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Improving Water Use Efficiency in India's Agriculture: The Impact, Benefits and Challenges of Micro-Irrigation under the Pradhan Mantri Krishi Sinchayee Yojana - Per Drop More Crop (PMKSY-PDMC) in Madhya Pradesh

AGRO- ECONOMIC RESEARCH CENTRE
Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur (M.P.) 482004

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Jabalpur (M.P.) 482004

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PROJECT TEAM

Data Collection & Tabulation of Data

Mr. Satyendra S. Thakur
Mr. Prem R. Pandey
Mr. Rajendra S. Bareliya
Mr. Akhilesh Kuril
Mr. Pradeep K. Patidar

Interpretation and Report Writing

Dr. Hari Om Sharma
Dr. Deepak Rathi
Mr. Rajendra S. Bareliya
Mr. Pradeep K. Patidar

Coordinator

Centre for Management in Agriculture,
Indian Institute of Management Ahmedabad, Gujarat

AGRO- ECONOMIC RESEARCH CENTRE
FOR MADHYA PRADESH AND CHHATTISGARH

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.)

PREFACE

The present study entitled "Improving Water Use Efficiency in India's Agriculture: The Impact, Benefits and Challenges of Micro-Irrigation under the Pradhan Mantri Krishi Sinchayee Yojana - Per Drop More Crop (PMKSY-PDMC) in Madhya Pradesh" was assigned by the Directorate of Economics and Statistics Ministry of Agriculture Government of India to this centre in the year2017-18 under the close coordination of Centre for Management in Agriculture, Indian Institute of Management, Ahmadabad, Gujarat.

The study comprises 96 beneficiaries and 24 non-beneficiaries respondents of PMKSY-PDMC of Dhar & Sagor districts of Madhya Pradesh. The impact of PMKSY-PDMC was found to be positive on water conservation, participation of women, upper caste, lower caste, rural youth, upland and low land farmers with improvement of overall environment in the area under study through optimal utilization of scare and limited water and land resources, fertigation and water use efficiency of farmers field.

On behalf of the Centre, I express deep sense of gratitude to Prof. P.K.Bisen, Hon'ble Vice-Chancellor and Chairman, Advisory Body of AERC, Jabalpur, Anil Sharma, Adviser, AER Division, Ministry of Agriculture and Farmers' Welfare, Govt. of India, New Delhi, Dr. D. Khare, Dean, Faculty of Agriculture, Dr. P.K.Mishra, Director Research Services, Dr. (Smt.) Om Gupta, Director Extension Services and Dr. R.M.Sahu, Dean, College of Agriculture/Prof. & Head (Dept. of Agril. Econ.&F.M.), Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur for providing the valuable guidance and all facilities during various stages in successful completion of this study of high importance.

I extend heartfelt thanks to Dr. Vasant P. Gandhi Professor and Nicky Johnson, Research Associate, Centre for Management in Agriculture, Indian Institute of Management, Ahmadabad, Gujarat for coordination and providing valuable guidelines and time to time suggestions for conducting the study successfully.

The present study was conducted by Dr. H. O. Sharma, Dr. Deepak Rathi and Mr. P. Patidar of this centre. The field investigation, tabulation, analysis, interpretation and drafting of the report were performed by them. I wish to express my deep sense of gratitude to team members namely; Dr. H.K. Niranjan, Mr. S. K. Upadhye, Mr. S. S. Thakur, Mr. R. P. Pandey, Mr. R. S. Bareliya and Mr. Akhilesh Kuril for their untiring efforts in bringing this innovative study to its perfect shape.

I express sincere thanks to Shri Ramlal Jhamre and Shri A. K. Nema, Deputy Director of Agriculture, of Dhar and Sagor districts respectively and their field staff for providing not only secondary data but also extending great assistance in collection of primary data from the selected respondents.

I hope the findings and suggestions made in the study would be useful to policy makers of the State and Govt. of India.

Date : 23.10.2020
Place: Jabalpur

(Hari Om Sharma)
Prof. & Director

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ACRONYMS

MP	-	Madhya Pradesh
PMKSY	-	Pradhan Mantri Krishi Sichai Yojana
PDMC	-	Per Drop More Crop
MI	-	Micro Irrigation
et.al	-	and others
Rs.	-	Rupees
ha.	-	Hectare
GCA	-	Gross Cropped Area
△	-	Change
AAGR	-	Annual Average Growth Rate

EXECUTIVE SUMMARY

Micro-irrigation refers to the slow application of water on, above or below the soil by surface drip, subsurface drip, bubbler, and micro-sprinkler systems. Water is applied as discrete or continuous drips, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line adjacent to the plant row. Micro-irrigation is proved to be an efficient method in water saving, projected additional returns from saved water should also be considered as compared to conventional surface method of irrigation. The Ministry of Agriculture and Farmers Welfare, Government of India, has launched the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) to address India's key agricultural challenges in the 21st century i.e., to reduce poverty and ensure food security for the growing population in the face of climate change, scarce and limited water and land resources. This initiative proposes to provide irrigation to every farm in the country (Har Khet Ko Pani) and improve water use efficiency (Per Drop More Crop and Income). It aims to bring together various schemes and programs for water harvesting, conservation and efficient management in order to ensure there is enough water for agriculture. The Per Drop More Crop component of PMKSY mainly focuses on water use efficiency at farm level through Precision/ Micro Irrigation (MI) (Drip and Sprinkler Irrigation). How for this particular component of PMKSY-PDMC successful in Madhya Pradesh? To know the answer of this question this particular study has been taken under the following objectives.

1. To examine the savings of various inputs such as water, fertilizers, power, pesticides and labour.
2. To examine the enhancement of productivity, quality and other benefits in selected agriculture/ horticulture crops.
3. To examine the adoption of MI including some of its determinants/ features such as need/ importance of subsidy, culture of water conservation, issues of fragmented land holdings, capital cost, maintenance cost and the distribution of subsidy.
4. To study overall impact of MI on farmer's income.
5. To identify any issues/problems in the benefit transfer work flow and monitoring by the implementing agency.

Both primary and secondary data were collected for study. The primary data were collected from the adopter and non adopter farmers of micro irrigation on various aspects. The primary data collected from the sample respondents for the in agricultural year 2019-20. The secondary data were collected from PMKSY website (https://pmksy.gov.in/), officers of the department of Farmer Welfare and Agriculture Development Department,

Madhya Pradesh and Commissioner Land Record & Settlement, Government of Madhya Pradesh for the period from 2015 to 2018. A multi stage stratified random sampling method used for selection of districts, blocks, villages and respondents. In first stage, the districts were selected based on higher irrigated area under different system of micro irrigation, and among all districts of Madhya Pradesh, Dhar district was selected for drip irrigation system and Sagar district was selected for sprinkler irrigation system. In the second stage from the each selected districts, two blocks having maximum area under micro irrigation namely Badnawar and Manawar were selected in Dhar district and Khurai and Deori blocks were selected from Sagar district. In third stage 3 villages in each selected blocks were selected randomly from the list of micro irrigation villages. Thus, Bakhatpura, Tilgara & Jabada and Ajanda, Mandwi & Pipriman villages were selected respectively from Badnawar and Manawar blocks of Dhar district and Silpari, Billaiya, & Khajarhar Chandra and Kushmi, Sisnghpur ganjan & Kaurasa villages were selected in Khurai and Deori blocks respectively from Sagar district for the study. In the fourth stage, a list of all the adopters and non- adopters in the selected villages prepared and 8 adopters and 2 non- adopters from each villages were selected constituting 96 adopters and 24 non-adopters from both districts (48 adopters and 12 non-adopters from each district) were selected for the study. Thus, the total size of sample was 120 farmers. The selection of crops was also done on the basis of higher area under drip and sprinkler irrigation used in the in cultivation of crops under selected districts were selected for the study. Hence, chilli & ginger and wheat crops have been selected under drip and sprinkler system of micro irrigation respectively for the study. Suitable statistical tools were used to drawn conclusion.

