

**ECONOMIC ANALYSIS OF SUMMER VEGETABLE CROPS  
THROUGH RAIN WATER HARVESTING STRUCTURES IN RAINFED  
AREAS OF JAMMU DISTRICT**

**By**

**Arushi Sharma**

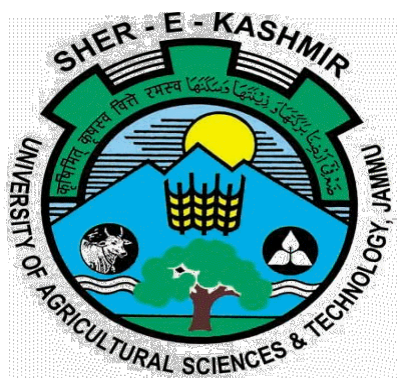
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A Thesis submitted to Faculty of Agriculture

in partial fulfilment of the requirements

for the degree of

**MASTER OF SCIENCE IN AGRICULTURE  
AGRICULTURAL ECONOMICS**

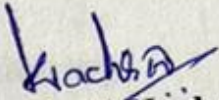


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**2022**

## CERTIFICATE -I

This is to certify that the thesis entitled "Economic Analysis of Summer Vegetable Crops through Rain Water Harvesting Structures in Rainfed Ares of Jammu District" submitted in partial fulfilment of the requirements for the degree of Master of Science in Agriculture (Agricultural Economics) to the faculty of Post- Graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu is a record of bonafide research carried out by Ms. Arushi Sharma, Registration No. J-20-M-711, under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma. It is further certified that such help and assistance received during the course of investigation have been duly acknowledged.

  
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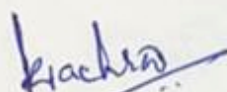
  
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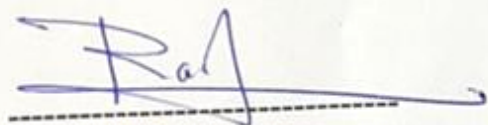


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*Arushi*  
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## ABSTRACT

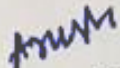
<b>Thesis Title</b>	<b>:</b>	<b>Economic Analysis of Summer Vegetable Crops through Rain Water Harvesting Structures in Rainfed Areas of Jammu District</b>
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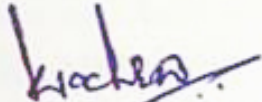
The study was conducted in Jammu districts of Jammu and Kashmir Union territory. Dansal, Nagrota, Chowki Choura and Akhnoor blocks were selected because only these blocks have maximum number rain water harvesting farm ponds. The study was conducted with the objectives of cost and return of major summer vegetable crops, their resource use efficiencies, impact of farm ponds on the cropping intensity, crop diversification and employment of farmers, factors that affect adoption of rain water harvesting structures and constraints faced by farmers in practicing rain water harvesting. The methodology used was CACP for cost and returns, cobb douglas production function for resource use efficiency, crop intensity was measured in percentage, herfindal's index was used in calculating crop diversification index, total man days employed was calculated per annum to measure the employment. The binary logistic regression was used in the calculation of factors affecting adoption and analysis of constraints was done using Garret's ranking. The total cost of bitter gourd was ₹28,000.02 in Dansal, ₹28,710.23 in Nagrota, ₹28,757.30 in Chowki Choura and ₹27,787 in Akhnoor with gross returns of ₹54,037, ₹63,680.00, ₹57,000.00 and ₹67,660.00 respectively having benefit cost ratios of 1:2.80, 1:3.80, 1:3.30 and 1:30 respectively. The total cost of bottle gourd cultivation in Dansal, Nagrota, Chowki Choura and Akhnoor was found to be ₹26,732.50, ₹27,195.00, ₹31,695.00 and ₹27,485.50 respectively with gross returns of ₹42,997.00, ₹45,500.00, ₹33,000.00 and ₹41,250.00 having benefit-cost ratios of 1:2.30, 1:2.40, 1:2.90 and 1:2.30 respectively. The total cost of cultivation of okra in Dansal, Nagrota, Chowki Choura and Akhnoor was found to be ₹34,231.75, ₹28,782.40, ₹31,971.40 and ₹28,615.50 respectively having gross returns of ₹1,09,211.00, ₹1,06,400, ₹99,900 and ₹1,12,000 having highest benefit-cost ratios among all the three crops of 1:3.50, 1:4.06,

1:3.43, 1:4.41 respectively. Using Cobb Douglas production function analysis, the value of R2 was calculated to be 0.93 which shows 93 per cent variability of dependent variable in case of bitter gourd, 0.81 per cent in bottle gourd and 0.83 per cent in okra. The cropping intensity was comparatively higher after farm pond (167.00%) when compared to before farm pond (138.63%). The crop diversification index got decreased from 0.12 to 0.09 which shows higher level of diversification. Employment per annum also got increased from 136.00 man days to 269.45 man days. The result of binary logistic regression revealed that the age, labour and education was significant at 1% level of significance and extension agency contact, farm size and experience in crop cultivation were significant at 5% level of significance. The evaporation and seepage losses was ranked number one constraint and damage of structure due to heavy rainfall was ranked number seven using garrett's score.

**Key words:** CACP, resource use efficiency, binary logistic regression, herfindal's index, constraints.

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Signature of Student

  
Signature of Major Advisor

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## LIST OF ABBREVIATIONS USED

Abbreviations/Symbol	Meaning
Ha	Hectare
Km	Kilometre
Kg	Kilogram
q	Quintals
q/ha	Quintal per hectare
Agri	Agriculture
GOI	Government of India
MOA	Ministry of Agriculture
UT	Union Territory
MT	Million tonne
%	Percent
J&K	Jammu and Kashmir
Et al.	And others
Fig.	Figure
MSP	Minimum support price
/	Per
i.e.	id est (that is)
Viz.	vi delicet (namely)
Rs.	Rupee
S.no.	Serial number
RWH	Rain water harvesting
RWHS	Rain water harvesting structures
LDPE	Low density polyethene
w.r.t	With respect to
CACP	Commission for Agriculture Costs and Prices
R <sup>2</sup>	Coefficient of determination
J & K	Jammu and Kashmir
B.C	Benefit Cost
Rs	Rupee
GS	Garret score
MVP	Marginal value product
DAP	Di-ammonium phosphate
Vis-à-vis	In relation to

# Introduction

Agriculture is the back bone of Indian economy. Agriculture and allied industries account roughly for 22 per cent of GDP, while agriculture employs 50 per cent of the population, although India has around 17 per cent of the world's population. It only has 4 per cent of the world's fresh water resources (Dasgupta, 2002). The distribution of these water resources is not equal across the country. The application of water has been an essential factor in raising productivity of crops in agriculture and increasing profitability in outputs. Water is essential to bring forward the potential of land and to enable improved production and enhancing other production factors as well. Adequate water is essential for agriculture as well as its allied activities which include fisheries, animal husbandry and so on.

## L1 Rainfall distribution

According to India Meteorological Department (IMD), India received 177 cm rainfall, 43.54 per cent above normal rainfall of 123.8 mm. In the state period last year, India received 134.8 mm rainfall, 8.54 per cent above the normal rainfall. As per IMD reports, the rainfall was in surplus category. About 36 per cent of the area of India gets less than 750mm of rainfall, 42 per cent receives between 750 to 1,250mm of rainfall and only 20 per cent gets 1,250 to 2,000mm rainfall. Total rainfall in India pours in just 150 hours and half of it falls to earth in 20 to 30 hours of span. Due to the uneven distribution of rainfall throughout the country it becomes necessary to store water for future purposes and it can be done by construction of farm ponds or tanks and other water harvesting structures.

Jammu has an average rainfall of 1400mm in which about 74 per cent is received during the monsoon season i.e. June to September. In Jammu nearly 70 per cent of area is under rainfed agriculture (Directorate of Agriculture Jammu, 2021). Water rains are received during January to March, long rainless period may occur during summer season causing water stress to crops. Profoundly clean water is poorly distributed among regions in our country. India at the time of independence had per capita availability of water of 500litre which has dramatically gone down to 200litre per year. Groundwater is so important that more than 70 per cent population uses the ground

**INTRODUCTION**

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**1.1 Rainfall distribution**

According to India Meteorological Department (IMD), India received 177.7 mm rainfall, 43.54 per cent above normal rainfall of 123.8 mm. In the same period last year, India received 124.6 mm rainfall, 0.64 per cent above the normal rainfall. As per IMD reports, the rainfall was in surplus category. About 30 per cent of the total area of India gets less than 750mm of rainfall, 42 per cent receives between 750 to 1,250mm of rainfall and only 20 per cent gets 1,250 to 2,000mm rainfall. Total rainfall in India pours in just 150 hours and half of it falls to Earth in 20 to 30 hours of span. Due to this uneven distribution of rainfall throughout the country it becomes necessary to store water for future purposes and it can be done by construction of farm ponds or tanks and other water harvesting structures.

Jammu has an average rainfall of 1400mm in which about 74 per cent is received during the monsoon season i.e June to September. In Jammu nearly 70 per cent of area is under rainfed agriculture (Directorate of Agriculture Jammu, 2021) Winter rains are received during January to March, long rainless period may occur during summer season causing water stress to crops. Freshly clean water is poorly distributed among regions in our country. India at the time of independence had per capita availability of water of 5000m<sup>3</sup> which has drastically come down to 2000m<sup>3</sup> per year. Groundwater is so important that more than 70 per cent population uses the ground water for their domestic needs and for irrigation purposes as well. If water availability

in a region or state is less than or equal to  $1700\text{m}^3$  per person per year it experiences water stress conditions whereas, if in a region water availability is  $1000\text{m}^3$  per year the region will experience water stress conditions. Hence, it can be seen that in northern parts of India experience water stress conditions and southern parts experience water scarcity conditions.

## **1.2 Role of irrigation in vegetable production**

Vegetables are grown worldwide ranging from small and marginal farmers to large farmers, urban households to rural households in more than 200 countries economically as well as domestically. India accounts for production of more than 189 million metric tons (2019-20) on an area of 10.1 million hectares which contributes to nearly 11.0 per cent of the global production (Statista,2020). The country's diverse climate provides a large vegetable production base. It ranks second in vegetable output globally, it is the largest production of okra and second in green peas, tomato, cabbage, and cauliflower.

In Jammu district gross cropped area is 1.76 lakh ha of which 0.57 lakh ha comes under irrigation which is less than the total average of 27 percent. (Dept. of Agriculture Production & Farmer's Welfare, Jammu 2021) In Jammu district the production of warm season vegetable crops under irrigated is 59275 (MTs), on an area of approximately 3330 ha (Chief agriculture office, Jammu) The total water requirement of vegetable crops of the state is 500-735mm (State Irrigation Plan,2020) The major warm season vegetable crops in Jammu district highest production is of okra (10670 MTs) followed by brinjal, tomato, radish, beans, bottle gourd, cucumber etc.

## **1.3 Kandi belt of Jammu region**

The Kandi belt is the foothill zone of Siwalik of Jammu and Kashmir. The Kandi belt is estimated to be  $811\text{ km}^2$  of which upper and lower Kandi belt constitutes  $610\text{ km}^2$  and  $210\text{ km}^2$  respectively (National institute of hydrology, Roorkee) The area under Kandi belt covers in three districts Jammu, Samba and Kathua. The Kandi belt is encompassed by three among five tehsils of Jammu district and two among four tehsils of Kathua district. The area of Kandi belt falling within each of these tehsils is Jammu ( $189\text{ km}^2$ ), Akhnoor ( $147\text{ km}^2$ ) and Samba ( $163\text{ km}^2$ ) in Jammu district and Kathua ( $158\text{ km}^2$ ) and Hiranagar ( $155\text{ km}^2$ ) in Kathua district ( National institute of Hydrology, Roorkee) The summer season starts from April and lasts up to June. June is the hottest

month in Kandi belt. The weather is very hot during summer period, followed by light rains respite of heat. The rain in June is erratic and quite uncertain, resulting in delays in the sowing of Kharif crops and subsequent reduction in crop yield. After continuous rains during July and August, the monsoon recedes by end of August or early September, leading to dry spells in the region leading to less water availability for crops that are sown in following seasons. Soils of Kandi belt are, in general, of low fertility due to deficiency in nitrogen, phosphorous and organic matter

#### **1.4 Sources of irrigation**

Rain water harvesting is one of the main sources of irrigating farm land which means means to collect, store and use rain water for agriculture purposes. This method requires catchment area, a storage area and water distribution scheme to irrigate fields in dry spells. Due to uneven and erratic rainfall in rainy seasons, the rain water harvesting system helps to fill the gap between need and abundance by storing excess water to utilize in the periods of need. Different irrigation systems (drip and sprinkler irrigation), correct lining of canals, and harvesting water in structures such as farm ponds, tanks, nala bunds can help to plan and use water properly and economically. Farm ponds are an important part of water collection, storage, and efficient to store rain water. In Jammu district area of 9876 ha has been brought under assured irrigation with the activities under interventions like community tanks, farm ponds, deep bore wells etc. benefitting nearly 9495 farmers of the kandi belt (Directorate of Agriculture, Jammu, 2021). On the basis of Survey, 406 ponds of various sizes in Kandi belt have been constructed that are used for agricultural as well as domestic purposes. (Goyal and Kumar, 2005)

Ponds played a very important role in Kandi belt and is the main source of drinking water. The Kandi belt is devoid of any springs or baolis so usage of ponds become crucial. There are three types of ponds in the Jammu district- chhapris, big ponds and pucca ponds. All Kandi regions are mainly have big ponds to meet their water requirements. Big ponds can be used for irrigating crops on community basis also. The government has introduced various schemes which are helpful to farmers to increase the irrigated area. Physical progresses under PDMC-PMKSY through farm ponds/ tanks w.e.f 2016-17 to 2020-21 are 139 in nos. to 491(in numbers) with the total of 945 farm ponds in the Jammu district (Directorate of Agriculture, 2021) This water can be utilized for various horticultural and agricultural uses as well as drinking

purposes. Although, many efforts have been put by various schemes started by government yet limited success has been achieved in the kandi belt due to ignorance and selection of site areas in this belt. Rain water harvesting and reusing rainfall improves the efficiency of available land and water resources. The treated regions where rain water harvesting ponds are made increased the productivity of the land two to three folds than before.

### **1.5 Objectives of the study**

1. To find out cost and returns of summer major vegetable crops using rain water harvesting and their resource use efficiency
2. To examine its impact on cropping intensity, crop diversification and employment of farmers
3. To determine the factors affecting adoption of rain water harvesting through farm ponds and to study the various constraints faced by farmers in practicing rain water harvesting

### **1.6 Scope of the study**

The present study is aimed at to find out the impact of farm ponds on improving the irrigation source in Kandi regions. It also aims to study the economic analysis of major summer vegetable crops like bitter gourd, bottle gourd and okra after installation of farm ponds used for irrigation. Further, cost and returns are determined which would be helpful in gathering information regarding expenses required for production of crops and net returns after meeting such expenses.

The study determines performance of farm ponds through determining various factors such as cropping intensity, cropping diversification as well as employment. These findings have been helpful in comparing the above factors before and after installing of farm ponds, by this way a comparison between after farm pond before farm ponds were made and performance of farm ponds can be determined.

The research also throws light on the socio-economic factors affecting the adoption of farm ponds in an area by the farmers. Therefore, findings of the study may be beneficial for policy makers as well as planners and researchers to assess the performance of farm ponds in rainfed area its uses and effective policies for its utilization.

### **1.7 Limitation of the study**

1. Due to limited time period the study was confined to Jammu district only and only 80 farmers were selected on the basis of census survey.
2. The primary data was collected based on memory through interview method from sample farmers as they do not maintain farm records related to cost and income.
3. It was not generalized more than the boundaries of the area selected unless the other areas have similar agro-climatic conditions.
4. Due to time constraint researcher could only include limited factors that affect adoption, more independent variables could have been included for better assessment.

Reviewing literature is beneficial for the researcher to grasp the current state of the study and progress. The review is to provide the knowledge, current approaches and the present study to draw meaningful conclusions. It gives knowledge and understanding of the subject on different aspects of the conclusions. Therefore, the review of the literature serves as the comprehensive overview of subsequent research projects must be based. The goal in this chapter is to explore what a topic's established knowledge and ideas, as well as what its advantages or shortcomings are. The specific goals of the study were set as two contributions while conducting the literature review. The following headings have been introduced as provided for the accessible and pertinent literature:

## *Review of Literature*

- 2.1 Impact of rain water harvesting, as Cropping intensity, crop diversification & employment
- 2.2 Factors affecting adoption of rain water harvesting
- 2.3 Constraints faced by farmers in practicing rain water harvesting
- 2.4 Cost and return analysis of cropping and efficiency

Tewari *et al.* (1974) studied the patterns of investment behaviour and income of vegetable growers and cereal growing fields in Hissar District. The gross income was found to be higher in vegetable crops as compared to cereal crops. The net expenditure was found to be higher in vegetable crops compared to cereal crops. It was also found that the expenditure on manure and fertilizers was more in vegetable crops. It can be concluded that improving the irrigation facilities and improving the quality of land can lead to increase in income.

According to Anandarama (1977), improving the management of soil and water is essential for increased crop production because optimum water in the soil is essential for returning crops. The high crop production is in arid and semi-arid regions. The main objective of the present research is to study the water use research based on waterlogging.

### REVIEW OF LITERATURE

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Reviewing literature is beneficial for the researcher to grasp the issues related to the title of the study and improve the frame work to provide the knowledge between past approaches and the present study to draw meaningful conclusions. It gives a knowledge and understanding to the scientists on different aspects of their examinations. Therefore, the review of the literature serves as the cornerstone on which all subsequent research projects must be based. Our goal in this chapter is to explain what a topic's established knowledge and ideas, as well as what its advantages and shortcomings are. The specific goals of the study were taken into consideration when conducting the literature review. The following headings have been reviewed and provided for the accessible and pertinent literature:

- 2.1 Cost & return analysis and resource use efficiencies
  - 2.2 Impact of rain water harvesting on Cropping intensity, crop diversification & employment
  - 2.3 Factors affecting adoption of rain water harvesting
  - 2.4 Constraints faced by farmers in practicing rain water harvesting
- 2.1 Cost and return analysis & resource use efficiencies**

Tewari *et al.* (1974) studied the patterns on investment behaviour and income of vegetable growers and cereal growing fields in Himachal Pradesh. The gross income was found to be higher in vegetable crops as compared to cereal crops. The input expenditure was found to be higher in vegetable crops compared to cereal crops. It was also found that the expenditure on manure and fertilizers was more in vegetable crops. Later he concluded that improving the irrigation facilities and improving the quality of land can lead to increase in income.

According to Anonymous (1977), improving the management of soil and water for enhanced agricultural output becomes necessary since water is the first naturally occurring component that limits crop production in arid and semi-arid regions. The main objective is the resource use research based on watersheds.

Singh (1990) revealed that among all the inputs such as seed, manures, fertilizers, irrigation only marketing and plant protection was significant using linear production function in tomato crop. Human labour was also a significant factor which helped increasing good returns.

Thakur *et al.* (1994) conducted a study on production, gross income and net profit of off season vegetable production in Himachal Pradesh and Sloan districts. Five off season vegetables were compared and it was seen that vegetable cultivation is extremely labour intensive. He also concluded that it is necessary to use large amounts of manures, fertilizers and pesticides. Five major crops were compared like tomato, cauliflower, cabbage, capsicum and pea. Improved cropping methods, application of modern technologies and recommended package of practices was suggested to increase profits.

Goyal *et al.* (1995) conducted a study on the assessment of a water harvesting pond in the Hangar watershed. According to the study, the system might continue to function even in the event of very little rainfall coupled to water collection from a farm pond with a capacity of 271 m<sup>3</sup> and ber (*Zizyphus mucronata*) in the neighbourhood. The system's computed benefit-cost ratio is 1.672, which suggests that farm ponds might hold the key to stabilising agriculture production on rain-fed land in dry and semi-arid conditions.

Kumar and Arora (1999) studied economics of vegetable production in Uttar Pradesh hills and concluded that majority of farmers were growing vegetable using labour-intensive techniques as whole of the family was involved in producing these crops. Most of the vegetables were grown on a larger scale than recommended.

Tiwari and Mai (2000), suggested that the water harvesting techniques include causing and increasing run-off from land surfaces employing surface utilizing conserved water most effectively at key times to give crops with life-saving irrigation involves treatment, collection, and storage of runoff water in a suitable reservoir or pond.

Radha and Prasad (2001) investigated the economics of vegetable cultivation in Andhra Pradesh. They concluded that there was highest cost of cultivation was in tomato crop, net returns of cauliflower was greatest, followed by tomato, cauliflower has highest cost-benefit ratio (1:2.90) and lowest for bhindi crop (1:0.28).

Kirve *et al.* (2002) studied production and marketing of French beans in Maharashtra's western region. The study concluded that French beans is highly profitable crop with high benefit- cost ratio of 1:1.08 and cost of cultivation of French bean per hectare of Rs. 15843.96.

Goel and Kumar (2005) came to the conclusion that water collecting structures of various sizes with expected lifespans of 25 and 40 years had benefit/cost ratios ranging from 0.41 to 1.33. The smallest increase in income from wheat and maize was \$1,180,800 for a productivity of 0.5 t ha<sup>-1</sup>. The project's expenses may be recovered in a few weeks in their investigation of water harvesting in the Soan river watershed in the northwest Himalayas of India.

Vincent *et al.* (2006) concluded that farm ponds excavated in or near the field have been shown to help increase the ground water table, and the stored water can be used as protective irrigation during critical crop growth phases, according to Any size farm pond can be constructed, and water can be gathered via carefully thought-out channels.

Ayoola *et al.* (2009) conducted an experiment on resource-use effectiveness in dry season vegetable production. The effectiveness of resource usage in dry season vegetable production was evaluated to ascertain profitability and expansion potential. It was determined that producers may increase income by expanding their farms and using more fertiliser while employing fewer workers.

Hasan *et al.* (2014) investigated profitability of important summer vegetables in Keranigonj upazilla of Bangladesh from months April to May to find out the cost and returns of major summer vegetables cultivated in Bangladesh namely bottle gourd, cucumber and brinjal. Total cost of cultivation was found to be ₹4,12,713/hectare, ₹2,69,629/hectare, ₹2,56,2548/hectare for bottle gourd, brinjal and cucumber respectively. The highest benefit- cost ratio was found to be of brinjal (1:3.72) and lowest benefit-cost ratio was found to be of bottle gourd (1:2.40). The net returns was found to be highest in brinjal (₹7,32,811/ha) and lowest for bottle gourd (₹5,79,431/ha).

Mishra and Ghadei (2015) conducted a study in 10 villages of Uttar Pradesh to examine the socio-economic profile of vegetable farmers. Data collected from 205 vegetable farmers revealed that, 35.61 per cent farmers had high school education whereas about 61.50 per cent of farmers had medium level of farming experience.

Mila *et al.* (2015) conducted a study on profitability, factors affecting yield and resource use efficiency using Cobb-Douglas production function and concluded that the yield of bitter melon was found to be 27.5 ton per hectare and average gross return was found to be ₹5,50,000 per hectare. By using Cobb- Douglas production function it was found that human labour, irrigation and manure and fertilizers were found to be significant among all the other variables.

Shrivastava *et al.* (2015) concluded that Net Present Worth (NPW) and Benefit Cost Ratio (BCR) were found to be greater than zero and greater than 1 resp. in farm ponds constructed in Navsari Agricultural University (NAU) campus which proved the feasibility of ponds in the area.

Mishra *et al.* (2016) conducted a study on the economic evaluation of a farm pond in a micro watershed was undertaken and concluded that money invested in farm pond instalment was recovered within 10 years. As a result, each element affects how economically viable the farm pond is. In order to arrive at the 1.57 BCR value, a cautious return estimate was used. If intangible benefits are taken into account and assessed, the BCR will almost certainly be higher. The BCR was 1.57, and the pond's net present value (NPV) was close to 30,000. As a result, each element affects how economically viable the farm pond is. In order to arrive at the 1.57 BCR value, a cautious return estimate was used. If intangible benefits are taken into account and assessed, the BCR will almost certainly be higher.

Tijjani (2018) conducted a study on socio-economic determinants of vegetable farmers awareness of safety measures in pesticides use in Jere local government area, Borno state in Nigeria and concluded that most of the farmers belong to age groups 26 to 35 years of age (36 per cent) and have family size of 6 to 10 members having farm size less than 10 acres.

Tejar (2019) carried a study to find out cost and returns of okra in four blocks of Bilaspur district of Chattisgarh. Four blocks were selected constituting 154 farmers in total. The cost of cultivation was found to be ₹60405.82/ha. The major share of operational cost was found to be from human labour comprised of 37.49 per cent of total cost.

