47(78)	167(70)
Traditional bin	16(27)	19(32)	25(42)	13(22)	73(30)

Constraints enlisted by farmers in cultivation of pulse crop

The table 4.55 shows result of constraints enlisted by farmers in cultivation of pulse crop. The results shows 88, 92, 85 and 67 per cent of growers from Doda, Kishtwar, Kathua and Udhampur respectively, expressed lack of irrigation as major constraint. Overall 83 percent of total respondents expressed lack of irrigation as major constraint. The poor extension linkage was expressed by 67, 52, 80 and 57 percent from Doda, Kishtwar, Kathua and Udhampur as a constraint. It means overall 64 percent of total respondents expressed poor extension linkage as a constraint. 87, 72, 70 and 70 per cent of respondents from Doda, Kishtwar, Kathua and Udhampur, respectively expressed lack of awareness as constraint. This shows 75 per cent of respondents expressed lack of awareness as constraint. Inputs are not available at right time was expressed by 55, 28, 73 and 38 percent of the respondents from Doda, Kishtwar, Kathua and Udhampur

respectively. It means overall 49 per cent of respondents expressed inputs not available at right time as a constraint. 23, 60, 13 and 8 percent of respondents from Doda, Kishtwar, Kathua and Udhampur respectively expressed wild animal destroyed crop as a problem. Overall, 26 percent of total respondents expressed wild animal destroyed the crop as a constraint. The problem of shattering during harvesting time was expressed by 13, 22, 17 and 15 per cent of respondents from Doda, Kishtwar, Kathua and Udhampur respectively. Overall 17 percent of total respondents expressed shattering problem during harvesting time as a constraint.

Table 4.55: Constraints enlisted by farmers in cultivation of pulse crop

Constraint	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Lack of irrigation facility	53(88)	55(92)	51(85)	40(67)	199(83)
Poor extension linkages	40(67)	31(52)	48(80)	34(57)	153(64)
Lack of awareness	52(87)	43(72)	42(70)	42(70)	179(75)
Inputs not available at right time	33(55)	17(28)	44(73)	23(38)	117(49)
Wild animal destroy the crop	14(23)	36(60)	8(13)	5(8)	63(26)

Suggestions put forth by respondents for improving the productivity of pulse crop

The table 4.56 shows results of suggestions put forth by respondents for improving the productivity of pulse crop. The results shows 85, 88, 77 and 87 percent of respondents from Doda, Kishtwar, Kathua and Udhampur districts respectively suggested proper awareness regarding pulse crop cultivation should be provided. Overall, 84 percent of total respondents suggested proper awareness regarding pulse crop cultivation should be provided. 25, 32, 12 and 38 percent of respondents from Doda, Kishtwar, Kathua and Udhampur districts respectively suggested organic cultivation of pulse should be promoted. Overall, 27 percent of total respondents suggested organic cultivation of pulse should be promoted. 88, 92, 85 and 67 percent of respondents from Doda, Kishtwar, Kathua and Udhampur districts respectively suggested that irrigation facilities needs to be strengthened. It means overall 83 percent of total farmers suggested that an irrigation facility needs to be strengthened.

62, 58, 70 and 65 percent of respondents from Doda, Kishtwar, Kathua and Udhampur districts respectively suggested marketing linkages should be promoted. It means overall 64 percent of the total farmers suggested marketing linkages should be promoted. 12, 25, 15 and 18 percent of the total respondents from Doda, Kishtwar, Kathua and Udhampur districts respectively suggested more research should be done on developing rainfed varieties. Overall 18 percent of the total respondents suggested that more research should be done on developing rainfed varieties. Storage facility needs to be developed was suggested by 38, 28, 32 and 45 per cent of the respondents from Doda, Kishtwar, Kathua and Udhampur districts respectively. It means overall 36 percent of the total respondents suggested storage facilities needs to be developed.

Table 4.56: Suggestions put forth by respondents for improving the productivity of pulse crop

Suggestion	Doda (n=60)	Kishtwar (n=60)	Kathua (n=60)	Udhampur (n=60)	Overall (N=240)
Proper awareness regarding pulse crop cultivation should be provided	51(85)	53(88)	46(77)	52(87)	202(84)
Organic cultivation of pulse crop should be promoted	15(25)	19(32)	7(12)	23(38)	64(27)
Irrigation facilities needs to be strengthened	53(88)	55(92)	51(85)	40(67)	199(83)
Marketing linkages should be promoted	37(62)	35(58)	42(70)	39(65)	153(64)
More research should be done on developing rain-fed varieties	7(12)	15(25)	9(15)	11(18)	42(18)
Storage facilities needs to be developed	23(38)	17(28)	19(32)	27(45)	86(36)

Digital database and mapping of pulse crop grown

The results presented in table 4.57 revealed that in case of six selected villages from Doda district namely Bigota, Masari, Shekpura, Bathoh, Tantla Thilroo were having latitude and longitude (75.58155, 33.10446), (75.56686, 33.09446), (75.57873, 33.08548), (75.57112, 33.10303), (75.57726, 33.09207), (75.58457, 33.08723), respectively and pulses grown in these villages were Rajma, Black gram, Green gram, Horse gram and French bean. In case of six selected villages from Kishtwar district namely Bhata, Moolcharar, Seeri, Sigdi, Markhar, Bankari, Dahayan having latitude and longitude (75.63105, 33.52031), (75.63695, 33.45965), (75.60092, 33.47102), (75.59178, 33.47733), (75.61303, 33.43984) (75.60114, 33.43124) and pulses grown

in these villages were Rajma, Black gram, Green gram and Red lentil. In case of six selected villages from Kathua district namely Machedi, Badnota, Nangla, Dull Bijohi, Najot, Kindli having latitude and longitude (75.59816, 32.70123), (75.63113, 32.73562), (75.60651, 32.68819), (75.59886, 32.70803), (75.59189, 32.66653), (75.60441, 32.73522) and pulse grown in these villages were Rajma, Black gram, Green gram, Horse gram and French bean. In case of six selected villages from Udhampur district namely Kultyar, Upper meer, Lower meer, Gailote, Sadhota, Suman having latitude and longitude (75.16333, 33.07143), (75.12999, 33.03086), (75.12705, 33.04711), (75.14129, 33.07402), (75.09844, 33.09973), (75.12337, 33.07776) and pulse grown in these villages were Rajma, Black gram, Green gram and French bean.

Table 4.57: Digital database and mapping of pulse crop grown in study area

Parameter	Village	Latitude	Longitude	Pulse crop grown
Doda District				
	Bigota	75.58155	33.10446	Rajma, Black gram, Green gram, Horse gram, French bean
	Masari	75.56686	33.09446	Rajma, Black gram, Green gram, Horse gram, French bean
	Shekpura	75.57873	33.08548	Rajma, Black gram, Green gram, Horse gram, French bean
	Bathoh	75.57112	33.10303	Rajma, Black gram, Green gram, Horse gram, French bean
	Tantla	75.57726	33.09207	Rajma, Black gram, Green gram, Horse gram, French bean
	Thilroo	75.58457	33.08723	Rajma, Black gram, Green gram
Kishtwar District				
	Bhata	75.63105	33.52031	Rajma, Black gram, Green gram, Red lentil
	Moolcharar	75.63695	33.45965	Rajma, Black gram, Green gram, Red lentil
	Seeri Sigdi	75.60092	33.47102	Rajma, Black gram, Green gram, Red lentil
	Markhar	75.59178	33.47733	Rajma, Black gram, Green gram, Red lentil
	Bankari	75.61303	33.43984	Rajma, Black gram, Green gram, Red lentil
	Dahayan	75.60114	33.43124	Rajma, Black gram, Green gram, Red lentil

Kathua District				
	Machedi	75.59816	32.70123	Rajma, Black gram, Green gram, Horse gram, French bean
	Badnota	75.63113	32.73562	Rajma, Black gram, Green gram, Horse gram
	Nangala	75.60651	32.68819	Rajma, Black gram, Green gram, French bean
	Dull Bijohi	75.59886	32.70803	Rajma, Black gram, Green gram
	Najot	75.59189	32.66653	Rajma, Black gram, Green gram
	Kindli	75.60441	32.73522	Rajma, Black gram, Green gram
Udhampur District				
	Kulytar	75.16333	33.07143	Rajma, Black gram, Green gram, French bean
	Upper Meer	75.12999	33.03086	Rajma, Black gram, Green gram
	Lower Meer	75.12705	33.04711	Rajma, Black gram, Green gram, French bean
	Gailote	75.14129	33.07402	Rajma, Black gram, Green gram, French bean
	Sadhota	75.09844	33.09973	Rajma, Black gram, Green gram
	Suman	75.12337	33.07776	Rajma, Black gram, Green gram, French bean

The result presented that the mapping of pulse crop using GPS coordinates could identify the major pulses grown in study area. Figure 4.13, 4.14, 4.15 showed that Rajma (*Phaseolus vulgaris*), Black gram (*Vigna mungo*), Green gram (*Vigna radiata*) were cultivated in four selected district of Jammu and Kashmir UT namely Doda, Kishtwar, Kathua and Udhampur district. In figure 4.18, 4.17 and 4.16 revealed that Red lentil (*Lens culinaris*) was cultivated in Kishtwar district, Horse gram (*Macrotyloma uniflorum*) was cultivated in Kathua district and French bean (*Phaseolus vulgaris*) was cultivated in Doda, Kathua and Udhampur district respectively.