1. Major Findings

The major findings related to adoption of micro irrigation, socio-economic status of adopter and non-adopter, impact of micro irrigation and challenges of micro irrigation are given in this sub-heads

a) Adoption of Micro Irrigation

- Madhya Pradesh is found to be a leading state with respect to micro irrigated area under PDMC with total micro irrigation area of 39758 hectares, which was 0.31 percent of gross irrigated area of Madhya Pradesh (2018). Dhar was found to be a leading district under micro irrigation having 17.96 percent of micro irrigated area to total micro irrigated area of the state. The area under Micro Irrigation was found to vary between 2.10 (Dindori) to 5946 (Dhar) ha. except Rewa. All the districts were found to have area under micro irrigation with the state (total of 39758.77 ha). The percent MI to total irrigated area of district was found to be maximum in Anupur (14.15%)

followed by Shahdol (3.27%), Umaria (3.04%) ,Burhanpur and Alirajpur (2.97% each), Sidhi (1.56%) ,Dhar (1.33%), Jhabua (1.18%), Singrouli (1.03%) while other districts were found to have less than 1 percent area under micro irrigation to total irrigated area of districts, while in state it was found to be 0.31 percent. This indicates that the area under MI to total irrigated area of district was found to be more in western part followed by eastern and southern part of the state.

b) Socio-economic status of the respondents

- The area under drip irrigation system was found to be maximum in case of large (1.59 ha) followed by medium (1.40 ha), small (.35 ha) and marginal (0.14 ha) categories. The area under sprinkler irrigation system was also found to be maximum in case of large (8.77 ha) followed by medium (1.71 ha), small (1.03 ha) and marginal (0.62 ha) categories of adopters.
- Out of 96 adopters, maximum were found to use well (28.13%) followed by tube well & well (26.04%), tube well (15.63%), tube well & river (9.38%), tube well & check dam (4.17%), well & river lift (4.17%), and canal (4.17%), well & check dam (3.13%), check dam (2.08 %) and tube well & pond (1.04%), well & pond (1.04%) and pond (1.04%).
- The maximum number of adopter reported that their area was covered by heavy soil (45.83%) followed by low (40.63%) and medium (13.53%) soil. None of the adopter was found to operate light, average and very low type of soil for crop husbandry. The majority of area was found to be flat type (85.42%) followed by up & down (11.46%) and hilly terrain (3.13 %). The maximum number of adopters (39.58%) adopted micro –irrigation in the last year (2018-19) followed by 2017-18 (32.29%), 2016-17 (25%), 2014-15 (2.08%) and current year 2019-20 (1.04%). Only 2 per cent adopters were started micro irrigation before 2016 on their farm in the area under study.
- All the respondents availed subsidy to purchase micro irrigation equipments and assets on their farms. The cent per cent adopters got subsidy for purchase of micro-irrigation system.
- An average adopter was found to allocate his 47.91 and 44.11 per cent of GCA in kharif and rabi season, respectively. He was found to use his maximum kharif area in cultivation of soybean (35%) followed by cotton (16%), urad (13%), paddy (4%), chilli (6%), ginger (5%) and other kharif vegetables (21%). Wheat was found to be a major rabi crop grown by an average adopter and allocated 39 per cent cultivated area of rabi season. Chickpea (30%), lentil (3%), other rabi (6%), winter vegetables (22%) were other major crops of rabi season cultivated by an average adopter in study area. An average adopter was also found to allocate is 7.66 per cent of GCA in cultivation of perennial crops.

c) Impact of micro irrigation

- An average adopter was found to investe Rs. 178645.83 and Rs. 31932.56 in installment of drip and sprinkler micro irrigation system, respectively, in their fields for crop production. The owned capital and subsidy were found to be 41.91 and 58.09 per cent in case of drip irrigation system/kit, while 61.58 and 38.52 per cent in case of sprinkler irrigation system kit, respectively in total funds invested. An average adopters share of owned fund and subsidy was found to be 50-50 percent in the area under study. An average adopter was found to be investe Rs. 6877 in maintenance of MI, out of which maximum cost was found to be incurred in filter (35.41%) followed by pipes (24.17%), other maintenance charges (19.30%) and valves (9.49%). None of the adopters was found to loan as a source of funds for annual replacement and maintenance cost of micro-irrigation in the area under study.
- The irrigation system Ltd. (26.04%), Pragati irrigation system Pvt. Ltd.(16.67%) and Netafim Pvt. Ltd. (13.54%) were found to be major companies involved in installation of Micro-irrigation set/kit as reported by the maximum number of adopters.
- As regards to micro irrigation in kharif season, the maximum area was found to be irrigated through drip irrigation in case of chilli (0.92ha) followed by ginger (0.56 ha) and cotton (0.51ha). As regards to micro-irrigation an average adopter was found to allocate his more rabi area in sprinkler as compared to drip. He was found to use sprinkler in wheat, chickpea, lentil and other rabi crops in 1.62, 1.12, 0.53 and 0.22 ha of cultivated land, while drip irrigation was found to be used only in chickpea (0.19ha) and other rabi crop (0.17ha) only.
- The maximum fertigation was found in 95.46 per cent in ginger followed by chilli (85.60%) and cotton (41.49%). While overall fertigation in other kharif crops was found to be 70.27 per cent. The fertigation was found to be practiced in 13.33 per cent area of chick pea, 51.37 in lemon and 26.33 per cent in other rabi crops.
- More than 20 per cent adopter of micro irrigation reported that their area under cotton, chilli, ginger, wheat, chickpea, other kharif crops, other rabi crops and perennial crops (lemon) was found to be increased which range between increase to large increase after introduction of micro irrigation in their farms.
- More than 50 per cent adopters reported that after of adoption micro irrigation facilities on their farm the yield of all the crops. viz. soybean, cotton, chilli, ginger, wheat, chickpea other kharif crops, other rabi crop, perennial crop including lemon was found to be increased and ranged between increased to large increase in the area under study. None of adopters reported

that the yield of any crop was decreased to large decrease after adoption of micro irrigation facilities on their farms.

- After adoption of MI facilities the production of all major crops of an average adopters was found to be increased by 33.91 per cent from 96 (without MI) to 129 q/ha (with MI) in the area under study. His total sale value of the product (gross return) was also found to be increased by 98.96 per cent from Rs. 245664 (without MI) to 488781/ha (with MI), while price of the product was increased by 48.03 per cent only after adoption of MI facilities in his farm.
- After adoption of MI facilities all the expenditures on cultivation of all major crops was found to be increased i.e. seeds/plants cost (129.44 %), fertilizer cost (44.08%) FYM/organic manure (35.79%), pesticide cost (47.46%), other stacking cost (44.98%), farm power/equipment cost (59.37%), labour cost (36.41%) and marketing cost (44.31%) except cost of irrigation (-37.56%) in an average beneficiary's farm. This might be due to after adoption of micro irrigation facilities the beneficiaries came across in close contact with technical and scientific personals and could be able to start adopting improving technology for cultivation of the crops, adopt improved verities of seed, superior quality of pesticide, micro nutrient with fertilizer, fertigation etc. with more focus and intensive surveillance with higher interest in producing quality products. Further, assured irrigation during crop growth period encouraged adopters to invest in superior quality of inputs in cultivation of crops without hesitation. The per rupee return over the expenditure of Rs. 1.00 was found to be increased 17.33 per cent from Rs. 2.40 (without MI) to 2.82 (with MI) after adoption of MI technology on an average adopters farm. The cost of production was found to be increased by 25.72 per cent from Rs. 1069 (without MI) to 1344 Rs./q (with MI) in the area under study.
- More than 60 per cent of adopter were agreed and strongly agreed that output/yield of crops was increased by 98.96 per cent after introduction of micro irrigation increases with reduced use of water (97.92%), fertigation and problem of weeds (71.88%) on their fields. The majority of respondents partially disagree with the statement that micro irrigation reduces pest problem/pesticide used (63.54%).
- More than 40 per cent adopter were agreed and strongly agreed with micro irrigation facilities raised output quality (72.92%), profitability/income (78.12%) and reduces input use & cost of input (42.71%).
- More than 45 per cent of adopters were agreed and strongly agreed upon

information of micro irrigation is easily available(77.09%), technology of micro irrigation understandable and operational (82.29%), proper financial facilities, supply of electricity in available and reliable and water supply in sufficient (78.13%) for adoption of micro irrigation facilities on their farm. The 44.79 per cent adopters partially agree, while 37.50 per cent were strongly agree on easily available subsidy for micro- irrigation.