## **2.2 Impact of rain water harvesting on cropping intensity, crop diversification & employment**

Phadnawis *et al.* (1990) suggested that the implementation of better technology boosted food grain yield from 5 to 10 q/ha of bajra crop. The water harvesting structures that were built in this region enabled the expansion of irrigation from 0.80 hectares to 40 ha. The annual per capita income rose from Rs. 1587 to Rs. 6541. The percentage of crops harvested grew from 106 to 150.7%. Ninety percent of the watershed's recommended cropping pattern was adopted.

Singh (1990) found that productivity increased by 21.4% (pigeon pea) and 24.58% (wheat) in roughly five years in his study done in Uttar Pradesh. The rise in output of other important crops, including mustard (up 23.9%), groundnuts (up 22.5%), pearl millet (up 22.0%), blackgram (up 17%), lentils (up 11.7%), grains (up 10.7%), and peas (up 7.5%). His research also showed that cropping intensity improved from 84.28 percent in 1984–85 to 173.9 percent in 1989–90. It was seen both in kharif and rabi seasons.

Hafeez *et al.* (1991) analysed crop diversification and its economics in Karnataka. Benefit-cost ratio was calculated to be 1.48, showing a better return on each rupee spent cultivating these crops. Crop diversification was continuously rising in the villages at the Chitravati watershed.

Jahagirdar (1991) in a study on the growth parameters in the Manoli watershed project of the Akola district in Maharashtra and discovered that cropping intensity increased from 104 to 115 percent, the area irrigated by well increased by 206 hectares, and that the use of in situ moisture conservation technologies, particularly vegetative barriers, helped to increase the yield per hectare of different crops.

Neema *et al.* (1991) found that the intensity of cropping in farms within the watershed was 13–20 per cent greater than that of farms outside of it in watershed Development Programme area of Barkheds-Hat in Guna district of Madhya Pradesh.

Srivatsava *et al.* (1991) studied the watershed initiative in the Madhya Pradesh district of Mandsur gave farmers the chance to plant more crops in rabi season and in some circumstances, summer crops as well. The total area that was cultivated grew by 38.31%. The largest production was observed in opium, and rabi crops had a greater increase in output than kharif crops (93 per cent )

Manhot *et al.* (1992) found that the watershed programme aids in increasing irrigation water availability to improve cropping intensity. Furthermore, their research

showed that the increase in man days worked by farmers and bullock days in the field as a result of the favourable shift brought about by soil and water conservation has indicated a growth in employment.

Kumar (1993) found that the net returns of small and large farmers in watershed area under existing cropping pattern and resources were Rs. 24099 and Rs. 50466 resp. income of small and large farms of watershed area by 8.83 and 4.86 per cent.

Kaushal *et al.* (1994) concluded that employment possibilities with the total of 70,606 man-days for casual work and 2,08,606 man-days for regular labour were created over a 24-year period. This information would be useful in preventing the outflow of people moving from rural to urban areas.

Singh and Singh (1997) evaluated the benefits of Rendhar watershed project in Uttar Pradesh Jalaun area and discovered that crop production and cropping intensity as well as productivity has increased as result of larger gross cultivated area.

Bharath Kumar (2001) revealed that over the course of four years, the average incremental employment in crop production and upkeep of horticulture crops was 15,263man days. Thus, over the course of four years, the watershed project added 37,550man days to the labour force on average.

Desai *et al.* (2007) examined the effects of rainwater harvesting in the Karnataka district of Dharwad and discovered that the gross cultivated area rose by 22.32 percent when there was a farm pond as opposed to one without. 4.08 percent more jobs were created in the farm-pond area than in the non-farm-pond area.

According to Mishra (2009), cropping intensity increased in Sadeiberini village in the Dhenkanal district of Orissa after the implementation of RWHT, rising from 100 to 131 percent in the first year to 176 percent in the second year to 200 percent in the third. With BCR of 2.65 to 2.70, there was also a considerable boost in rice yield.

Palanisami and Kumar (2009) evaluated the effects of watershed initiatives executed under the DPAP (Drought Prone Area Programme). Net cropped area, gross cropped area, cropping intensity, and crop diversification all altered after watershed development intervention from 1.15 ha to 1.28 ha, 1.38 ha to 1.88 ha, 120 percent to 146.88 percent, and 1 to 0.97 resp. in the Coimbatore district of Tamil Nadu.

Kumar *et al.* (2015) examined the effects of local rainwater harvesting systems in Rajasthan's semiarid Tonka and Karauli districts. Cropping intensity increased from 120 percent to 190 percent as a result of the use of RWH. Herfindahl Index after adoption showed a decrease from 0.82 to 0.67 in Karauli and from 0.78 to 0.54 in Tonk, indicating that both study areas underwent greater diversification. The adoption of farm ponds by farms has been confirmed by the high benefit-cost ratio (1.9 and 2.3) and net present worth (119 and 126 thousand in both districts) values.

Hyalij (2017) discovered that the mean of employment creation of beneficiaries after use of farm pond was 152.60man days while the mean of employment generation of beneficiaries before farm pond was 96.55man days. Calculated from these means, the "Z" value revealed a sizable variation in employment generation.

### **2.3 Factors affecting adoption of rain water harvesting**

Senkondo *et al.* (1998) found that farm size, number of family members working in the farm, farming experience, and level of understanding in RWH techniques were relevant in explaining the intensity of adoption of RWH techniques.

He *et al.* (2007) found that using logit regression, farmers' educational background, the size of the active labour force, contact with extension, and positive attitude toward rainwater harvesting and supplementary irrigation technology were some of the variables that had significantly positive effects on adoption while farmer's age and the distance from water storage tanks to farmers' dwellings had significantly negative correlations with adoption.

Tesfay (2007) examined that high seepage loss in clay-lined ponds was found to be main issue this might be caused by a thin layer of clay or by improper compaction at the appropriate moisture level. Although it has been discovered that ponds with plastic linings are good at holding water, occasionally the plastic will get damaged and develop holes, which will cause water to leak.

Mihayo (2008) evaluated variables influencing RWH adoption in Morogoro, Tanzania. While the water problem was statistically significant but had a negative effect on adoption of RWH, the monthly average household income, technological expertise, and credit availability were statistically significant and had a favourable impact. This

implied that because of poverty, families with severe water difficulties were unable to implement water storage devices on their own.

Segers *et al.* (2008) discovered that the improper site selection, insufficient compaction of the pond's floor and walls, lack of effort to remove or prevent sediments from entering the ponds, lack of construction of the diversion channels and inlets necessary to harvest run-off water, and quick infiltration were the causes of the malfunctioning of RWH ponds in Degua Temben, Tigray, Ethiopia

Badisa (2011) found that hired labour had a significantly negative impact on the adoption of rainwater harvesting while land size, access to financial services, access to information, and contact with extension offices had positive effects on farmers' decisions to adopt the practice in Thulamela local municipality, Vhembe district, Limpopo.

Ahmed *et al.* (2013) found that the educational level of household heads, experiences with water scarcity, farm size, awareness, farming as a source of income, and household age were the most significant influences on households' decisions to adopt rainwater harvesting techniques in Yatta district of Kenya.

Shikur and Beshah (2013) found that four variable sex of the household head, labour availability, farm size, and participation in off-farm income—were at 10 percent probability level, five variables indigenous water harvesting experience, livestock availability, land security, and training in RWH are were at less than 5 percent probability level, and one variable availability of extension service was at less than 1 percent probability level. Only the market distance among these showed an adverse relationship with the adoption of RWH technology, indicating that farmers who are located closer to market hubs will be more likely to use RWH technology.

Murgor *et al.* (2013) examined the root causes of the low adoption rates of rainwater harvesting practises. The adoption of rain water harvesting systems was found to be positively influenced by the respondents' education level and social responsibility. The factors that influenced the adoption of rainwater harvesting technologies were poor capital and human endowment, lack of access to financing, participation in off-farm activities, negative perception, gender concerns, inaccessibility of construction supplies, and a lack of technical know-how. The study

indicated that farmers need to be made aware of the need for technical and institutional help.

Ariane *et al.* (2014) found that the logit regression model indicated that household size, farm income, household endowment with physical assets, and membership in farmer organisations all had a positive and significant impact on the adoption of RWH through farm ponds.

Mume and Kemal (2014) investigated the variables influencing RWH adoption in Ethiopia's Eastern Hararghe Low Land. The adoption of rainwater harvesting by households in the study area was significantly influenced by the age of the household head, education level, number of livestock, size of the land holding, distance between the home and the farmers' extension centre, and labour availability, according to a logit regression analysis.

Baiyegunhi (2015) statistically explained the factors including gender, age, education, income, social capital, interaction with an extension agent, and perceptions of and attitudes toward RWHT in Msinga, Kwa Zulu-Natal, South Africa. Only age, out of these important factors, had an adverse effect on RWHT adoption

Kattel (2015) concluded that training in agriculture and livestock was the most major element influencing farmers' decisions to embrace RWHT in Nepal's mid-hill areas. While the farmer's training and the household head's gender (i.e., being a man) had a considerably beneficial impact on the decision to adopt a RWH, the household head's age, yearly household income from off-farm activities, and poverty status had a considerable but negative impact. The adoption decision was unaffected by additional factors like the number of economically engaged family members or the household head's educational level.

Zongo *et al.* (2015) found that the adoption of supplemental irrigation (where RWH farm ponds were included) was significantly influenced by socio-economic factors like marital status, age of the head of household, household size, and the number of active labourers, equipment, and farm income in Burkina Faso, Belgium. Household size (at 1% l.o.s), agricultural income (at 5% l.o.s), transportation, and marital status were factors that had an advantage (at 10 percent l.o.s).

Shalander *et al.* (2017) studied the main predictors of the efficiency of farm-level rainwater collection structures included technical support, tailored design, amount of farmer engagement, age, yearly rainfall, and household assets.

Shalander *et al.* (2017) examined the collection of rainwater at the farm level in several agroclimatic areas of India and concluded that the main predictors of the efficiency of farm-level rainwater collection structures included technical support, tailored design, amount of farmer engagement, age, yearly rainfall, and household assets. Age, labor, and institutional factors like credit services, on the other hand, were found to have little or no impact on the adoption of WHT.

Adhikari *et al.* (2018) used a probit model to find characteristics that affect the adoption of RWT. The results revealed that years of schooling, total physical assets, and household members all had a positive and substantial impact on RWHT adoption.

#### **2.4 Constraints faced by farmers in practicing rain water harvesting**

Amha (2006) discovered that accidents caused by a lack of a roof cover and a fence around the RWH ponds and issues with water lifting and watering equipment were the key factors limiting the efficacy of technology implementation. This showed that assistance was required to supply farm households with affordable but enhanced water lifting and watering equipment as well as instruction in the creation and use of roof covers and pond barriers.

Eyasu *et al.* (2006) concluded that the main challenge facing RWHT adopters in Tigray, Ethiopia, was the enormous impact of seepage loss on the net captured water of the unlined pond. The silt trap constructions failed to reduce the amount of deposited sediment. To increase the ponds' storage capacity, it was suggested that construction and upkeep be improved.

Tesfay (2007) found that high seepage loss in clay-lined ponds was found to be caused by improper compaction at the appropriate moisture level. Although it has been discovered that ponds with plastic linings are good at holding water, occasionally the plastic will get damaged and develop holes, which will cause water to leak.

Segers *et al.* (2008) discovered that the improper site selection, insufficient compaction of the pond's floor and walls, lack of effort to remove or prevent sediments from entering the ponds, lack of construction of the diversion channels and inlets

necessary to harvest run-off water, and quick infiltration were the causes of the malfunctioning of RWH ponds in Degua Temben, Tigray, Ethiopia.

Mishra (2009) revealed that the poor farmers found it difficult to go for large initial investment to adopt RWH technology, for which institutional subsidized credit support was needed.

Oweis and Hachum (2009) discovered that the main obstacle to the adoption of RWHT in the Sahel zone of Africa were farmers' unfamiliarity with the technology, conflicts and disputes over water rights, land ownership, use, and lack of adequate characterization of rainfall, evapotranspiration, and soil properties.

Yosef and Asmamaw (2015) revealed that the using farm ponds required a lot of labour because water had to be physically pumped out of the pond to irrigate the field and apply directly to the crop. The main obstacles to the adoption of RWHT in Ethiopia included seepage loss and knowledge shortage.

Munyaneza *et al.* (2016) concluded that the RWH technology could have adverse impacts such as social conflicts, mosquito breeding grounds, water-related diseases, accidents, and others with a severity level of 32%, 24%, 20%, 16%, and 8%, respectively. These occurred as a result of improper management of the RWH ponds. Animals entering the pond and destroying the plastic sheets were the main causes of water loss, along with sedimentation, evapotranspiration, and other factors.

Hyalij (2017) in Latur district of Marathwada region of Maharashtra state studied the constraints faced by farmers and concluded that high labour wages was the primary difficulty (88.34 per cent) faced by farmers followed by lesser availability of credit on time (81.67 per cent) were the major constraints faced by farmers.

Singh and Athokpam (2018) found that the main issue experienced by RWHT adopters in Chandonpokpi village, Chandel district, Manipur, was excessive seepage loss, which ranged from 300 to 400 l m<sup>-2</sup> wetted area per day. Therefore, in order to keep the harvested water in the pond throughout the dry season, the pond needed to be lined with a non-permeable film (i.e. from November to March).



**Plate 1: Farm Ponds used by farmers for storage of rain water**

1.1 The methodology used to accomplish the objectives of the study are discussed in this chapter. It is covered under structure, layout of the study, sampling design, collection of data, methods of analysis of data and techniques used during investigation.

1.2 Layout of study

The present study was conducted in the Jammu district of Jammu and Kashmir (J&K) which is selected purposefully on the basis of highest number of vegetable growers irrigating the fields using water harvesting farm ponds.

1.3 Sampling design

For sample selection, a multistage sampling technique was used, with block

# Materials and Methods

(i) Selection of blocks: Four blocks of Jammu district were selected purposefully on the basis of highest water harvesting farm ponds.

(ii) Selection of villages: List of villages falling in each selected blocks were prepared and selected purposefully (purposive sample) from each block to constitute a total of 15 villages.

(iii) Selection of farmers: From each village households were selected purposefully so as to constitute a sample of 30 farmers.

1.4 Collection of data

Both primary and secondary data was collected to accomplish the objectives of the study. The primary data was collected through survey method by interviewing the farmers with the help of prepared pre-tested schedule. The required secondary data was collected from various published sources agencies such as Economic Survey (various years), Digest of Statistics, Annual Reports other relevant government publications and various websites.

**MATERIALS AND METHODS**

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**3.1** The methodology used to accomplish the objectives of the study are discussed in this chapter. It is covered under sections, locale of the study, sampling design, collection of data, method of analysis of data and techniques used during investigation.

**3.2 Locale of study**

The present study was conducted in the Jammu district of Jammu and Kashmir UT which is selected purposively on the basis of highest number of vegetable growers irrigating the fields using water harvesting farm ponds.

**3.3 Sampling design**

For sample selection, a multistage sampling technique was used, with blocks, villages and vegetable growers as the first, second and third stage units, respectively.

- i) Selection of blocks: Four blocks of Jammu district were selected purposively on the basis of highest water harvesting farm ponds.
- ii) Selection of villages: List of villages falling in each selected blocks were prepared and selected purposively (census sample) from each block to constitute a total of 15 villages.
- iii) Selection of farmers: From each villages households were selected purposively so as to constitute a sample of 80 farmers.

**3.4 Collection of data**

Both primary and secondary data was collected to accomplish the objectives of the study. The primary data was collected through survey method by interviewing the farmers with the help of prepared pre-tested schedule. The required secondary data was collected from various published sources/ agencies such as Economic Survey (various issues), Digest of Statistics, Annual Reports other relevant government publications and various website

**Table 3.1: Blocks and villages selected for study**

S.No.	Name of blocks	Name of villages	Sample size
1.	Dansal	Samral	5
		Chringal	5
		Upper Kuwara	5
		Mandal	5
2.	Nagrota	Panjgrain	5
		Sandhi	5
		Bhawal mullo	5
		Seri, Kalan	5
3.	Chowki Choura	Chowki	5
		Choura	5
		Kaneri	6
		Gangal	6
4.	Akhnoor	Godhan	6
		Kandi	6
		Gargal	6
Total	4	15	80

### 3.5 Quantification of variables

The inputs used in the cultivation of vegetable crops with various cost and return concepts were computed as follows:

#### 3.5.1 Machine labour

For the computation of cost of machine labour, the number of tractor hours utilized per acre on vegetable crops is multiplied by the rate at which a tractor could be hired at customer basis. Tractors were used on farms for various purposes such as ploughing, seeding, weeding etc.

#### 3.5.2 Human labour

The cost of hired labour were computed by adding both family labour and hired labour. In cultivation of vegetable crops family labour contribute more than hired labour.

### 3.5.3 Seed

Amount of seed utilized per acre was computed for vegetable crops. To calculate the cost of cultivation, the value of seed was assessed and amount of seed utilized was multiplied by prevailing market prices for per acre of land.

### 3.5.4 Manures and fertilizers

Cost of manures and fertilizers such as urea, MOP and DAP were computed by multiplying the market price of the chemicals with the physical quantity used per acre of land.

### 3.5.5 Irrigation

Irrigation prices were computed by multiplying the per hour cost of the units used by motor to irrigate farm area from farm ponds.

### 3.5.6 Plant protection

Various plant protection chemicals used by the farmers such as weedicide, insecticide, weedicide were assessed. The quantity of the inputs were multiplied by the prevailing market rates of the chemicals.

### 3.5.7 Depreciation

The depreciation rate was calculated by using straight line method by using the following formula:

$$\text{Straight line depreciation method} = \frac{\text{Cost of asset} - \text{Residual value}}{\text{Useful life of an asset}}$$

### 3.5.8 Fixed cost

It includes expenditure made on fixed cost such as rental value of owned land, rent paid for leased in land, depreciation on farm buildings and equipment, interest on fixed capital.

### 3.5.9 Variable cost

It includes expenditure on variable components such as human labour, machine labour, seed, manures, fertilizers, FYM, plant protection and irrigation costs.

### 3.5.10 Interest on working capital

The interest on working capital is taken as 7 per cent per annum (computed by prevailing bank rate for short term loans)

### 3.5.11 Interest on fixed capital

The interest on fixed capital is taken as 10 per cent per annum (calculated at prevailing bank rate for long term loans)

### 3.5.12 Gross returns

The gross returns for vegetable crops was calculated by multiplying the yield of the crop per acre with the price per quintal of the produce.

### 3.5.13 Net returns

Net returns was computed by subtracting gross returns with the total cost.

### 3.5.14 Benefit cost ratio

The benefit-cost ratio of the project is defined as the discounted value of cash inflows to the cash outflows. It can be computed by using the following formula:

$$\text{BCR} = \frac{\sum_{t=1}^n \text{B}_i / (1+r)^t}{\sum_{t=1}^n \text{C}_i / (1+r)^t}$$

Where,

B<sub>t</sub> = cash inflows obtained by the sample farms due to the farm ponds in the year

r = discount rate

t = number of years

n = life period of the farm pond

C<sub>t</sub> = cash outflow due to the farm ponds in the i<sup>th</sup> year (t = 1,2,...,n)

## 3.6 Economic analysis

### 3.6.1 For estimating cost and returns

The cost and returns analysis will be worked out using CACP (Commission for Agricultural Costs and Prices) cost concepts like cost A<sub>1</sub>, cost A<sub>2</sub>, cost B<sub>1</sub>, cost B<sub>2</sub>, cost C<sub>1</sub>, cost C<sub>2</sub> and cost C<sub>3</sub>.

**Cost A<sub>1</sub>** = paid out costs like wages of hired human labour, owned and hired machine labour, farm machinery, seeds, fertilizer and manure, insecticides and pesticides, charges, depreciation and interest on working capital.

**Cost A<sub>2</sub>** = Cost A<sub>1</sub> + rent paid for leased in land

**Cost B<sub>1</sub>** = Cost A<sub>2</sub> + interest on value of owned fixed capital assets.

**Cost B<sub>2</sub>** = Cost B<sub>1</sub> + rental value of owned land

**Cost C<sub>1</sub>** = Cost B<sub>1</sub> + imputed value of family labour.

**Cost C<sub>2</sub>** = Cost B<sub>2</sub> + imputed value of family labour.

**Cost C<sub>3</sub>** = Cost C<sub>2</sub> + 10 per cent of Cost C<sub>2</sub> (as managerial cost)

### 3.6.2 For estimating resource use efficiency

In order to study the relationship between output and various inputs to be used, Cobb-Douglas production function will be used. This function is used extensively in agricultural production function analysis. The functional form applied is given as under:

$$Y_t = \beta_0 \left( \prod_{i=1}^n X_i^{\beta_i} \right) u_t \quad (i = 1, 2, 3 \dots 0n)$$

Where, Y and X<sub>i</sub> (i = 1, 2, 3...n) are the output and level of inputs. The constant β<sub>0</sub> and β<sub>i</sub>'s (i=1, 2, 3...n) represent the efficiency parameters and the production elasticities of the respective input variables for the given population at a particular period, t.

The fitted Cobb-Douglas production may be written for the present case with five input variables as

$$y = a_0 x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5}$$

On log transformation, the above function can be transformed to a linear form as:

$$\text{Log } y = \text{log } a_0 + b_1 \text{log } x_1 + b_2 \text{log } x_2 + b_3 \text{log } x_3 + b_4 \text{log } x_4 + b_5 \text{log } x_5$$

Or

$$\text{Log } y = \text{log } a_0 + b_i \sum_{i=1}^5 \text{log } x_i$$

Where,

Y = Output (qts./acre)

X<sub>1</sub> = Human labour (man days per acre)

$X_2$  = Expenditure on manure and fertilizer (kg/acre)

$X_3$  = Expenditure on plant protection ( ₹/acre)

$X_4$  = Expenditure on irrigation ( ₹/acre)

$X_5$  = Expenditure on seeds ( ₹/acre)

$a_0$  = Constant

$b$ 's = Elasticities of production of respective resource categories

For examining the productivity of different inputs to be used in production of various crops, marginal value productivities of inputs was estimated at geometric mean levels of inputs. To calculate Marginal Value Productivity (MVP) of resource  $x_i$ , the following formula was used:

$$\text{MVP} = \hat{b}_i \frac{GM(Y)}{GM(X_i)} \times P_y$$

Where,

MVP ( $X_i$ ) = marginal value productivity of  $i^{\text{th}}$  resource

$\hat{b}_i$  = regression coefficient (estimated)

GM (Y) = geometric mean output.

GM ( $X_i$ ) = geometric mean of inputs

$P_y$  = Price of output

### 3.7 To measure cropping intensity

Cropping intensity was measured by dividing gross cropped area with net cropped area expressed in percentage.

$$\text{Cropping intensity} = \frac{\text{Gross cropped area}}{\text{Net sown area}} \times 100$$

### 3.8 To measure crop diversification

The crop diversification in the sample farms before and after farm ponds was measured using Herfindahl index. HHI values (with farm ponds and without farm ponds) were compared to know the impact of farm ponds on crop diversification. HHI was measured by using the following formula:

$$HI = \sum_{t=1}^N P_i^2$$

Where,

$N$  = total number of crops in an area

$P_i$  = proportion of area under  $i$ th crop

The Herfindahl index decreases with increase in crop diversification. The value of the index lie between 0 to 1.

### 3.9 To measure employment of farmers

Employment was calculated by counting man days which is defined as work performed by a man in eight hours in a day. Total employment is calculated by addition of total man days employed on a farm.

### 3.10 To determine factors affecting adoption of farm ponds

Binary logistic model was used to determine the factors affecting adoption of farm ponds. It is determined by following formula

$$P_i = F(Z_i)$$

Where,

$P_i$  = probability to determine adoption of farm pond

$X_i$  = explanatory variables (to be estimated)

The log odd ratio was determined by using the following equation:

$$Z_i = \ln (P_i/1-P_i)$$

Where,

$Z_i$  = log odd ratio

$X_i$  = explanatory variables

$e$  = base of natural logarithm

The above equations can be simplified as follows,

$$ARWH = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + u_i$$

Where,

ARWH= Adoption of farm ponds

$X_1$ = Age of the respondent

$X_2$ =extension agency contact (per year)

$X_3$ =farm size (in acres)

$X_4$ =education (in years)

$X_5$ =farming experience (in years)

$X_6$ =labour force (in numbers)

$b_1, b_2, \dots, b_6$ = parameters corresponding to estimated variables coefficients

$u_i$ = error term consisting of unobservable random variables

### 3.11 To find the constraints in practicing rain water harvesting

The Garrett ranking technique will be used to analyse the constraints in practicing rain water harvesting. The Garrett ranking technique used will be as follows:

$$\text{Per cent position} = 100 \times (R_{ij} - 0.5) \div N_j$$

Where,  $R_{ij}$  stands rank given for the  $i^{\text{th}}$  factor ( $i= 1, 2, \dots, 8$ ) by the  $j^{\text{th}}$  individual ( $j = 1, 2, \dots$ ) and  $N_j$  stands for number of factors ranked by  $j^{\text{th}}$  individual.

Once the per cent positions is found, scores will be determined for each per cent position by referring to the Garrett's table. Then the scores for each factor will be summed over the number of households.