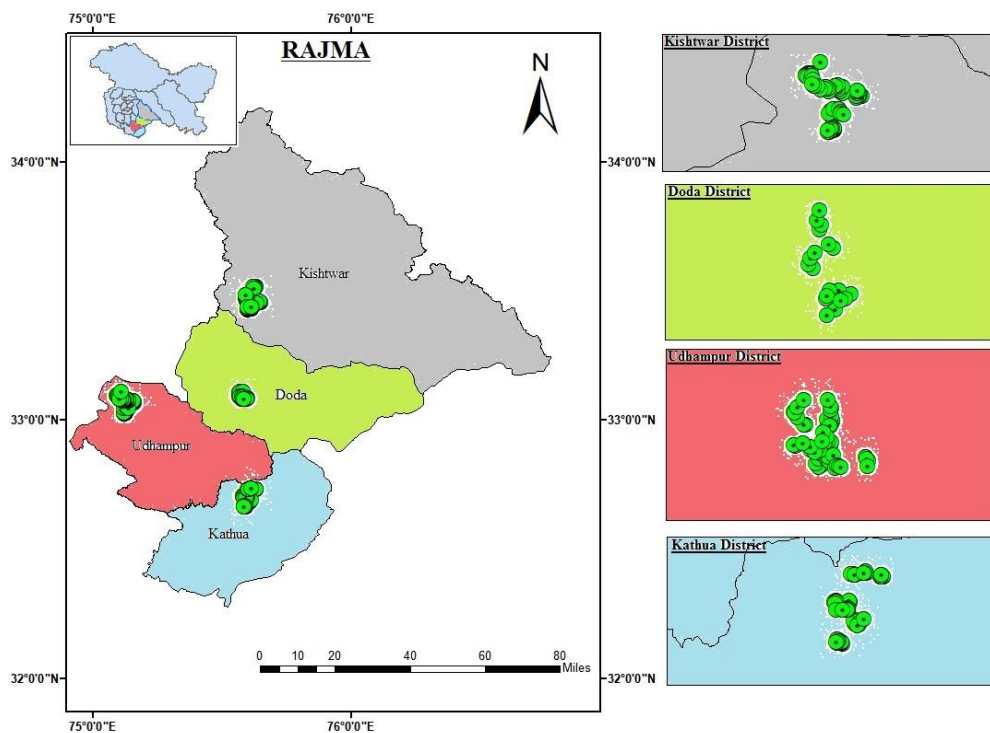


Figure 4.13: Map of Rajma crop cultivation

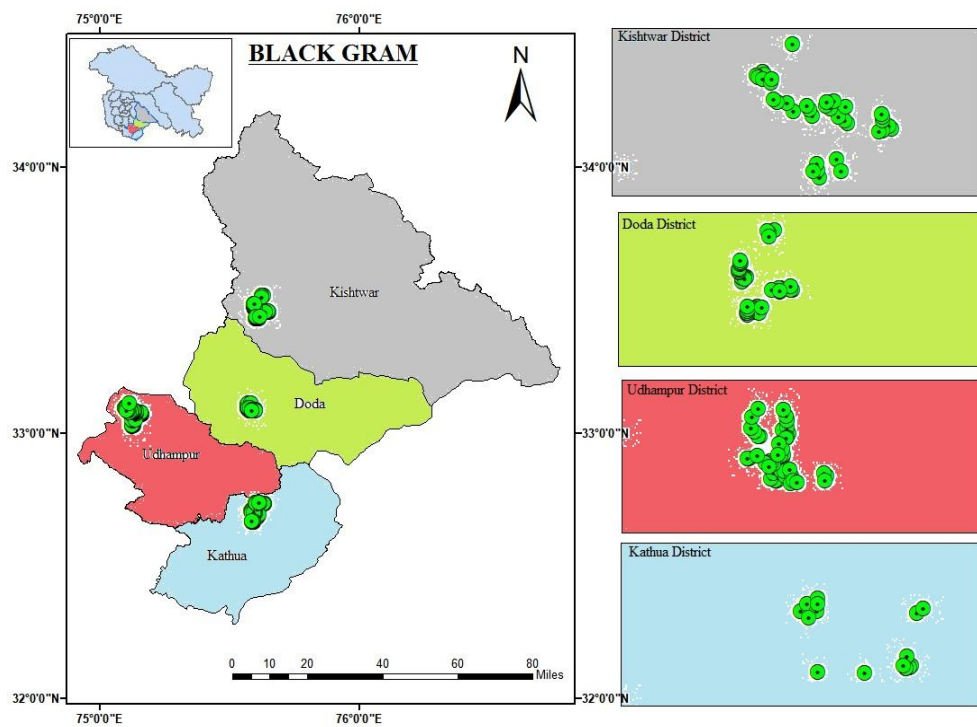


Figure 4.14: Map of Black gram cultivation

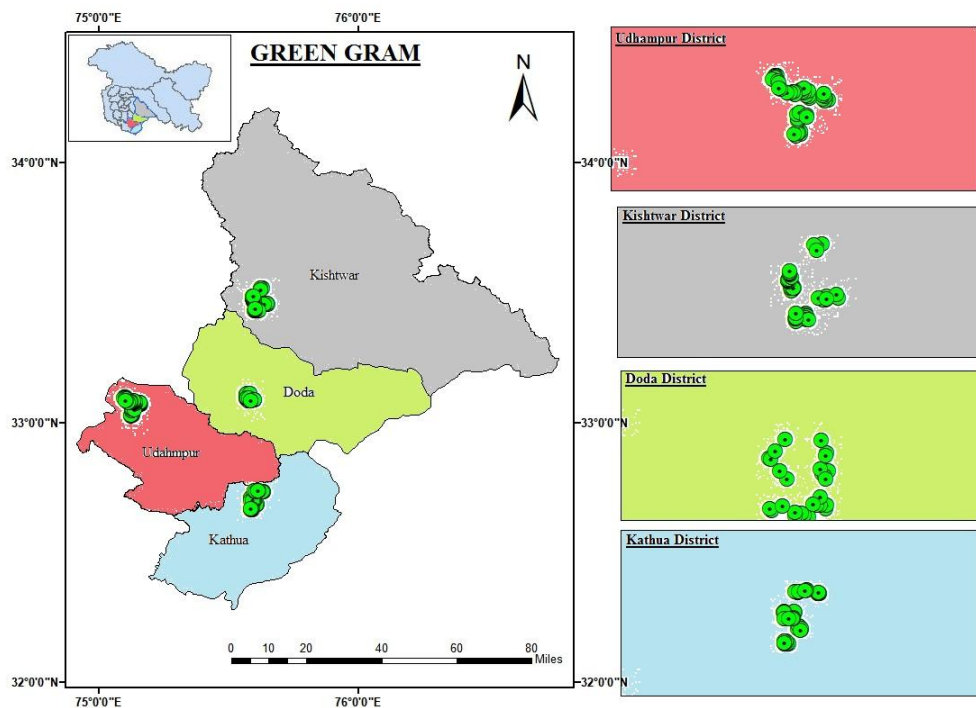


Figure 4.15: Map of Green gram cultivation

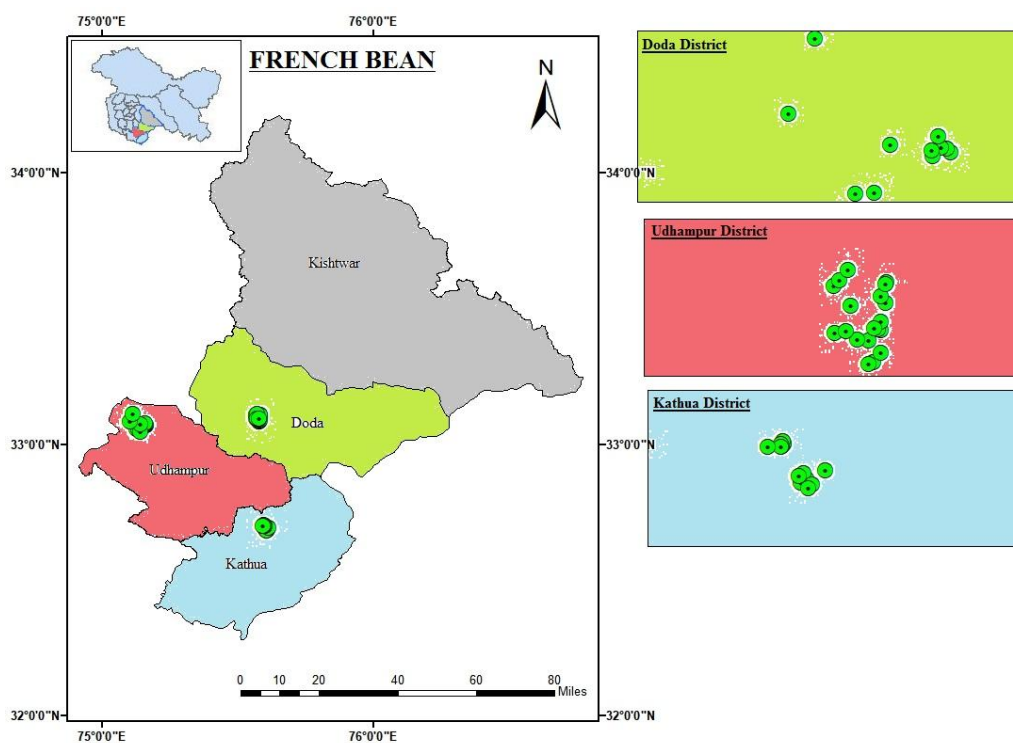


Figure 4.16: Map of French bean cultivation

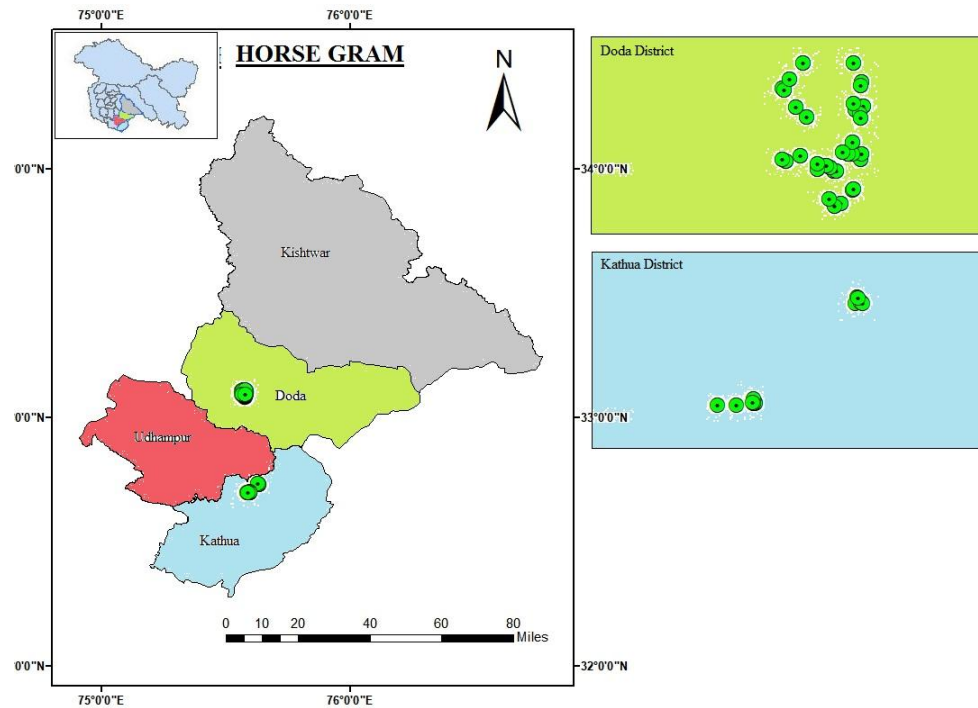


Figure 4.17: Map of Horse gram cultivation

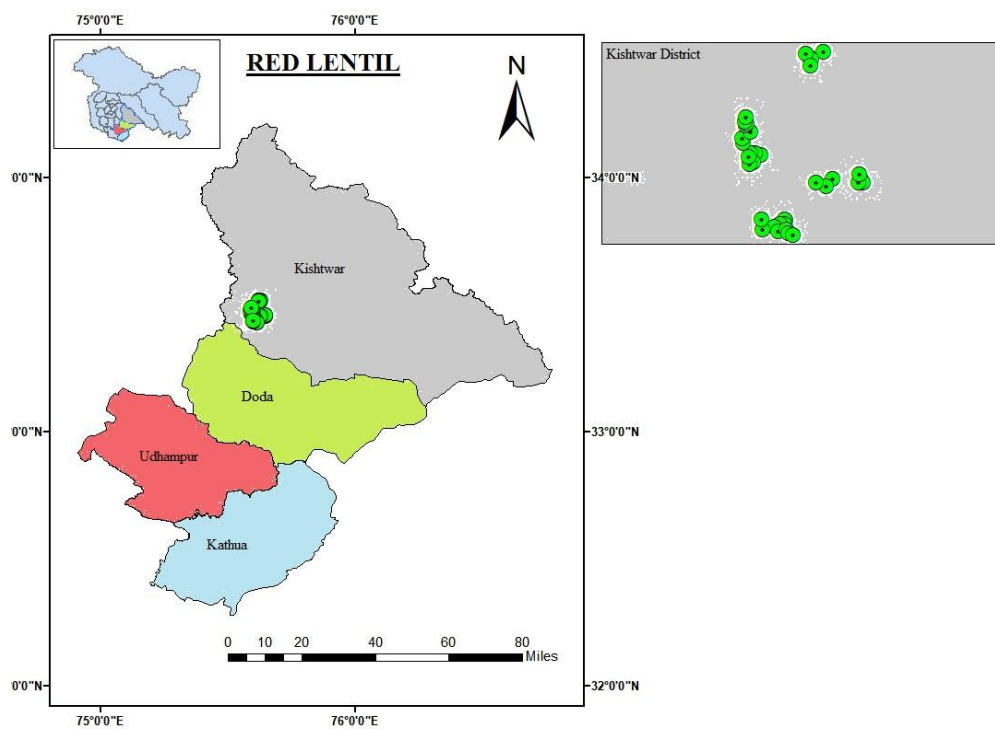


Figure 4.18: Map of Red lentil cultivation

Factor affecting per cent of income from pulse crop in total annual income of the respondents

Linear regression model was applied to analyze the factors affecting per cent of income from pulse crop to total annual income of the respondents (Table 4.58). The per cent of pulse income was against various independent variables (age, qualification, farming, family size, land holding, irrigated land, unirrigated land, fragmentation, farming experience, livestock, on-farm income, off-farm income, source of information, extension contact and productivity of pulse). It was revealed that among all the factors age ($p = .000$), land holding ($p = .002$), fragmentation ($p = .000$), farming experience ($p = .000$), on-farm income ($p = .000$), off-farm income ($p = .001$), extension contact ($p = .003$) and productivity of pulse ($p = .004$) significantly affected the per cent of income from pulse crop of the respondent having R^2 value = .499 which indicates that model so applied had prediction power of 49 per cent.