- More than 60 per cent adopters were found to be agree and strongly agree with the statement that supply of micro irrigation equipment is sufficient as there were found to be large number of companies for the supply of micro-irrigation equipments (68.75%) and the quality of these equipments also good (60.42%).
- The majority of respondents were agree and partially agree with the distribution of micro irrigation facilities as there are large number of dealers located nearby (59.37%), dealer provide good quality products(68.75%), and charge reasonable price (56.25%) and also arranged subsidy/credit (84.37%) and provides after sale services (61.46%) for micro irrigation equipments.
- The majority of adopters were agree with high cost of wells and tube-wells (57.29%), while around 45 percent respondents were found to be agree with the problem such as poor quality of micro-irrigation equipment difficulty in obtaining government subsidy and support, poor after sale services from dealer of micro-irrigation equipments, high cost of maintaining of micro-irrigation and lack of credit facilities around (35%) poor market arrangement (36.46%) and land fragmentation (33.33%).

d) Challenges of micro irrigation

- More than 50% of adopters agreed and strongly agreed with the problem of poor quality of micro irrigation equipment, high need/cost of maintenance of micro irrigation equipments, difficulty in obtaining govt. subsidies and support, high cost of well and tube-well, poor after sell services by the dealer, poor marketing arrangement, fragmentation of land, lack of fencing & damage of micro irrigation system by animals, not enough information about micro irrigation is available (41.67%), lack of micro-irrigation equipment's in the market (45.83%), high investment cost of micro-irrigation kit (41.67%) credit for micro-irrigation was not available (25%), and high operating cost of micro-irrigation (20.83%). The majority of them disagree and strongly disagree with the problem of inadequate water, poor quality of water, unreliable electric supply and lack of govt. support. They were partial agree and

disagree with the statements like water table doing down fast, lack of micro irrigation dealers and low output price and profitability.

e) Overall impact of micro irrigation

- The overall impact of micro-irrigation was found to be positive in the area under study as none of the adopters reported that the impact of micro-irrigation was negative and substantially negative. Micro-irrigation gave positive impact on village, water conservation, women, upper caste, lower caste, rural youth & farmers and upland & low land farmers with improvement of overall environment of villages in the area under study.

2 Conclusion and Policy Implication

It can be concluded from the above findings that:

- Madhya Pradesh is one of the leading state in successfully introduction of micro irrigation facilities at farmers' field under PMKSY - PDMC in all most all the districts to ensure food security for the growing population in the face of climatic change, scare and limited water & land resources and to provide irrigation to every farm through improvement of water use efficiency. Government of Madhya Pradesh done excellent efforts in creating MI facilities through providing subsidy, equipments, technical knowledge etc. to beneficiaries under the programme. Although, farmers of Anuppur, Shahdol, Umaria, Burhanpur, Alirajpur, Sidhi, Dhar, Jhabua and Singroli were found to be benefitted more than rest of the districts. Hence, efforts should be made in such a way that across districts of the State will be benefitted by such an excellent programme of the Govt. of India.
- After adoption on MI facilities in cultivation of crops, the expenditure on cost of irrigation was found to be decreased by 37.56 per cent after adoption MI facilities due to improvement in quality of output. Although, the expenditure of all the other items viz. seed, fertilizer, manures, pesticides, labour etc. were found to be increased but the per rupee return on investment of Re. 1.00 increased by 17.77 per cent from Rs. 2.40 to 2.82 after adoption of MI technology in the farms. It is also clear from the finding that introduction of MI facilities in adopters fields capital intensive which raised profitability, income of adopters.
- It is easy to adopt MI facilities by adopters as information on micro irrigation is easily available to the fallow farmers, it is understandable and operational, with proper financial facilities with supply of electricity, reliable water supply and sufficient micro irrigation equipment. A large number of dealers also located nearby & charges reasonable price & provide after

sale services with quality MI equipment in the area under study.

- The major problems faced by adopters of MI facilities in the area under study as reported by majority of adopters were high cost of wells and tube wells, difficulty in obtaining Govt. subsidy and support, high cost of maintenance of MI equipment, non-availability of loan for maintenance of MI equipment's poor marketing arrangement, fragmentation of land, lack of fencing and damage of MI system by animals.
- MI facilities are advantageous for higher yield, better quality of products, high output price, less water, labour, fertilizer etc. need, easy marketing of out- put, less risk/ uncertainty at provide employment for youths and others.
- After adoption of micro irrigation by the adopters they sifted from low value to high value crops, thereby change in cropping pattern of the area. This calls for building a new market infrastructure including efficient cold, supply and value chain management, farm get level processing and bringing institutional reform in place for establishing efficient economic environment in the area under study. Which not only ensure remunerative prices for farming communities but also provide nonfarm employment avenues for youth in a big way.
- The impact of PMKSY-PDMC was found to be positive on water conservation, participation of women, upper caste, lower caste, rural youth, upland and low land farmers with improvement of overall environment in the area under study through optimal utilization of scare and limited water and land resources, fertigation and water use efficiency of farmers field. Hence, overall impact of PMKSY, PDMC is found to be positive in case of water conservation and overall environment of the village. Efforts should be made to promote MI in all the districts of the State with proper awareness of programme. Efforts should also be made to lower down the price of MI equipment's in order to reduce the subsidy in a gradual manner for the horizontal expansion of the technology on large scale, provision/ support for farm fencing, easier process getting subsidy/Govt assistance for latest and improved MI technology/ equipment's and better training for MI for the farmers is required for betterment of programme as majority of the adopters strongly agreed to expand the use of MI in future course of action.

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CHAPTER - I

INTRODUCTION

1.1 Background

Water scarcity is an abstract concept to many and a stark reality for others. It is the result of myriad environmental, political, economic, and social forces. Due to geography, climate, engineering, regulation, and competition for resources, some regions seem relatively flush with freshwater, while others face drought and debilitating pollution. In much of the developing world, clean water is either hard to come by or a commodity that requires laborious work or significant currency to obtain. Freshwater makes up a very small fraction of all water on the planet. While nearly 70 per cent of the world is covered by water, only 2.5 per cent of it is fresh. The rest is saline and ocean-based. Even then, just 1 per cent of fresh water is easily accessible, with much of it trapped in glaciers and snowfields. In essence, only 0.007 per cent of the planet's water is available to fuel and feed is its 6.8 billion people.

Water is considered to be a scarce resource in Indian agriculture. Agriculture is the largest water user consuming about 83% of the total available water. Increasing demand for industrial and domestic water will result in reduction in water diversion to agriculture (Bhowmik et al, 2018). The surface methods of irrigation causes uneven distribution of water, water loss in the form of seepage and deep percolation, promotes excessive weed growth besides creating salinization, water logging thus, affect the land and crop productivity (Shankar et al, 2015). In India, both surface and ground water are dependent on the monsoon. More than 85% of ground water is used for irrigation. Thus, surface water and ground water irrigated agriculture suffers from the vagaries of monsoon. In world, India has the second largest net irrigated area after China. The irrigation efficiency under canal irrigation is not more than 40% and for ground water schemes, it is 69%. The net irrigated area in the country is about 61 m ha, which is about 43% of the total sown area (Ashoka et al, 2015). It is reported that in the next three decades, the global food systems will need 40-50 per cent more fresh water than today. Municipal and industrial demand for water will increase by 50-70 per cent during this period, while demand for energy sector will increase by 85 per cent. India faces high water stress and the country is

amongst those with the most fragile and uncertain water resources in the world (Tripathi et al, 2019). It is projected that availability of water for agricultural use in India may be reduced by 21% by 2020-25, resulting in reduction in productivity of irrigated crops there by production, especially rice, thus price rise and non accessibility of food for poor masses.

Irrigation is a major determinant of agricultural productivity. Indian agriculture has been constrained by limited irrigation and only about 40.6% of arable land is irrigated. The remaining 60% continues to depend on rainfall. The irrigation and rainfed cultivation cleavage is a major influence on agricultural productivity, earning opportunities, and the welfare of the rural population (CAPE India, 2016). Efficient use of available irrigation water is essential for increasing agricultural productivity for the alarming Indian population because the population of India is increasing day by day, the pressure on agriculture is increasing in the same way. Thus, only solution will be enhancing the micro irrigation facilitates for Indian agriculture.

Micro-irrigation refers to the slow application of water on, above or below the soil by surface drip, subsurface drip, bubbler, and micro-sprinkler systems. Water is applied as discrete or continuous drips, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line adjacent to the plant row (Rao and Anitha, 2015). Micro-irrigation is proved to be an efficient method in water saving, projected additional returns from saved water should also be considered as compared to conventional surface method of irrigation. It is necessary to further evaluate and confirm the best system for local producers that will result in the highest profits so that repayment of irrigation investment loans can be achieved (Suryavanshi and Buttar, 2016).

Drip irrigation is an irrigation method that saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. It is done through narrow tubes that deliver water directly to the base of the plant (Ram kumar et al, 2016). Adoption of drip irrigation is one of the most efficient methods of scheduling of irrigation having more than 90 percent irrigation efficiency. As water is applied very frequently and uniformly, usually there is no moisture stress in crop root zone and it

results into 25 to 30 per cent increase in crop yield as compared to surface irrigated crop (Tasal and pawar 2013). Drip irrigation is most suitable for row crops (vegetables, soft fruit), tree and vine crops where one or more emitters can be provided for each plant. Drip irrigation is adaptable to any farmable slope and most soils (Verma and Sharma, 2017). Drip method of irrigation helps to reduce the over-exploitation of groundwater that partly occurs because of inefficient use of water under surface method of irrigation. Water logging and salinity are also completely absent under drip method of irrigation (Kumar et al, 2017).