In this way, total scores will be arrived at for each factor and mean scores will be calculated by dividing the total score by the number of respondents, who will give ranks. Finally, overall ranking of the eight factors will be done by assigning rank 1, 2, 3...8 in the descending order of the mean scores. The same procedure will be followed for different areas of Jammu district.



**Plate 2: Rain water harvesting structures used by farmers for collecting water**

## RESULTS

In this chapter the results pertaining to the present investigation "Socio-economic characteristics of farmers under study area and their knowledge on rain water harvesting" have been presented. For any research study appropriate presentation of results are important under the concerned area of study. The results obtained under the study are presented under the following sections:

- 4.1 Socio-demographic characteristics of farmers under study area
- 4.2 Extension and relative use efficiency of major summer vegetable crops
- 4.3 Impact of farm ponds on cropping intensity, crop diversification and employment of farmers.
- 4.4 Factors affecting adoption of rain water harvesting
- 4.5 Constraints faced by farmers in practicing rain water harvesting
- 4.6 Socio-demographic characteristics of farmers under study area

## Results

The socio-economic status depends on the strength of an individual in particular area which can be determined by analyzing various characteristics such as age, education level, experience of farmer in crop cultivation, family size, type of family. These characteristics were analyzed and results are presented in Table 4.1.

### 4.1.1 Age

The table indicates that 25.20 per cent of the farmers belong to the age group greater than 50. About 33.30 per cent of the farmers belong to the age group 30-49 years of age and lesser number of farmers i.e. 11.25 per cent belong to age group less than 30.

### 4.1.2 Educational qualification

From the table it can be seen that majority i.e. 68.75 per cent of the farmers were educated up to High school level, 18.75 per cent of the farmers were graduates and 12.50 per cent of the farmers were illiterate.

# RESULTS

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In this chapter the results pertaining to the present investigation “Economic analysis of summer vegetable crops through rain water harvesting structures in rainfed areas of Jammu district” have been presented. For any research study systematic presentation of results are important under the concerned area of study. The results obtained under the study are presented under the following sections:

- 4.1 Socio-demographic characteristics of farmers under study area
- 4.2 Economics and resource use efficiency of major summer vegetable crops
- 4.3 Impact of farm ponds on cropping intensity, crop diversification and employment of farmers
- 4.4 Factors affecting adoption of farm ponds
- 4.5 Constraints faced by farmers in practicing rain water harvesting

### **4.1 Socio-demographic characteristics of farmers under study area**

The socio-economic features determine the strength of an individual in a particular area which can be determined by analyzing various characteristics such as age, education level, experience of farmer in crop cultivation, family size, type of family. These characteristics were analyzed and results are presented in Table 4.1

#### **4.1.1 Age**

The table indicates that 56.25 per cent of the farmers belong to the age group greater than 50. About 32.50 per cent of the farmers belong to the age group 30 -50 years of age and lesser number of farmers i.e 11.25 per cent belong to age group less than 30.

#### **4.1.2 Educational qualification**

From the table it can be seen that majority i.e 68.75 per cent of the farmers were educated up to high school level, 18.75 per cent of the farmers were graduated and 12.50 per cent of the farmers were illiterate.

### 4.1.3 Experience in crop cultivation

The majority of farmers had experience of crop cultivation between 20-30 years, 26.25 per cent of farmers had experience of more than 30 years whereas only 11.25 per cent of farmers had experience of less than 10 years.

### 4.1.4 Family size

The table indicates that the family size of majority of farmers were 5-7 members followed by 33.75 per cent of farmers having 1-5 number of members and 11.25 per cent were large families (more than 8 members)

### 4.1.5 Type of family

It is seen from the table that 61.25 per cent of the farmers belonged to the joint family and 38.75 per cent of the farmers belong to nuclear family.

### 4.1.6 Extension agency contact

It can be observed from the Table that the 77.50 per cent of the farmers visited the extension agency twice in a year and 22.50 per cent of the farmers visited agency contact once in year.

**Table 4.1: Socio-demographic characteristics of farmers under study area**

S.No	Variable	Category	Frequency	Percentage(%)
1.	Age	Young (<30)	9	11.25
		Middle(30-50)	26	32.50
		Old(>50)	45	56.25
2.	Education	Illiterate	10	12.50
		Intermediate	55	68.75
		Graduate	15	18.75
3.	Experience in crop Cultivation	<10	9	11.25
		10-20	3	3.75
		20-30	47	58.75
		>30	21	26.25
4.	Family size	Small	27	33.75
		Medium	44	55.00
		Large	9	11.25
5.	Type of family	Nuclear	31	38.75
		Joint	49	61.25
6.	Extension agency contact	10-12	18	22.50
		12-25	62	77.50

## **4.2 Economics and resource use efficiency of major summer vegetable crops**

The cost structure of major summer vegetable crops is presented in Tables 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12 and 4.13. It is observable from the tables that machine labour, hired labour, owned labour, seed, fertilizers, FYM, irrigation, plant protection are major constituents of operational cost. Likewise, rent paid for leased in land, depreciation on farm buildings and equipment and interest on fixed capital (excluding land) are the major constituents of fixed cost.

### **4.2.1 Cost and returns of major summer vegetable crops**

The returns and cost of cultivation to different factors of production helps in determining the selection of the enterprise. Hence, different components of cost of cultivation, cost structure, cost concepts, gross returns and net returns from major summer vegetables were worked out.

#### **4.2.1.1 Item wise cost structure for vegetable cultivation**

The operation wise cost of cultivation of vegetables in Dansal block is presented in Table 4.2. It shows that in Dansal block, three major summer vegetable crops were grown by farmers i.e bitter gourd, bottle gourd and okra and per acre total cost of cultivation were found to be ₹25,818.20, ₹24,3012.26 and ₹31119.80 respectively. Expenditure on total human labour, seed and FYM were the important components of operational cost. Rent paid for leased in land was important component in fixed cost. The results discovered that the operational cost was ₹19453.66, ₹17937.72 and ₹24755.20 per acre and fixed cost was ₹6364.54 per acre. Per acre cost of cultivation was found to be of okra ₹31119.80 per acre whereas least cost incurred was in cultivation of bottle gourd i.e ₹24302.26 per acre.

The operation wise cost of cultivation of major summer vegetables in block Nagrota is presented in Table 4.3 and the results revealed that bitter gourd, bottle gourd and okra were the major summer vegetable crops grown in the region. The human labour, seed and fertilizers were the major components in operation cost whereas rent paid for leased land and depreciation were the major components in fixed cost. The table also concluded that among all the components the highest cost were incurred on human labour in all the crops ₹6977.45, ₹38794.46 and ₹7936.71. Per acre operational cost was found to be ₹19237.40, ₹17859.00 and 19303.00 whereas fixed cost incurred was ₹6862.81 per acre. The highest cost incurred was on cultivation of okra (₹

26165.80/acre) followed by bitter gourd (₹26100.21) and least cost incurred on cultivation of bottle gourd (₹24721.78/acre)

Per acre cost of cultivation in Chowki Choura block is presented in Table 4.4. Bitter gourd, bottle gourd and okra were the major summer vegetables in Chowki Choura block. Per acre cost of cultivation was found to be ₹28757.20, ₹28814.57 and ₹29064.80 respectively. Expenditure on human labour, seed and plant protection were major components of operational cost. Likewise, depreciation and rent paid were most important components of fixed cost. The results further revealed that among all the inputs used per acre human labour was found to be the highest ₹6764.22, ₹8158.82 and ₹7104.50. However, operational cost was found to be ₹18705.00, ₹18762.55 and ₹19013.00 and fixed cost was found to be ₹10051.50 in all the three crops. Among all the three crops highest cost incurred was on okra ₹29064.80 and least cost was incurred on bottle gourd ₹28814.57 per acre.

**Table 4.2 Item wise cost of cultivation of major summer vegetables in block Dansal**  
(₹/acre)

S.No.	Particulars	Bitter Gourd	Bottle gourd	Okra
A.	Operational cost			
I	Machine labour	2538.00	2048.00	2360.00
II	Human labour			
	Hired	3524.00	3225.70	6101.00
	Owned	4296.00	4002.10	5626.00
	Total human labour	7820.00	7227.80	11727.00
III	Seed	2362.00	2392.66	1236.36
IV	Fertilizers	1447.20	827.10	2487.59
V	FYM	2392.00	2099.00	2165.00
VI	Irrigation	246.00	209.20	1486.61
VII	Plant Protection	2064.50	2603.11	2560.00
VIII	Interest on working capital @7% per annum	583.67	530.90	732.68
	Subtotal (A) (from I to VIII)	19453.66	17937.72	24755.20
B.	Fixed cost			
IX	Rental value of owned land	0.00	0.00	0.00
X	Rent paid for leased in land	3500.00	3500.00	3500.00
XI	Depreciation on farm buildings and equipment	2656.78	2656.78	2656.78
XII	Interest on fixed capital @ 10% per annum	207.76	207.76	207.76
	Subtotal(B) (from IX to XII)	6364.54	6364.54	6364.54
	Total cost (A+B)	25,818.20	24,302.26	31,119.80

**Table 4.3 Item wise cost of cultivation of major summer vegetables in block Nagrota**

(₹/acre)

S.No.	Particulars	Bitter gourd	Bottle gourd	Okra
A.	Operational cost			
I	Machine labour	2745.00	1828.48	2085.78
II	Human labour			
	Hired	3680.20	35545.43	3136.71
	Owned	3297.25	3249.00	4800.00
	Total human labour	6977.45	38794.46	7936.71
III	Seed	2025.00	2379.49	1600.00
IV	Fertilizers	2272.00	1056	2056.00
V	FYM	2501.00	2086.07	2300.00
VI	Irrigation	343.53	215.81	163.18
VII	Plant protection	1804.00	2961.12	2590.00
VIII	Interest on working capital @ 7% per annum	569.37	528.57	571.31
	Subtotal (A) (from I to VII)	19237.40	17859.00	19303.00
B.	FIXED COST			
IX	Rental value of owned land	0.00	0.00	0.00
X	Rent paid for leased in land	3500.00	3500.00	3500.00
XI	Depreciation on farm buildings and equipment	3190.31	3190.31	3190.31
XII	Interest on fixed capital @ 10 % per annum	172.50	172.50	172.50
	Subtotal (B) (from IX TO XII)	6862.81	6862.81	6862.81
	Total Cost(A+B)	26,100.21	24,721.78	26,165.80

**Table 4.4 Item wise cost of cultivation of major summer vegetables in block Chowki Choura**

(₹/acre)

S.No.	Particulars	Bitter gourd	Bottle gourd	Okra
A.	Operational cost			
I	Machine labour	2962.47	2329.60	1903.00
II	Human labour			
	Hired	3497.72	3980.40	2744.00
	Owned	3266.50	4178.43	4360.50
	Total human labour	6764.22	8158.82	7104.50
III	Seed	2421.81	1160.78	2000.00
IV	Fertilizers	1297.45	2288.00	2400.00
V	FYM	2138.18	1756.86	1600.00
VI	Irrigation	404.00	225.00	169.00
VII	Plant protection	2202.18	2288.00	3200.00
VIII	Interest on working capital @ 7% per annum	515.23	555.32	636.59
	Subtotal (A) (from I to VIII)	18705.00	18762.55	19013.00
B.	FIXED COST			
IX	Rental value of owned land	0.00	0.00	0.00
X	Rent paid for leased in land	3000.00	3000.00	3000.00
XI	Depreciation on farm buildings and equipment	6816.00	6816.00	6816.00
XII	Interest on fixed capital @ 10% per annum	235.50	235.50	235.58
	Subtotal (B) (From X TO XII)	10051.50	10051.50	10051.50
	Total cost (A+B)	28,757.20	28,814.57	29,064.80

**Table 4.5: Item wise cost of cultivation of major summer vegetables in block Akhnoor**

(₹/acre)

S.No.	Particulars	Bitter gourd	Bottle gourd	Okra
A.	Operational cost			
I	Machine labour	2530.60	1494.00	1990.00
II	Human labour			
	Hired	3800.00	4296.00	3500.00
	Owned	1346.66	3237.00	3276.00
	Total human labour	5146.66	7533.00	6776.00
III	Seed	2400.00	1200.00	1950.00
IV	Fertilizers	1368.00	1060.00	1560.00
V	FYM	1600.00	1600.00	1600.00
VI	Irrigation	176.50	194.10	200.00
VII	Plant protection	0.00	0.00	0.00
VIII	Interest on working capital @ 7% per annum	538.33	404.20	434.90
	Subtotal (A) (from I to VIII)	13760.09	13485.40	14510.00
B.	FIXED COST			
IX	Rental value of owned land	0.00	0.00	0.00
X	Rent paid for leased in land	3000.00	3000.00	3000.00
XI	Depreciation on farm buildings and equipment	8231.00	8231.00	8231.00
XII	Interest on fixed capital @ 10 % per annum	269.00	269.00	269.00
	Subtotal (B) (from IX TO XII)	11501.00	11501.00	11501.00
	Total cost (A+B)	25,461.60	24,986.00	26,012.00

**Table 4.6: Overall item-wise cost of cultivation of major summer vegetables in all farms**

(₹/acre)

S.No.	Particulars	Bitter gourd	Bottle gourd	Okra
A.	Operational cost			
I	Machine labour	2694.01	1925.20	2084.70
II	Human labour			
	Hired	3625.48	3761.78	3870.50
	Owned	3051.60	3666.63	4515.70
	Total human labour	6677.08	7428.41	8386.00
III	Seed	2302.20	1783.23	1696.59
IV	Fertilizers	1596.16	1307.78	2125.00
V	FYM	2157.80	1885.48	1916.30
VI	Irrigation	292.50	211.30	504.80
VII	Plant protection	1517.67	1963.06	2087.50
VIII	Interest on working capital @ 7% per annum	551.65	504.75	593.90
	Subtotal (A) (from I to VIII)	17789.07	17008.80	19395.60
B.	FIXED COST			
IX	Rental value of owned land	0.00	0.00	0.00
X	Rent paid for leased in land	3250.00	3250.00	3250.00
XI	Depreciation on farm buildings and equipment	5225.52	5225.52	5225.52
XII	Interest on fixed capital @ 10 % per annum	221.20	221.20	221.20
	Subtotal (B) (from IX TO XII)	8694.73	8694.73	8694.73
	Total cost (A+B)	26,483.80	25,703.50	28,090.30

The operation wise cultivation of vegetables in Akhnoor block is presented in Table 4.5 and it indicates bitter gourd, bottle gourd and okra as major summer vegetable crops. The table revealed that the total cost of cultivation was ₹25461.00, ₹24986.00 and ₹26012.00. respectively. The results further revealed that the among all the inputs human labour incurred the highest cost ₹5146.66, ₹7533.00 and ₹6776.00 resp. However, operational cost was found to be ₹13760.09, ₹12485.40 and ₹14510.00 per acre and fixed cost was found to be ₹11501.00 in all the three crops. Among all the three crops highest cost incurred was on okra ₹26012.00 per acre and least cost was incurred on bottle gourd ₹24986.00 per acre.

The overall item-wise cost of cultivation is presented in Table 4.6. The operational overall cost in bitter gourd, bottle gourd and okra was found to be ₹17,789.07, ₹17,008.80 and ₹19,395.60 respectively. The overall fixed cost was found to be ₹8694.73 per acre. The overall fixed cost was found to be ₹26,483.80, ₹25,703.50, ₹28,090.30 per acre in bitter gourd, bottle gourd and okra.

#### 4.2.1.2 Concept-wise cost structure for vegetable cultivation

In order to view the cost of cultivation of vegetables, various concepts of costs were worked out in Dansal block on per acre basics and is presented in Table 4.7. Per acre cost  $A_1$  of cultivation of bitter gourd, bottle gourd and okra was found to be ₹17814.44, ₹16592.40 and ₹21786.02. Cost  $A_2$  incurred was ₹21314.44, ₹20092.40 and ₹25286.02 per acre. Similarly, cost  $B_1$  was found to be ₹18022.20, ₹16800.16 and ₹21993.78 per acre respectively. The table further revealed that cost  $B_2$  was found to be ₹21522.20, ₹20300.16, ₹25493.78 per acre. Cost  $C_1$  incurred was found to be ₹22318.20, ₹20802.26 and ₹27619.78 per acre. Per acre cost  $C_2$  was found to be ₹25818.20, ₹24302.26 and ₹31119.78 respectively. After working out management cost cost  $C_3$  was found to be ₹28000.02, ₹26732.50 and ₹34231.75 respectively.

To view the cost of cultivation of vegetables, various concepts of costs were worked out in Nagrota block on per acre basics and is presented in Table 4.8. Per acre cost  $A_1$  of cultivation of bitter gourd, bottle gourd and okra was found to be ₹19130.46, ₹17800.25 and ₹17693.30. Cost  $A_2$  incurred was ₹22630.46, ₹21300.25 and ₹21193.30 per acre. Similarly, cost  $B_1$  was found to be ₹19302.96, ₹17972.75 and ₹17865.80 per acre respectively. The table further revealed that cost  $B_2$  was found to be ₹22802.96, ₹21472.75, ₹21365.80 per acre. Cost  $C_1$  incurred was found to be ₹26100.21, ₹21221.78

and ₹22665.80 per acre. Per acre cost  $C_2$  was found to be ₹26100.21, ₹24721.78 and ₹26165.80 respectively. After working out management cost cost  $C_3$  was found to be ₹28710.23, ₹27193.95 and ₹28782.38 respectively.

**Table 4.7: Concept-wise cost of cultivation of major summer vegetables in block Dansal**

(₹/acre)

Particulars	Bitter gourd	Bottle gourd	Okra
	<b>COST-A1</b>		
Hired labour	3524.00	3225.7	6101.00
Machine labour	2538.00	2048.00	2360.00
FYM	2392.00	2099.08	2165.00
Seed	2362.00	2392.66	1236.36
Fertilizers	1447.20	827.00	2487.59
Plant protection	2064.50	2603.11	2560.00
Irrigation charges	246.90	209.16	1486.61
Interest on working capital	583.00	530.90	732.68
Depreciation	2656.78	2656.78	2656.78
Total cost-A1	17814.44	16592.40	21786.02
Cost- A1	17814.44	16592.40	21786.02
Rent paid for leased in land	0.00	0.00	0.00
Cost- A2	17814.44	16592.405	21786.02
Interest on fixed capital	207.76	207.76	207.76
Total cost- B1	18022.20	16800.16	21993.78
Cost-B1	18022.20	16800.16	21993.78
Rental value of owned land	0.00	0.00	0.00
Rental value of leased in	3500.00	3500.00	3500.00
Total cost- B2	21522.20	20300.16	25493.78
Cost B1	18022.20	18022.20	21993.78
Family labour	4296.00	4002.10	5626.00
Total Cost-C1	22318.20	20802.26	27619.78
Cost-B2	21522.20	20300.16	25493.78
Family labour	4296.00	4002.10	5626.00
Total cost-C2	25818.20	24302.26	31119.80
Cost C2	25818.20	24302.36	31119.80
Cost of management (10% of Cost-C2)	2581.82	2430.22	3111.97
Total cost- C3	28,000.02	26,732.50	34,231.75

**Table 4.8: Concept-wise cost of cultivation of major summer vegetables in block Nagrota**

(₹/acre)

Particulars	Bitter gourd	Bottle gourd	Okra
	<b>COST-A1</b>		
Hired labour	3680.20	3554.50	3139.71
Machine labour	2745.00	1828.48	2085.78
FYM	2501.00	2086.07	2300.00
Seed	2025.00	2379.49	1600.00
Fertilizers	2272.00	1056.00	2056.00
Plant protection	1804.05	2961.012	2590.00
Irrigation charges	343.53	215.811	163.18
Interest on working capital	569.37	528.577	571.31
Depreciation	3190.31	3190.31	3190.31
Total cost-A1	19130.46	17800.25	17693.30
Cost- A1	19130.46	17800.25	17693.30
Rent paid for leased in land	0.00	0.00	0.00
Cost- A2	19130.46	17800.25	17693.30
Interest on fixed capital	172.50	172.50	172.50
Total cost- B1	19302.96	17972.75	17865.80
Cost-B1	19302.96	17972.75	17865.80
Rental value of owned land	0.00	0.00	0.00
Rental value of leased in	3500.00	3500.00	3500.00
Total cost- B2	22802.96	21472.75	21365.80
Cost B1	22802.96	17972.75	17865.80
Family labour	3297.25	3249.25	4800.00
Total Cost-C1	26100.21	21221.78	22665.80
Cost-B2	22802.96	21472.75	21365.80
Family labour	3297.25	3249.03	4800.00
Total cost-C2	26100.21	24721.78	26165.80
Cost C2	26100.21	24721.78	26165.80
Cost of management (10% of Cost-C2)	2610.021	2472.17	2916.58
Total cost- C3	28,710.23	27,193.95	28,782.38

In order to view the cost of cultivation of vegetables in block Chowki Choura, various concepts of cost were worked out and are presented in Table 4.9. Per acre cost  $A_1$  for bitter gourd, bottle gourd and okra were found to be ₹22255.20, ₹ 21400.10 and ₹21668.80 respectively. Cost  $A_2$  was found to be ₹25255.20, ₹24400.10 and ₹24468.80 per acre. Cost  $B_1$  was found to be ₹22490.70, ₹21635.70 and ₹21704.40 per acre. Similarly, cost  $B_2$  was found to be ₹25490.70, ₹24635.70 and ₹24704.40 respectively. Per acre  $C_1$  was found out to be ₹28757.20, ₹25814.10 and ₹26064.90. Per acre cost  $C_2$  was found to be ₹28757.20, ₹28814.10 and ₹29064.90 respectively. After working out managerial cost of 10 % cost  $C_3$  was found to be ₹31632.90, ₹31695.50 and ₹ 31971.40 per acre respectively.

In order to view the cost of cultivation of vegetables in block Akhnoor, various concepts of cost were worked out and are presented in Table 4.10. Per acre cost  $A_1$  for bitter gourd, bottle gourd and okra were found to be ₹20645.20, ₹18480.23 and ₹19466.73 respectively, cost  $A_2$  was found to be ₹23645.26, ₹21480.23 and ₹22466.73 per acre. Cost  $B_1$  was found to be ₹20914.82, ₹18749.79 and ₹19736.73 per acre. Similarly, cost  $B_2$  was found to be ₹23114.90, ₹21749.79 and ₹22736.29 respectively for bitter gourd, bottle gourd and okra respectively. Per acre  $C_1$  was found out to be ₹26461.60, ₹21986.79 and ₹22742.73. Per acre cost  $C_2$  was found to be ₹ 29461.60, ₹24986.79 and ₹26012.00 respectively. After working out managerial cost of 10 % cost  $C_3$  was found to be ₹32407.80, ₹27485.46 and ₹28613.20 per acre respectively.

The overall concept-wise cost of cultivation among the selected blocks of Jammu district is presented in table 4.11. The per acre cost  $A_1$  for bitter gourd, bottle gourd and okra was found to be ₹19,962.00, ₹18,568.20 and ₹20,104.80 respectively. The total cost  $C_2$  was found to be highest in okra (₹28,091.70) followed by bitter gourd (₹29,134.30) and bottle gourd (₹28,276.70) per acre. After working out the management cost the cost  $C_3$  was found to be ₹29,134.30, ₹28,276.70 and ₹30,900.80 per acre for bitter gourd, bottle gourd and okra.