Table 4.58: Factor affecting per cent of income from pulse crop in total annual income of the respondents

Dependent variable	Independent variables	Coefficient (B)	S.E	t-value (p-value)	Model summary
Per cent of pulse income from total income	(Constant)	37.237	9.006	4.135(.000)	F= 6.316 R square= .499 Adjusted R square= .452
	Age	.271	.147	-1.846 (.000)	
	Qualification	.353	.205	-1.725(.086)	
	Farming	-.109	6.296	-.017(.986)	
	Family size	.098	.558	.176(.860)	
	Land holding	8.437	10.131	.833 (.002)	
	Irrigated land	-9.789	10.795	-.907(.366)	
	Unirrigated land	-3.401	10.340	-.329(.742)	
	Fragmentation	.034	.863	.040(.000)	
	Farming Experience	.131	.144	.912(.000)	
	Livestock	-.308	.789	-.391(.696)	
	On farm income	.350	.112	6.462(.000)	
	Off farm income	.480	.013	3.412(.001)	
	Source of information	-1.504	.842	-1.786(.075)	
	Extension contact	3.690	1.247	2.960(.003)	
Productivity	.715	.779	-.918(.004)		

Principal Component Analysis of pulse crop cultivation

The result presented in table 4.59 revealed that Doda district data were considered in each components with Eigen value >1 which determined at least 10% of the variation. The higher Eigen values were considered as best representative of system attributes in principal components. Only five components showed more than 1 Eigen value and first principal component accounted for 32.23 per cent of variation in Doda district with an eigen value of 4.51, therefore these five components were given due important for the further explanation. Components were used for further explanation.

In table 4.60, the contribution of each and every variable used in this study can be seen. Here columns represented the variables. From PC1 it was found that area variable (0.918) had highest amount of loading followed by un-irrigated land variable (0.816), maximum fragmentation variable (0.793) and so on. From PC2 it was found that total income variable (0.870) had highest amount of loading followed by on-farm income variable (0.819), off-farm income variable (0.515) and so on. From PC3 it was found that minimum fargmentation variable (0.694) had highest amount of loading followed by maximum fragmentation variable (0.384), farming experience variable (0.351) and so on. From PC4 it was found that irrigated land variable (0.524) had highest amount of loading followed by off-farm income variable (0.445), age variable (0.274) and so on.

In figure 4.19, scree plot showed that the eigenvalues start to form a straight line after the first principal component. Therefore, the remaining principal components account for a very small proportion of the variability.

In figure 4.20, Bi plot showed that horizontal axis represents PC1 and vertical axis represents PC2. Length of arrows represents the amount of the contribution by a particular variable. Longer the length of arrow higher was the contribution of that particular variable. The circumference of the circle in this biplot is known as correlation circle. If the arrows are closer to the circumference of the circle they were having high correlation. Density of the color also represented the amount of contribution. With respect to PC1 age had highest amount of contribution and with respect to PC2 total income, on-farm income, area, unirrigated variable and maximum fragmentation had highest amount of contribution.

Table 4.59: Total variance explained of pulse crop cultivation in Doda district

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.513	32.238	32.238	4.513	32.238	32.238
2	2.063	14.736	46.974	2.063	14.736	46.974
3	1.977	14.118	61.092	1.977	14.118	61.092
4	1.380	9.854	70.946	1.380	9.854	70.946
5	.952	6.797	77.743			
6	.901	6.436	84.179			
7	.729	5.208	89.387			
8	.590	4.212	93.599			
9	.343	2.453	96.051			
10	.294	2.097	98.148			
11	.178	1.271	99.419			
12	.069	.493	99.912			
13	.012	.088	100.000			
14	-3.766E-16	-2.690E-15	100.000			
Extraction Method: Principal Component Analysis.						

Table 4.60: Component Matrix of pulse crop cultivation in Doda district

Component Matrix ^a				
Variable	Component			
	1	2	3	4
Age	-.724	.060	.327	.274
Qualification	.404	.117	-.682	-.027
Animal.Rearing	-.220	.261	-.324	-.666
Area	.918	-.172	.130	.070
Irrigated land	.522	.176	-.378	.524
Un.Irrigated land	.816	-.251	.298	-.057
Fragmentation	.530	-.063	-.422	.182
Max.Frag	.793	-.258	.384	-.152
Min.Frag	.429	-.124	.694	-.037
Farming Experience	-.717	.044	.351	.249
Onfarm income	.324	.819	.224	-.250
Offfarm income	.241	.515	.095	.445
Pulse income	.269	-.232	-.119	.147
Total income	.391	.870	.218	-.069
Extraction Method: Principal Component Analysis.				
a. 5 components extracted.				

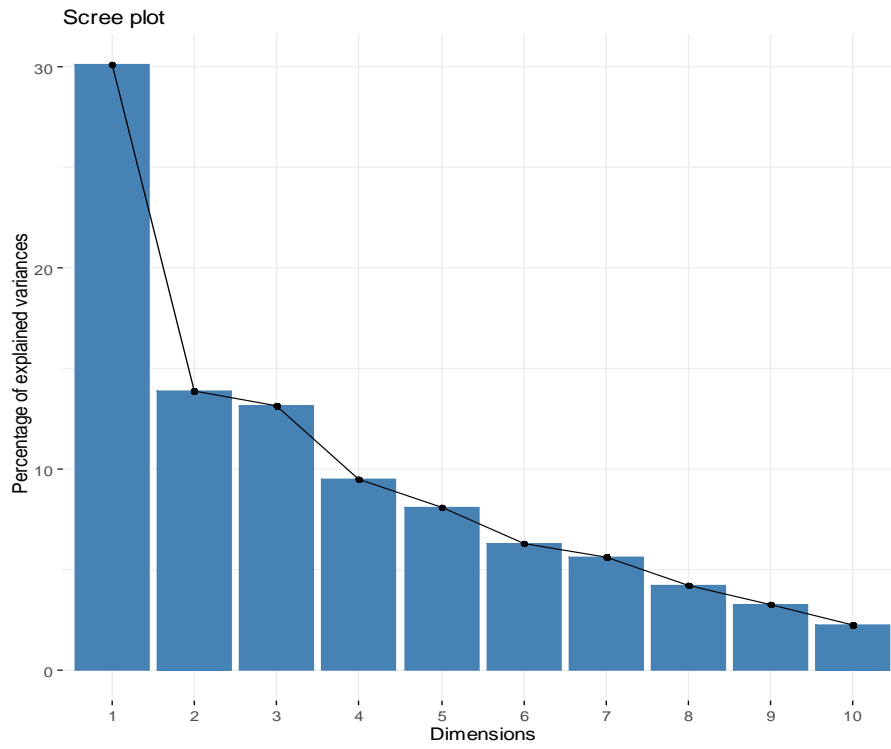


Figure 4.19: Scree plot of Doda district

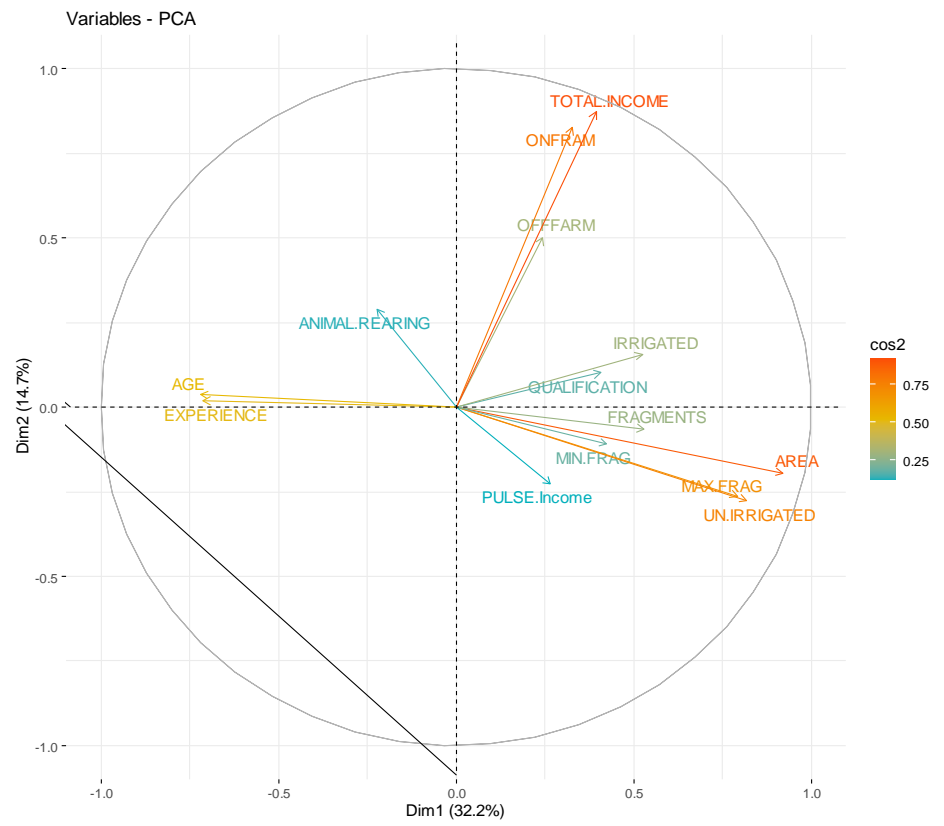


Figure 4.20: Bi plot of Doda district

The result presented in table 4.61 revealed that Kishtwar district data were considered in each components with Eigen value >1 which determined at least 10% of the variation. The higher Eigen values were considered as best representative of system attributes in principal components. Only five components showed more than 1 Eigen value and first principal component accounted for 34.54 per cent of variation in Kishtwar district with an Eigen value of 4.83, therefore these five components were given due important for the further explanation. Components were used for further explanation.

In table 4.62, the contribution of each and every variable used in this study can be seen. Here columns represented the variables. From PC1 it was found that land holding variable (0.920) had highest amount of loading followed by maximum fragmentation variable (0.871), un-irrigated land variable (0.830) and so on. From PC2 it was found that total income variable (0.824) had highest amount of loading followed by on-farm income variable (0.730), animal rearing variable (0.598) and so on. From PC3 it was found that on-farm income variable (0.473) had highest amount of loading followed by total income variable (0.384), minimum fargmentation variable (0.414) and so on. From PC4 it was found that off-farm income variable (0.679) had highest amount of loading followed by pulse income variable (0.529), un-irrigated land variable (0.290) and so on. From PC5 it was found that off-farm income variable (0.463) had highest amount of loading followed by farming experience variable (0.315), on-farm income variable (0.287) and so on.

In figure 4.21, scree plot showed that the eigenvalues start to form a straight line after the first principal component. Therefore, the remaining principal components account for a very small proportion of the variability.