Sprinkler irrigation is an advanced irrigation technique for water-saving and fertigation and accurately controlling irrigation time and water amount. Study on winter wheat showed that crop yield and water use efficiency in sprinkler-irrigated fields was higher than that in surface irrigated fields. Sprinkler irrigation resulted in crop transpiration reduction by more than 50% during irrigation process (Ramadan Eid et al, 2014). Superiority of drip irrigation or micro-sprinkler irrigation over traditional irrigation methods in terms of yield and water saving, economics is well established for most of the crops (Rao et al, 2014). The successful adoption of MI requires, in addition to technical and economic efficiency, two additional preconditions, viz, technical knowledge about the technologies and accessibility of technologies through institutional support systems (Palanisami et al, 2014). Micro-irrigation technologies are believed to be one of such innovative intervention approaches. Originally, micro-irrigation was often associated with the capital intensive, commercial farms of wealthier farmers. The systems used on large farms, however, are unaffordable for smallholders and are not available in sizes suitable for small plots. Recently, these technologies have gone through technical transformations from largely sophisticated and capital-intensive features to an almost input mode (Namara et al, 2007).

The Ministry of Agriculture and Farmers Welfare, Government of India, has launched the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) to address India's key agricultural challenges in the 21st century i.e., to reduce poverty and ensure food security for the growing population in the face of climate change, scarce and limited water and land resources. This initiative proposes to provide irrigation to every farm in the country (Har

Khet Ko Pani) and improve water use efficiency (Per Drop More Crop and Income). It aims to bring together various schemes and programs for water harvesting, conservation and efficient management in order to ensure there is enough water for agriculture (Anonymous, 2016).

PMKSY has been formulated to promote micro irrigation facilities at farmer's field it amalgamating ongoing schemes viz. Accelerated irrigation Benefit programme (AIBP) of the Ministry of Water Resources, River development & Ganga Rejuvenation (MoWR, RD&GR), Integrated watershed Development Programme (IWMP) of Department of Land Resources (DoLR) and the on Farm Water Management (OFWM) of Department Of Agriculture and Cooperation (DAC).

The Per Drop More Crop component of PMKSY mainly focuses on water use efficiency at farm level through Precision/ Micro Irrigation (MI) (Drip and Sprinkler Irrigation). PDMC-PMKSY, has put great emphasis on micro-irrigation technologies (drip and sprinklers), and wherein an area of 690 m ha is proposed to be brought under micro irrigation in India for achieving the target of "Har Khet Ko Paani", but the scheme looks to have hit the roadblock due to poor response to such initiatives from small and marginal farmers, who constitutes majority of workforce in agriculture (Spehia and Verma, 2019).

At present, area under micro-irrigation is only 11.41 million hectare which is dismal compared to large rain fed area in India. The top all among States in India for area under micro-irrigation are Rajasthan (21.80%), Maharashtra (16.45%), Andhra Pradesh (15.05%), Karnataka (10.96%) and Gujarat (10.73%), Haryana (7.42%), Madhya Pradesh (4.56%), Tamilnadu (4.15%), Chattisgarh (3.12%) and Bihar (1.32%).

The micro irrigated area under PMKSY in the country was found to be increased from 0.55 to 1.18 mha. Out of which area under drip and sprinkler was found to be increased from 0.35 to 0.63 and 0.20 to 0.56 mha, respectively during the year 2015-16 and 2019-20.

In Madhya Pradesh, micro irrigated area under PMKSY was found to be 0.21 m ha with 0.15 m ha and 0.06 m ha under drip and sprinkler irrigated, respectively during the year 2015-20. Madhya Pradesh occupied 4.35 per cent area under micro irrigation, out of which 5.90 and 2.53 per cent area was found to be under drip and sprinkler, respectively in the Country.

The water has became precious input for cultivation of crops now-a-days, the planning of forms depend on this, with its limited availability and accessibility, it is going to become most critical input in the year to come looking to its tremendous importance, how for this particular components PMKSY- PDMC is successful in Madhya Pradesh ?. This particular study was under taken with the following specific objectives.

1.2 Objectives

(a) To examine the savings of various inputs such as water, fertilizers, power, pesticides and labour.

(b) To examine the enhancement of productivity, quality and other benefits in selected agriculture/ horticulture.

(c) To examine the adoption of MI including some of its determinants/ features such as need/ importance of subsidy, culture of water conservation, issues of fragmented land holdings, capital cost, maintenance cost and the distribution of subsidy.

(d) To study overall impact on farmer's income and the cost-benefit selected of major MI crops viz. Wheat, Green Chilli and Ginger.

(e) To identify any issues/problems in the benefit transfer work flow and monitoring by the implementing agency.

1.3 Limitation of the Study

The present study is based on primary as well as secondary data. The study pertains to the primary data collected for the agricultural year, 2019-20. Moreover, adopters and non-adopter provided information based on their recall memory. However, there is a possibility of certain memory bias may enter in the considerable care required to be taken while generalizing the acceptability of the results of this study.

1.4 Organization of the Study

The study is organized into five chapters, Chapter I covered Introduction of the study its cover background, objectives and limitation. Overview of Madhya Pradesh is given in Chapter-II, the chapter highlighted demographic features, working population, agro climatic zone of madhya pradesh, soil and climate, operational holdings, land use pattern, cropping pattern, source wise irrigated area, growth of micro irrigation in the State, Ddct wise MI Area in Madhya Pradesh. Sampling, sample profile and Methodology were dealt in

Chapter III, Profile of Sample Respondents deals in Chapter IV, Impact of Micro Irrigation in Madhya Pradesh is described in Chapter V, Challenges of Micro Irrigation were dealt in Chapter VI. Impact of irrigation in Madhya Pradesh is presented in Chapter VII. Major findings and conclusion and policy implication of the study are given in Chapter VIII.

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CHAPTER - II

OVERVIEW OF AGRICULTURE IN MADHYA PRADESH

This chapter deals with the description of the Madhya Pradesh, which includes demographic features, working population, agro climatic zones, soil & climate, operational holding, land use pattern, cropping pattern and source wise irrigation along with growth of micro irrigation, district and crop wise adoption of micro irrigation in the State.

2.1 Description of Madhya Pradesh

Demographic features, working population, agro climatic zone of madhya pradesh, soil and climate, operational holdings, land use pattern, cropping pattern, source wise irrigated area, market structure in Madhya Pradesh and storage facilities of Madhya Pradesh are described in this sub- head.

2.1.1 Demographic Features

Madhya Pradesh lies between latitude 21^{0}50' to 26^{0}88'N and longitude 74^{0}03' to 82^{0}90'E and situated 1350 meters from MSL covering 308252 sq km area with population of 726.30 lakh with a density of 236 person/km and sex ratio of 931 female over 1000 male. The total working population cultivators and agricultural labours to total population were found to be 43.47, 31.18 and 38.61 per cent, respectively in the state (Table 2 .1).

Madhya Pradesh has 10 commissionaire divisions (Chambal, Gwalior, Bhopal, Ujjain, Indore, Sagar, Rewa, Jabalpur, Hosangabad (Narmadapurum) & Shahdol and divided into 51

Table 2.1: Demographic features of Madhya Pradesh

Particulars	Madhya Pradesh
Geographical Situation	
Latitude	21^{0}5' to 26^{0}88'N
Longitude	74^{0}03' to 82^{0}90' E
Mean sea level (Meter)	1350
Rainfall (mm)	949.1
Area (Lakh ha)	307.59
Population Indicators (% to Total Population)	
Population (Lakh)	726.3
Male	51.79
Female	48.21
SC	15.62
ST	21.09
Urbanization Population (%)	21.09
Density /km	236
Literacy (%)	69.32
Sex Ratio (per 1000)	931
Total workers (% to Total Population)	43.47
Cultivators (% to Total Workers)	31.18
Agriculture Labour (% to Total Workers)	38.61

Source: Census, 2011

districts, 342 Tehsils, 313 blocks ,376 towns and 54,903 villages (Table 2.2) .

It is abundantly rich in minerals and bio resource with 27 per cent of land area under forests; it supports a wide variety of animal and plant life.