**Table 4.9: Concept-wise cost of cultivation of major summer vegetables in block Chowki Choura**

(₹/acre)

Particulars	Bitter gourd	Bottle gourd	Okra
COST-A <sub>1</sub>			
Hired labour	3497.72	3980.39	2744.00
Machine labour	2962.47	2329.60	1903.00
FYM	2138.81	1756.86	1600.00
Seed	2421.81	1160.78	2000.00
Fertilizers	1297.45	2288.00	2400.00
Plant protection	2202.18	2288.00	3200.00
Irrigation charges	404.16	225.17	169.25
Interest on working capital	515.23	555.32	636.59
Depreciation	6816.00	6816.00	6816.00
Total cost-A1	22255.20	21400.10	21668.80
Cost- A1	22255.20	21400.10	21668.80
Rent paid for leased in land	0.00	0.00	0.00
Cost- A2	22255.20	24400.10	21668.80
Interest on fixed capital	235.50	235.50	235.58
Total cost- B1	22490.70	21635.70	21704.40
Cost-B1	22490.70	21635.70	21704.40
Rental value of owned land	0.00	0.00	0.00
Rental value of leased in	3000.00	3000.00	3000.00
Total cost- B2	25490.70	24635.70	24704.40
Cost B1	25490.70	21635.70	21704.40
Family labour	3266.50	4178.43	4360.50
Total Cost-C1	28757.20	25814.10	26064.90
Cost-B2	25490.70	24635.70	24704.40
Family labour	3266.50	4178.43	4360.50
Total cost-C2	28757.20	28814.10	29064.90
Cost C2	28757.20	28814.10	29064.90
Cost of management (10% of Cost-C2)	2875.70	2881.410	2906.49
Total cost- C3	31,632.90	31,695.50	31,971.40

**Table 4.10: Concept-wise cost of cultivation of major summer vegetables in block Akhnoor**

(₹/acre)

Particulars	Bitter gourd	Bottle gourd	Okra
Hired labour	3800.00	4296.00	3500.00
Machine labour	2530.60	1494.18	1990.00
FYM	1600.00	1600.00	1600.00
Seed	2400.00	1200.00	1950.00
Fertilizers	1368.00	1060.00	1560.00
Plant protection	0.00	0.00	0.00
Irrigation charges	176.50	194.09	200.00
Interest on working capital	538.33	404.20	434.90
Depreciation	8231.83	8231.83	8231.83
Total cost-A1	20645.20	18480.23	19466.73
Cost- A1	20645.20	18480.23	19466.73
Rent paid for leased in land	0.00	0.00	0.00
Cost- A2	20645.20	18480.23	19466.73
Interest on fixed capital	269.56	269.56	269.56
Total cost- B1	20914.82	18749.79	19736.73
Cost-B1	20914.82	18749.79	19736.73
Rental value of owned land	0.00	0.00	0.00
Rental value of leased in	3000.00	3000.00	3000.00
Total cost- B2	23914.82	21749.79	22736.29
Cost B1	20914.82	18749.79	19736.73
Family labour	1346.66	3237.00	3276.00
Total Cost-C1	22261.48	21986.79	22742.73
Cost-B2	23914.82	21749.79	22736.29
Family labour	1346.66	3237.00	3276.00
Total cost-C2	25461.60	24986.79	26012.00
Cost C2	25461.60	24986.70	26012.00
Cost of management (10% of Cost-C2)	2546.16	2498.67	2601.20
Total cost- C3	27,787.62	27,485.46	28,613.20

**Table 4.11: Overall concept-wise cost of cultivation of major summer vegetables in all farms**

(₹/acre)

Particulars	Bitter gourd	Bottle gourd	Okra
Hired labour	3625.48	3761.80	3870.50
Machine labour	2694.01	1925.20	2084.70
FYM	2157.80	1885.50	1916.30
Seed	2302.20	1783.23	1696.59
Fertilizers	1596.20	1307.80	2125.00
Plant protection	1517.70	1963.06	2087.50
Irrigation charges	292.50	211.30	504.80
Interest on working capital	551.65	504.80	593.90
Depreciation	5225.52	5225.52	5225.52
Total cost-A1	19962.00	18568.20	20104.80
Cost- A1	19962.00	18568.20	20104.80
Rent paid for leased in land	0.00	0.00	0.00
Cost- A2	19962.00	18568.20	20104.80
Interest on fixed capital	221.20	221.20	221.20
Total cost- B1	20184.20	18789.40	20326.00
Cost-B1	20184.20	18789.40	20326.00
Rental value of owned land	0.00	0.00	0.00
Rental value of leased in	3250.00	3250.00	3250.00
Total cost- B2	23434.20	22039.40	23576.00
Cost B1	20184.20	18789.40	20326.00
Family labour	3051.60	3666.65	4515.70
Total Cost-C1	23235.80	22456.04	24841.70
Cost-B2	23434.20	22039.40	23576.00
Family labour	3051.60	3666.63	4515.70
Total cost-C2	26485.80	25706.04	28091.70
Cost C2	26485.80	25706.04	28091.70
Cost of management (10% of Cost-C2)	2648.50	2570.60	2809.17
Total cost- C3	29,134.30	28,276.70	30,900.80

#### 4.2.1.3 Cost and return structure of vegetables in Jammu district

Per acre cost and return analysis of vegetables in Dansal block was estimated and are presented in Table 4.12 and figure 4.1 and it was estimated that the total cost of cultivation was highest in okra ( ₹31119.80/acre) followed by bitter gourd (₹25818.20) and bottle gourd (₹24302.26). The gross returns were found to be highest in okra (₹109200/acre) and least in bottle gourd (₹42997.00/acre) The net returns was found to be highest in okra (₹78080.26/acre) and lowest in bottle gourd (₹31797.78/acre) The cost-benefit ratio was found to be highest in okra (1:3.50) and least in bottle gourd (1:2.30)

**Table 4.12: Cost and return of major summer vegetables in block Dansal**

Particulars	Bitter gourd	Bottle gourd	Okra
<b>Cost</b>			
Total variable cost	19453.66	17937.72	24755.20
Total fixed cost	6364.54	6364.54	6364.54
Total cost	25818.20	24302.26	31119.80
<b>Returns</b>			
Yield	45.00	33.00	56.00
Price/q	1650.00	1700.00	1950.00
Gross returns/ acre	74250.00	56100.00	109200.00
Net returns/ acre	48431.78	31797.78	78080.26
Cost-benefit ratio	1:2.87	1:2.30	1:3.50

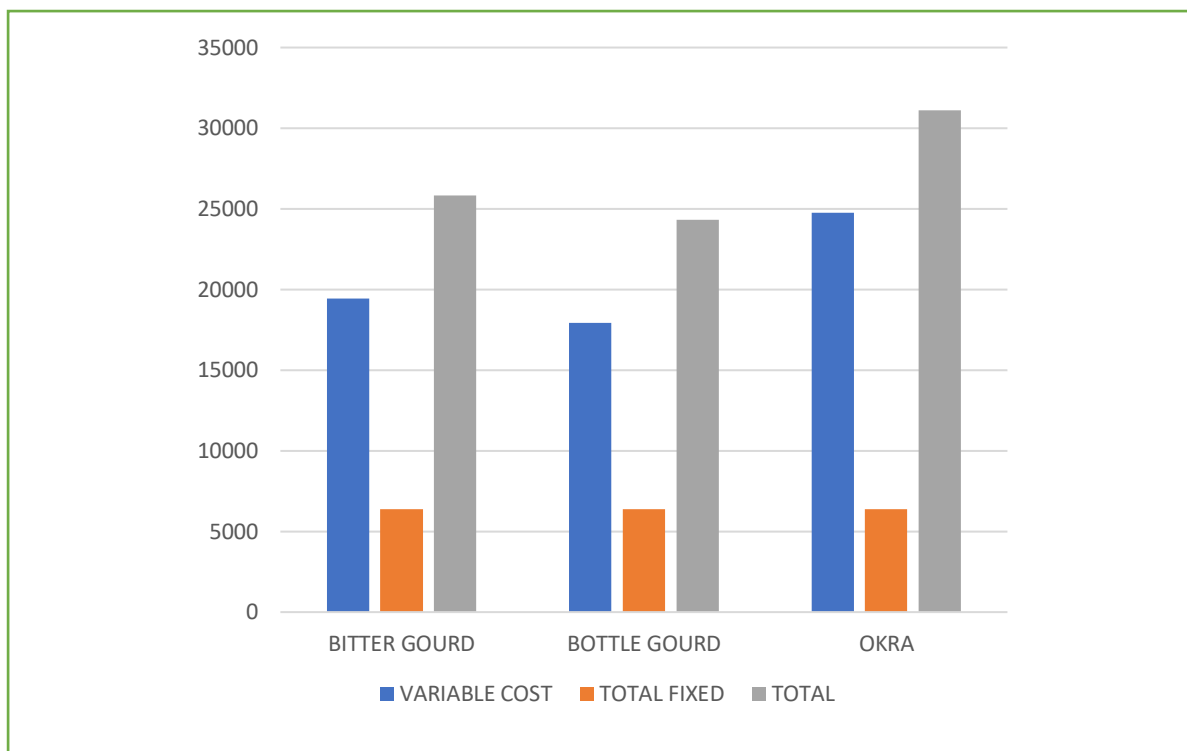
The variation between fixed costs and operational costs are represented in figures 4.1, 4.2, 4.3 and 4.4. for blocks Dansal, Nagrota, Chowki Choura and Akhnoor respectively.

**Table 4.13 Cost and return of major summer vegetables in block Nagrota**

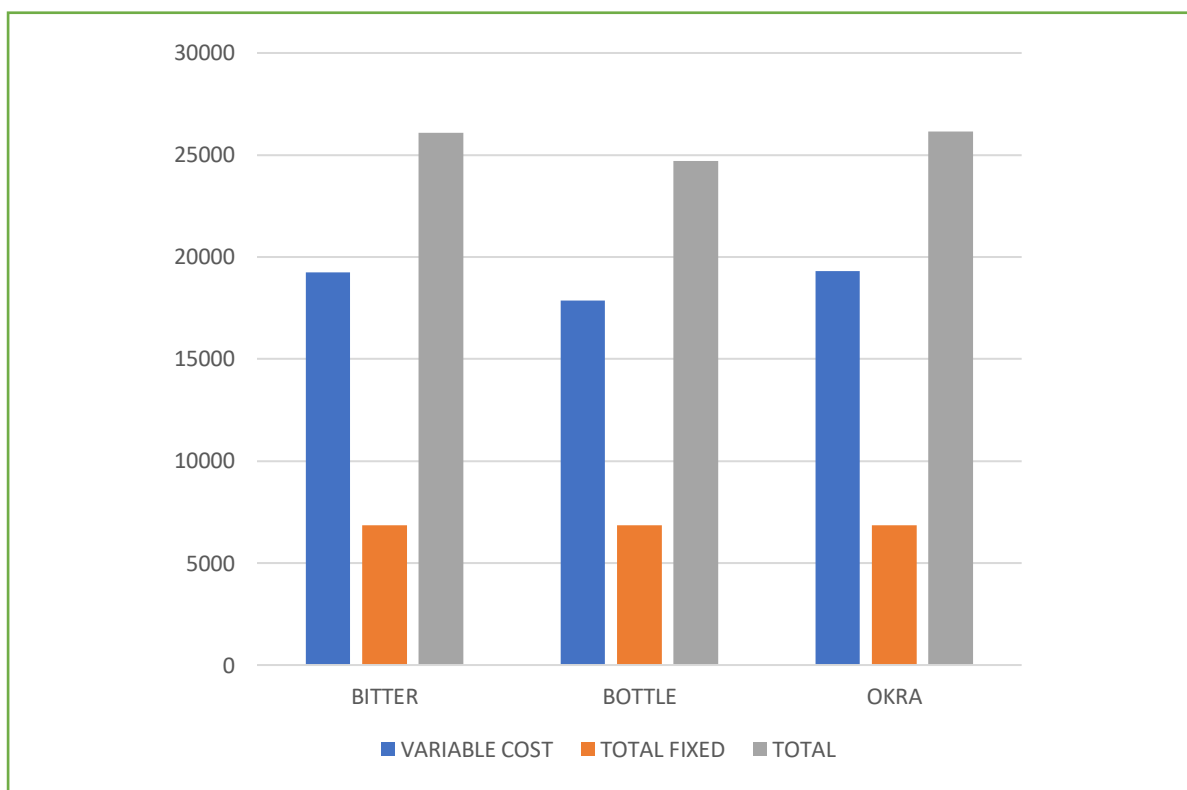
Particulars	Bitter gourd	Bottle gourd	Okra
<b>Cost</b>			
Total variable cost	19237.40	17858.97	19303.00
Total fixed cost	6862.81	6862.81	6862.81
Total cost	26100.21	24721.78	26165.80
<b>Returns</b>			
Yield	50.00	35.00	56.00
Price/q	1990	1700.00	1900.00
Gross returns/acre	99500.00	59500.00	106400.00
Net returns/ acre	73399.80	34778.22	80234.20
Cost-benefit ratio	1:3.81	1:2.40	1:4.06

Per acre cost and return analysis of vegetables in Nagrota block were estimated and are presented in Table 4.13 and figure 4.2 and it was estimated that the total cost of cultivation was highest in okra (₹26165.80/acre) followed by bitter gourd (₹26100.21) and bottle gourd (₹24721.78). The gross returns were found to be highest in okra (₹106400.00/acre) and least in bottle gourd (₹59500.00/acre) The net return was found to be highest in okra (₹80234.20) and lowest in bottle gourd (₹34778.22/acre) The cost-benefit ratio was found to be highest in okra (1:4.06) and least in bottle gourd (1:2.40)

Per acre cost and return analysis of vegetables in Chowki Choura block was estimated and are presented in table 4.14 and figure 4.3. It was estimated that the total cost of cultivation was highest in okra (₹29064.80/acre) followed by bitter gourd (₹28757.20) and bottle gourd (₹28814.05). The gross returns were found to be highest in okra (₹99900/acre) and least in bottle gourd (₹56100.00/acre) The net return was found to be highest in okra (₹70835/acre) and lowest in bottle gourd (₹37185.95/acre/acre) The cost-benefit ratio was found to be highest in okra (1:3.43) and least in bottle gourd (1:2.90).



**Fig 4.1: Total cost of cultivation of major summer vegetables in Dansal block (₹/acre)**



**Fig 4.2: Total cost of cultivation of major summer vegetable crops in Nagrota block (₹/acre)**

**Table 4.14: Cost and return of major summer vegetables in block Chowki Choura**

Particulars	Bitter gourd	Bottle gourd	Okra
<b>Cost</b>			
Total variable cost	18705.70	18762.55	19013.30
Total fixed cost	10051.50	10051.50	10051.50
Total cost	28757.20	28814.05	29064.80
<b>Returns</b>			
Yield/q	52.00	34.00	54.00
Price/q	1900.00	1650.00	1850.00
Gross returns/ acre	95000.00	56100.00	99900.00
Net returns/acre	66242.80	37185.95	70835.20
Cost-benefit ratio	1:3.30	1:2.90	1:3.43

**Table 4.15: Cost and return of cultivation of vegetables under block Akhnoor**

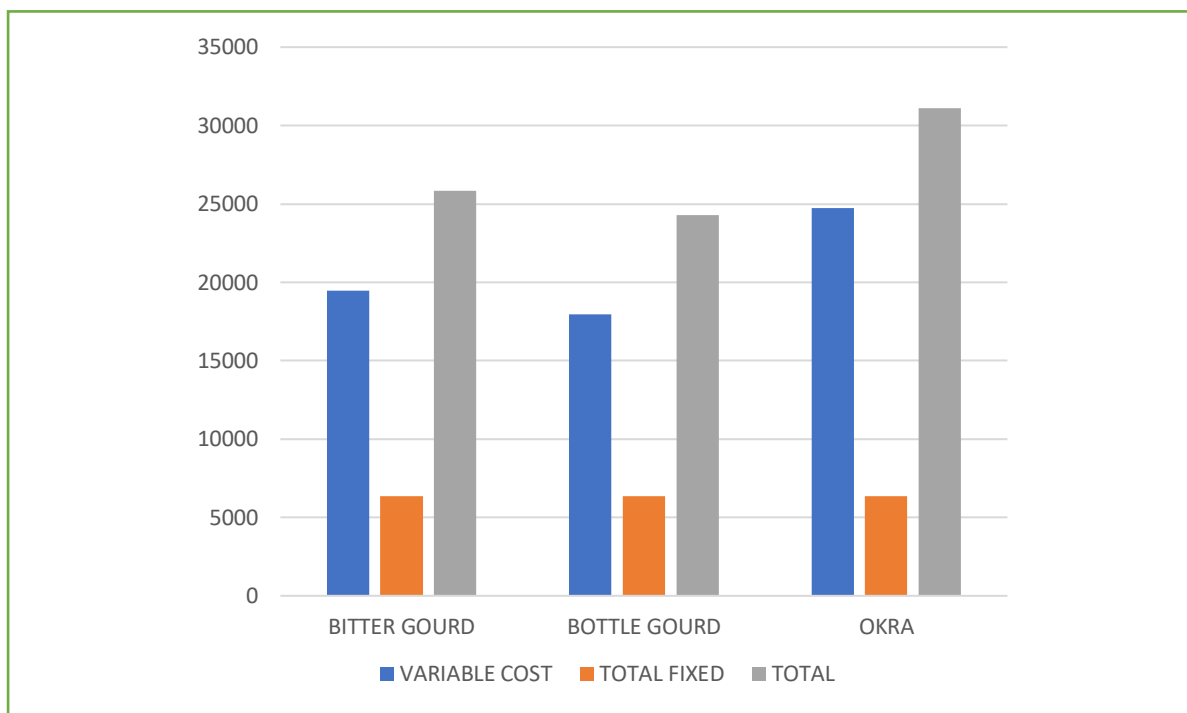
Particulars	Bitter gourd	Bottle gourd	Okra
<b>Cost</b>			
Total variable cost	13960.10	13485.40	14510.90
Total fixed cost	11501.39	11501.39	11501.40
Total cost	25461.40	24986.70	26012.30
<b>Returns</b>			
Yield/q	45.00	36.00	64.00
Price/q	1990.00	1650.00	1750.00
Gross returns/acre	89550.00	59400.00	112000.00
Net returns/acre	60086.60	34413.30	86622.60
Cost- benefit ratio	1:3.03	1:2.35	1:4.41

Per acre cost and return analysis of vegetables in Akhnoor block was estimated and are presented in Table 4.15 and Figure 4.4. It was estimated that the total cost of cultivation was highest in bitter gourd (₹25461.40/acre) followed by okra (₹26012.30/acre) and bottle gourd (₹24986.70). The gross returns were found to be highest in okra (₹112000.00/acre) and least in bottle gourd (₹59400.00/acre) The net return was found to be highest in okra (₹86622.60/acre) and lowest in bottle gourd (₹34413.30/acre) The cost-benefit ratio was found to be highest in okra (1:4.41) and least in bottle gourd (1:2.35)

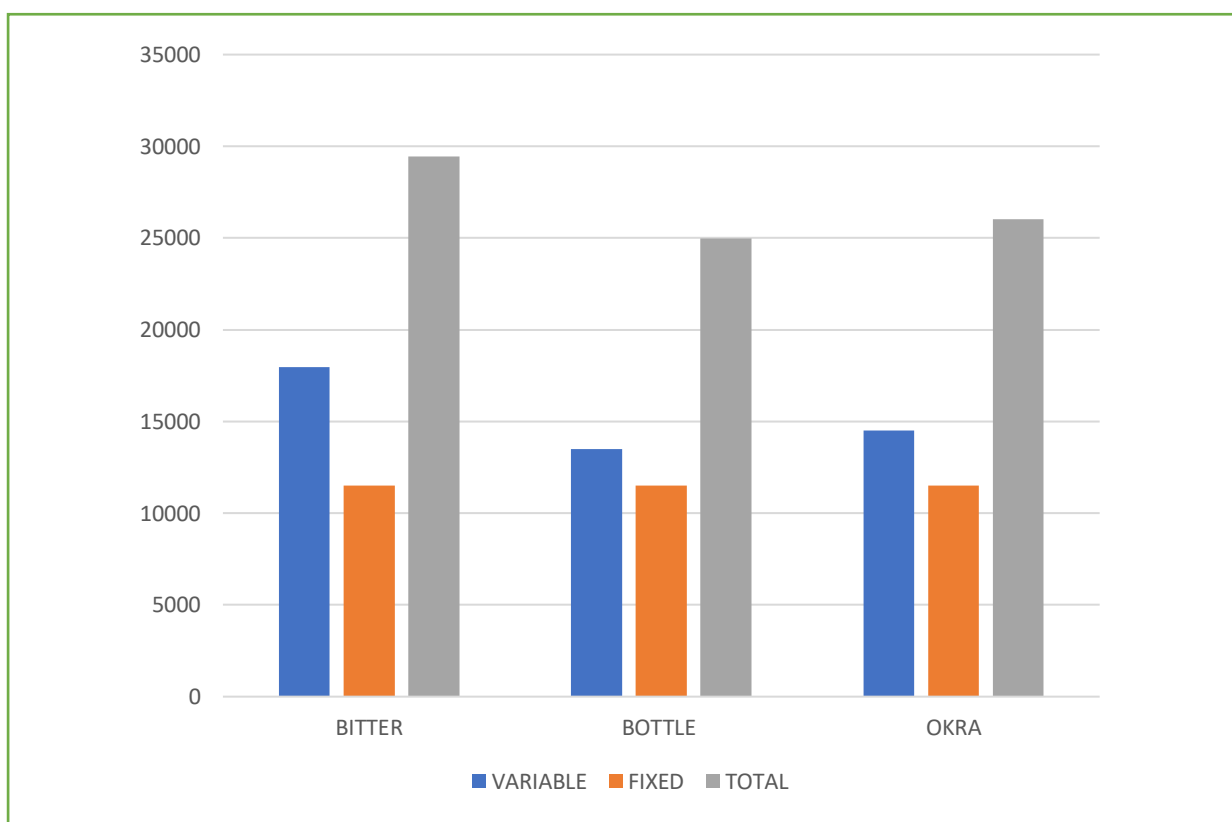
The overall total cost of major summer vegetable is presented in Table 4.16 was found to be ₹26,484.30, ₹25,706.00 and ₹28,090.70 for bitter gourd, bottle gourd and okra respectively. The overall yield among all the vegetables was found to highest in okra (57.50 quintals per acre) followed by bitter gourd (48.00 quintals per acre) and bottle gourd (34.50 quintals per acre). Overall gross returns per acre and benefit cost ratios was found to be ₹90,360, ₹57,787.50 and ₹1,07,094 and 1:3.40, 1:2.20, 1:3.80 for bitter gourd, bottle gourd and okra respectively.

**Table 4.16: Overall cost and return of major summer vegetables in all farms**

Particulars	Bitter gourd	Bottle gourd	Okra
<b>Cost</b>			
Total variable cost	17789.20	17010.90	19395.60
Total fixed cost	8695.50	8695.06	8695.06
Total cost	26484.30	25706.00	28090.70
<b>Returns</b>			
Yield/q	48.00	34.50	57.50
Price/q	1882.00	1675.00	1862.50
Gross returns/ acre	90360.00	57787.50	107094.00
Net returns/acre	63875.70	32081.50	79003.10
Cost-benefit ratio	1:3.40	1:2.0	1:3.80



**Fig 4.3 Total cost of cultivation of major summer vegetable crops in Chowki Choura block (₹/acre)**



**Fig 4.4 Total cost of cultivation of major summer vegetable crops in Akhnoor block (₹/acre)**

## **4.2.2 Resource use efficiency of major summer vegetable crops**

Cobb Douglas production function was used in log linear form fitted to the data collected for the summer vegetable crops. Gross product has been taken as dependent variable and total human labour, seed, manure and fertilizers, irrigation and plant protection were taken as independent variables to find out the resource use efficiency of major summer vegetable crops. The MVP was obtained by calculating the values of regression coefficients obtained is used to represent expected addition to gross return caused by additional one unit of resource input while other inputs held constant. Choice of best equation is made through  $R^2$  explained and relevance of the expected sign of coefficient.

### **4.2.2.1 Estimated regression coefficients of various factors, their standard errors and marginal value productivity (MVP) of all farms for bitter gourd cultivation**

The estimated resource use efficiency and MVP of bitter gourd production had been furnished in Table 4.17. The  $R^2$  value was estimated as 0.93 which indicated that 93% of the variations is due to above mentioned variables. The results also indicated that the human labour, seed and irrigation were significant at 5 per cent level of probability with regression coefficients of 0.412, 0.273 and 0.270. The other variables such as manure and fertilizers, plant protection was found to be non-significant with regression coefficients 0.077 and 0.001. The MVP values of the variables such as human labour, seed, manure and fertilizers, irrigation and plant protection were found to be 2.27, 5.88, 1.12, 52.65 and 0.019 respectively.

### **4.2.2.2 Estimated regression coefficients of various factors, their standard errors and marginal value productivity (MVP) of all farms for bottle gourd cultivation**

The estimated resource use efficiency and MVP of bottle gourd production had been furnished in table 4.15. The  $R^2$  value was estimated as 0.81 which indicated that 81% of the variations is due to above mentioned variables. The results also indicated that the human labour was found to be significant with 1 per cent level of significance and irrigation as well as plant protection were also found to be significant at 5 per cent level of significance. The other variables such as seed, manure and fertilizers were

found to be non-significant with regression coefficients 0.068 and 0.010. The MVP values of the variables such as human labour, seed manure and fertilizers, irrigation and plant protection were found to be 0.87, 1.60, 0.14, 20.75 and 1.11 respectively.

**Table 4.17: Resource use efficiency of bitter gourd in all farms**

<b>Variables</b>	<b>Regression coefficient</b>	<b>Standard error</b>	<b>MVP</b>
Constant	1.241*	0.267	-
Human labour (X <sub>1</sub> )	0.412*	0.091	2.273
Seed(X <sub>2</sub> )	0.273*	0.088	5.88
Manure & fertilizers (X <sub>3</sub> )	0.077	0.057	1.12
Irrigation (X <sub>4</sub> )	0.270*	0.042	52.65
Plant protection(X <sub>4</sub> )	0.001	0.009	0.019
Coefficient of determination (R <sup>2</sup> )= 0.930			

\*Significant at 5% level of significance.