In figure 4.22 Bi plot showed that horizontal axis represents PC 1 and vertical axis represents PC 2. Length of arrows represents the amount of the contribution by a particular variable. Longer the length of arrow higher was the contribution of that particular variable. The circumference of the circle in this biplot is known as correlation circle. If the arrows are closer to the circumference of the circle they were having high correlation. Density of the color also represented the amount of contribution. With respect to PC1 area and maximum fragmentation had highest amount of contribution and with respect to PC2 age and farming experience had highest amount of contribution.

Table 4.61: Total variance explained of pulse crop cultivation in Kishtwar district

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.836	34.541	34.541	4.836	34.541	34.541
2	2.560	18.287	52.828	2.560	18.287	52.828
3	1.457	10.405	63.233	1.457	10.405	63.233
4	1.288	9.203	72.436	1.288	9.203	72.436
5	1.020	7.286	79.721	1.020	7.286	79.721
6	.760	5.429	85.151			
7	.681	4.864	90.015			
8	.588	4.199	94.214			
9	.300	2.141	96.356			
10	.269	1.920	98.276			
11	.128	.911	99.187			
12	.099	.708	99.895			
13	.015	.105	100.000			
14	2.833E-16	2.023E-15	100.000			
Extraction Method: Principal Component Analysis.						

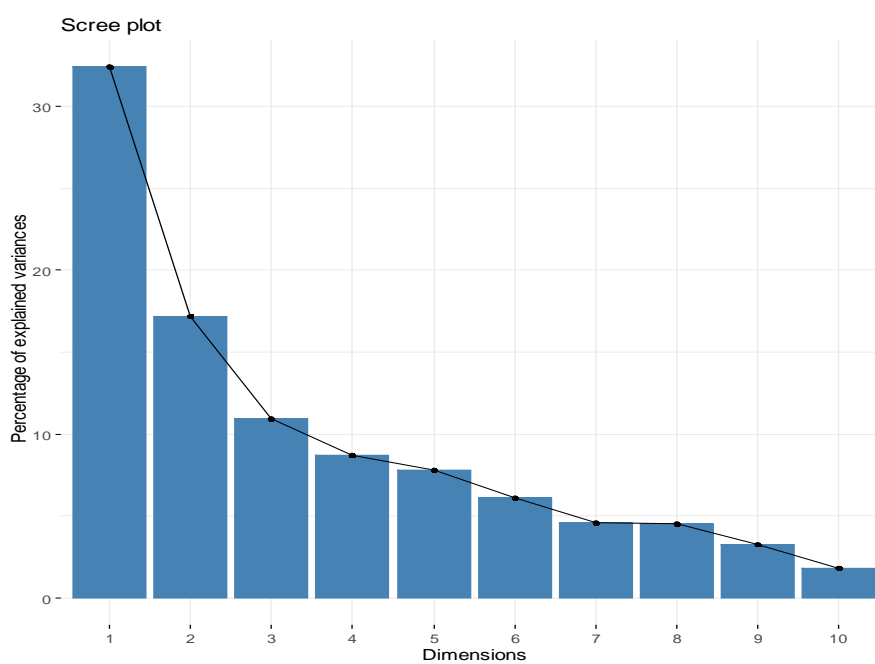
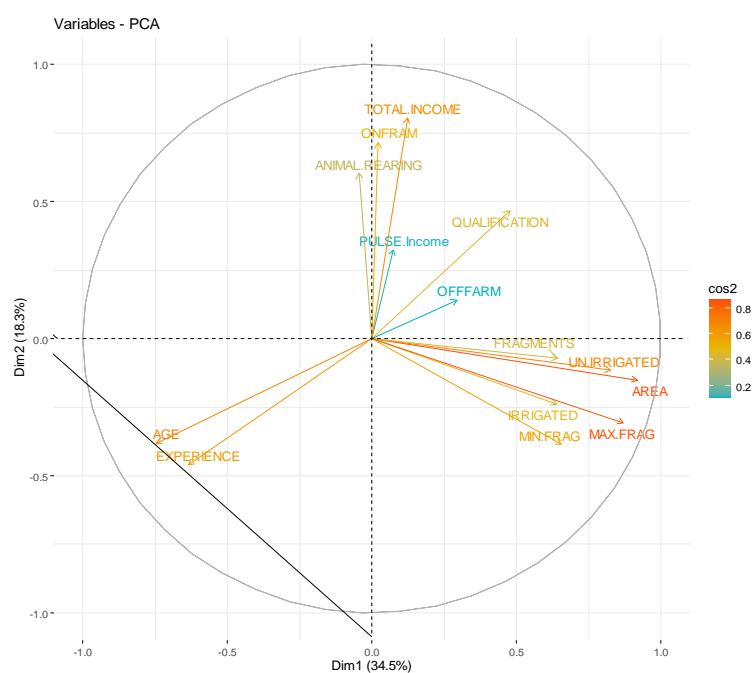
**Figure 4.21: Scree plot of Kishtwar district**

Table 4.62: Component Matrix of pulse crop cultivation in Kishtwar district**Component Matrix^a**

Variable	Component				
	1	2	3	4	5
Age	-.747	-.381	.264	.136	.267
Qualification	.493	.430	-.600	-.190	.087
Animal.Rearing	-.049	.598	-.135	.164	-.184
Area	.920	-.142	.055	.185	.137
Irrigated	.636	-.223	.232	-.258	-.193
Un.Irrigated land	.830	-.112	-.005	.290	.253
Fragmentation	.642	-.064	.157	-.347	.038
Max.Frag	.871	-.293	.136	.019	.010
Min.Frag	.648	-.358	.414	-.009	-.188
Farming experience	-.627	-.466	.225	.036	.315
On-farm income	.010	.730	.473	-.369	.287
Off-farm income	.292	.147	.060	.679	.463
Pulse income	.066	.333	-.059	.529	-.471
Total income	.109	.824	.444	-.005	.260

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

**Figure 4.22: Bi plot of Kishtwar district**

The result presented in table 4.63 revealed that Kathua district data were considered in each components with Eigen value >1 which determined at least 10% of the variation. The higher Eigen values were considered as best representative of system attributes in principal components. Only four components showed more than 1 Eigen value and first principal component accounted for 42.54 per cent of variation in Kathua district with an Eigen value of 5.95, therefore these four components were given due important for the further explanation. Components were used for further explanation.

In table 4.64, the contribution of each and every variable used in this study can be seen. Here columns represented the variables. From PC1 it was found that un-irrigated land variable (0.943) had highest amount of loading followed by maximum fragmentation variable (0.866), total income variable (0.831) and so on. From PC2 it was found that qualification variable (0.785) had highest amount of loading followed by off-farm income variable (0.724), irrigated land variable (0.485) and so on. From PC3 it was found that animal rearing variable (0.655) had highest amount of loading followed by farming experience variable (0.505), age variable (0.486) and so on. From PC4 it was found that irrigated land variable (0.729) had highest amount of loading followed by area variable (0.330), animal rearing variable (0.253) and so on.

In figure 4.23, scree plot showed that the eigenvalues start to form a straight line after the first principal component. Therefore, the remaining principal components account for a very small proportion of the variability.

In figure 4.24 Bi plot showed that horizontal axis represents PC1 and vertical axis represents PC2. Length of arrows represents the amount of the contribution by a particular variable. Longer the length of arrow higher was the contribution of that particular variable. The circumference of the circle in this biplot is known as correlation circle. If the arrows are closer to the circumference of the circle they were having high correlation. Density of the color also represented the amount of contribution. With respect to PC1 off-farm income, total income, area, unirrigated land and maximum fragmentation had highest amount of contribution and with respect to PC2 qualification had highest amount of contribution.

Table 4.63: Principal Component Analysis of pulse crop cultivation in Kathua district

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.956	42.544	42.544	5.956	42.544	42.544
2	2.425	17.322	59.866	2.425	17.322	59.866
3	1.474	10.530	70.396	1.474	10.530	70.396
4	1.202	8.584	78.980	1.202	8.584	78.980
5	.761	5.436	84.416			
6	.615	4.396	88.812			
7	.526	3.754	92.566			
8	.397	2.834	95.399			
9	.351	2.506	97.905			
10	.179	1.278	99.183			
11	.067	.478	99.661			
12	.048	.339	100.000			
13	3.551E-16	2.537E-15	100.000			
14	2.699E-17	1.928E-16	100.000			
Extraction Method: Principal Component Analysis.						

Table 4.64: Component Matrix of pulse crop cultivation in Kathua district

Component Matrix ^a				
Variable	Component			
	1	2	3	4
Age	.639	-.425	.486	-.146
Qualification	-.245	.785	-.138	-.033
Animal rearing	.188	-.280	.655	.253
Area	.896	.163	-.004	.330
Irrigated	.080	.485	.085	.729
Un.Irrigated	.943	.032	-.029	.141
Fragmentation	.707	-.327	-.414	-.009
Max.Frag	.866	-.248	-.339	.011
Min.Frag	.647	-.253	-.445	.099
Farmingexperience	.647	-.419	.505	-.095
Onfarm Income	.812	.280	-.051	.110
Offfarm Income	.410	.724	.199	-.276
Pulse Income	.410	-.037	-.115	-.541
Total.Income	.831	.456	.009	-.140
Extraction Method: Principal Component Analysis.				
a. 4 components extracted.				