Table 2.2: Location of Madhya Pradesh

S. No.	Particulars	Number
1	Number of Divisions	10
2	Number of Tehsils	412
3	Number of Blocks	313
4	Number of Villages	54903
5	No. of districts	52
6	No. of Gram Panchayat	23043
7	No. of electrified Village	35910
8	Percentage of electrified village to total villages	65.41

Source: Department of Public Relation, Government of Madhya Pradesh

2.1.2 Working Population

The total workers population of the state was 43.47 per cent out of total population (72626809) with 53.56 and 32.64 per cent of male (37612306) and female (35014503) population respectively. The majority of the population engaged as agricultural labourers (38.61%) followed by cultivators (31.8%), other workers (27.17%) and workers in household industries (3.04%) The majority of male population was engaged as other worker (33.43%) followed by cultivators (32.71%), agricultural labourers (31.31%) and workers in household industries (2.54%), while, more than half female population were engaged as agricultural labourer followed by cultivators (28.47%), other worker (16.14%) and workers in household industries (3.92%) (Table 2.3).

Table 2.3: Composition working population in Madhya Pradesh

Particulars	Total Population	Total Workers (Main and Marginal)	Cultivators	Agricultural Labourers	Workers in Household Industry	Other Workers
Total	72626809	31574133 (43.47)	9844439 (38.61)	12192267 (38.61)	959259 (3.04)	8578168 (27.17)
Male	37612306	20146970 (53.56)	6591064 (32.71)	6310657 (31.32)	511048 (2.54)	6734201 (33.43)
Female	35014503	11427163 (32.64)	3253375 (28.47)	5881610 (51.47)	448211 (3.92)	1843967 (16.14)

Source: Census, 2011

2.1.3 Agro Climatic Zone of Madhya Pradesh

The state fall under catchment of Yamuna, Ganga, Narmada, Mahanadi and Godavari rivers. On the basis of broad land features and different soil and rain fall pattern, the State classified in 5 physiographic regions and 11 agro-climatic zones (Table 2.4)

1. Northern low lying plains comprising Gwalior, Bhind and Morena districts and extend to Bundelkhand up to the west of Panna range and excludes certain parts of Rewa district between Panna and Kaymore hills of Bundelkhand.
2. The Malwa and Vindhha Plateu comprises of Vidisha, Shivpuri, Datia, Guna, Ujjain and Mandsour districts and parts of Sehore, Raisen and Dewas districts. It consists of large undulating plains of black cotton soil dotted with flat-topped hills. It has also hilly Vindhyan Plateau situated in the north of Narmada Valley and to the south of the low-lying regions of Bundelkhand and Baghelkhand. It spared from east to Malwa plateau to Maikal and Dorea hills of Satpura range.
3. The Narmada Valley stretching from Jabalpur in the east up to Barwani district in the west. It is nearly 560 km long and 48 Km wide and is walled on the north by the Vindhya Range and on the south by Satpura range. It covers the districts of Jabalpur, Narsinghpur, Hosangabad, Khandwa, Khargone, Barwani, Dhar and some parts of Raisen, Sehore, and Dewas districts.
4. The Satpura range runs from West to East for about 640 km through Khandwa, Betul, Chhindwara, Seoni, Mandla, Bilaspur and Sarguja districts. Its northern spurs go into

Source: EIVIS Centre of Madhya Pradesh' S State of Environment

Fig. 2. 1: Map of agro-climatic zones of Madhya Pradesh

Hosangabad and Narsighpur districts and in the south an extensive spur of 160km covers entire Balaghat district.

5. Madhya Pradesh also covers Balaghat and Shahdol districts of Chhattisgarh Plains and Northern Hills of Chhattisgarh zone respectively. The state is bordered on the west by Gujarat, on the North-East by Uttar Pradesh, on the East by Chhattisgarh, and on the South by Maharashtra.

Table 2.4: Districts/tehsils covered under various Agro-Climatic Regions of Madhya Pradesh (Lakh ha)

S. No.	Agro-Climatic Regions	Districts/Tehsils	Geographical Area (% to Geographical Area)
1	Malwa Plateau	Indore, Dhar (Dhar, Badnawar, Sardarpur tehsils) Shajapur, Mandsour, Neemuch, Ratlam, Ujjain, Dewas, Rajgarh districts and Petlawad tehsil of Jhabua district	51.47 (16.74)
2	Vindhya Plateau	Bhopal, vidisha, Sehore(Sehore, Ashtha, Ichhwar, Narsullaganj tehsils) Raisen (Raisen, Gairatganj, Begamganj, Silwani, Goharganj, Udaipura tehsils), Damoh, Guna(Chachora&Raghogarh tehsils) &Sagar districts	42.59 (13.85)
3	Central Narmada Valley	Hoshangabad (Seoni-Malwa,Hoshangabad,Sohagpur tehsils), Harda, Narsighpur districts, Budhani and Barelli tehsil of Sehore and Raisen districts respectively	17.45 (5.67)
4	Satpura Plateau	Betul, Chhindwara districts	21.93 (7.13)
5	Jhabua Hills	Jhabua, Jobat, Alirajpur tehsils of Jhabua district &kukshi tehsil of Dhar district	6.88 (2.24)
6	Gird Region	Gwalior, Bhind, Morena, Sheopur-kalan, Guna(Mungawali and Ashoknagar tehsils), Shivpuri (Shivpuri, Kalaras, Pohari tehsils)	31.85 (10.36)
7	Kymore Plateau `	Jabalpur, Katni, Rewa, Panna, Satna, Sidhi, Seoni and Gopadbanas&Deosar tehsils of Sidhi district.	31.85 (10.36)
8	Bundelkhand Region	Tikamgarh, Chhatarpur, Datia districts, Karela, Pachore tehsil of Shivpuri and Guna tehsil of Guna district	22.82 (7.42)
9	Nimar Valley	Khandwa, Khargone, Barwani district, Mahawar tehsil of Dhar district and Harda district	25.17 (8.18)
10	Northern Hills of Chhattisgarh	Shahdol, Umariay, Mandla, Dindori district &Singrauli tehsil of Sidhi district	28.17 (9.16)
11	Chhattisgarh plain	Balaghar district	9.25 (3)
Madhya Pradesh			307.56 (100)

Source: EIVIS Centre of Madhya Pradesh & State of Environment

2.1.4 Soil and Climate

The main soil types found in Madhya Pradesh are alluvial, deep black, medium black, shallow black, mixed red and black, mixed red and yellow and skeletal soils. (Table 2.5)

Table 2.5: Soil types and districts covered in Madhya Pradesh

Types of Soil	Districts Covered
Alluvial Soil	Bhind, Morena and Gwalior
Deep Black Soil	Hoshangabad and Narsinghpur
Medium Black Soil	Jabalpur, Sagar, Vidisha, Sehore, Damoh, Guna, Bhopal, Raisen, Rajgarh, Indore, Dewas, Ujjain, Mandsour, Shajapur, Ratlam, Dhar, Khargone and Khandawa
Shallow Black Soil	Betul, Chhindwara and Seoni
Red & Black Soil	Shivpuri, Rewa, Satna, Panna, Sidhi, Chagttarpur, Tikamgarh, Datia and some parts of Guna district.
Red & Yellow Soil	Balaghat
Gravelly Soil	Mandla

Source: EIVIS Centre of Madhya Pradesh & State of Environmen

The climate of Madhya Pradesh by virtue of its location is predominately moist sub humid to dry sub humid, semi arid to dry sub-humid and semi arid in East, West and Central plateau and Hills respectively, according to agro-climatic regions of India. The seasons in Madhya are as given in Table 2.6.

Table 2.6: Seasons and their periods in Madhya Pradesh

Seasons	Period	
	From	To
Rainy	June	September
Post Monsoon	October	November
Winter	December	February
Summer	March	May

Source: EIVIS Centre of Madhya Pradesh & State of Environment

The annual rainfall received in the State varies from 800 mm. in the Northern and Western regions to 1600 mm in the Eastern districts. In some years rainfall goes much below to the normal. The most of rainfall is received in the *Monsoon* season from June to September and about 10 per cent of the rainfall is received in the remaining months of the year. The maximum temperature of the State found during extreme summer reaches as high as 47^0C and the minimum during winter dips up to 2^0C. The maximum normal temperature varies between 25^0 to 35^0 C and minimum normal between 10^0 to 20^0C. The relative humidity ranges from 40 to 70 per cent throughout the year.