#### **4.2.2.2 Estimated regression coefficients of various factors, their standard errors and marginal value productivity (MVP) of all farms for bottle gourd cultivation**

The estimated resource use efficiency and MVP of bottle gourd production had been furnished in Table 4.18. The R<sup>2</sup> value was estimated as 0.81 which indicated that 81% of the variations is due to above mentioned variables. The results also indicated that the human labour was found to be significant with 1 per cent level of significance and irrigation as well as plant protection were also found to be significant at 5 per cent level of significance. The other variables such as seed, manure and fertilizers were found to be non-significant with regression coefficients 0.068 and 0.010. The MVP values of the variables such as human labour, seed manure and fertilizers, irrigation and plant protection were found to be 0.87, 1.60, 0.14, 20.75 and 1.11 respectively.

**Table 4.18: Resource use efficiency of bottle gourd in all farms**

Variables	Regression coefficients	Standard error	MVP
Constant	1.232*	0.214	-
Human labour (X <sub>1</sub> )	0.193**	0.083	0.87
Seed(X <sub>2</sub> )	0.068	0.061	1.60
Manure & Fertilizers(X <sub>3</sub> )	0.010	0.065	0.14
Irrigation (X <sub>4</sub> )	0.121*	0.082	20.75
Plant protection(X <sub>4</sub> )	0.618*	0.106	1.11
Coefficient of determination (R <sup>2</sup> ) = 0.81			

\*Significant at 1 % level of significance

\*\* Significant at 5% level of significant

#### **4.2.2.3 Estimated regression coefficients of various factors, their standard errors and marginal value productivity (MVP) of all farms for okra cultivation**

The estimated resource use efficiency and MVP of bitter gourd production had been furnished in Table 4.19. The R<sup>2</sup> value was estimated as 0.83 which indicated that 83 per cent of the variations is due to above mentioned variables. The results also indicated that the seed, manures and fertilizers and plant protection were significant at 5 per cent level of probability with regression coefficients of 0.34, 0.73 and -0.16 respectively. The other variables such as human labour and plant protection with negative regression coefficients -0.011 and -0.165 implies that these resources were over used. The MVP values of the variables such as human labour, seed, manure and fertilizers, irrigation and plant protection were found to be 0.10, 19.95, 16.91, 3.60 and 5.22 respectively.

**Table 4.19: Resource use efficiency of okra in all farms**

Variables	Regression coefficient	Standard error	MVP
Constant	1.7*	0.162	0.107
Human labour (X <sub>1</sub> )	-0.011	0.022	0.10
Seed (X <sub>2</sub> )	0.340*	0.070	19.95
Manure & Fertilizers(X <sub>3</sub> )	0.736*	0.103	16.91
Irrigation (X <sub>4</sub> )	0.009	0.020	3.60
Plant protection (X <sub>4</sub> )	-0.165*	0.035	5.22
Coefficient of determination (R <sup>2</sup> ) = 0.830			

\*Significant at 5% level of significance

### 4.2.3 Impact of farm ponds

#### 4.2.3.1 Impact of farm ponds on cropping pattern and cropping intensity

The cropping pattern and cropping intensity of the sample farms were studied in kharif and rabi seasons and is presented in tables 4.17, 4.18 and 4.19 and in figures 4.5, 4.6, 4.7, 4.8 and 4.9. The table 4.20 indicate that the total cultivated area under kharif season without farm pond is estimated to be 171.88 acres, majority of the total cultivated area was under summer vegetable crops such as bitter gourd (19.25 % ) followed by bottle gourd (26.23 % ) and okra (24.22%), chilli (2.3%), brinjal (8.8%), pumpkin (2.3%), maize (10.3%) and bajra (4.42%). It also indicated that total cultivated area after installing farm pond was found to be 305.2 acres. The crops cultivated under kharif season were bitter gourd (16.90%), bottle gourd (19.26%), okra (17.95%), chilli (7.73%), brinjal (6.94%), pumpkin (6.9%), maize (17.43%) and bajra (6.8%) There was a significant difference in means of cultivated area in before and after farm pond during kharif.

The cropping pattern of the study area is revealed in Table 4.21 and indicated that total area under cultivation before farm pond was 66.40 acre and after farm pond was 204.20 acres. Tomato (37.95%) and radish (30.12%) occupied largest area followed by onion (22.89%), wheat (7.5%) and potato (1.50%) before farm pond. After farm pond the area under tomato, radish, onion, wheat and potato constituting 34.80 per cent , 24.48 per cent, 28.40 per cent, 9.70 per cent and 2.44 per cent respectively constituting the total area of 204.20 acres. There is a wide difference between total area of cultivation in before and after farm pond during rabi season.

**Table 4.20: Cropping pattern in kharif season****(acres)**

Crop	Before farm pond		After farm pond	
	Area	Percent (%)	Area	Percent (%)
Bitter gourd	34.00	26.90	51.6	16.90
Bottle gourd	46.40	19.78	58.8	19.20
Okra	42.84	24.90	54.8	17.90
Chilli	4.00	2.30	23.6	7.70
Brinjal	15.20	8.80	21.2	6.90
Pumpkin	4.00	2.30	21.2	6.90
Maize	17.85	10.30	53.2	17.40
Bajra	7.6	4.40	20.8	6.80
	<b>171.88</b>	<b>100</b>	<b>305.2</b>	<b>100</b>

**Table 4.21: Cropping pattern in rabi season****(acres)**

Crop	Before farm pond		After farm pond	
	Area	Percent (%)	Area	Percent (%)
Radish	20.00	30.12	50.00	24.48
Tomato	25.20	37.95	71.20	34.86
Onion	15.20	22.89	58.00	28.40
Potato	1.00	1.50	5.00	2.45
Wheat	5.00	7.50	20.00	9.79
	<b>66.40</b>	<b>100</b>	<b>204.20</b>	<b>100</b>

The cropping intensity was calculated and cropping intensity of sampled blocks of before farm ponds and after farm ponds were compared and is presented in Table 4.22 and figure 4.9. The gross cropped cultivated area of before farm pond was 238.28 acres and after farm pond was 509.40 acres, whereas the net cropped area of before farm pond was 171.88 acres and after farm pond was 305.20 acres. From the table it can also be concluded that there is a difference in cropping intensity when compared to before farm pond and after farm pond. The cropping intensity calculated was 138.63 per cent before farm ponds and 167.00 per cent after farm pond.

**Table 4.22: Cropping intensity of crops in selected blocks (acres)**

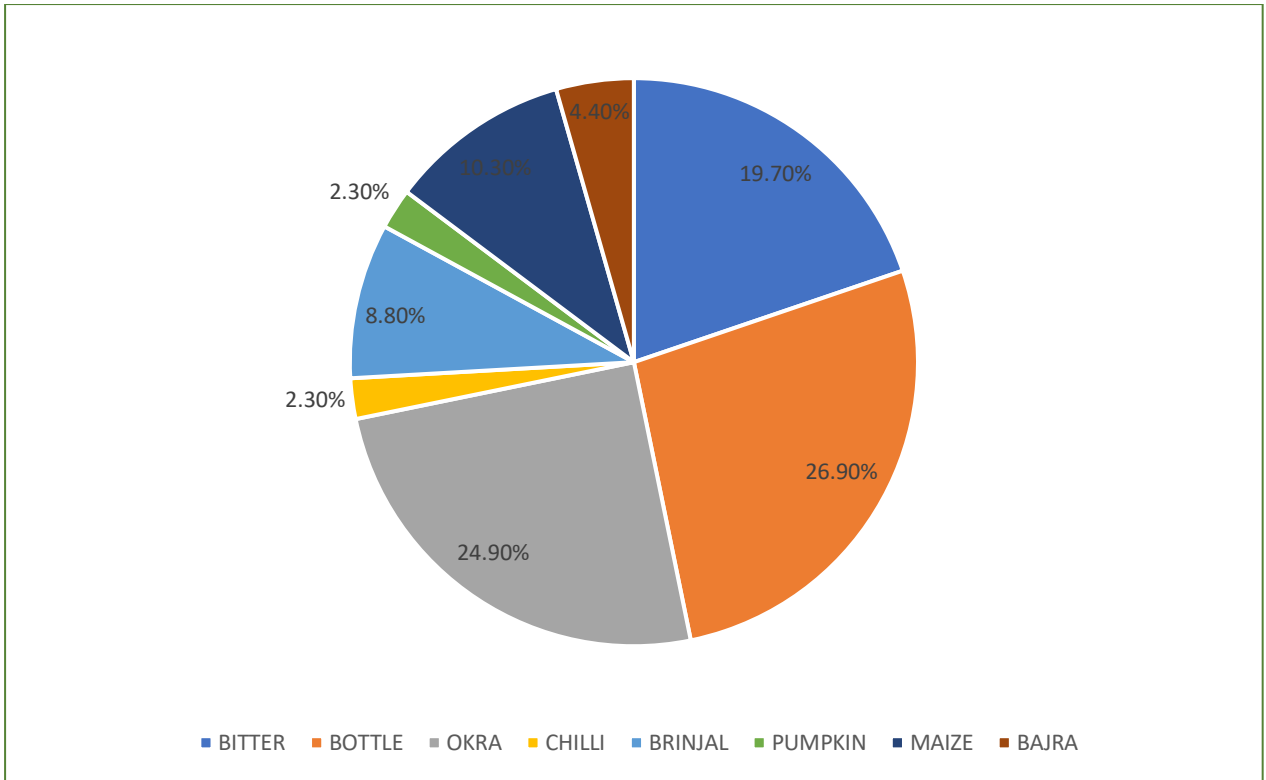
<b>Particulars</b>	<b>Before Farm Pond</b>	<b>After Farm Pond</b>
Gross Cropped	238.28	509.40
Net Cropped	171.88	305.20
Cropping Intensity (%)	<b>138.63</b>	<b>167.00</b>

#### **4.2.3.2 Impact of farm ponds on crop diversification**

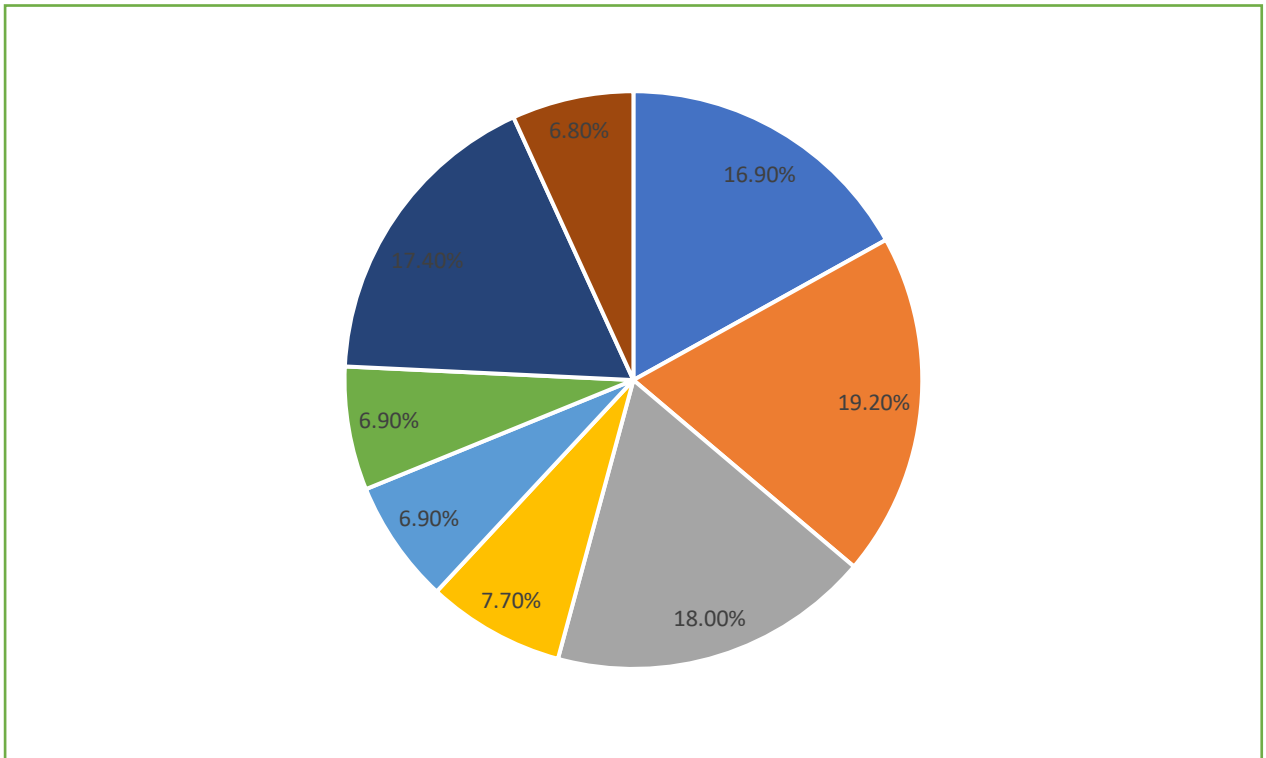
The crop diversification index of the sample blocks was computed using Herfindal's index and is presented in Table 4.23. From the table it can be concluded that the level of diversification was more in when farm pond was installed as compared when it was not installed. The crop diversification was shifted from 0.19 to 0.05 indicating increase in diversification index. Similarly, crop diversification index in rabi season also got decreased from 0.29 to 0.27. The overall crop diversification was observed as 0.12 before farm pond and 0.09 after farm pond.

**Table 4.23: Crop diversification index of sample farmers**

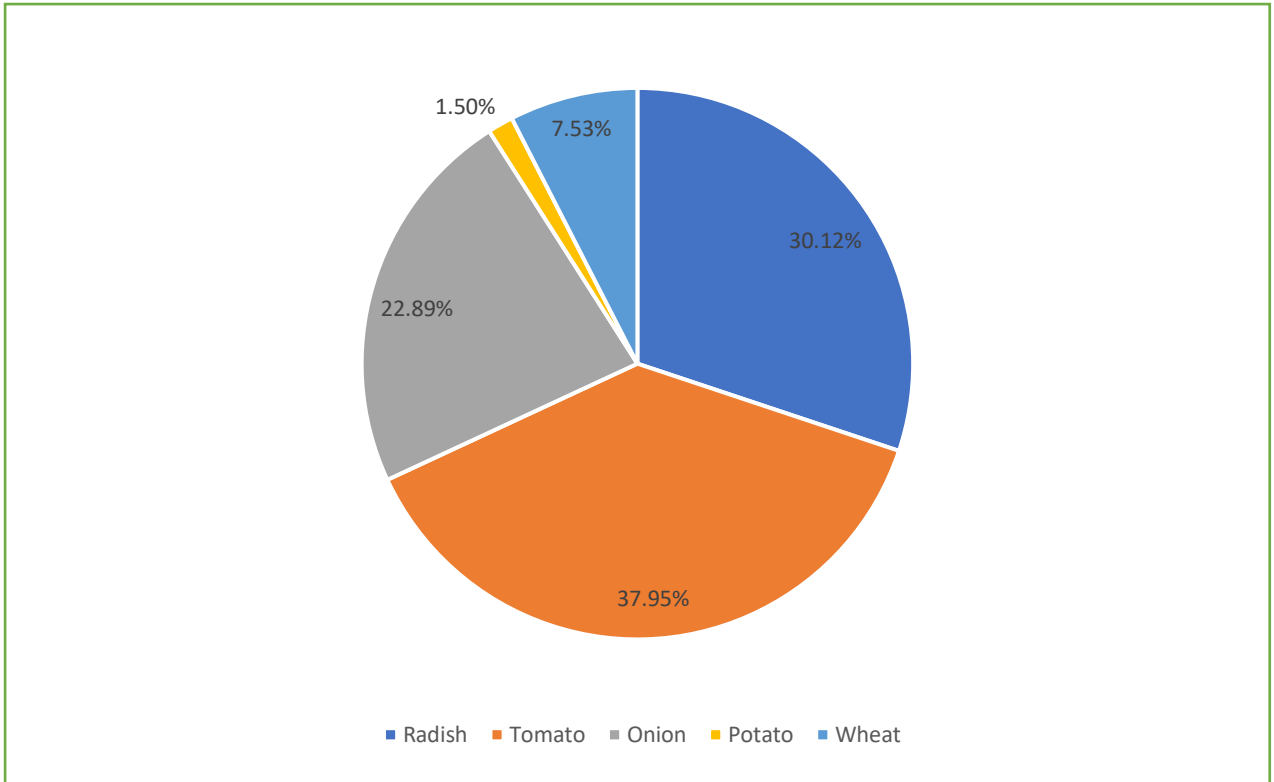
<b>Particulars</b>	<b>Before farm pond</b>	<b>After farm pond</b>
Crop diversification (Kharif)	0.19	0.05
Crop diversification (Rabi)	0.29	0.27
Crop diversification (Overall)	<b>0.12</b>	<b>0.09</b>



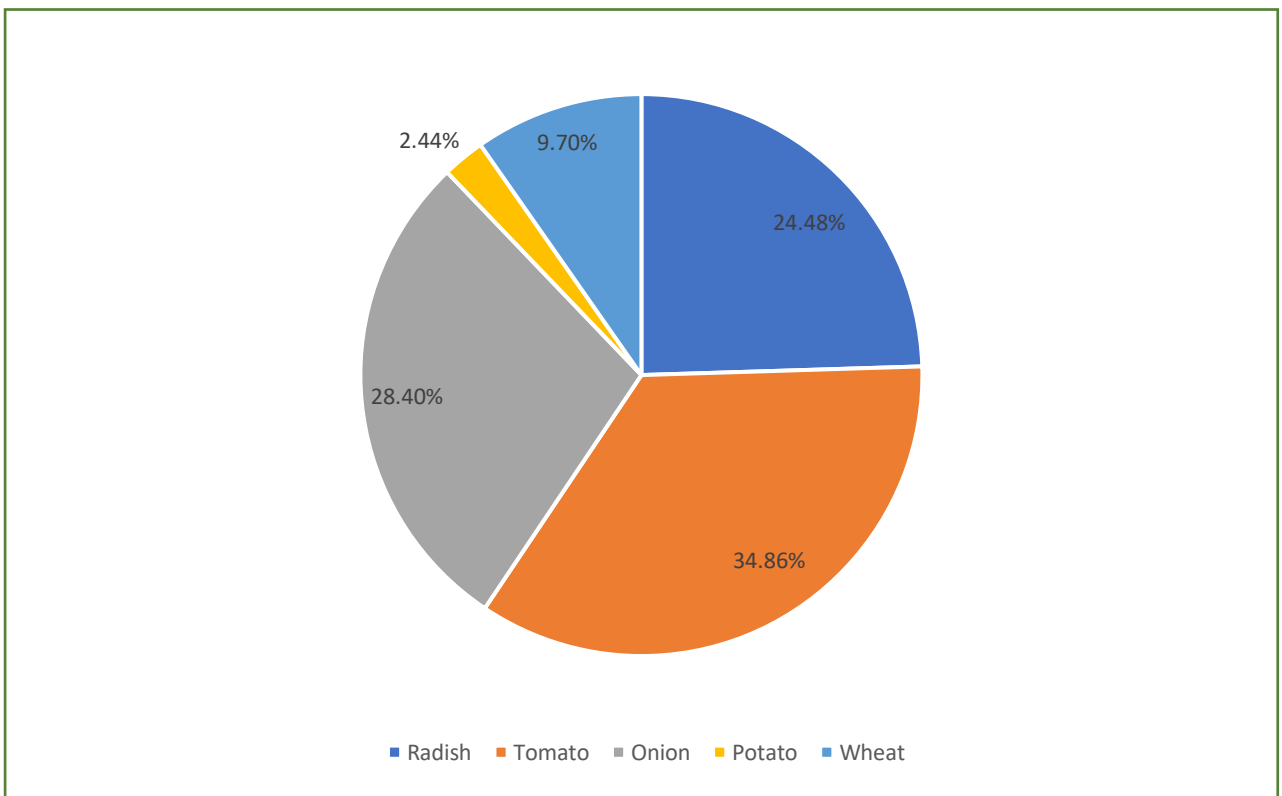
**Fig 4.5: Cropping pattern before farm ponds in kharif season (percent)**



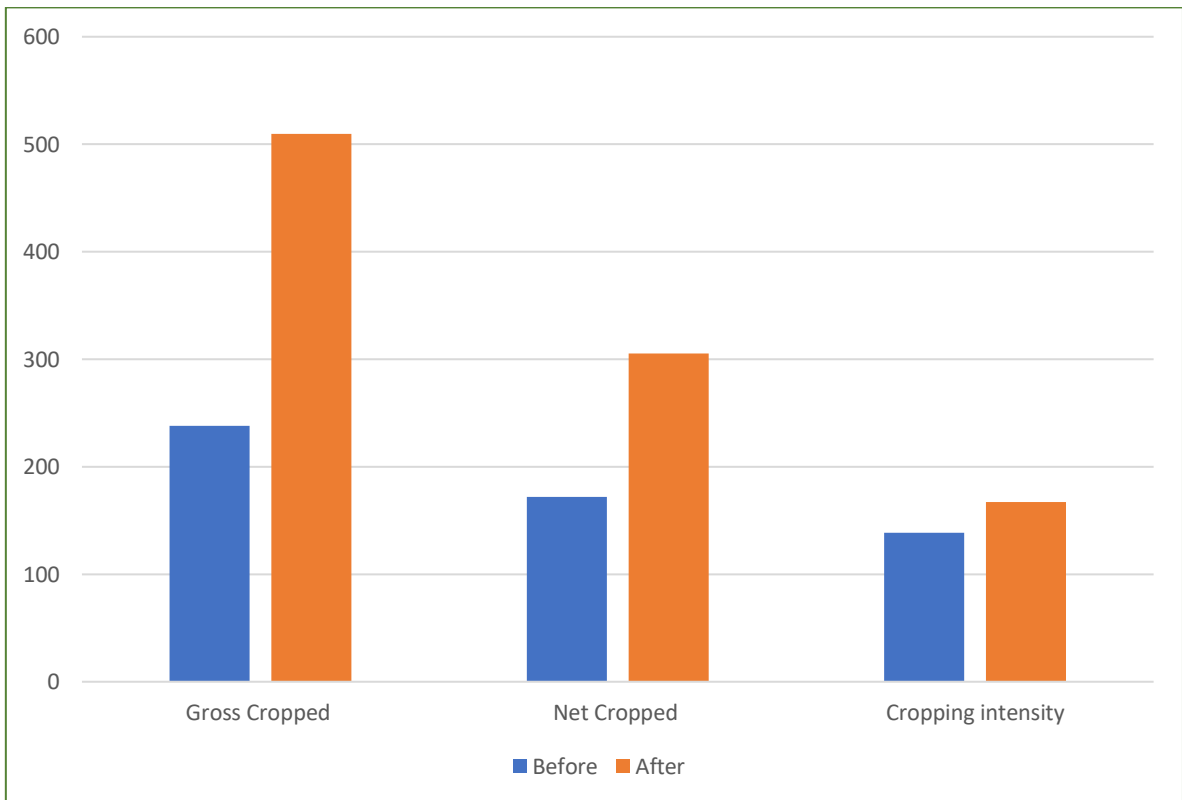
**Fig 4.6: Cropping pattern after farm ponds in kharif season (percent)**



**Fig 4.7: Cropping pattern before farm ponds in rabi season (percent)**



**Table 4.8: Cropping pattern after farm pond in rabi season (percent)**



**Fig 4.9: Cropping intensity of selected blocks**

### 4.2.3.3 Impact of farm ponds on employment

The average employment generated per month in sample farms is depicted in Tables 4.24, 4.25, 4.26 and 4.27. The kharif season extends from July to October. Table 4.24 depicted that in the kharif season the highest employment rate was seen in the month of July (23.50man days) followed by September (21.75man days), August (21.75man days) and least in the month of October (20.00man days) when farm ponds were used. The table also depicted that the same trend was followed when there were no farm ponds in the sampled blocks. On an average 44.20 more man days were generated after the use of farm ponds in kharif season. Table 4.25 depicts the employment generated by sample farm in rabi season, and it was observed that the highest employment was generated in December (25.00man days), January (25.00 man days) and February (25.00 man days) with fields having farm ponds, whereas employment generated before farm ponds in November, December, January and February were 15.00 , 10.00 and 12.00 man days respectively. The difference of 42.00 man days were generated in the rabi season.