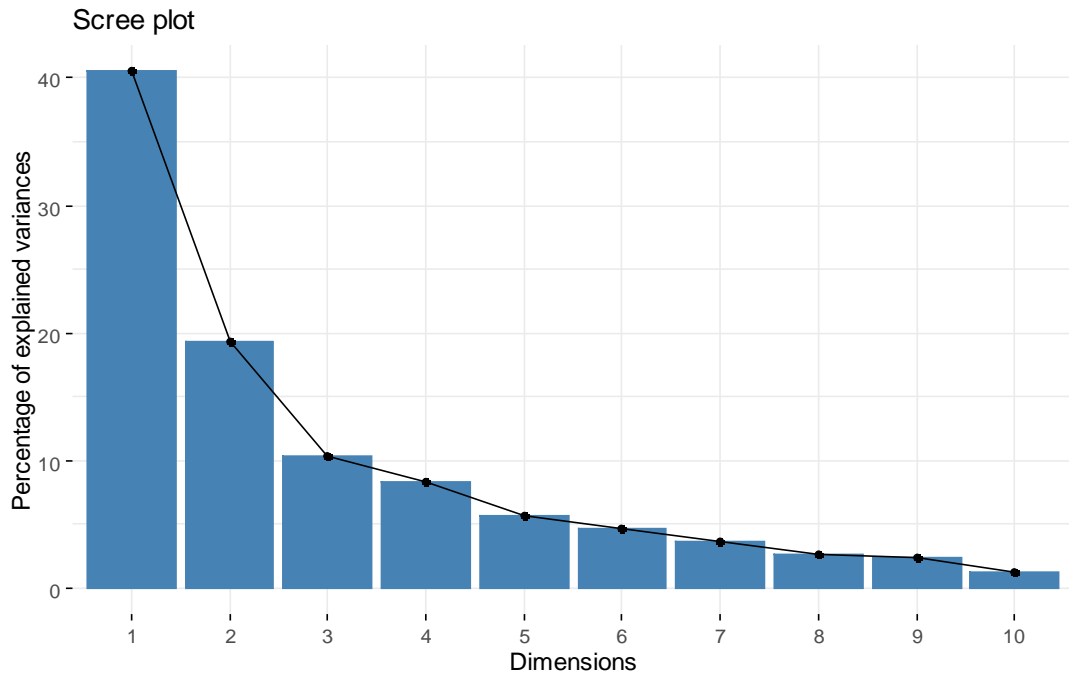


Figure 4.23: Scree plot of Kathua district

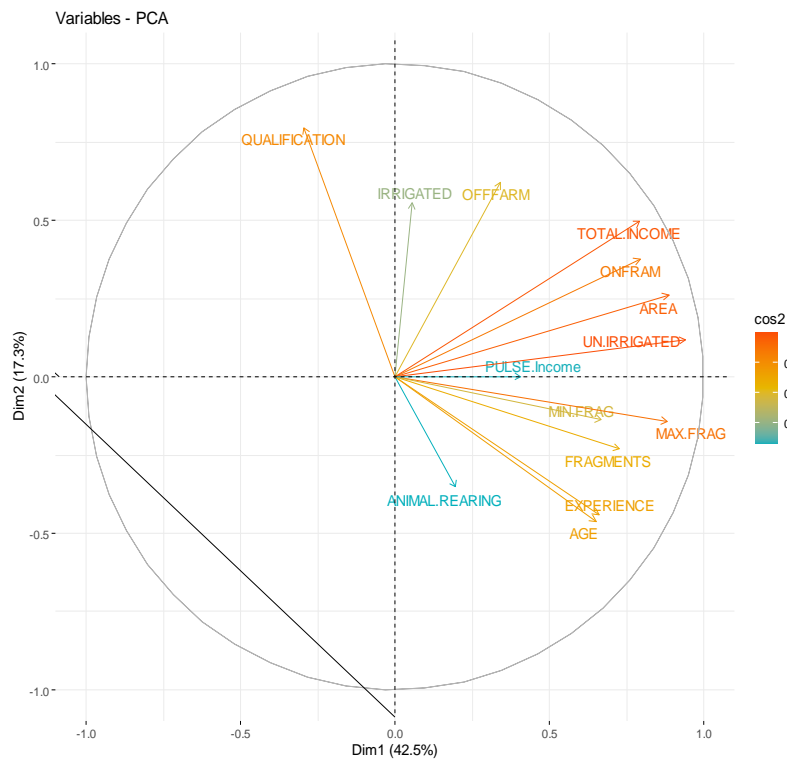


Figure 4.24: Bi plot of Kathua district

The result presented in table 4.65 revealed that Udhampur district data were considered in each components with Eigen value >1 which determined at least 10% of the variation. The higher Eigen values were considered as best representative of system attributes in principal components. Only four components showed more than 1 Eigen value and first principal component accounted for 41.991 per cent of variation in Udhampur district with an Eigen value of 5.879, therefore these four components were given due important for the further explanation. Components were used for further explanation.

In table 4.66, the contribution of each and every variable used in this study can be seen. Here columns represented the variables. From PC1 it was found that un-irrigated land variable (0.947) had highest amount of loading followed by area variable (0.893), maximum fragmentation variable (0.865) and so on. From PC2 it was found that off-farm income variable (0.811) had highest amount of loading followed by qualification variable (0.653), irrigated land variable (0.504) and so on. From PC3 it was found that animal rearing variable (0.731) had highest amount of loading followed by farming experience variable (0.593), age variable (0.543) and so on. From PC4 it was found that pulse income variable (0.766) had highest amount of loading followed by total income variable (0.301), on-farm variable (0.059) and so on.

In figure 4.25, scree plot showed that the eigenvalues start to form a straight line after the first principal component. Therefore, the remaining principal components account for a very small proportion of the variability.

In figure 4.26 Bi plot showed that horizontal axis represents PC1 and vertical axis represents PC2. Length of arrows represents the amount of the contribution by a particular variable. Longer the length of arrow higher was the contribution of that particular variable. The circumference of the circle in this biplot is known as correlation circle. If the arrows are closer to the circumference of the circle they were having high correlation. Density of the color also represented the amount of contribution. With respect to PC1 qualification had highest amount of contribution and with respect to PC2 Fragments, minimum fragmentation, maximum fragmentation, unirrigated land, area, on-farm income, total income and off-farm income had highest amount of contribution.

Table 4.66: Total variance explained of pulse crop cultivation in Udhampur district

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.879	41.991	41.991	5.879	41.991	41.991
2	2.535	18.106	60.097	2.535	18.106	60.097
3	1.662	11.869	71.966	1.662	11.869	71.966
4	1.202	8.584	80.550	1.202	8.584	80.550
5	.838	5.983	86.533			
6	.632	4.514	91.047			
7	.486	3.472	94.519			
8	.339	2.424	96.943			
9	.257	1.834	98.777			
10	.104	.744	99.521			
11	.040	.287	99.808			
12	.027	.192	100.000			
13	1.904E-15	1.360E-14	100.000			
14	-5.849E-16	-4.178E-15	100.000			
Extraction Method: Principal Component Analysis.						

Table 4.66: Component Matrix of pulse crop cultivation in Udhampur district**Component Matrix^a**

Variable	Component			
	1	2	3	4
Age	.687	-.320	.543	.040
Qualification	-.401	.653	-.263	-.030
Animal.Rearing	.191	.043	.731	-.297
Area	.893	.233	-.138	-.229
Irrigated land	.029	.504	-.119	-.618
Un.Irrigated land	.947	.103	-.113	-.066
Fragments	.699	-.411	-.382	.030
Max.Frag	.865	-.322	-.291	.035
Min.Frag	.761	-.365	-.389	.033
Farming Experience	.656	-.279	.593	-.004
On-farm income	.822	.242	-.045	.059
Off-farm income	.377	.811	.060	.044
Pulse income	-.065	.284	.130	.766
Total income	.704	.601	.036	.301

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

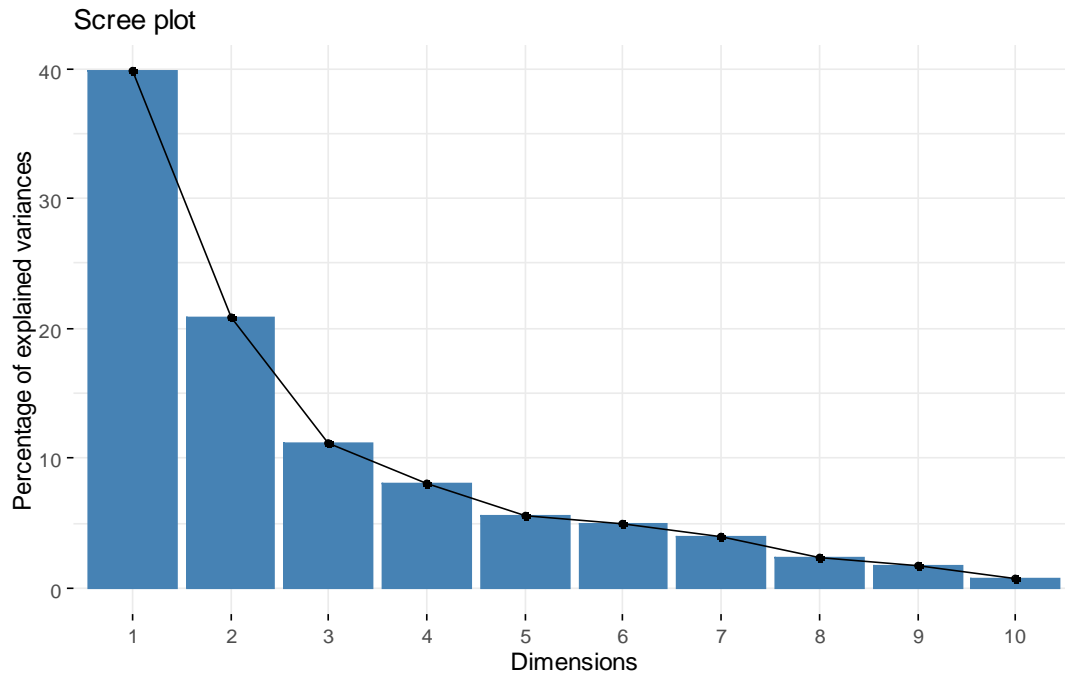


Figure 4.25: Scree plot of Udhampur district

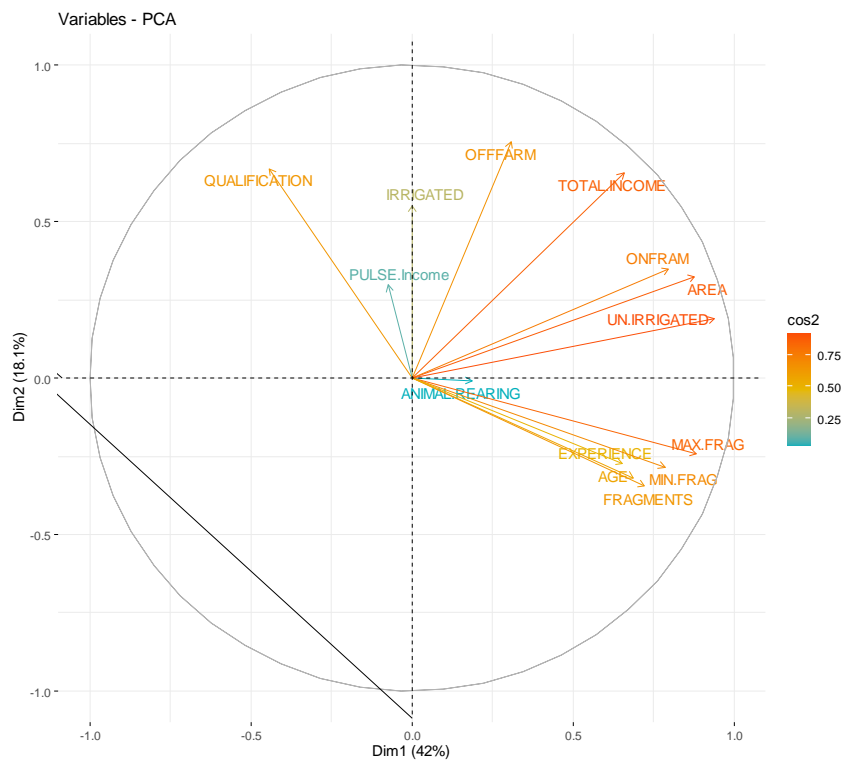


Figure 4.26: Bi plot of Udhampur district



Chapter-5

Discussion

CHAPTER V

DISCUSSION

This chapter deals with the discussion of the results presented in the chapter four and are presented under the following heads

Socio- personal profile of pulse crop growers

Identification of different pulse crops grown and input use pattern in the cultivation of pulse crop in temperate area.

Economics of identified pulse crop.

Factors driving the dependency of households on pulse crop for livelihood security.

Digital database and mapping of pulse crop.

Constraints faced by farmers in cultivation of pulse crop.

Socio-personal profile of pulse crop growers

Among different socio-personal variables the age structure of the farmers is an important factor in the context of agricultural productivity Farmer's age is said to influence farmer's maturity and decision making ability. Overall average age of respondent farmers was 47 years and majority of sampled farmers fall in the age group of 36 to 59 which indicates that young persons are taking interest in carrying out different agricultural related activities. Findings regarding age are supported by Sani *et al.*, 2014. Education broadens the knowledge base of the person. Educated person try to gain more knowledge about enterprise in which he or she is engaged. Regarding education it was found on the basis of findings that average number of schooling years completed was seven years but higher educated sampled farmers are also found fully engaged in agricultural activities. However education was a significant variable contributing to their overall knowledge in practicing pulse crop cultivation. About 32 per cent of the respondent farmers were illiterate. The probable reason for the respondents being illiterate might be illiteracy of their parents, non-realization of importance of formal education and lack of proper educational facility. Since majority of the farmers are small and medium farmers, they might not afford to send their children to school. Other contributing reason could be the rural-social environment in which they live might not have encouraged the parents to send their children to school but preferred to send them for farm work. The similar situation was noticed in the findings of Kapoor (2011), Ali (2011).

Regarding family size and type it was observed from the findings that agricultural families in villages opting for small size of families and trend of nuclear families is also on rise even in rural areas. Regarding main occupation 63 per cent pulse crop growers were mainly dependent on agriculture, rest 37 per cent were also having other government service, private service, retired servicemen, some sort of business activities or as a labour. It could be attributed to the fact that continuation of inheritance traditional occupation of agriculture by the next generations and less scope of employment in non-agricultural sector might lead to these results. The results are in line with Nagesh (2006).