2.1.5 Operational Holdings

The total number of holdings were found to be 88.72 lakhs with 158.35 lakh hectare area under these holdings in the states (Table 2.7). The maximum number of operational holdings belongs to the marginal (43.86%) followed by small (27.60%), semi medium (18.65%), medium (8.89%) and large (1.00%), the area covered under these holdings was found to be 12.10, 21.89, 28.70, 28.48 and 8.84 per cent, respectively. As the size of holdings increases the number of holdings decreases, showing inverse relationship between number and area operated under different size of holdings.

2.1.6 Land Use Pattern

The Madhya Pradesh state has 307.56 lakh ha of geographical area out of which almost 50 per cent was found to be under cultivation. Amongst other parameter of land, the area under forest contributed around 28 per cent followed by area not available for cultivation (11%), other cultivated land excluding fallow land (7.57%) and fallow land (3%). The area sown more than once was found to be 29.22 per cent with cropping intensity of 159 percent. (Fig. 2.2).

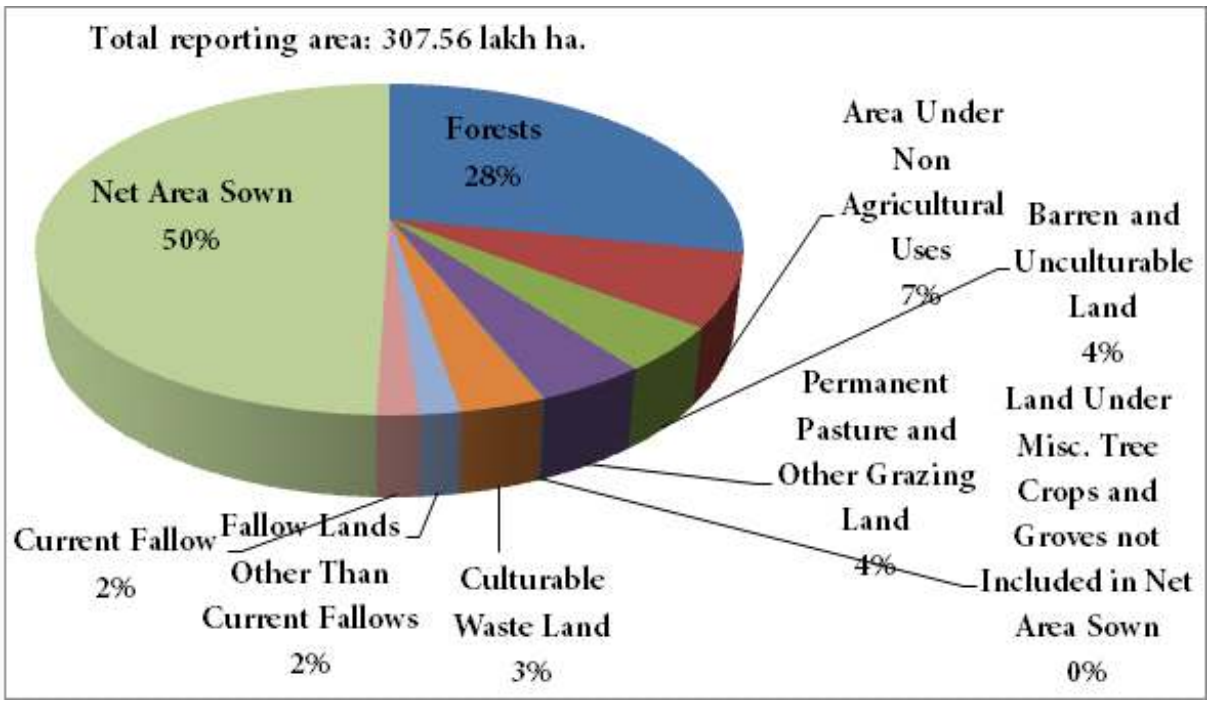
Table 2.7: Number and area of operational holdings

Particulars	Number (000)	Area (in "000" ha.)
Marginal	3891.02 (43.86)	1915.35 (12.1)
Small	2448.65 (27.6)	3466.14 (21.89)
Semi-medium	1654.83 (18.65)	4510.22 (28.48)
Medium	789.14 (8.89)	4544.53 (28.7)
Large	88.73 (1)	1399.63 (8.84)
Total	8872.38 (100)	15835.87 (100)

Source: Agriculture Census, 2011

2.1.7 Cropping Pattern

The gross cropped area of the Madhya Pradesh was found to be 242.14 lakh hectares which was found to be dominated by cereals and millets which occupied 42.17 per cent gross cropped area followed by oilseeds (30.40%), pulses (19.49%), other non food crops (0.02%) total fruits and vegetables (1.89%), total species (1.85%) and sugarcane (0.50%). Amongst different cereals wheat (63%) occupied maximum area followed by rice (21%), maize (9.86%) and other cereals (6.46%). In case of



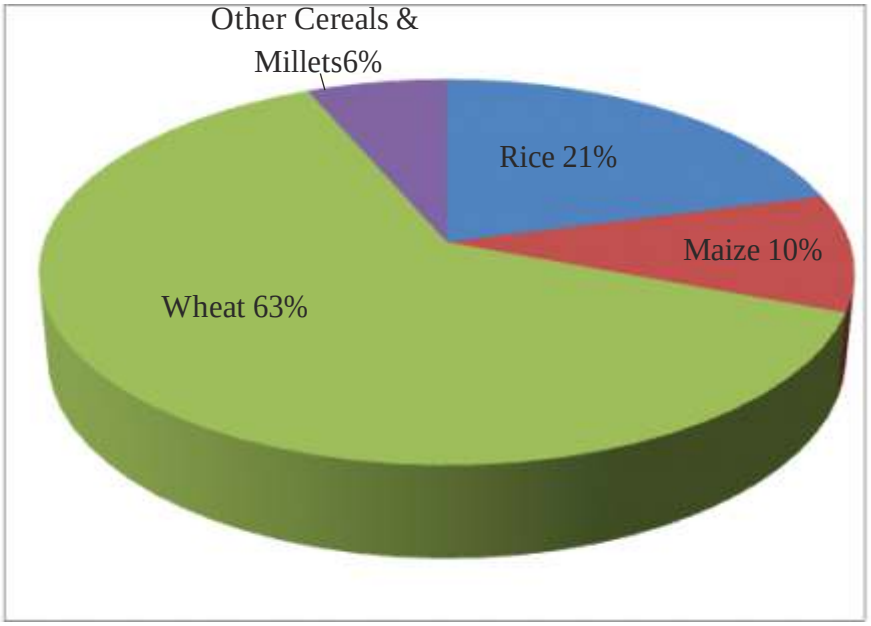
Source; Farmer Welfare and Agriculture Development Department

Fig. 2. 2: Share of Different Parameters of Land Use Pattern in MP

Table 2.8: Cropping pattern of Madhya Pradesh (ha.) 2016-17

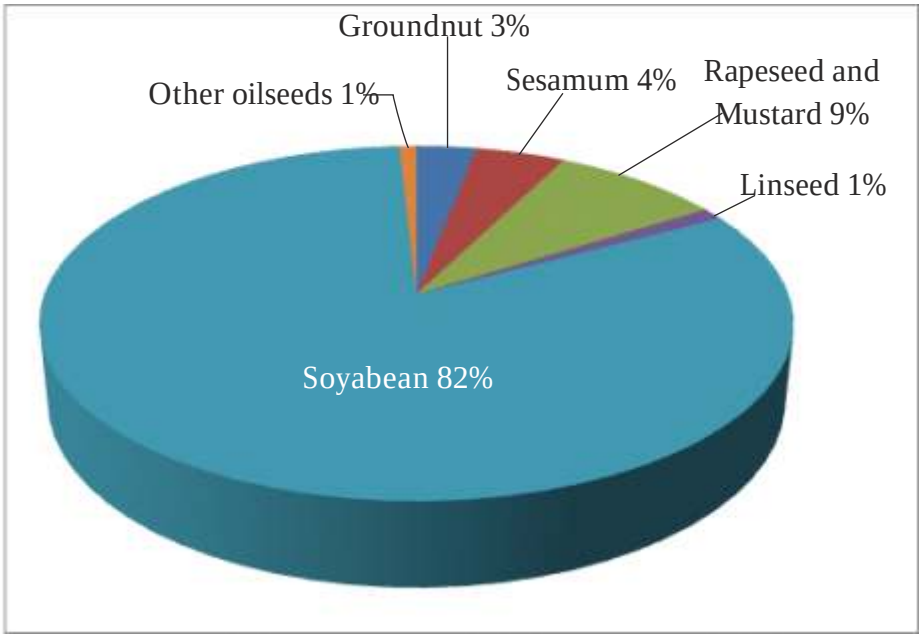
Particulars	Madhya Pradesh
Rice	2136116 (20.92)
Maize	1006499 (9.86)
Wheat	6409504 (62.77)
Other Cereals & Millets	659704 (6.46)
Total Cereals and Millets	10211823 (42.17)
Gram	2126766 (45.06)
Arhar	473540 (10.03)
Other Pulses	2119672 (44.91)
Total Pulses	4719978 (19.49)
Total Food Grains	14931801 (61.67)
Sugarcane	120052 (0.50)
Total Condiments and Spices	447626 (1.85)
Total Fruits and Vegetable	457673 (1.89)
Total Food Crop	15957306 (65.90)
Groundnut	220897 (3.00)
Sesamum	332390 (4.52)
Rapeseed and Mustard	627918 (8.53)
Linseed	81267 (1.10)
Soybean	6035486 (81.99)
Other oilseeds	63422 (0.86)
Total Oilseeds	7361380 (30.40)
Other Non Food Crops	4884 (0.02)
Gross Cropped Area (GCA)	24214048 (100.00)
Area Sown More Than Once	8986044
Net Area Sown	15228004