**Table 4.24: Employment generated by sample farms before and after farm pond in kharif season (man days/farm)**

Particulars	Before farm pond	After farm pond	Difference
July	10.00	23.50	13.50
August	10.00	20.22	10.22
September	11.00	21.75	10.75
October	10.00	20.00	10.00
Total	<b>41.00</b>	<b>85.20</b>	<b>44.20</b>

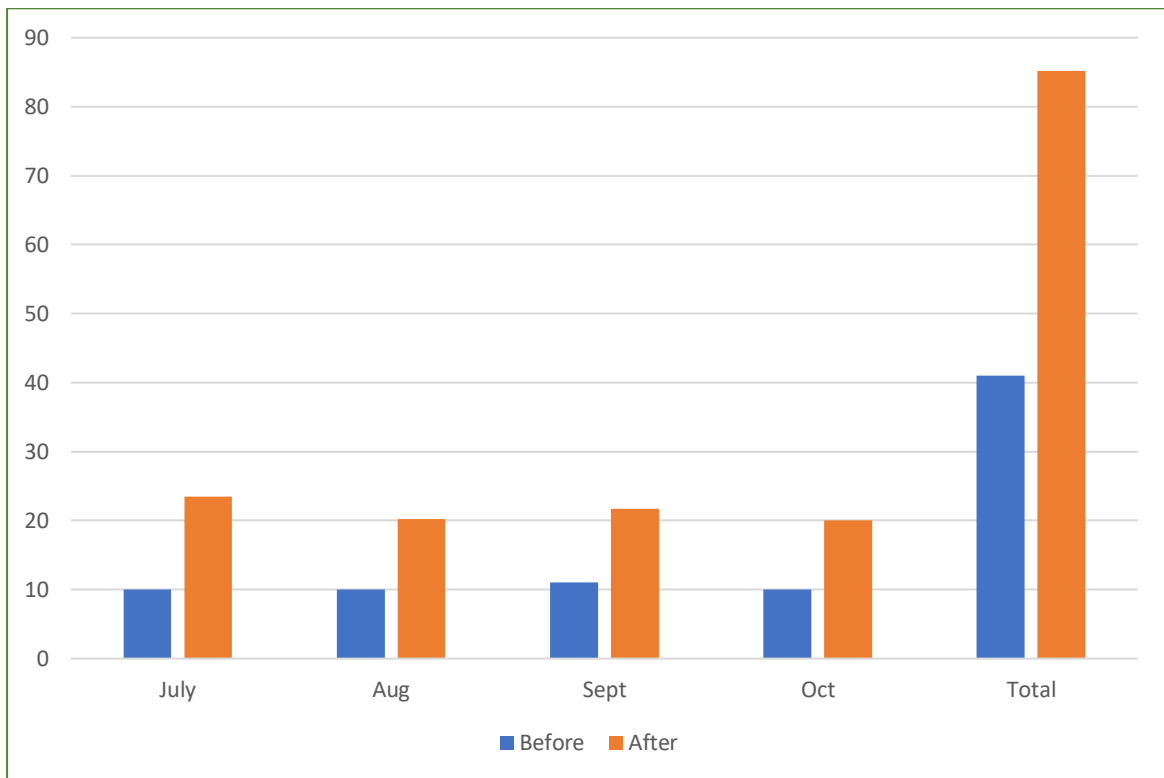
**Table 4.25: Employment generated by sample farms before and after farm pond in rabi season (man days/farm)**

Month	Before farm pond	After farm pond	Difference
Nov	15.00	20.00	5.00
Dec	10.00	25.00	15.00
Jan	12.00	25.00	13.00
Feb	11.00	20.00	9.00
<b>Total</b>	<b>48.00</b>	<b>90.00</b>	<b>42.00</b>

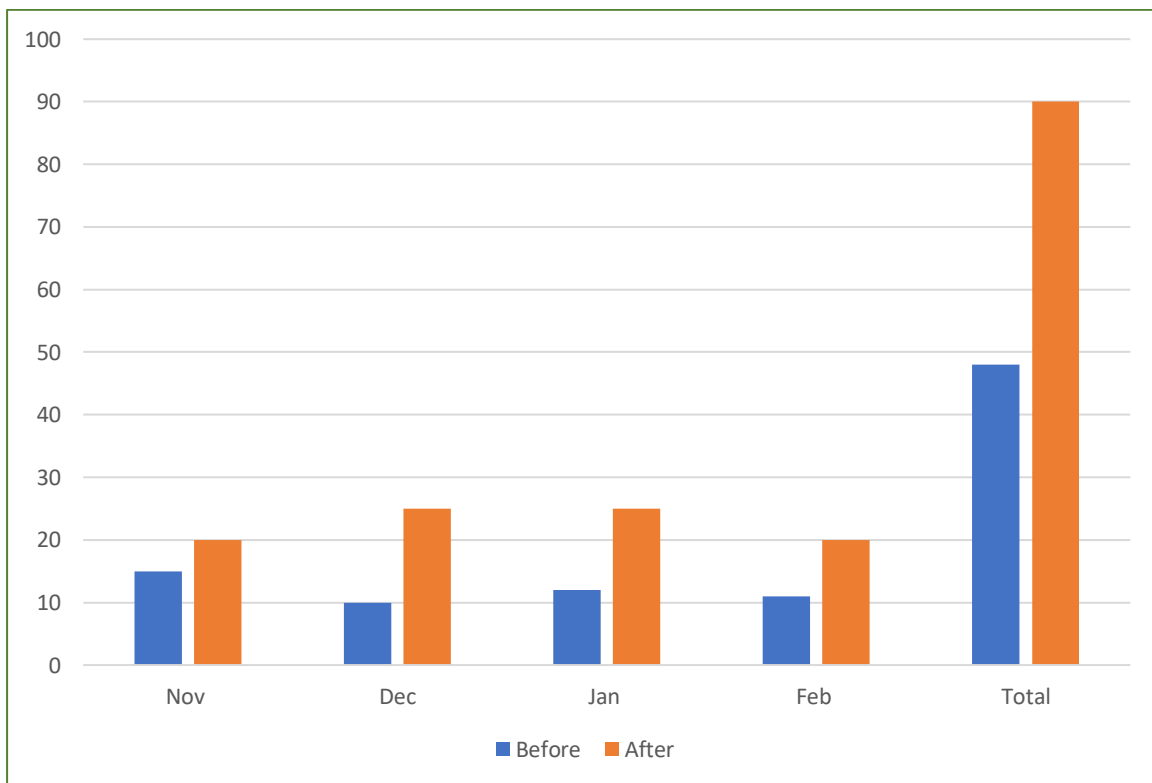
Table 4.26 depicts the employment generated by sample farm in zaid season, and it was observed that the highest employment was generated after farm ponds were in April (25.00 man days) and June (25.00 man days) followed by May (23.00 man days), and March (21.25 man days) The employment generated before farm pond in months March, April, May, June were 10.00, 10.00, 15.00 and 12.00 man days respectively.

**Table 4.26: Employment generated by sample farms before and after farm pond in zaid season (Man days/ farm)**

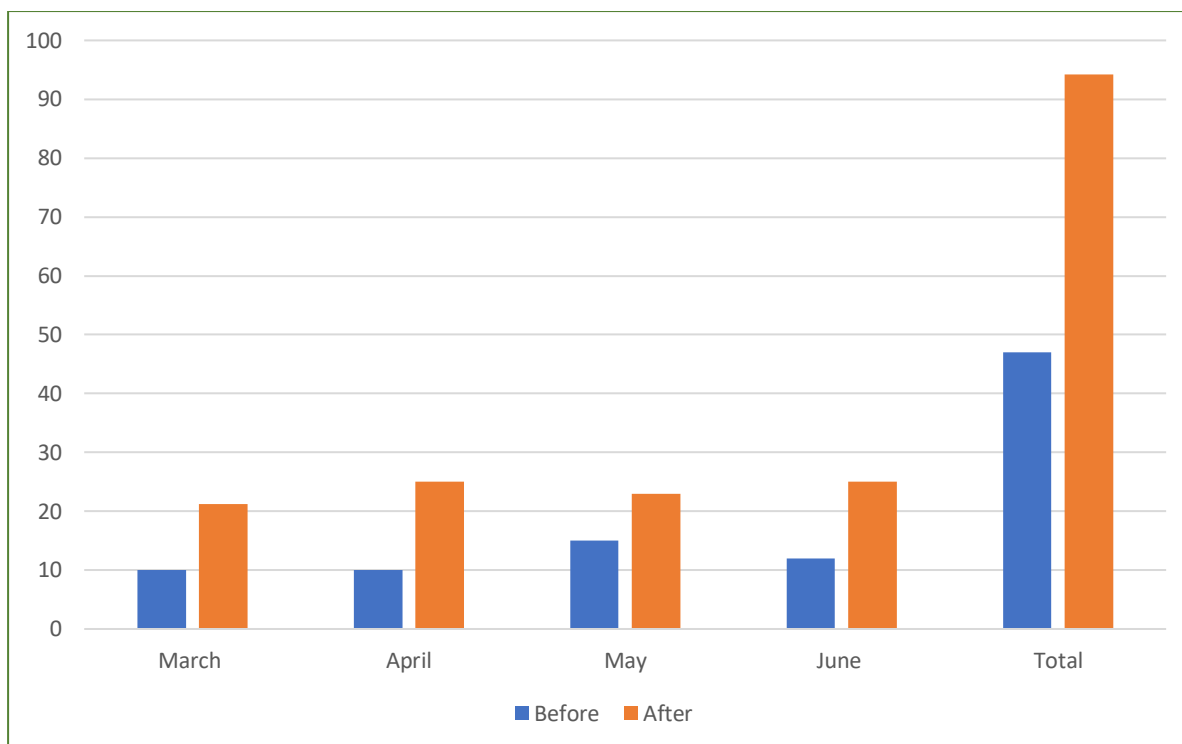
Particulars	Before farm pond	After farm pond	Difference
March	10.00	21.25	11.25
April	10.00	25.00	15.00
May	15.00	23.00	8.00
June	12.00	25.00	13.00
<b>Total</b>	<b>47.00</b>	<b>94.25</b>	<b>47.25</b>



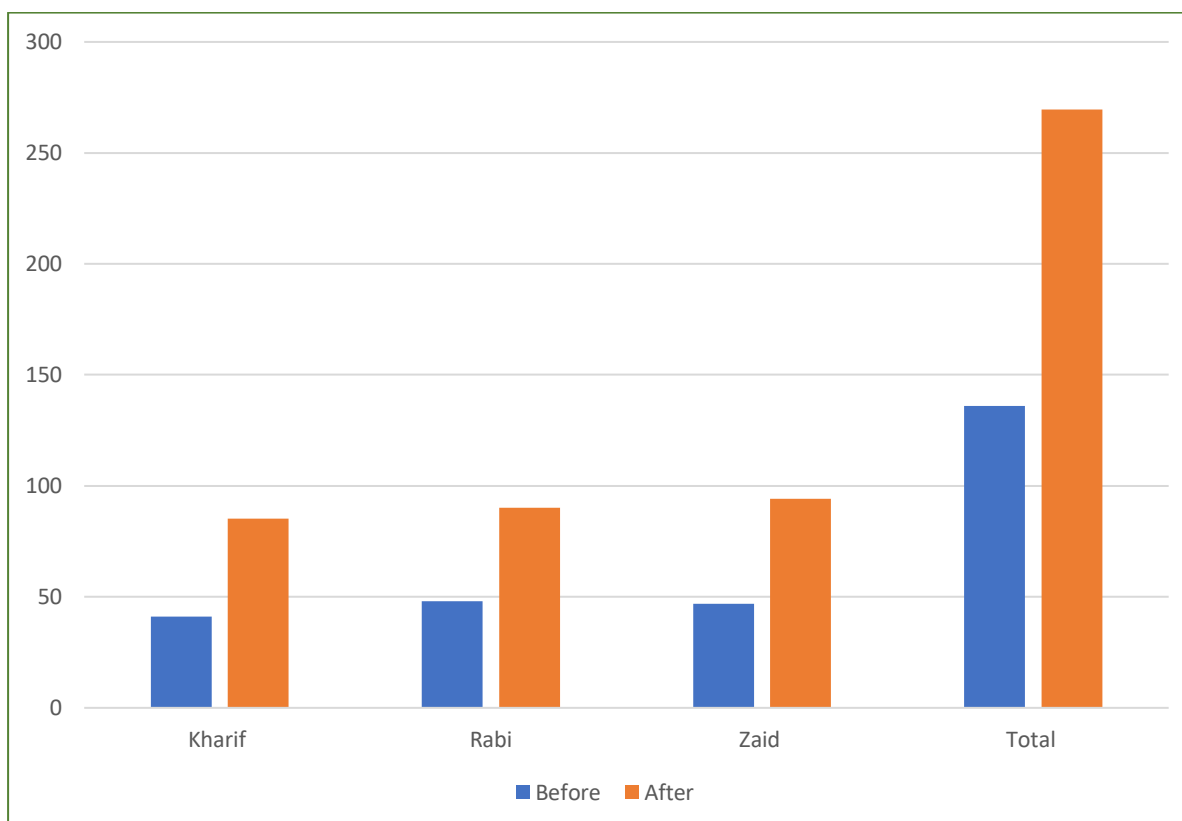
**Fig 4.10: Employment generated by sample farms in kharif season (man days)**



**Fig 4.11: Employment generated by sample farms in rabi season (man days)**



**Fig 4.12 : Employment generated by sample farms in zaid season (man days)**



**Fig 4.13: Overall employment generated by sampled blocks before and after farm ponds (man days)**

The average employment generated per year in sample farms is depicted in Table 4.27. The table depicted that in zaid season, 47.25 more man days were generated after farm pond as compared to before farm pond. In kharif season, 44.20 more man days were generated after farm pond as compared to farms before farm ponds. Similarly, 42.00 more man days were generated in rabi season when compared to before farm and after farm pond. The total of 136.00 man days were generated before farm ponds and a total of 269.45 man days were generated after farm ponds. So, the difference in average employment per annum is estimated to be 133.45 man days between before and after farm ponds.

**Table 4.27: Overall employment generated by sample farms (Man days/ farm)**

<b>Particulars</b>	<b>Before farm pond</b>	<b>After farm pond</b>	<b>Difference</b>
Kharif	41.00	85.20	44.20
Rabi	48.00	90.00	42.00
Zaid	47.00	94.25	47.25
	<b>136.00</b>	<b>269.45</b>	<b>133.45</b>

#### 4.2.4 Factors affecting adoption of farm ponds for rain water harvesting

The binary logistic regression was used to determine the factors affecting adoption of rain water harvesting through farm ponds. For the determination of the adoption of farm ponds factors such as age of the respondent, number of times the adopter has contacted the extension agencies, total land holding, education, farming experience, labour and gender of the respondent were analyzed. Table 4.28 include unstandardized beta, log odd ratio, standard error and level of significance. Among the explanatory variables age, education level, and labour force had statistically significant positive effect on adoption of farm ponds at 1 per cent level of significance whereas, farm size, experience in crop cultivation also had a statistically significant effect at 5 per cent level of significance only gender was found to be no significant effect on farmers level of adoption of rain water harvesting. Nagelkerke  $R^2$  was found to be 0.91 which indicates that the 91 per cent of the variation in dependent variable were explained by independent variables.

**Table 4.28: Parameter estimates of the binary logistic regression model for factors affecting adoption of rain water harvesting farm ponds**

Var	B	Exp (B)	S.E	Significance
Age	0.336	1.399	0.082	0.00*
Extension agency contact	0.866	2.377	0.313	0.006*
Land holding	0.084	1.088	0.044	0.054**
Education	1.465	4.327	0.436	0.001*
Farming experience	0.077	1.080	0.034	0.024**
Labour	3.514	3.35	0.843	0.00*
Gender	-0.27	0.29	0.083	0.672
<b>Intercept</b>	1.166	3.211	0.263	0.00*
Nagelkerke R square : 0.919				

\*Significant at 1% l.o.s

\*\*Significant at 5% l.o.s

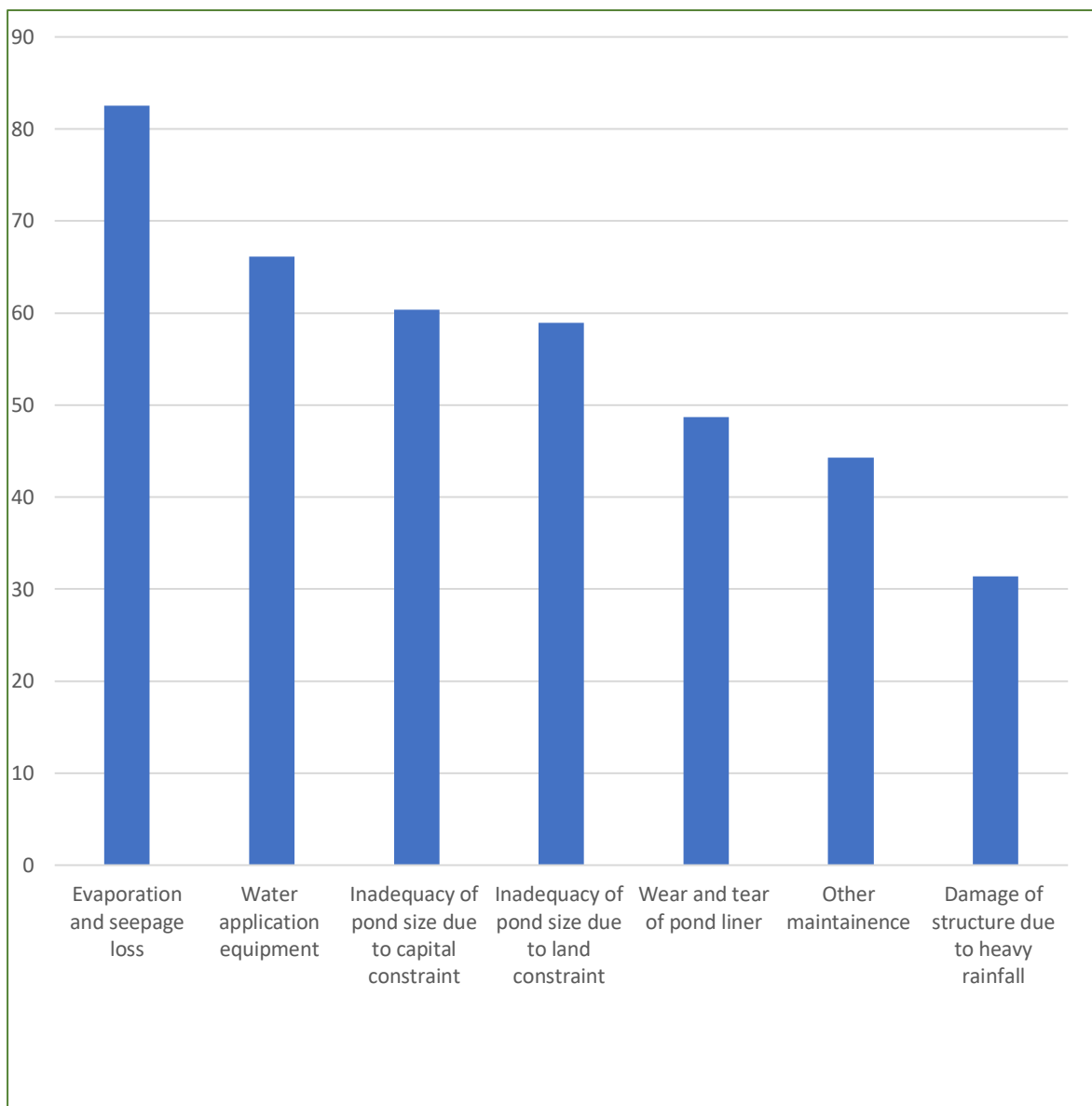
#### 4.2.5 Constraints faced by farmers in practicing rain water harvesting

The major constraints faced by farmers in practicing rain water harvesting were estimated by using garret's ranking technique in Table 4.29 and figure 4.11. The table revealed that the evaporation or seepage losses was ranked I with average score of 82.50, followed by water application equipment ranked number II with the average score of 66.11, non-adoption of farm pond due to land constraint was ranked no. III with average score of 60.36.

The constraints faced by farmers on moderate level were non-adoption of farm pond due to capital constraint ranked IV (average score 58.91), followed by damage of pond liners ranked V with an average score of 48.68, other maintenance such as weeding, de-siltation, removal of big boulders to avoid puncture was ranked VI with average score of 44.31, damage of structure due to heavy rainfall was ranked with the average score of 31.38 and poor soil fertility was ranked at last with the average land holding was 25.45.

**Table 4.29: Garrett's score and ranking of the constraints faced by farmers in practicing water harvesting**

S.No.	Constraints (n=80)	Average	Rank
1.	Evaporation or seepage losses	82.50	1
2.	Lack of water delivery equipment	66.11	2
3.	Non-adoption of farm ponds due to land constraint	60.36	3
4.	Non-adoption of farm pond due to capital constraint	58.91	4
5.	Damaging of pond liners	48.68	5
6.	Weeding, De-siltation, Boulders and other maintenances	44.31	6
7.	Damage due to heavy rainfall, natural calamity	31.38	7
8.	Poor soil fertility	25.45	8



**Fig 4.14: Major constraints faced by farmers in practicing rain water harvesting**



**Plate 3: Vegetables grown by farmers using rain water**

The chapter deals with the analysis, interpretation and utilization of the data generated from the survey of human related variables. The objectives of the study were to identify the conceptual framework. The findings of the study are summarized in the report under the following headings:

- 1.1 Socio-demographic characteristics of farmers under study area
- 1.2 Knowledge and resource use efficiency of maize producer vegetable crop
- 1.3 Impact of farm ponds on cropping intensity, crop diversity, nutrient application of farmers
- 1.4 Factors affecting adoption of farm ponds
- 1.5 Constraints factors hindering
- 1.6 Socio-demographic characteristics of farmers under study area

# Discussion

Socio-demographic characteristics include variables such as sex, education, family size, type of family, experience of farmer, crop cultivation, cropping system, contact of farmers which helps in determining the decision-making process of an individual and adoption of the new technology that has been introduced in the block.

The data that were revealed in table, indicates that the frequency of adoption belonging to age group less than 30, between 30 to 50 and greater than 50 were 9, 2 and 45 respectively. It is evident that the majority of farmers were from middle age group. Most possible reason for farmers belonging to this age group who adopted farm ponds was that they are more vigorous, active and responsible than the younger farmers. Similar findings were obtained by (Joshi-GDIP).

Out of the total sampled area 68.73 per cent of the farmers were educated up to high school followed by farmers who were graduated constituting 18.75 per cent and only 12.50 per cent of the farmers were illiterate. After stratification, it was found that majority of the farmers were educated up to high school hence their knowledge and adoption of farm ponds in the sampled area. Similar findings were reported by (Joshi-GDIP).

## CHAPTER-V

### DISCUSSION

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This chapter deals with the analysis of data and discussion of the results obtained through survey in Jammu district under four blocks. The revelation of the study was based on the initial chapter's conceptual framework. The findings of the study are discussed in this chapter under the following headings:

- 5.1 Socio-demographic characteristics of farmers under study area
- 5.2 Economics and resource use efficiency of major summer vegetable crops
- 5.3 Impact of farm ponds on cropping intensity, crop diversification and employment of farmers
- 5.4 Factors affecting adoption of farm ponds
- 5.5 Constraints faced by farmers in practicing rain water harvesting

#### **5.1 Socio-demographic characteristics of farmers under study area**

Socio-demographic characteristics include variables such as age, education, family size, type of family, experience of farmer in crop cultivation, extension agency contact of farmers which helps in determining the decision- making process of an individual and adoption of the new technology that has been introduced in the blocks.

The data that was revealed in table, indicates that the frequency of respondents belonging to age group less than 30, between 30 to 50 and greater than 50 were 9, 26 and 45 respectively. It indicated that the majority of farmers were from middle age groups. Most possible reasons for farmers belonging to this age group who adopted farm ponds was that they are more vigorous, active and responsible than the younger farmers. Similar findings were obtained by Tijjani (2018).

Out of the total sampled area 68.75 per cent of the farmers were educated up to high school followed by farmers who were graduated constituting 18.75 per cent and only 12.50 per cent of the farmers were illiterate. After obtaining such results it can be concluded that majority of the farmers were educated up to high school hence there was

more adoption of farm ponds in the sampled area. Similar findings were reported by Mishra and Ghadei (2015).

The vegetable growers using farm ponds were categorized on the basis of experience in crop cultivation and it was found that 58.75 per cent of the farmers hold crop cultivation experience of 20 to 30 years followed by experience greater than 30 years constituting 26.25 per cent with least cropping experience of 10 to 20 years constituting 3.75 per cent. Cropping experience was the major factor leading to usage of farm ponds as they have higher experience in farming and they know the importance of water in cultivating vegetable crops.

Majority i.e 55.00 per cent of the farmers hold a family size of 3-5 members followed by small size of family (1-3 members) constituting 33.75 per cent and least having large family (8 members) constituting 11.25 per cent. The reason behind this was due to increased awareness about the size of the family, increasing conflicts in joint families hence, there was increase in trend in small and medium families.

The table also revealed that 61.25 per cent of farmers belonged to nuclear family and 38.75 per cent of farmers belonged to joint family. The reason behind this can be due to fact that the cost of living is increasing day by day which encourages the farmers to have medium sized families.

The results revealed that majority of farmers (77.50 per cent) visited the extension agencies more often maybe twice or thrice a month whereas 22.50 per cent of farmers visited extension agencies once a month or 12 times year. This was due to fact that some villages of the blocks were situated near extension agencies or extension personnel visited these villages more frequently than others.

## **5.2 Economics of production of major summer vegetable crops**

## 5.2.1 Cost and returns of major summer vegetable crops

The different components of cost of cultivation, cost concepts, gross returns, net returns from major summer vegetable crops were computed and worked out which helps in the selection of an enterprise.