The findings of the study revealed that overall average land holding of sampled pulse crop growers was 0.81 ha which suggest that pulse crop being a rain-fed crop was the priority of almost all the farmers to meet the requirement of consumption of pulses besides cereals. Majority of the respondents of Doda (95%) followed by Kishtwar (83%), Kathua (50%) and least in Udhampur district (48%) were having fragmented land holding. It could be attributed to the fact that the inherent system of land holding leads to its distribution among all the children of the family which further leads to the fragmentation of land holding in the absence of land consolidation policy of J&K. The findings are in conformity with Gebeyehu (1995) and Webster and Wilson (1980).

The average farming experience of pulse farmers was about 25 years. This indicated that, the farmers were experienced enough to be able to understand the technologies and adopt it. The length of experience in farming is probably an indicator of a farmer's commitment to agriculture. It may not necessarily pre-dispose them to adoption of new practices. It is more logical to expect veteran farmers to be less receptive to innovation. Long farming experience is an advantage for increasing farm productivity since it encourages rapid adoption of farm innovation, according to Sani *et al.*, (2014). The results of the present study revealed that the overall distance of market was 12 km. The overall distance of Department of Forest was 14 km while the overall distance of Department of Agriculture was 8 km. It could be attributed to the fact that market is available far away from the villages in the temperate area. It is evident from the study that variables namely distance from home to agricultural office had significant relationship with use of fertilizer in pulse crop which suggests that more the distance of agricultural office, lesser will be the use of chemical fertilizers.

Only 13 per cent of the pulse crop growers had social participation. This might

be due to low literacy level of the sampled farmers and less exposure of sampled farmers to different social organizations. Sampled pulse farmers had good extension contacts with agriculture department as they can meet them in their departmental offices which indicates that there was good network of field extension functionaries of agricultural department and farmers also make efforts to remain in touch with these field functionaries for obtaining necessary technical information about the cultivation of pulse crop in particular and other agricultural enterprises in general. Adoption of production technologies is highly facilitated by the efforts of extension workers in introducing and demonstrating to the farmers how to use the technologies (Tijjani *et al.*, 2015).

The finding of the present study showed that 97 per cent of the respondents of Udhampur district followed by Doda (95%), Kishtwar (93%) and Kathua district (83%) possessed telephone facility and all of them have a mobile phone. The reason for good telephone connectivity may be due to the revolution in telecommunication sector and that too in mobile sector in particular. Another reason could be due to the attributes of handiness apart from mobility is a major factor that respondents possessed mobile phones than landline telephone connection. All the above discussed socio-personal characteristics influence the decision making of farmers regarding cultivation of different pulse crop.

Identification of different pulse crops grown and inputs used for their cultivation

Regarding identification of different pulse crop, the study reported that six different type of pulse crop were cultivated in the study area namely Rajma (*Phaseolus vulgaris*), Black gram (*Vigna mungo*), Green gram (*Vigna radiata*), Red lentil (*Lens culinaris*), Horse gram (*Macrotyloma uniflorum*) and French bean (*Phaseolus vulgaris*), respectively. All these pulse crops had an economical contribution in the livelihood of the people in this temperate region.

Majority (98 %) of the respondents cultivated Rajma crop followed by Black gram (79 %), Green gram (76%), Horse gram (21 %), French bean (19 %) and Red lentil (15 %) in overall area, respectively. The overall area under pulse crops was 63.9 hectares for Rajma, 40.55 hectares for Black gram, 29.8 hectares for Green gram, 5.8 hectares for Horse gram, 4.05 hectares for French bean and 3.65 hectares for Red lentil. The result reported that Rajma crop was grown with Maize crop under intercropping system. This may be due to the reason that intercropping combination is an ideal combination to generate high economy in the hilly regions and is a

sustainable soil enhancing practice. Maize crop gives ideal staking to rajma plant for its twining pole type variety. The finding is in conformity with the study of Mukherjee *et al.*, (2018).

Majority of the growers of Black gram (100 %), Green gram (100 %), Horse gram (100 %), French bean (100 %), Red lentil (100 %) and Rajma (98 %) prefer the seeds produced from their own farm and do not depend on external sources for procuring the seeds. This might be because of the reason that it saves their money and the seed is more readily available. The findings are in conformity with the study of Wekesa *et al.*, (2003).

It was found that most of the farmers that grow rajma sow the seed that was saved by them and only 2% of the rajma growers got seed from private dealer because the villages were far away from market and they do not have knowledge about latest seeds. Same was the case with growers of other pulses they prefer to sow seed that was saved by them from previous crops. This might be because they were not big farmers so they do not want to increase their input cost. The most evident thing which was found during the study was that all the respondents applied FYM that means all the farmers were more inclined towards organic way of farming. It was also found that only 13 per cent and 11 per cent of rajma growers used urea and DAP, it shows that most of the respondents were organic farmers. Same was the case with growers of black gram where only 11 per cent of the respondents used Urea and DAP. In green gram and red lentil, the 13 per cent and 28 per cent of the growers respectively used chemical fertilizers for production. Whereas in case of horse gram and French bean none of the respondents used chemical fertilizers. When it come to weed management practices, all the respondent farmers practiced only manual method to control weeds because the farmers wanted less input cost and they were more focused to produce the pulses for their own consumption only. The small farm size, less awareness and self consumption leads the farmers to adopt organic way of farming.

Organic farming is the best way to improve the soil quality as well as the health of living beings. Pulses are mostly grown in rainfed areas that do not witness high use of chemical inputs where adoption of organic farming may be the option to enhance the sustainability of the ecosystem. Organic production systems maintain and improve the soil health through stimulating the activity of soil micro-organisms and are also helpful in alleviating the increasing incidence or deficiency of secondary and

micronutrients and are capable of sustaining crop productivity. The real potential of organic farming lies in growing pulses especially under rainfed condition. Avasthe *et al.*, (2016) also reported that the rainfed tribal, north-east and hilly regions of the country where negligible chemicals are used in agriculture have been practicing subsistence agriculture for a long period. Most of the north-eastern hilly areas are organic by default, utilizing very low chemicals for cultivation of crops.

Economics of identified pulse crop

The cost structure in production of identified pulse crops included the cost on cultivation like, seed, land preparation, FYM, urea, DAP, hoeing, threshing, harvesting. The cost on various inputs used for cultivation of pulse crop per hectare on the sample holdings have been worked out. We can see that there was less average expenditure on urea and DAP as compared to expenditure on FYM in all most all identified pulse crops. The less average expenditure in chemical fertilizers shows that there were less number of farmers using chemical fertilizers and most of the farmers prefer organic farming in temperate region of Jammu region. This is good sign in today's world where most people prefer chemical fertilizer. We also found that the average cost of cultivation was lowest in red lentil (Rs. 8115.96). Although cost of cultivation was highest in horse gram but average productivity was also highest (3.34 q/ha) in horse gram. The lowest productivity (1.59 q/ha) was found in red lentil. The average sale of Rs. 11250/q price/q was highest in rajma that shows high demand of rajma in market. The lowest sale price of Rs.9448/q was recorded in green gram. Although green gram has lowest sale price among different pulses in Jammu but it was way higher than popular cereal crops like rice, wheat and maize that shows how we can diversify cultivation of cereals with pulses so that we can increase the income of farmers.

When we see the results of B:C ratio of different crops it was found that French bean has the highest average B:C ratio (2.16:1) which means French bean is the most profitable crop among the others. From the results it was found that there was very low B:C ratio for different crops in different districts it was due to the fact that most of the farmers uses organic way of farming and farmers does not know about the different techniques of growing pulses . They were less aware about the latest techniques of growing crops , they were less cosmopolite , focused more on traditional way of farming and do substantial type of farming , all these factors leads to low benefit cost ratio in study area. The economics of pulse crop cultivation were

also studied by Kumar *et al.*, (2017), Reddy (2007), Kumar and Bourai (2012) and they also found similar results.

Factors driving the dependence of households on pulse crop for livelihood security

Achieving higher income of any crop depends upon the fulfillment of certain critical factors. In the present study too, different factors affected the per cent income of pulse crops. Linear regression model was applied to analyze the factors affecting per cent of income from pulse crop in total annual income of the respondents. Out of age, qualification, farming, family size, land holding, irrigated land, unirrigated land, fragmentation, farming experience, livestock, on-farm income, off-farm income, source of information, extension contact and productivity, it was founded that age, land holding, fragmentation, farming experience, on-farm income, off-farm income, extension contact and productivity significantly affected the percentage of pulse income of the respondent and R^2 value of 0.499 indicates that 49.9% variation in dependent variable is due to these independent factors. It might be due the fact that the farmer who had good extension contact more area under pulse crop and experience in pulse crop cultivation had good income from pulses. More efforts need to be done to aware the farmers about pulse crop cultivation and its benefits, so that they can enhance their area under pulse crop and enhance their production and productivity of pulse crop and make additional income for their livelihood as pulse crop adds more income because of its high price in the market.

Results also revealed that Education (X2), Size of holding(x6), Cropping Intensity(x8), Distance From Market(x12) and Crop Biodiversity(x16) variables were found to exert strong and determining contribution to estimate dependent variables wages (y1) and man-days (y2) required in pulse crop cultivation and the set of economic and ecological variables as selected for the study by Mandal *et al.*, (2020).

Principal component analysis is a simple non parametric method for extracting relevant information from confusing data sets. The principal components are orthogonal because they are the Eigen vectors of the covariance matrix, which is symmetric. The eigenvalues measure the amount of variation retained by each principal component. Eigenvalues are large for the first PCs and small for the subsequent PCs. That is, the first PCs corresponded to the directions with the maximum amount of variation in the data set. We examined the eigenvalues to determine the number of principal components to be considered

An eigenvalue > 1 indicates that PCs account for more variance than accounted by one of the original variables in standardized data. This is commonly used as a cutoff point for which PCs are retained. This holds true only when the data are standardized.

An alternative method to determine the number of principal components was to look at a Scree Plot, which was the plot of eigenvalues ordered from largest to the smallest. The number of component was determined at the point, beyond which the remaining eigenvalues were all relatively small and of comparable size.

Thus, it indicated considerable amount of variability among fifteen component of pulse crop cultivation. The result of PCA explained in Doda district was the first principal component accounted for 30.14 per cent of variation with an eigen value of 4.52, in Kishtwar district was the first principal component accounted for 32.41 per cent of variation with an Eigen value of 4.86, in Kathua district was the first principal component accounted for 39.89 per cent of variation with an Eigen value of 6.04 and in Udhampur district was the first principal component accounted for 39.89 per cent of variation with an Eigen value of 6.04. The objective of principal component analysis is to identify the minimum number of components, which can explain maximum variability out of the total variability. These finding similar to the Mahendra *et al.*, (2015) that the cumulative variance of 77.38% of total variation. These findings are also confirmation with Akande (2007), Ojo *et al.*, (2012), Miladinovic *et al.*, (2006), Iqbal *et al.*, (2008) and Amrita *et al.*, (2014).

Digital database and mapping of pulse crop.

Field survey identified 6 pulse crops in the study area namely Rajma (*Phaseolus vulgaris*), Black gram (*Vigna mungo*), Green gram (*Vigna radiata*), Red lentil (*Lens culinaris*), Horse gram (*Macrotyloma uniflorum*) and French bean (*Phaseolus vulgaris*) respectively. Maximum diversity of pulses was observed in Doda district (Fig. 3). Mapping of pulse crop using GPS coordinates will help identify in the major pulses grown in an area. It shows the number of pulse crops grown temporally in a particular area over a period of one year. Major pulses were grown in kharif season and some pulses were also grown in rabi season. This might be due the fact that the study area was rainfed and pulses can be grown in rainfed areas because due to less requirement of water to the pulse crop, thus leading to these results. Majority of the farmer did not use chemical fertilizers/pesticides in their field and thus are growing pulses organically.