Source: Directorate of Statistics and Economics



Source; Farmer Welfare and Agriculture Development Department

Fig. 2. 3: Percentage Contribution of Different Cereals in Total Cereals in MP



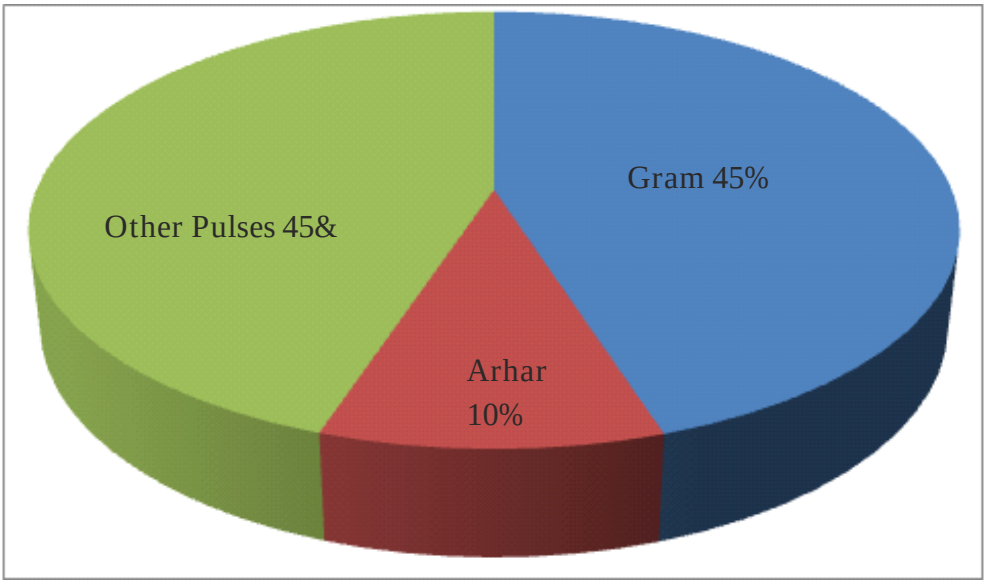
Source; Farmer Welfare and Agriculture Development Department

Fig. 2. 4: Percentage Contribution of Different Oilseeds in Total Oilseeds in MP

oilseeds soybean (82%) occupied maximum area followed by rapeseed & mustard (9%), sesame (4.52%), ground nut(3%), linseed (1%) and other oilseed (1%) and in case of pulses chickpea (45.06%) occupied maximum area followed by arhar (10.03%) and other pulses including moong and urad etc. (44.91%) in Madhya Pradesh (Table 2.8).

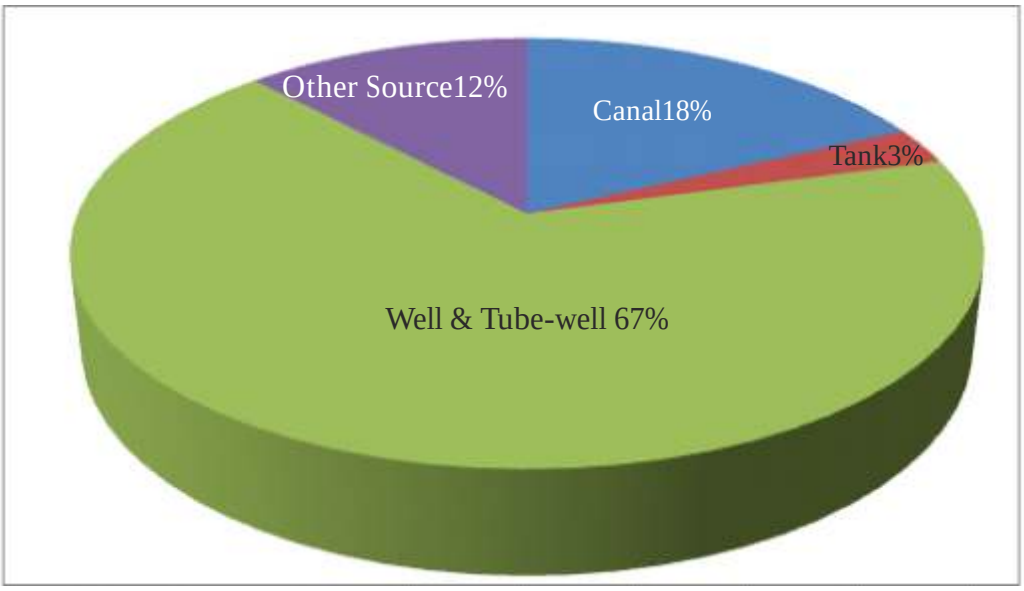
2.1.8 Source Wise Irrigated Area

The 44.07 per cent area out of Gross Cropped Area (242.14 lakh ha.) was found to be irrigated in the State (Fig. 2.6). The major source of



Source; Farmer Welfare and Agriculture Development Department

Fig. 2. 5: Percentage contribution of different pulses in total pulses in MP



Source; Farmer Welfare and Agriculture Development Department

Fig. 2. 6: Percentage Contribution of Different Irrigation Sources to GIA (GIA) in MP

irrigation was found to be well/tube well around (67%) followed by canal (18%), other source (12%) and tank (3%).

2.2 Growth of Micro Irrigation in the State

Year wise funds allocated/ received under PMKSY–PDMC, area under micro irrigation (MI) percentage of gross irrigated area including annual average growth rate were analysed for Madhya Pradesh and presented in table 2.9.

The funds allocated under PMKSY –PDMC were found to be decreased from Rs.161.74 (2015-16) to Rs. 102.00 (2019-20) crores with the annual average growth rate of -

Table 2.9: Year-wise trend and growth of micro-irrigation in the State

Year	Funds allocated under PMKSY-PDMC	Area under Micro Irrigation (MI)	Cumulative area under micro irrigation	Gross Irrigated area (ha)	MI as % of gross irrigated area
2015-16	161.74	75224	75224	10028515	0.75
2016-17	121.1	54323	129547	10670815	1.21
2017-18	150	39761	169308	11385090	1.49
2018-19	132.56	35195	204503	12686140	1.61
2019-20	102	9485	213988	-	-
Annual/average Growth rate	-7.39%	-17.48%	36.89	6.63	-

Source: Field survey

7.39 per cent, the area under micro irrigation under the PMKSY-PDMC also showed the decreasing trend from 75224 (2015-16) to 9485 (2019-20) hectares with annual growth rate of-17.48 % . This shows that allocation of funds is directly proportionate to area under micro irrigation. This indicates that with the decrease in allocation of funds under PMKSY-PDMC, the area under MI was found to be decreased.

However, the cumulative area under micro irrigation was found to be increased from 75224 (2015-16) to 213988 (2019-20) hectares with the annual average growth rate of 36.89 per cent. The area under micro irrigation to gross irrigated area was also found to be increased from 0.75 (2015-16) to 1.61(2018-19) per cent per year in the State.