### 5.2.1.1 Cost of cultivation of major summer vegetable crops in selected blocks of Jammu district (₹/acre)

The item wise cost structure was divided into variable cost and fixed cost. The major three summer vegetable crops i.e bitter gourd, bottle gourd and okra were cultivated in Dansal, Nagrota, Chowki Choura and Akhnoor blocks of Jammu district. In block Dansal, the results revealed that the highest expenditure was incurred on total human labour which constitutes 40 per cent, 40.57 per cent, 47.37 per cent of the operational cost and 30.20 per cent, 29.29 per cent 37.68 per cent of the total cost in bitter gourd, bottle gourd and okra respectively. Highest cost of cultivation was incurred on cultivation of okra. The maximum share of cost was contributed by human labour because this crop was labour intensive and labour engagement was comparatively higher. In block Nagrota, bitter gourd, bottle gourd and okra were cultivated mainly in summer season and results revealed that the highest cost of cultivation was incurred in cultivation of okra due to higher expenditure on human labour followed by expenditure in manures and fertilizers. The least cost of cultivation was incurred on bottle gourd cultivation due to lesser planting density and lesser number of fruits per acre of land. In block Chowki Choura, among the operational cost the highest cost was contributed by human labour ₹6764.22, ₹8158.82 and ₹7014.50 in bitter gourd, bottle gourd and okra respectively. The total cost incurred was highest in okra among all the four blocks followed by bitter gourd and least cost incurred was from bottle gourd. The similar results were reported by Tejar (2019). Among all the four blocks highest total cost of cultivation was in block Chowki Choura per acre in bitter gourd, bottle gourd and okra due to high expenditure incurred on human labour, plant protection, manures and fertilizers while block Akhnoor has least cost of cultivation for bitter gourd, bottle gourd and okra respectively because farmers of Akhnoor used these resources more efficiently. On the other hand, fixed cost was highest in Akhnoor block due to higher rate of depreciation.

The overall operational item-wise cost of cultivation of major summer vegetable in all farms was found to highest in okra. The highest overall operational cost was found to be highest in human labour in bitter gourd, bottle gourd and okra. Total overall operational and fixed cost was found to be highest in okra and least in bottle gourd.

From the above results, it can be concluded that the vegetable crops are highly labour intensive. The highest cost was incurred on human labour because of larger number of pickings in vegetable crops. The farmers were to pay high prices for manures and fertilizers because the farmers are buying these inputs at market prices and there are almost no incentives as well as subsidies provided by government to farmers. Demand for manures and fertilizers was more to meet the requirements of vegetable crops hence increasing the cost of cultivation. These findings were same as reported by Kumar and Arora (1999).

#### **5.2.2.2 Concept wise cost of cultivation of major summer vegetable crops in selected blocks of Jammu district (₹/acre)**

The cost structure of Dansal block is discussed by concept. The cost  $A_1$  per acre of the three major summer vegetable crops were calculated viz; bitter gourd, bottle gourd and okra and it was observed that okra incurred highest cost per acre followed by bitter gourd and bottle gourd. Similarly, cost  $B_1$  per acre was found to be highest in case of okra followed by bitter gourd and bottle gourd. Thereafter, the cost  $C_3$  which is 10 per cent of the cost  $C_2$  was found to be highest in case of okra which was followed by bitter gourd and bottle gourd. Similarly, in case of block Nagrota, the cost  $C_2$  was found to be higher in case of okra. The highest cost of cultivation i.e  $C_2$  was found to higher because of higher labour cost per acre. Under block Chowki Choura, the cost  $C_2$ , was found to be highest in okra per acre but the cost  $A_1$  and  $A_2$  was found be highest in bitter gourd because okra is labour intensive and cost of family labour is more so it was the reason for hiking of the cost of okra. Under block Akhnoor, the among all the blocks highest cost was incurred in cultivation of okra due to higher utilization of labour. In block Akhnoor cost  $C_3$  was found to be lowest in bitter gourd followed by bottle gourd and okra because they do not use plant protection measures and thus lowers the cost of these major vegetable crops in Akhnoor.

The overall concept-wise of major vegetables in all farms were calculated and it was observed that cost  $A_1$  was found to be highest in okra followed by bitter gourd

and bottle gourd. Similarly, cost  $B_1$ ,  $B_2$  was found to be highest in okra. After deducing the managerial costs i.e 10 per cent cost of  $C_2$  overall cost  $C_3$  was found to be highest in lady finger. The table also indicated that the cost  $A_1$  was found to be lowest in bottle gourd among all the selected blocks of Jammu district. Similarly, overall cost  $C_3$  was found to lowest in bottle gourd. The overall cost of okra in selected blocks was found to be highest just because of higher usage of family labour in pickings of okra. Also manures and fertilizers were applied in higher amount in case of okra. The least cost involved in bottle gourd cultivation because of less pickings due to less number of fruits per plant.

### **5.2.2.3 Cost and return structure of major summer vegetable crops in selected blocks of Jammu district (₹/acre)**

The total cost was found to be highest in okra and lowest in bottle gourd in Dansal block. Similarly, gross returns was also found to be highest in okra, while lowest in bottle gourd. Therefore, net returns per acre was also found to be highest in okra followed by bitter gourd and bottle gourd. The amount of yield, price of output were important factors in determining the benefit cost ratio of the crops. The highest cost benefit ratio was experienced in okra followed by bitter gourd and bottle gourd. Cost of cultivation and the net returns on various factors of production helps to determine how much land and resources to be used for the production of vegetable crops. Due to higher yield, gross returns was found to be highest in lady finger. In block Nagrota, the total cost of cultivation was found to be highest in okra followed by bitter gourd and bottle gourd. Per acre gross returns and net return was found to be highest in okra followed by bitter gourd and bottle gourd respectively. Okra had the highest cost benefit ratio followed by bitter gourd and bottle gourd. The lady finger was found to be the most beneficial crop among others due to highest yield and highest gross returns. In block Chowki Choura, highest gross returns, net returns and cost benefit ratio was found to be highest in okra crop followed by bitter gourd. The lowest benefit cost ratio was found to be in bottle gourd. Among all the blocks okra was found to be most profitable crop due to highest yield per acre of land and higher gross returns among all the other crops. Similar results were also observed by Hasan *et. al*, (2014). The input expenditure was found to be higher in vegetable crop and gross income was also found to be higher in the selected area due to improved irrigation facilities. The overall cost of major summer vegetable crops was found to highest in case of okra followed by bitter gourd

and bottle gourd. The highest overall yield per acre was found to be highest in okra due to higher density planting leading to higher gross returns among the three crops followed by bitter gourd and bottle gourd. The highest returns was found to be of okra with highest benefit-cost ratio among all the other major summer vegetable crops. The lowest benefit-cost ratio was found to be in bottle gourd.

#### **5.2.2.4 Estimated regression coefficients of various factors, their standard errors and marginal value productivity (MVP) for major summer vegetable crops in selected blocks of Jammu district**

The resource use efficiency of bitter gourd, bottle gourd and okra was calculated using Cobb-Douglas production function and results revealed that the human labour, seed and irrigation were significant at the 5 per cent level of significance whereas, manures and fertilizers and plant protection measures were found to be non-significant in bitter gourd cultivation, similar results have been reported by Mila *et. al*, (2015). The coefficient of determination was found to 0.93 which indicated that the 93 per cent of the variation is due the above-mentioned independent variables. In bottle gourd cultivation, irrigation and plant protection were found to be 1 per cent significant and human labour was found to be at 5 per cent level of significance. The estimated value of coefficient of determination ( $R^2$ ) was found to be 0.81 determining that 81 per cent of variation is due to these variables and obviously there are some other factors that determine the variations in the crop other than these. In okra cultivation seed, manure and fertilizers and plant protection were found to be significant at 5 per cent level of significance. The estimated value of  $R^2$  was found to be 0.83 that signifies 83 per cent of total variation from the above mentioned variables.

Marginal value product to factor cost ratio measures the resource use efficiency. In bitter gourd cultivation the marginal value of product to factor cost ratio of human labour, seed, manure and fertilizers, irrigation and plant protection measure were positive which indicates that additional rupee spend on these inputs will increase gross returns by ₹2.27, ₹5.88, ₹1.12, ₹52.65, ₹0.01 respectively. The value less than one signifies that there is a scope to increase level of these inputs in production. Further, in bottle gourd cultivation the marginal value productivity of all inputs such as human labour, manures and fertilizers, irrigation and plant protection were found to be ₹0.87, ₹1.60, ₹0.14, ₹20.75 and ₹1.11 respectively. In the cultivation of okra, additional one rupee spent on the inputs human labour, seed, manures and fertilizers, irrigation

and plant protection would increase in gross returns by ₹0.10, ₹19.95, ₹16.91, ₹3.06 and ₹5.22 respectively. Similar results have also been reported by Shrivastava *et. al.* (2015) .

### **5.3 Impact of farm ponds on cropping intensity, crop diversification and employment of farmers**

The kharif season extends from June to October and rabi season extends from November to March. It can be inferred from the table 4.17 that during kharif season, before farm ponds maximum area under major summer vegetable crops were bitter gourd, bottle gourd and okra constituting 34.00 acres, 46.00acres and 42.84acres having 19.78 per cent, 26.99 per cent and 24.92 per cent respectively. The total cropped area under kharif season was found to be 171.88 acres. In rabi season, maximum area was found to be under tomato, radish and onion constituting 37.95 per cent, 30.12 per cent and 22.89 per cent respectively. The total cropped area under rabi season was found to be 66.40 acres. These results are in conformity with the findings of Palanisami and Kumar (2019)

Cropping pattern of crops after farm ponds is predicted in tables 4.17 and 4.18. It can be revealed from this table that during kharif season, after farm ponds the area under summer vegetable crops got increased to 51.60 acres, 58.80 acres and 54.80 acres for bitter gourd, bottle gourd and okra constituting 16.90 per cent, 19.26 per cent and 17.95 per cent respectively. The total cropped area also got increased from 171.88 acres to 305.20 acres. In rabi season the area under major crops also got increased to 71.20 acres, 50.00 acres and 58.00 acres for tomato, radish and onion respectively constituting total cropped area equal to 204.20 acres.

The gross cropped area is calculated by adding the part of net sown area which is used for two to three crops in a year whereas net cropped area represents the total area sown with crops. The table 4.19 revealed that the total gross cropped area was found to be 238.28 acres before farm ponds and 509.40 acres after farm ponds. Net cropped area was found to be 171.88 acres before farm pond and 204.20 acres after farm pond. By computing the values of gross and net cropped areas the cropping intensity was found to be 138.63 per cent before farm pond and 167.00 per cent after farm ponds. The increased cropping intensity was due to higher gross cropped area after

farm pond than before farm pond. The similar results have been observed by Kumar *et al* (2015).

The crop diversification was computed using herfindal's index, the value of the index ranges from 0 to 1, when the value of the index approaches towards 0 means the total diversification and when it approaches towards 1 means diversification starts to decrease. The index before and after farm ponds were computed and table 4.20 revealed that the value of index got decreased from 0.91 to 0.05 in kharif season and value got decreased from 0.29 to 0.27 in rabi season. The overall value of the index decreased from 0.12 to 0.09 leading to more diversification than before.

The kharif season extends from July to October and employment rate was calculated by using man days employed per annum for each month before farm ponds. The maximum employment generated was 18.74man days followed by 17.25man days, 15.50man days, 14.75 per cent constituting 28 per cent, 26.03 per cent, 23.40 per cent and 22.20 per cent in the months of July, September, August and October respectively. The rabi season extends from November to February and it was revealed in table 4.22 that the maximum employment was calculated in month of November (15.00man days) constituting 31.91 per cent followed by December (10man days), January (14.00man days) and February (6.00man days) having 21.27 per cent, 29.78 per cent, 12.70 per cent respectively. The zaid season extends from March to June and highest employment was generated in the month of June (18.70man days) followed by April (15.70man days) and May (15.00man days) constituting 30.40 per cent, 25.55 per cent and 24.44 per cent respectively.

The employment rate generated after farm pond was found to be increased in kharif, rabi as well as zaid season. In kharif season the employment in July, August, September and October constituted 23.47 per cent, 23.70 per cent, 25.55 per cent and 27.28 per cent respectively. In rabi season the employment generated is 27.77 per cent, 27.77 per cent, 34.72 per cent, 16.66 per cent in the months of November, December, January, February. The employment rate in zaid season was found to be 21.25man days, 25.10man days, 23.20 per cent, 25.30man days constituting 22.80 per cent, 26.68 per cent, 25.00 per cent and 25.30 per cent respectively.

The difference in employment was seen between before and after farm ponds, the variation in man days was seen in kharif, rabi and zaid seasons with the difference

in man days of 18.95man days, 25.00man days and 31.77man days respectively. The total man days generated before farm pond was 174.65man days and after farm ponds was 250.30man days with the difference of 75.72man days per annum. Similar findings have been reported by Hyalij (2017).

#### **5.4 Factors affecting adoption of farm ponds**

The binary logistic regression was used to determine factors affecting adoption. It was found that the age, extension agency contact, education and labour were significant at 1 per cent level of significance and farm size, experience in crop cultivation were significant at 5 per cent level of significance. Similar findings were reported by Mume and Kemal (2014).

##### **5.4.1 Age of the respondent**

The age was found to be statistically significant at 1 per cent level of significance. The log odd ratio (1.33) indicates that the probability of adoption of farm ponds increased by 1.33 for every oneyear increase in age of the respondent and concluded that the older farmers adopt more farm ponds than young farmers, these results were in conformity with Zongo *et.al* (2015) and of Baiyegunhi (2015)

##### **5.4.2 Extension agency contact**

The extension agency contact was significant at 1 per cent level of significance. The farmer who visits extension agencies were more likely to adopt rain water harvesting farm ponds. The log odd ratio 2.37 signifies that for every one time increase in extension agency contact the level of adoption was increased by 2.37.

##### **5.4.3 Education**

The education was found to be statistically significant at 1 per cent level of significance having log odd ratio of 4.32 indicates that for every one year increase in schooling the probability of adoption of farm pond was increased by 4.32, similar findings were reported by Ahmed *et.al* (2013).

##### **5.4.4 Farming experience**

The experience in crop cultivation was found to be statistically significant at 5 per cent level of significance. The log odd ratio of 1.08 indicates that for every one year increase in experience in crop cultivation the probability of adoption would increase by 1.08.

#### **5.4.5 Labour**

The number of working people in a family is determined by labour force and it was found to be statistically significant at 1 per cent level of significance. The log odd ratio of 3.35 indicates that with every unit increase in labour the probability of adoption of farm pond would increase by 3.35.

#### **5.4.6 Gender**

The log odd ratio showed almost no variation (0.29) in adoption level of farm ponds. Most of the respondents in the sampled blocks were male, leading to almost no variation in adoption of farm ponds hence was statistically insignificant.

### **5.5 Constraints faced by farmers in practicing rain water harvesting**

The major difficulties faced by farmers in practicing rain water harvesting through farm ponds in Jammu district shows that the majority of farmers faced the problem of evaporation or seepage losses (ranked I), lack of water delivery equipment such as motors, drip irrigation, sprinkler irrigation facilities (ranked II) and these were the main constraints faced by farmers constituting 19.75 per cent and 15.82 per cent respectively. Constraints faced by farmers who adopted the farm ponds at a moderate level were, non-adoption of farm pond due to land constraint (ranked III) and non-adoption of farm ponds due to capital constraint (ranked IV) were also the problems faced by farmers constituting 14.45 per cent and 14.10 per cent of the constraints respectively. The constraints least faced by farmers were, damage in pond liners (ranked V) and other maintenance costs such as deposition of silt at the bottom of the ponds, growth of weeds along the lining of the ponds, (ranked VI) and damage of structure due to heavy rainfall (ranked VII) and poor soil fertility (ranked VIII) constituted 35.86 per cent of total constraints faced by the farmers collectively. These results are in conformity with the findings of Singh and Athokpam (2018).



**Plate 4: Interaction with farmers during collection of data**

## SUMMARY AND CONCLUSIONS

## Chapter-6

This chapter discusses the importance of summary and conclusions in a research paper. It explains how to write a summary that captures the main points of the study and how to write conclusions that answer the research objectives and provide a clear statement of the findings.

Water harvesting means collecting, storing and utilizing water from large fields during water stress conditions. It includes rooftop rain water harvesting, surface runoff water harvesting, dam, pond, well and other small scale harvesting systems are useful to fill the gap between total soil moisture at the end of dry spells by storing excess water and utilize when it is required.

## Summary and Conclusions

Water harvesting is a sustainable and cost-effective method of water conservation in vegetable as well as cereal crops. Due to higher need of water in various vegetable crops, water free water stress conditions leading to low yields leading to lower benefit and return.

In Kandi district, rainfall is low and there are long dry spells especially during summer months. In these areas, farmers are using various artificial sources of irrigation. One of the main sources of irrigation in Kandi belt is through community farm ponds. Farm ponds are small water bodies that are made and maintained through different schemes started by the Government of India with an aim to provide water to the farmers. Various schemes are also taken by the Government for providing water to the farmers. For example, the Government is providing water to the farmers for drinking purposes, irrigation, etc. and so on. The farmers living in the area do not have land or water resources of ponds are benefited through community farm ponds tanks so that more they can benefit out of all the facilities available.

Farmers of Kandi belt have started to cultivate more vegetables during winter as well as summer season. Due to higher profits and lower risk involved, there is increase in cultivation of vegetable crops leading to higher yield and income for farmers and also more income for the community.

## CHAPTER-VI

### SUMMARY AND CONCLUSION

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This chapter dispense the representation of summary and conclusions that have been derived from the objectives of the study entitled “Economic analysis of summer vegetable crops through rain water harvesting structures in rainfed areas of Jammu district”.

Rain water harvesting means collecting, storing and utilizing rain water to irrigate fields during water stress conditions. It includes rooftop rain water harvesting and surface runoff water harvesting. Due to uneven and erratic rainfall, rain water harvesting systems are useful to fill the gap between need and abundance of water during dry spells by storing excess water and utilize when it is required.

In certain areas of Jammu district, due to severe shortage of water bodies and no other means of water the farmers in these areas face serious problems in cultivation of vegetable as well as cereal crops. Due to higher need of water in summer vegetable crops, crops face water stress conditions leading to low yields leading to lesser benefit-cost ratios.

In Jammu district, mainly Kandi belt faces dry spells specially during summer season. Hence, in these areas there is a need to construct artificial sources of irrigation. One of the main sources of artificial irrigation in Kandi belt is through construction of farm ponds. Farm ponds are the structures that are made and maintained through different schemes started by the government of India such as PDMC-PMKSY (Directorate of Agriculture,2021) and initiatives are also taken by SKUAST-J, benefiting the farmers in every possible way, such as for agricultural purposes, livestock purposes, fisheries, domestic uses and so on. The farmers having less area and do not have land for construction of ponds are benefitted through constructing community farm ponds/ tanks so that more than one household can avail the facility at the same time.

Farmers of Kandi belt have started to cultivate more vegetables crops in both kharif, rabi as well as summer season. Due to higher profits and lesser cost of cultivation, there is increase in cultivation of vegetable crops leading to higher benefit ratios. The investment made by farmers are nearly zero because the total investment is

made by the government under different schemes leading to higher level of adoption among farmers.

It is expected from the results of the study to enlighten the importance of constructing farm ponds in the rainfed areas of Jammu district, that would help the policy makers to construct the policies and strategies effectively and to highlight the factors that affect the adoption of rain water harvesting and to strengthen these factors so that more farmers get benefitted hence, strengthening the agriculture sector. By observing the above said facts, the present study was undertaken by keeping in mind the following objectives:

- 6.1 Socio-demographic characteristics of farmers under study area
- 6.2 Economics and resource use efficiency of major summer vegetable crops
- 6.3 To study the impact of farm ponds on cropping intensity, crop diversification and employment of farmers
- 6.4 To determine the factors affecting adoption of rain water harvesting farm pond
- 6.5 Constraints faced by farmers in practicing rain water harvesting through farm ponds

To successfully carry out this study Jammu district of Jammu and Kashmir was selected purposively on the basis of highest number of rain water harvesting farm ponds present in an area. Further, multistage sampling technique was used to select the blocks and villages of the Jammu district. The total of 4 blocks were selected constituting 15 villages. The farmers of these four blocks were selected on census basis so as to constitute a total of 80 respondents.

Both primary and secondary data was collected to accomplish the objectives of the study. The primary data was collected through survey method by interviewing the farmers with the help of prepared pre-tested schedule. The required secondary data will be collected from various published sources/ agencies such as Economic Survey (various issues), Digest of Statistics, Annual Reports other relevant government publications and various websites.

The data collected was used to fulfill the specified objectives under study. The simple tabular analysis was done, to find out the socio-demographic characteristics of the farmers under the study area. The cost and returns of major summer vegetable crops

were computed by using cost concepts, for the examination of resource use efficiency Cobb-Douglas production function was used to compute productivity of different inputs to produce per unit of output. For comparison cropping patterns, cropping intensities were compared before and after farm ponds. For the computation of crop diversification, herfindal's index was used and indexes were compared, to find out the impact of farm ponds on employment total man days were calculated for the whole year. To find out the factors affecting adoption of farm ponds binary logistic regression model was used and the problems that were faced by farmers in practicing rain water harvesting through farm ponds were studied and were ranked by using Garrett ranking techniques.

### **6.1 Socio-demographic characteristics of farmers under study area**

The average age group of the farmers using water harvesting farm ponds was greater than 50 years (56.25 per cent) whereas 32.50 per cent of the total respondents were from age group 30-50 years and 68.75 per cent of the farmers had intermediate level of education. Majority of the farmers had 20-30 years of experience of crop cultivation whereas 18.75 per cent of the farmers had an experience of more than 30 years. The average size of family was medium (3-5 members) and least number of farmers belonged to small sized families (1-3 members). Majority of the farmers constituting 77.50 per cent, visited the extension agencies and contacted extension personnel more than twice a month whereas, 22.50 per cent visited once a month or less than that.

### **6.2 Economics and resource use efficiency of major summer vegetable crops**

In the sampled blocks per acre cost of cultivation of bitter gourd was found to ₹25818.20, ₹26100.21, ₹28757.20 and ₹25261.48 for Dansal, Nagrota, Chowki Choura and Akhnoor respectively. For bitter gourd, the operational cost was highest in Dansal block (₹19453.66/acre) and lowest for Akhnoor block (₹13760.10/acre) whereas the fixed cost was found to be highest for Akhnoor block (₹11501.00/acre) and lowest in Dansal block (₹6364.54/acre). It was revealed that the out of all the inputs used for the cultivation of bitter gourd highest cost was incurred on total human labour among all he blocks (₹7820.00/acre, ₹6977.45/acre, ₹6742.22/acre and ₹5146.66/acre) and lowest cost was incurred on irrigation (₹246.00/acre, ₹343.55/acre, ₹404.00/acre, ₹176.50/acre). For bottle gourd per acre cost of cultivation was found to be ₹24303,26,

₹24721.78, ₹28814.57 and ₹24986.00 for blocks Dansal, Nagrota, Chowki Choura and Akhnoor respectively. The highest operational cost for bottle gourd was found to be highest in block Chowki Choura (₹18762.55/acre) and lowest in block Akhnoor (₹12485.40/acre) whereas the fixed cost was found to be highest in block Akhnoor (₹11501.00/acre) and lowest in block Dansal (₹6364.54/acre). It was revealed that the among all the inputs used in the cultivation total human labour incurred the maximum cost (₹7227.80/acre, ₹38794.46/acre, ₹8158.82/acre and ₹7533.00/acre) and least cost was incurred on irrigation (₹209.20/acre, ₹215.81/acre, ₹225.00/acre and ₹194.10/acre) among all the four blocks respectively. In the cultivation of okra crop, per acre total cost of cultivation was found to ₹31119.80, ₹26165.80/acre, ₹29064.80/acre, ₹26012.00/acre for blocks Dansal, Nagrota, Chowki Choura and Akhnoor respectively which is highest among all the selected major summer vegetable crops. Total operational cost was found to be highest in block Dansal (₹24755.20/acre) and lowest in block Akhnoor (₹14510.00/acre) whereas total fixed cost was found to be highest in block Akhnoor (₹11501.00/acre) and lowest in block Dansal (₹6364.54/acre) due to higher depreciation on farm buildings and equipment which was found to be highest in block Akhnoor (₹8231.00/acre) and lowest in block Dansal (₹6364.54/acre)

In the selected blocks the highest  $C_3$  cost of the cultivation was found to be in block Chowki Choura (₹31632.90/acre) which was found after working out the management cost i.e. 10 per cent of the cost  $C_2$  ₹28757.20/acre), cost  $A_1$ , cost  $A_2$ , cost  $B_1$ , cost  $B_2$ , cost  $C_1$  which constituted 70.03 per cent, 79.8 per cent, 70.90 per cent, 80.58 per cent, 81.04 per cent and 90.09 per cent of cost  $C_3$  respectively. Cost  $C_3$  was found to be lowest in block Nagrota (₹27787.62/acre) after adding management cost of ₹2546.16/acre in cost  $C_2$  of (₹25461.60/acre). In bottle gourd cultivation among all the four blocks, highest  $C_3$  cost was found to in block Chowki Choura (₹31695.50/acre) where cost  $A_1$ , cost  $A_2$ , cost  $B_1$ , cost  $B_2$ , cost  $C_1$  constituted 67.50 per cent, 75.00 per cent, 68.82 per cent, 77.75 per cent and 90.09 per cent of the cost  $C_3$  respectively. Per acre lowest  $C_3$  cost was found to be in block Nagrota (₹27193.95) whereas for okra cultivation  $C_3$  cost was found to be highest in block Dansal (₹34231.75/acre) and lowest  $C_3$  cost was found to in block Akhnoor (₹28613.50/acre) due to no use of plant protection chemicals and measures.