It may also be possible to adopt organic farming in rainfed areas where low yields are a permanent feature. Organic farming has a role in ensuring sufficient and nutritious food supply in the future and, high returns can be obtained by organic farmers. In addition, organic farming may be a better strategy for promoting the environmental and socio-economic sustainability of agrarian life than the conventional farming (Reganold, 2012).

Inclusion of pulse in cereal-based cropping system may enhance the sustainability of the system by improving soil health (Babu *et al.*, 2016). There is need to educate the farmer to go for pulse crop cultivation because pulses are rich source of protein and farmer can also enhance their income by cultivating pulses as there is much demand in the market of pulses especially organic pulses. Similar results were founded by Panigrahy *et al.*, (2010).

Constraints faced by farmers in cultivation of pulse crop

Constraints are part and parcel for producing any commodity in any sector and agriculture sector is no exception to this. In the present study pulse crop growers too reported series of constraints in successful cultivation of pulse crop. Sampled pulse crop growers of temperate districts i.e. Doda, Kishtwar, Kathua and Udhampur reported different constraints. Lack of irrigation facilities especially in hilly areas were reported as major constraint because like other crops pulse crop is also raised as rain-fed crop in hilly region and sometimes due to erratic rainfall their pulse crop gets badly affected as reported by respondent farmers. Lack of awareness was the second most important constraint reported by the sampled pulse crop growers especially in weed and nutrient management. The present findings got support from the study conducted by Singh *et al.* (2013) on oilseeds at Central Agricultural University, Imphal in collaboration with DRMR, Bharatpur, Rajasthan in which it was reported that scarcity of irrigation at critical stages and high incidence of pest and diseases is the major constraint in oilseed cultivation. However study conducted by Sharma *et al.* (2014) reported different set of constraints in rapeseed mustard cultivation such as non-availability of pure seeds at sowing time, inadequate supply of fertilizers, poor fertility of soil, lack of technological know-how, and lack of visit by extension personnel to the village.

Chapter-6

Summary and Conclusion

CHAPTER VI

SUMMARY AND CONCLUSION

The development of Indian agriculture over the last few decades has aided the country in achieving national food security. The country's next major challenge, and Indian agriculture's in particular, is to maintain this growth while still achieving nutritional stability. Pulses are environmentally sustainable, a significant source of protein, and also supplement cereals in both production and consumption, so they play an important role in this situation. Pulses increase soil fertility, takes less water than cereals in the production process, and their rotation with cereals aids in disease and pest control. Pulses are a low-cost source of high protein content. Pulses are high in calcium and iron and contain 55 to 60 percent carbohydrates. Since ancient times, pulse crops have been an integral part of agriculture. India, Canada, China, Myanmar, and Brazil are the world's leading producers of pulses, accounting for half of global demand. Pulses are also an integral part of the Indian diet and are the cheapest and most abundant source of dietary amino acids, and also satisfy the protein needs of the vegetarian community, earning it the nickname of "poor man's meat." Pulses are unique in the agricultural world because of their high protein content, which is almost twice that of cereals. Pulses contain high-quality lysine, tryptophan, ascorbic acid, and riboflavin, in addition to protein. Pulses are good for diabetics, as well as those with coronary heart disease and anaemia, since they lower cholesterol. Pulses have anti-cancer effects due to the presence of bioactive compounds such as phytochemicals and antioxidants. The crop can withstand harsh weather conditions. Pulses are grown throughout the year in India due to its varied agro-climatic conditions, and thus play an important role in crop rotation, mixed and inter-cropping, sustaining soil fertility by nitrogen fixation, and releasing soil-bound phosphorus, all of which contribute to the long-term sustainability of farming systems. Pulse genotypes have the ability to produce reasonably well even under stress conditions such as drought, frost, and water logging.

According to World Bank data, the total geographical area under cultivation for pulses was 81.61 million hectares, with 55.10 million metric tonnes produced (FAO, 2017). India produces 14.76 million tonnes of pulses from a total area of 23.63 million hectares, making it one of the world's biggest pulse producers. However, about 2-3 million tons of pulses are imported annually to meet the domestic

consumption requirement (World Bank indicator, 2017). Pulses are important component of Indian agricultural economy next to food grains oilseeds in terms of acreage, production economic value (Choudhary, 2009). India is largest producer consumer of pulses in the world, accounting for about 25 percent of global production, 27 percent of consumption 34 percent of food use (F.A.O.). India is also the top importer with 11 percent share of global imports during 1995- 2001 (Gregory, et al. 2003). The United Nations has declared 2016 the International Year of Pulses, recognising pulse's potential to help meet future global food security, education, and environmental protection needs. Pulses are a smart food because they are essential for the food basket, a good source of plant protein, and can assist with obesity, diabetes, and other issues. Pulse production grew by 36.5 percent in the last decade, with chickpea, mung bean, and urd bean contributing the most. To meet its shortfall, India must raise pulse production from 19 Mt/mt to somewhere between 25.4 and 36.9 Mt. Pulse production in the country has increased significantly in recent years, rising from 14.7 Mt in 2009-10 to 18.2 Mt in 2010-11 and reaching a new peak of 19.8 Mt in 2013-14, with chickpea production reaching an all-time high of 9.53 Mt. (Reddy 2015). Pulses are consumed at about 7 kilogrammes per human per year on a global scale. To close the pulse demand supply deficit, the country's total pulse requirement is expected to reach 39 million tonnes by 2050, implying a 2.2 percent annual growth rate. This requires a paradigm shift in research, technology generation and dissemination regarding pulses production. (Rajasekaran, *et al.* 2011). At macro level a number of factors are responsible for sluggishness in the growth of area and yield of pulse crops. Low level of area under irrigation, non-availability of improved seeds and lack of improved production technology, price variability, lack of market information, subsistence farming, etc. are some constraints influencing production of pulses. Since the third Five-Year Plan, multiple promotion initiatives have been implemented to improve pulse production, including the National Pulses Development Programme (NPDP), the National Food Security Mission (NFSM), and the Integrated Scheme of Oilseeds, Pulses, Oil palm, and Maize. However, there has been no significant technological advancement that has positively impacted pulse production. Despite the government's efforts, the yield of pulses has not increased significantly. One of the main reasons for this may be a weak pulse marketing network that operates against farmers. As a result, there is an urgent need to develop techniques for effective pulse marketing in order to increase marketing effectiveness.

Farmer's challenges can be solved by combining new and traditional farming methods in a way that is both environmentally sustainable and market-oriented. This is particularly important for marginal and small farmers, who have often struggled with limited resources. The farmers in the hills of Uttaranchal are mostly marginal farmers practicing low external input based production system. (Singh 2004) Since the topography of Jammu and Kashmir (J&K) is nearly identical to that of Uttaranchal, this fact applies here as well, and it can be a blessing in disguise because the negative consequences of synthetic chemical-based cultivation are minimal, the soil is unpolluted, and the climate is clean and green with plentiful bio-diversity. Since chemical fertilisers are scarce in these areas and farmers hardly use them, J&K has a tremendous opportunity for organic farming. A substantial portion of the state is already under semi-organic agriculture in hilly districts.

The total pulse crop area of the Jammu and Kashmir state was 18,893 hectares. In Jammu region and Kashmir region it was reported 12,955 ha and 5938 ha respectively (DSE 2018). Some important pulse crops like Green gram (*Vigna radita*), Red lentil (*Lens culinaris*), red gram (*Cajanus cajan*), Black gram (*Vigna mungo*), Horse gram (*Macrotyloma uniflorum*), Cowpea (*Vigna unguiculata*), Pea (*Pisum sativum*), French bean (*Phaseolus vulgaris*), Moth bean (*Vigna sativum*), etc. The main pulses found in J&K are Rajma, Black gram, Green gram, French bean, Horse bean, Red lentil etc. In vast areas of cultivable land across Jammu, particularly in the higher reaches of the Kishtwar, Udhampur, Doda, Kathua, Reasi, Ramban, Poonch, and Rajouri districts, farming is now semi-organic by default. Though, a large number of crops are grown there without or with little use of chemical pesticides and fertilizers in view of the temperate climate, the agricultural yield so produced needs certification, officials point out (Sharma 2012). As a result, the marketable surplus of these areas' produce can be traded as an organic or semi-organic crop. Farmers in Jammu and Kashmir will take advantage of the increasing demand for organic goods. Organic farming is inherently environmentally sustainable, since it preserves soil quality and increases biodiversity.

Thus, the present study entitled “**Status and digital documentation of pulse crops in the temperate area of Jammu region**” was undertaken with the following specific objectives.

Objectives

- To identify the different pulse crops grown and inputs used for their cultivation in temperate area of Jammu region.
- To study the economics of identified pulse crops.
- To delineate the factors driving the dependence of households on pulse crop for livelihood security
- To generate digital database and mapping of pulse crop.

The major findings of the study are sub divided under following headings:-

- ❖ Socio-personal description of respondent pulse crop grower.
- ❖ Identification of different pulse crops grown and input use pattern in the cultivation of pulse crop in temperate area.
- ❖ Economics of identified pulse crops.
- ❖ Factors driving the dependence of households on pulse crop for livelihood security
- ❖ Constraints faced by farmers in cultivation of pulse crop.
- ❖ Suggestions put forth by respondents for improving the productivity of pulse crop

Socio-personal description of respondent pulse crop grower

The overall mean age of respondent pulse crop growers was 47 years. Majority (69%) of the respondent farmers fall in 36-59 age group category. The majority (49%) of farmers had pakka house followed by 26 per cent which had kacha house while 25 per cent of farmers had semi-kacha house. 56 per cent of the total respondents lived in nuclear family, where as rest lived in joint family. 62 per cent of the respondents had a family size of 5 to 7 members followed by 24 per cent who had family size of 2 to 4 members and only 14 per cent had family size of above 7 members per family. The overall total land holding of all the respondent farmers was 195 ha. Overall average operational land holding of the respondent farmers in the study area was 0.81 (± 0.79) hectares. Overall, 90 per cent of pulse growers had contact with the Department of Agriculture, 50per cent had contact with private agencies, 21per cent had contact with the District Forest Officer, 4percent had contact with Krishi Vigyan Kendra, and only 2per cent had contact with the State Agricultural University. The overall average income of respondent farmers was ₹10100.

Identification of different pulse crops grown and input use pattern in the cultivation of pulse crop in temperate area.

- Overall 98 per cent of farmers grow rajma crop, 79 per cent grow black gram, 76 per cent of respondents grow green gram, 15 per cent of respondents grow red lentil, 21 per cent of respondents grow horse gram and 19 per cent of respondents grow french bean.
- The total area in terms of hectares under rajma crop was 63.9. The overall average area of rajma crop of respondent farmers was 0.27 (± 0.29) hectares. Overall, average seed rate used by the respondent farmers was 16.47 (± 4.28) kg/ha. 13per cent of the total rajma growers applied urea and all of them applied it as top dressing and average dose of top dressing the urea was 1.50 ± 1.76 kg/ha and 11per cent of them applied DAP and the average quantity used was 0.57 ± 0.21 kg/ha.
- The total area in terms of hectares under black gram was 40.55. The overall average area of black gram was 0.20 (± 0.23) hectares. The overall average seed rate used by the black gram growers was 12.09 (± 6.95) kg/ha. The results shows that 11per cent of the total black gram applied the urea and all of them applied it as top dressing and average dose of top dressing the urea was 0.69 ± 0.15 kg/ha and 11per cent of them applied DAP and the average quantity used was 0.67 ± 0.14 kg/ha.
- The total area in terms of hectares under green gram was 29.8. The overall average area of green gram was 0.18 (± 0.23) hectares. The overall average seed rate used by the green gram growers was 17.77 (± 7.02) kg/ha. The results shows that 13 per cent of the green gram applied urea and all of them applied it as top dressing and average dose of top dressing the urea was 0.66 ± 0.11 kg/ha and 13per cent of them applied DAP and the average quantity used was 0.63 ± 0.14 kg/ha.
- The total area in terms of hectares under red lentil was 3.65. The overall average area of red lentil was 0.10 (± 0.06) hectares hectares. The overall average seed rate used by the red lentil growers was 36.95 (± 9.35) kg/ha.
- The total area in terms of hectares under horse gram was 5.8. The overall average area of horse gram was 0.07 (± 0.11) hectares. The overall average seed rate used by the horse gram growers was 17.46 (± 2.68) kg/ha.