The productivity of bitter gourd was found to be highest in block Chowki Choura i.e.52q/acre whereas the lowest productivity was found to be in block Dansal

i.e. 45q/acre. It was found that the highest gross returns and net returns was found to highest in block Chowki Choura ₹103480/acre and ₹74722.80/acre and lowest in block Dansal ₹74250.00/acre and ₹48431.78/acre respectively. The highest benefit-cost was found to in Nagrota (1:3.81) and lowest in block Dansal (1:2.87) in bitter gourd cultivation. In bottle gourd cultivation, the highest productivity was found to be in block Akhnoor i.e.45.00q/acre and lowest productivity was found to be in block Dansal (33.00q/acre). The highest gross returns was found to in Nagrota (₹61250.00/acre) and lowest returns was found to be in Dansal (₹56100.00/acre). Highest benefit-cost ratio of 1:2.90 is in block Chowki Choura and lowest ratio was found in block Dansal (1:2.30) respectively. In okra the highest productivity was found to be in block Akhnoor (64.00q/acre) and lowest productivity was found in block Chowki Choura (54.00q/acre). The highest gross and net returns was found to be in block Akhnoor (₹112000.00 and ₹86622.60) and lowest returns was found out in block Chowki Choura (₹99900.00 and ₹70835.20). The highest per rupee returns was made in block Akhnoor (1:4.41) and lowest was made in block Chowki Choura (1:3.43). The highest benefit-cost returns in blocks Akhnoor and Chowki Choura was high due to low cost of cultivation and high returns whereas low benefit-cost ratios in Dansal was due to high cost of cultaivation and less returns from per acre area of land.

### **6.2.1 Estimated regression coefficients of various factors, their standard errors and marginal value productivity (MVP) for major summer vegetable crops in selected areas of Jammu district**

From a factor input analysis, the regression coefficients, standard errors and marginal value product were determined by using Cobb-Douglas production function. The regression coefficients, MVP and standard errors of the three major summer vegetable crops i.e.bitter gourd, bottle gourd and okra were computed. The value of  $R^2$  computed for bitter gourd, bottle and okra was found to 0.93, 0.81 and 0.83 which indicated that 93 per cent, 81 per cent, 83 per cent of the variation was found to from the independent variables such as total human labour, seed, manures and fertilizers, irrigation and plant protection chemicals.

In bitter gourd human labour, seed and irrigation was found to be statistically significant at 5 per cent level of significance having regression coefficients of 0.41, 0.23 and 0.27 respectively. Manure, fertilizers and plant protection were found to be non-significant with regression coefficients of 0.07 and 0.001. Marginal value of

product was found to be positive and per rupee spent on the independent variables such as human labour, seed, manures and fertilizers, irrigation and plant protection would increase gross return by ₹2.27, 5.88, ₹1.12, ₹52.65 and ₹0.019 respectively.

In bottle gourd cultivation, human labour, irrigation and plant protection was found to be significant at 5 per cent and 1 per cent level of significance having positive regression coefficients of 0.183, 0.121 and 0.618 respectively. Seed, manures and fertilizers were found to be non-significant with regression coefficients of 0.068 and 0.010. Per rupee spent on the independent variables such as total human labour, seed, manures and fertilizers, irrigation and plant production would increase the gross returns by ₹0.87, ₹1.60, ₹0.14, ₹20.75 and ₹1.11 respectively, which was determined by finding values of marginal value of product.

In okra cultivation, seed, manures, fertilizers and plant protection was found to be significant at 5 per cent level of significance having regression coefficients of 0.340, 0.736 and -0.165 respectively. The negative regression coefficients mean the more you add additional unit of independent variable the value of dependent variable tend to decrease, it has a negative impact on dependent variable means the independent variable is overused. Per rupee spent on total human labour, seed, manures and fertilizers, irrigation and plant protection increase the gross return by ₹0.10, ₹19.95, ₹16.91, ₹3.60 and ₹5.22 respectively.

### **6.3 To study the impact of farm ponds on cropping intensity, crop diversification and employment of farmers**

The cropping intensities, crop diversification and the employment of the farmers were computed to study the impact of farm ponds on these factors. Data collected and comparative analysis was done by dividing the data collected into before and after farm ponds. The cropping intensity was calculated by finding area under different crops produced in kharif as well as rabi season. The area under crops in kharif season before farm ponds were used was found to 171.88 acres constituting crops such as bitter melon (19.78 per cent), bottle gourd (26.99 per cent), okra (24.92 per cent), chilli (2.30 per cent), brinjal (8.80 per cent), pumpkin (2.30 per cent), maize (10.30 per cent) and bajra (4.40 per cent) in the months of March to October. The area under crops in rabi season before farm ponds was found to be 66.40 acres comprised of vegetable

as well as cereal crops such as radish (30.12 per cent), tomato (37.95 per cent), onion (22.90 per cent), potato (1.50 per cent) and wheat (7.50 per cent) respectively.

The cropping patterns of crops after farm ponds were constructed in kharif season was found to 305.20 acres constituting crops such as bitter gourd (16.90 per cent), bottle gourd (19.20 per cent), okra (17.90 per cent), chilli (7.70 per cent), brinjal (6.90 per cent), pumpkin (6.90 per cent), maize (17.40 per cent) and bajra (6.80 per cent) from the months of March to October. The area under crops in rabi season before farm ponds was found to be 204.20 acres comprised of vegetable as well as cereal crops such as radish (24.48 per cent), tomato (34.86 per cent), onion (28.40 per cent), potato (2.45 per cent) and wheat (9.79 per cent) respectively.

The total cultivated area increased from 171.88 acres to 305.20 acres in kharif season after construction on farm ponds and was increased from 66.40 acres to 204.20 acres in rabi season. The total gross cropped area increased from 238.28 acres before farm pond and 509.40 acres after farm ponds were constructed. The cropping intensity was found to be 138.63 per cent before farm pond and got increased to 167.00 per cent after farm ponds. There was the increase in cropping intensity when the two factors were compared.

For the computation of crop diversification, the proportion of ith crop in an area was calculated and the squares of the area were computed hence, by adding the sum of the areas of the different crops the herfindal's index was calculated. The index calculated in kharif season before farm pond was found to be 0.91 and after farm pond was found to be 0.05 which decreased drastically leading to more crop diversification. The index calculated in rabi season was found to be 0.29 to 0.27. The overall crop diversification index got decreased from 0.12 to 0.09 leading to more crop diversification.

The impact of employment before and after farm ponds were calculated by calculating man days in kharif, rabi and zaid season. Maximum employment was generated in kharif season before and after farm pond was constructed i.e 41.00 man days to 85.20 man days with the difference of 44.20 man days with highest in the month of July (23.50 man days) in before farm pond and 20.22 in August after farm ponds. In rabi season maximum employment was generated in month of December, January after farm ponds with the difference of 42.00 man days in total. The maximum employment

difference in man days were found to be highest in summer season i.e. March to June with overall difference of 47.25 man days creating the maximum employment per annum. The total employment generated per annum before farm pond was found to be 136.00 man days and 269.45 man days per annum creating an overall difference of 133.45 man days hence creating a significant impact on cropping patterns, cropping intensity, crop diversification as well as employment.

#### **6.4 To determine the factors affecting adoption of rain water harvesting farm pond**

To determine the factors that might affect the adoption of the farm ponds were determined and binary logistic regression was used to calculate the unstandardized coefficients, log odd ratios, standard errors and level of significance. The value of  $R^2$  was found to be 0.91 which means the 91 per cent of the variation is made by the independent variables such as age of the respondent, area of farm, extension agency contact, experience in crop cultivation, education level of the respondent, the people working in the field and gender on the dependent variable i.e adoption of rain water harvesting farm pond. The proportionate change in dependent variable with the proportionate change in independent variables was determined by log odd ratio. The log odd ratios of the independent variables such as age of the respondent, extension agency contact of the farmer, land holding of the respondent, experience in farming, labour and gender of the respondent were found to be 1.39, 2.37, 1.08, 4.32, 1.08, 3.35, 0.29 respectively. The larger value of log odd ratio determines more adoptability of farm ponds. The factors such as education and labour were found to have the highest values indicating higher impact on adoptability and gender was found to negative indicating no effect on adoption. Factors such as age of the respondent, education level and labour working in the field was found to be statistically significant at 1 per cent level of significance whereas land holding, farming experience were found to be significant at 5 per cent level of significance.

#### **6.5 Constraints faced by farmers in practicing rain water harvesting through farm ponds**

The various constraints faced by farmers in practicing rain water harvesting was ranked by calculating garret's score and were ranked from 1 to 7. The major constraint faced by farmers in practicing farm ponds was evaporation o seepage losses (ranked I),

lack of water delivery equipment from ponds to the fields by using motors, pumps etc. was another major constraint (ranked II) followed by non-adoption of farm ponds due to land constraint (ranked III) and non-adoption of farm ponds due to capital constraint (ranked IV), intermediate constraints such as damage of pond liners due to inadequate films (ranked V) followed by other maintenance costs such as desilting of farm ponds, growth of weeds along the farm ponds etc. (ranked V) damage of structure due to heavy rainfall or any other damage due to natural calamity (ranked VI) and poor soil fertility (ranked VII).

## 6.6 Conclusion

On the basis of the study, it was revealed that the farm ponds played a crucial and significant role in production of vegetable crops by supplying water at the time of need in Kandi regions of Jammu regions. It was also seen that there was a tremendous positive change in cultivation of summer vegetable crops by comparative study of before and after farm pond construction. Average age group of the respondent was found to be above 50 years, most of the farmers received intermediate level of education and 12.50 per cent of the respondents were found to be illiterate. Most of the farmers had a farming experience between 20-30 years followed by more than 30 years of experience. Average family size was medium (3-5 members) followed by small sized families. The economics of major summer vegetable crops in selected blocks of Jammu district was compared and it was found that among operational cost human labour, manures and fertilizers, irrigation, plant protection chemicals used were higher in okra (₹24755.20/acre, ₹19303.00/acre, ₹19013.00/acre, ₹14510.00/acre) when compared to bitter gourd and bottle gourd. The net returns was found to be highest in okra compared to all the four blocks than bitter gourd and bottle gourd. The crops that were grown in summer was irrigated through farm ponds only, so it became important to educate farmers regarding the usage and importance of farm ponds in the area where water is a scarce resource. The cost of cultivation was highest in okra due to maximum cost incurred on total human labour and manures and fertilizers. Due to high market price of okra per quintal the gross returns and net returns were found to be highest in okra. Cobb-Douglas production function was used to find out the resource use efficiency of the vegetable crops. In bitter gourd cultivation, the human labour, seed and irrigation was found out to be significant at 5 per cent. It can be said that if these resources were used efficiently there could be increase in gross returns. In case of bottle gourd human

labour was found to be significant at 5 per cent level of significance and irrigation, plant protection was found to be significant at 1 per cent level of significance. In case of okra, seed, manure, fertilizers and plant protection was found to be significant at 5 per cent level of significance, where plant protection has a negative impact on the independent variable. There are two main agriculture seasons kharif and rabi. The area under crops before and after farm ponds have been increased drastically in both kharif as well as zaid seasons leading to increased net cultivated area and gross cropped area. The cropping intensity before constructing farm ponds increased from 138.63 per cent to 167.00 per cent. Crop diversification index was decreased from 0.12 to 0.09 on overall basis whereas in kharif season index was decreased from 0.19 to 0.05 and 0.29 to 0.27 in rabi season indicating increase in diversification. The employment rate of farmers also increased from 174.65man days to 250.37man days per annum in all the agriculture seasons combined. The farmers who had rain water harvesting farm ponds constructed on their fields had more employment rate than before. After the farm pond were constructed, more land was used for the cultivation of vegetable crops leading to more engagement of labour hence increasing the employment rate among farmers. The difference of 18.95man days, 25man days and 31.77man days were generated in kharif, rabi and zaid seasons respectively. The binary logistic regression model was used to estimate the factors as well as the strength of the factors that affect the adoption of rain water harvesting farm pond by the farmer. The independent factors that were taken to study the impact, were age of the respondent, extension agency contact, size of land holding, education, experience in crop cultivation, labour force and gender of the respondent. The factors such as age of the respondent, education level, labour force was found to be 1 per cent level of significance and extension agency contacts, size of land holding was found to significant at 5 per cent level of significance whereas gender was found to be statistically non-significant. The log odd ratios of age, extension agency, size of land holding, education level, experience in crop cultivation and labour was found to be 1.39, 2.37, 1.08, 4.32, 1.08, 3.35 and 3.21 respectively. The major constraints faced by farmers in practicing rain water harvesting farm ponds were evaporation and seepage losses followed by lack of water application equipment such as motors, pumps etc. (ranked I and II) the intermediate constraints were found to be inadequacy of pond size due to capital (ranked III) and land constraints (ranked IV) followed by damaging of pond liners (ranked V) the least of all the constraints faced by the farmers in using farm ponds were found to be costs of maintenance that do not

occur much and can be categorized as deposition of silt in some areas, growth of weeds along the lining of the ponds or inside ponds (ranked VI) followed by damaging of the whole structure by wind storms, thunder storms of any other natural calamities (ranked VII) and poor soil fertility was ranked at last (ranked VIII)

### **6.7 Suggestions and policy implications**

It may be seen that when the objectives of the study were formulated and analyzed it was suggested that the construction of the farm ponds has a positive impact on agricultural purposes on the basis of the results found during the study. Hence, it is necessary to construct the farm ponds or other water harvesting structures in more rainfed areas where the shortage of water prevails. The suggestions are:

1. In the Kandi belt major vegetable crops grown such as bitter melon, bottle gourd and okra, were found to be profitable crops among all the other crops hence, it is suggested to grow these crops by using the resources efficiently and economically so that the farming conditions in these areas can be improved. =
2. The cropping intensity, rate of employment and crop diversification have been increased after the construction of farm pond hence there is a need to provide knowledge to farmers regarding the importance and proper utilization of farm ponds. This can be done by proper extension agencies, department of agriculture, KVKs so that more farm ponds can be constructed.
3. The farm women should be given proper knowledge about the importance of farm ponds as the respondents where the head of family was a woman did not adopt the farm ponds. The knowledge towards the feasibility of investment towards farm ponds should be done so adoption level might increase.
4. Training regarding the cost-effective methods to reduce seepage or evaporation losses and during the site selection process initially trainers or engineers should be concerned. The films used for construction should be made of good materials like LDPE so that durability of farm ponds can be increased as suggested by farmers under the study area. The water delivery equipment shall be provided by the government under the concerned scheme or subsidies should be given to farmers.

### **6.7.1 Policy implications**

1. Government should implement more schemes and programmers regarding construction of farm ponds in the Kandi belt. The extension agencies, KVKs, NGOs should take initiatives and should aware the farmers regarding the useful needs of the ponds and their role in improving agricultural practices and ultimately yield and profit.
2. The subsidies should be extended to the farmers by the government agencies regarding motors, pipes etc. and also for setting up the ponds. Agriculture department should create awareness regarding distribution and supply of water application equipment, better linkages shall be made between the banking institutions and farmers to reduce capital costs.



**Plate 5: Site visitation with the farmers**

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APPENDIX - I

Department of Agricultural Sciences and Technology, of Jammu  
Survey Schedule for Data Collection of M. Sc. Research Student  
Study on Impact of Rainwater Harvesting Structure  
in Rainfed Areas of Jammu District

Village: \_\_\_\_\_ Block: \_\_\_\_\_ Date: \_\_\_\_\_

DEMOGRAPHIC PROFILE OF THE RESPONDENT AND BASE LINE DATA

Married \_\_\_\_\_ Unmarried \_\_\_\_\_  
Widow \_\_\_\_\_ Widower \_\_\_\_\_  
Male/Female \_\_\_\_\_

# APPENDIX

Sl. No.	Gender	Higher Education	Income year	Income/year	
				1st farm	2nd farm

Number of people in family/ \_\_\_\_\_  
Working experience (years) \_\_\_\_\_  
Occupation and holdings (if Kharab) \_\_\_\_\_  
Remarks: \_\_\_\_\_

**APPENDIX - I**



**Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu  
Survey Schedule for Data Collection of M.Sc. Research Problem**

**Economic Analysis of Summer Vegetable Crops through Rain Water Harvesting Structures  
in Rainfed Areas of Jammu District**

S.No.\_\_\_\_ Village : \_\_\_\_\_ Block : \_\_\_\_\_ Date: \_\_\_\_

**I. SOCIO-DEMOGRAPHIC PROFILE OF THE RESPONDANT AND BASE LINE DATA**

1. Name of respondent :
2. Father's name :
3. Age of respondent (years) :
4. Marital Status : Married/ Un-married/ Widow/ Widower
5. Sex : Male/Female
6. Telephone/ Mobile no. :
7. No of family members :
8. Family composition :

Age	Male	female	Higher Education	Income year	Income/year	
					On farm	Off farm
0-15						
15-30						
30-45						
45-60						
Above 60						

9. Working people in family?
10. Farming experience (years)
11. Operational land holdings (in Kanals)
12. Education (in yrs)

S.No.	Land holding (kanals)	Irrigated	Unirrigated	Total
(i)	Owned			
(ii)	Leased in			
(iii)	Leased out			
(iv)	Total operational land holding (i+ii)-iii			

12. If leased out, sum of money received from the tenant per unit area \_\_\_\_\_

If leased in, sum of money paid to the owner per unit area \_\_\_\_\_

13. Source of irrigation (Canal/Tubewell/Pond)

14. Extension agency contact

How often in a year?

Purpose of contact

1. Agriculture      2. Non agriculture      3. Both

15. Access to credit : Yes/No

1. Source of credit:

2. Amount

16. Do you have ration card Yes/No

17. List the crops cultivated last year

S.No.	Crop	Area (in Kanal)	Production (Kanal)

18. Crops grown for self consumption or sale, if sold, income out it.

Crop	Income (Rs)
1.	
2.	
3.	
4.	

19. What was the yield of vegetable crops during the last year?

Crop	Area in kanal	Quantity

20. Total income from the vegetable crops during the last year?

- (i)
- (ii)

21. Total annual income from agriculture (in Rs):

(a)	Cereal crops	:	
(b)	Vegetable Crops	:	
(c)	Horticulture Crops	:	
(d)	Livestock	:	

Since, how many years have you cultivating vegetable crops? \_\_\_\_\_

## II. Farm Inventories:

S.No.	Equipment	No.	Year of Purchasing	Purchase value (in Rs)	Life(in yrs)	Present value (in Rs.)
1.	Farm Building					
2.	Tractor					
3.	Tube well					
4.	Bullock Cart					
5.	Pump set					
6.	Chaff Cutter					
7.	Plough					
8.	Sprayer/Duster					
9.	Others a. Pickaxe(Gainthi) b. Spade c. Axe d. Plastic crates e. Sceatures					

### III. Livestock

S.No.	Kind of animal	No.	Breed	Age (in yrs)	Owned/Purchased	Month and year of purchase	Purchase value (in Rs.)	Present value (Rs.)	Expected life period (yrs.)
1.	Bullock								
2.	Cow (local)								
3.	Cow (hybrid)								
4.	Buffalo								
5.	Sheep								
6.	Goat								
7.	Poultry								
8.	Others								

### IV. CROPPING INTENSITY AND CROP DIVERSIFICATION

Before water harvesting pond				After water harvesting pond			
Crop /variety	Area (in kanals)	Irrigation (Number)	Production (in quintals)	Crop /variety	Area (in kanals)	Irrigation (Number)	Production (in quintals)

### V. Cost of Cultivation:

#### A. NURSERY RAISING

1. Please give the information regarding nursery raising of vegetable crops cultivated by you.

Crop	Month of sowing	Area sown	Variety sown	Quantity of seed/kanal	Cost of Seed/kanal	Source of seed

2. Did you treat the seed with seed treating chemical before sowing?

Yes/No

3. If yes, please give the following information

Name of seed Treating chemical	Quantity of seed treated	Quantity of seed treating chemical used	Total cost of seed treatment

4. Where from did you get the information about seed treatment? \_\_\_\_\_

5. If no, was the seed already treated? Yes/No

6. If no, what were the constraints for not applying the seed treating chemical?

- a) Lack of technical Knowledge
- b) Unawareness about chemical treatment
- c) Timely availability of chemicals
- d) Any other (please specify)

7. Are there any benefits of seed treatment? Yes/No/Don't Know

S.No.	Name of operation	BITTER GOURD		BOTTLE GOURD		OKRA	
		QTY	COST	QTY	COST	QTY	COST
1.	Area in kanals						
2.	<b>Land preparation</b> 1) Bullock/Tractor 2) Labour a) Owned b) Hired						
3.	<b>Seed/Sowing</b> 1) Variety 2) Source 3) Quantity 4) Cost of seed treatment 5) Method of sowing 6) Labour a) Owned b) Hired						

4.	<b>FYM</b> 1) Quantity used (in qtl.) 2) Labour used a) Owned b) Hired						
5.	<b>Fertilizer</b> 1) Urea Quantity 2) DAP Quantity 3) Potash Quantity 4) Others, if any (Zn/S) 5) Labour a) Owned b) Hired						
6.	<b>Irrigation</b> 1) Number 2) Time 3) Source 4) Labour a) Owned b) Hired						
7.	<b>Intercultural operations</b> 1) Nos and times of hoeing 2) By machine/chemical 3) Labour a) Owned b) Hired						
8.	<b>Weed Control</b> 1) Weedicide used 2) Quantity 3) Cost of hiring sprayer etc 4) Labour used a) Owned						

	b) Hired						
<b>9.</b>	<b>Pest &amp; Disease control</b>  1) Fungicide/Pesticide used 2) Quantity 3) Labour a) Owned b) Hired						
<b>10.</b>	<b>Harvesting(Labour)</b>						
<b>11.</b>	<b>Transportation</b>  1) Bullock cart/Tractor Trolley						
<b>12.</b>	<b>Land rent</b>						
<b>13.</b>	Production  1) Main crop 2) By product						

Note: 1.Wage rate/day:

Male (₹/day)

Female (₹/day)

2. Bullock labour/day:

3. Machine Rate/day/hour

## VI. FARM POND DETAILS

1.	Year of construction	
2.	Size of pond	
3.	Storage capacity	
4.	Area covered (for irrigation)	
5.	Construction material	
6.	Life of pond	

7.	Water utilization method	
	a) Earthen channel	
	b) Piped- gravity flow	
	c) Piped- motorized pump	
	d) Manually	
	e) Others (specify)	
8.	Water extracted application mechanism	
	a) Flooding	
	b) Sprinkler	
	c) Drip	
	d) Others (Specify)	

9. Costs

a. Initial investement

b. Mainatenance Cost

Years	Maintenance cost
1.	
2.	
3.	
4.	

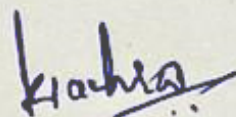
**VII. PROBLEMS FACED BY FARMERS IN PRACTICING RAIN WATER HARVESTING THROUGH FARM PONDS**

S.No.	Problems	Always	Sometimes	Never
1.	Evaporation and seepage losses			
2.	Water application equipment			
3.	Inadequacy of pond size			

4.	Wear and tear of pond liner			
5.	Other maintenance like removal of weeds and silt, etc.			
6.	Damage of structure due to heavy rainfall			
7.	Lack of information			
8.	Land constraints			
9.	Expensive			
10.	Not interested			
11.	Others (specify)			

## CERTIFICATE-IV

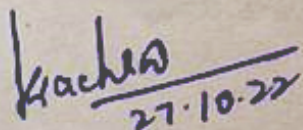
Certified that all the necessary corrections as suggested by the external examiner and the Advisory Committee have been duly incorporated in the thesis entitled "Economic Analysis of Summer Vegetable Crops through Rain Water Harvesting Structures in Rainfed Areas of Jammu District" submitted by Ms. Arushi Sharma, Registration No. J-20-M-711.



**Dr. Jyoti Kachroo**  
**Major Advisor &**  
**Chairman Advisory Committee**

Place: Jammu

Date: 27.10.22



27.10.22

Head

(Division of Agricultural Economics and ABM)

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