- The total area in terms of hectares under French bean was 4.05. The overall average area of French bean was 0.08 (\pm 0.03) hectares. The overall average seed rate used by the French bean growers was 55.11 (\pm 22.80) kg/ha.
- The results shows that all the respondents use FYM for cultivation but the dosage of application varies between different area and under different crops.
- The results shows that all the respondents use manual method for weed management and 63 per cent of the total respondents used manual method for threshing while 19 per cent of the total respondents used thresher. 18 per cent of the total respondents used bullocks for threshing.

Economics of identified pulse crops.

- The average productivity of rajma was 2.64 q/ha while that of black gram was 2.47 q/ha. The productivity of green gram, red lentil, horse gram and French bean was 2.02 q/ha, 1.37 q/ha, 3.34 q/ha and 2.71 q/ha, respectively.
- The overall B:C ratio of rajma, black gram, green gram, red lentil, horse gram and French bean was 1.53:1, 1.17:1, 1.02:1, 0.95:1, 2.15:1 and 2.16:1, respectively.

Factors driving the dependence of households on pulse crop for livelihood security

- Among all the factors age ($p=$.000), land holding ($p=$.002), fragments ($p=$.000), experience ($p=$.000), on farm ($p=$.000), off farm ($p=$.001), extension contact ($p=$.003) and productivity ($p=$.004) significantly affected the per cent of income from pulse crop of the respondent.
- R^2 value = .499 which indicates that model so applied had prediction power of 49 per cent.

Digital database and mapping of pulse crop.

- By using the GPS coordinates in different locations of studied areas a digital map was generated which can help to easily find the pulse growing areas for future references.
- The digital database is also generated which shows the information and status of different pulse crops grown in different areas of study.
- And further these digital database can be accessed by visiting a newly created online platform (<http://www.jkpulses.wordpress.com/>)

Constraints faced by farmers in cultivation of pulse crop.

- 83 per cent of total respondents expressed lack of irrigation as a constraint, 64 per cent of total respondents expressed poor extension linkage as constraint, 75 per cent of respondents expressed lack of awareness as constraint, 49 per cent of respondents expressed inputs not available at right time as a constraint, 26 per cent of total respondents expressed wild animals destroy crop as a constraint and 17 per cent of total respondents expressed shattering problem during harvesting time as a constraint.

Suggestions put forth by respondents for improving the productivity of pulse crop

- 84 per cent of the respondents give suggestion that proper awareness regarding pulse crop cultivation should be provided. 27 per cent respondents suggest that organic cultivation of pulse crop should be promoted. 83 per cent of the respondents suggested that irrigation facilities need to be strengthened. Marketing linkages should be promoted was suggested by 64 per cent of the respondents. 18 per cent of the respondents thought that more research should be done on developing rain fed varieties. 36 per cent of the respondents suggested that storage facilities need to be developed.

CONCLUSION

Organic farming is the most effective way to increase soil quality and the welfare of living creatures. The value of high-quality food free of industrial inputs such as artificial fertilisers, insecticides, and pesticides in crop production, and hormones and chemicals in the livestock industry is now widely recognised. Synthetic fertilizers and pesticides are unnecessary for maintaining sufficient supply of nutritious food to feed the growing global population (Badgley *et al.*, 2007) and worse yet, may lead to practices that degrade the environment in general, and soil quality in particular (Horrigan *etal.*, 2002). As a result, organic farming, which is founded on the values of ecological, cultural, and physical methods to provide crops with proper nutrition and pest control, is a safer choice. According to a recent report, widespread substitution of traditional with organic farming is not recommended if significant increases in food production are needed to feed a population of 10 billion humans by 2050, as some estimates indicate a yield loss of 20% when crops are grown

organically versus conventionally. Organic farming can, however, be feasible in rainfed areas where low yields are a permanent feature. Organic farming can help ensure a reliable and safe food supply in the future, and organic farmers can achieve high yields. Furthermore, organic farming could be a more effective method for supporting agrarian life's environmental and socioeconomic sustainability than traditional farming.

In the present study it was found that most of the farmers were the marginal farmers and many of them was doing subsistence types of farming that is why they were not aware of new technology of production as they do not have that much resources. It was found that most of the farmers in studied areas were already preferring organic way of farming it can be seen in fertilizer usage and weed management practices used by farmers as all the farmers were using manual method for weed control and only some of the farmers were using chemical fertilizers. It was found in the study that pulses has way more better economic benefit for the respondents than cereal crops and if they are promoted well it can help in achieving the target of doubling farmers income by 2022 which is target set by government. Pulses not only give good income but also help in improving soil health. It was found that farmers of temperate region of Jammu can be the path guiders for other farmers in state for adopting organic way of farming. The study can be concluded on the point that if farmers in temperate region of Jammu grows pulses with organic way of farming were provided with proper guidance of new production technologies by agriculture extension workers, it can be a game changer for farmers in living in temperate region of Jammu which can motivate other farmers not only of Jammu region but also for the farmers of whole Jammu and Kashmir.



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Appendix

APPENDIX



**Sher-e- Kashmir University of Agricultural Sciences and Technology of
Jammu, FOA, Chatha, Jammu-180009
Division of Agricultural Extension Education**

**Title of Research Problem: Status and digital documentation of pulse crops in the
temperate area of Jammu region**

Interview Schedule

S.No.: _____

Village: _____

Date: _____

PART-1: Socio personal and economic profile of the respondent

1. Name of the respondent: Sh. _____

2. Father's Name Sh. _____

3. Head of the family _____

4. Caste _____

5. Phone Connection Yes/No If Yes, Mobile/Landline/Both.

Mobile No.: _____

Smartphone: Yes/No

Internet Enabled: Yes/No

Landline No. : _____

6. Family composition:

a) Joint/ Nuclear: _____

b) Total no. of family members _____

S.No.	Family relationship	Age	Qualification	Involvement in		Other occupation	Income/ month
				Farming	Animal Rearing		
i	Self						
ii							
iii							
iv							
v							
vi							

11. Livestock Possession

Milch animals	Number	Utility	Avg. Yield (kg/day)	Quantity sold (kg/day)	Sale price (Rs/kg)
Cow					
Buffalo					

Livestock	Number	Utility	Number sold (last year)	Sale price
Oxen				
Ram				
Sheep				
Poultry birds				
Any other				

12. Any other on-farm economic activity

	No. of units	Income
Apiculture		
Mushroom		
Sericulture		
Floriculture		
Any other		

13. Type of house (**Kacha/Pacca/Semi-Kacha**)

14. Social participation

S.No.	Organization	Member(Yes/No)	Office bearer(Yes/No)
1	Panchayat member		
2	Namberdar		
3	Chowkidar		
4	Co-operatives		
5	Farmer's club		
6	Youth club		
7	Any other		

15. Distance from house (in km)

Main Road	
Forest Office	
Agricultural Office	
Market	
Selling place of pulse crop	
Any other	

16. Source of Information for agricultural purpose

	Awareness (Y/N)	Utilization	
		Yes	No
NGO			
Contractor			
Input Dealer			
Progressive Farmers			
Friends/ Relatives			
Radio			
Television			
Newspaper			
Training			
Group Meeting			
Field visits/ Tour			
Demonstrations			
Kisan Mela			
Kisan Call Centre			

17. Extension contact/activities

	Awareness (Y/N)	Utilization	
		Yes	No
SAU			
DFO			
Department of Agriculture			
KVK			
Private Agencies			
Other (Specify)			

18. Do you have Kisan Credit Card **Yes/No**
19. Do you have MGNERGA Card **Yes/No**
20. Do you have Soil health card **Yes/No**
21. Do you have toilet at home **Yes/No**
23. Do you have Aadhar card? **Yes/No**
24. Do you have Ayushman health card? **Yes/No**
22. Do you have ration card? **Yes/No** **If**
yes, please tell PHH/NPHH/EXCLUDED

PART- II

1. Area under pulse crop, variety wise (kanals/acres)

Crop	Variety sown	Area in kanals	Seed rate	Irrigated/ Unirrigated	Source of seed	Cost of seed	Since when you are cultivating these varieties	Time of sowing	Method of sowing	Sole/ Mixed crop

Do you replace your pulse seed? Yes /No

- i) If yes, after how many years _____
- ii) What are the benefits of seed replacement?

2. Land Preparation

Method of ploughing	No. of ploughing	Cost of ploughing

3. Did you treat seed with any fungicide? Yes/No. If yes, please tell the following information

Pulse crop	Name of chemical	Quantity

i) If no, was the seed already treated? _____

ii) What are the benefits of seed treatment?

iii) Reasons for not treating the seed

4. Did you inoculate the pulse crop seed before sowing? Yes/No. If yes, please tell the following information

Pulse crop	Name of inoculum	Quantity

If No, Please give reasons _____

5. Did you irrigate your pulse crop in the last season? Yes/No

(In case of irrigated land)

i) If no, what were the reasons

ii) If yes, how many irrigations do you give and at which stage:

Crop/Variety	No of Irrigations	Stage/DAS of irrigation

Reasons for not adopting the recommended irrigation schedule _____

6. Did you use organic manure Yes/No? If yes, please tell the following information

Name of Organic Manure	Quantity	Benefits

7. Did you use inorganic manure Yes/No? If yes, please tell the following information

Pulse crop	Urea(kg/kanal)		DAP	MOP	Any other
	Basal dose (B D)	Top dressing (DAS)	BD/AS	BD/AS	

8. What is the source of information about fertilizer? _____

If not applying give reasons _____.

9. Weed management practice adopted: Manual/ Chemical/Both/None

. i) In case of manual weed control give the following information

Pulse crop	No. of hoeings	No. of days after sowing	Time taken by a person for hoeing one kanal land	Rate of hoeing in Rs/day

12. Disease management

Crop	Name of disease observed	In case of chemical treatment, name of fungicide	Dosage	Method of application		Cost of application (Rs.)
				Sprayed with pump	Mixed and broadcasted (Mixed with what material)	

13. What was the source of information about pesticides/pest management?

i)___

ii)_____

23. If no pest treatment even after observation of insects/pests, what are the reasons?

i)_____

ii)_____

14. Harvesting

Pulse crop	Symptom of harvesting

15. Post harvesting operations

How you thresh your harvested pulse crop? _____

16. Cost of cultivation other than inputs (per kanal)

Harvesting	Threshing

17. Yield of pulse crop per kanal

Pulse crop	Variety	Area	Production	Yield per kanal	Quantity sold	Rate Rs./Quintal	To whom sold

18. Do you follow any traditional practice in the cultivation of pulse crop? Yes/No

If yes, then type of traditional practice

i) Advantage of using traditional practice:

- _____
- _____
- _____
- _____

19. Major constraints in adoption of recommended cultivation practices of pulse crop.

20. How do you store pulse crop grains?

Store bin / Traditional bin/Earth bin-

21. Farmer's Suggestions for bringing improvement in yield and area of pulse crop



Vita

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Bachelor's Degree	Bachelor of Science (Honors) Agriculture
University and Year of Award	Punjab Agricultural University, Ludhiana, 2015
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Master's Degree	Master of Science (Agriculture) in Agricultural Extension Education
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