2.3 District wise Adoption of Micro Irrigation

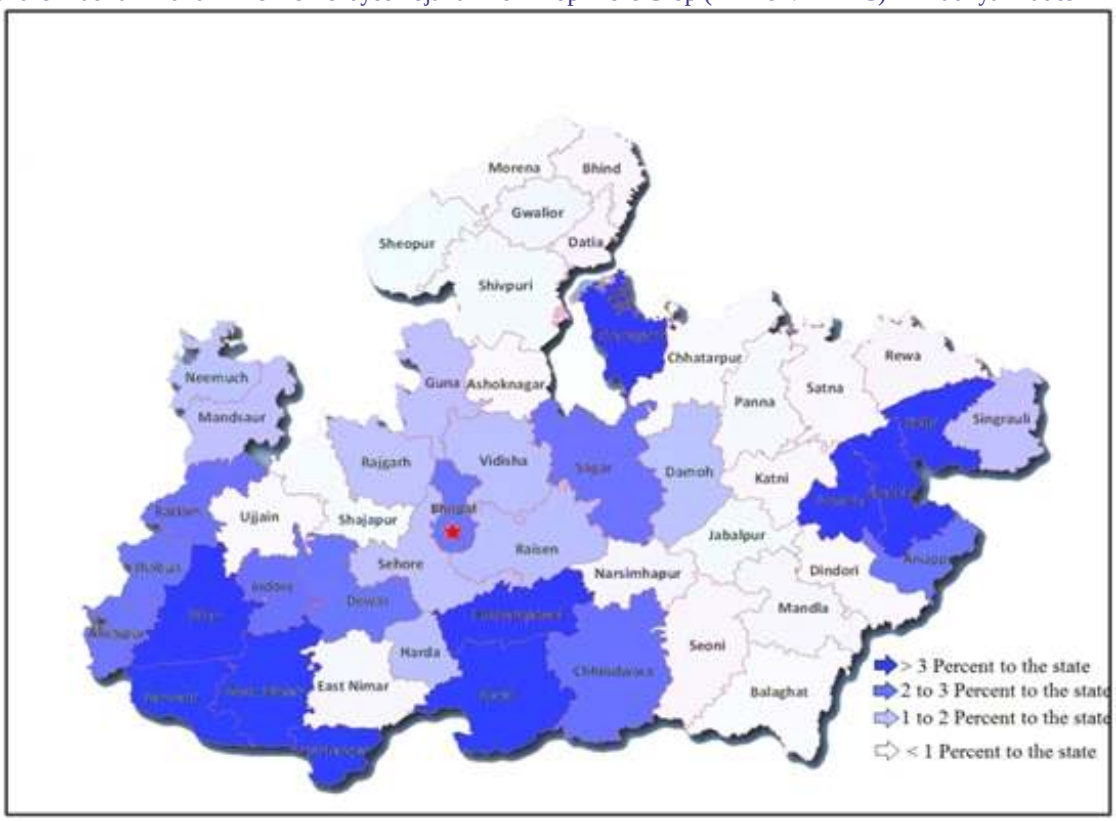
The area under MI, percentage area under micro irrigation to gross irrigated area across district of Madhya Pradesh is and presented in table 2.10.

Madhya Pradesh is found to be one of the leading State as for as micro irrigated under PDMC is concerned. The area under micro irrigation area was found 39758, which was 0.31 percent of gross irrigated area of Madhya Pradesh (2017-18). Dhar was found to be a leading district under micro irrigation having 17.96 percent of micro irrigated area to total micro irrigated area of the state. The area under Micro Irrigation was found to vary between 2.10 (Dindori) to 5946 (Dhar) ha. except Rewa all the districts were found to have area under micro irrigation with the state total of 39758.77 ha.

Table 2.10: District-wise micro irrigation area in Madhya Pradesh (2017-18/latest year)

S. No.	Name of District	Area under Micro Irrigation(ha)	Micro irrigation % to total irrigated area of District
1	Dhar	5946	1.33
2	Burhanpur	2550.9	2.97
3	Khargone	2329.7	0.45
4	Tikamgarh	2329	0.81
5	Umaria	1786.5	3.04
6	Shahdol	1697.9	3.27
7	Barwani	1567.02	0.91
8	Sidhi	1468.58	1.56
9	Hoshangabad	1265.06	0.23
10	Betul	1257.11	0.59
11	Bhopal	1149.14	0.81
12	Alirajpur	1114	2.97
13	Dewas	1024.85	0.28
14	Ratlam	999.7	0.37
15	Indore	988.13	0.4
16	Chhindwara	962	0.42
17	Sagar	895.2	0.22
18	Anuppur	877.48	14.15
19	Jhabua	862.6	1.18
20	Neemuch	679.75	0.45
21	Guna	669.13	0.21
22	Mandsaur	656.53	0.22
23	Rajgarh	632.5	0.17
24	Sehore	626.1	0.15
25	Raisen	568.8	0.11
26	Damoh	534.8	0.21
27	Singrauli	500.92	1.03
28	Vidisha	480.06	0.1
29	Harda	397.64	0.2
30	Satna	351.8	0.12
31	Jabalpur	253	0.08
32	Ujjain	247.93	0.05
33	Ashoknagar	228.4	0.09
34	Seoni	216.7	0.09
35	Chhatarpur	194.3	0.06
36	Katni	188	0.07
37	Sheopur	163.4	0.09
38	Datia	161.1	0.07
39	Shajapur	133	0.05
40	Mandla	128.67	0.2
41	Khandwa	128	0.05
42	Panna	120.42	0.07
43	Bhind	115	0.04
44	Balaghat	102.31	0.06
45	Shivpuri	91.4	0.02
46	Narsinghpur	52.24	0.02
47	Gwalior	41.4	0.02
48	Agar Malwa	19.5	0.01
49	Morena	3	0
50	Dindori	2.1	0.04
51	Rewa	0	0
Total		39758.77	0.31

Source: Farmer Welfare and Agriculture Development Department



Source; Farmer Welfare and Agriculture Development Department

Fig. 2. 7: District-wise micro irrigation area in Madhya Pradesh

The percent MI to total irrigated area of district was found to be maximum in Anuppur (14.15%) followed by Shahdol (3.27%), Umaria (3.04%), Burhanpur and Alirajpur (2.97% each), Sidhi (1.56%), Dhar (1.33%), Jhabua (1.18%), Singrouli (1.03%) while other districts were found to have less than 1 percent area under micro irrigation to total irrigated area of respective districts, while in state, it was found to be 0.31 percent. This indicates that the area under MI to total irrigated area of districts was found to be more in western part followed by eastern and southern part of the state (Fig.2.7).

2.4 Crop wise Adoption of Micro Irrigation

The crop wise micro irrigated area in Madhya Pradesh and percentage of individual crop to total micro irrigated area were analyzed and presented in table 2.11. The highest area under micro irrigation was found to be occupied under green chilli 5920.5 ha (40.89%) followed by tomato 4923.14 (12.38%), banana 2576.64 ha (6.48%), onion 1927.9 (4.85%), garlic 1832.62 ha (4.61%), potato 1779.76 ha (4.48%), peas 1322.14 (3.33%), okra 1256.9 ha (3.16%), coriander Seed 1070.49 (2.69%), brinjal 936.29 (2.35%) and cabbage 796.79 (2.0%), while the

Table 2.11: Crop-wise adoption of micro irrigation (2017-18)

S. No.	Crop Name	Area under Micro irrigation (in ha)	Percent
1	Green Chilli	5920.5	14.89
2	Tomato	4923.14	12.38
3	Banana	2576.64	6.48
4	Onion	1927.9	4.85
5	Garlic	1832.62	4.61
6	Potato	1779.76	4.48
7	Peas	1322.14	3.33
8	Okra/Ladyfinger/Bhindi	1256.9	3.16
9	Coriander Seeds	1070.49	2.69
10	Brinjal	936.29	2.35
11	Cabbage	796.79	2
12	Cauliflower	774.45	1.95
13	Ajwain/Carum	351.35	0.88
14	Wheat	232	0.58
15	Bottle Gourd	228.65	0.58
16	Orange	227.8	0.57
17	Red Chillies	160.6	0.4
18	Ridge/Sponge Gourd	132.95	0.33
19	Mango	91.7	0.23
20	Guava	78.85	0.2
21	Bitter Gourd	67.6	0.17
22	Ginger	61.65	0.16
23	Arbi	56	0.14
24	Capsicum	55.1	0.14
25	Pumpkin	53	0.13
26	Turmeric	51.8	0.13
27	Radish	51.2	0.13
28	Broccoli	46.3	0.12
29	Water Melon	39.8	0.1
30	Cucumber	37.4	0.09
31	Carrot	30.3	0.08
32	French Beans	29.5	0.07
33	Leafy Vegetables	28.8	0.07
34	Lime/Lemon/Citrus	28.45	0.07
35	Papaya	9.4	0.02
36	Chrysanthemum	9	0.02
37	Turnip	7	0.02
38	Fenugreek	6.5	0.02
39	Beetroot	5	0.01
40	Pomegranate	2	0.01
41	Aonla/Amla	2	0.01
42	Almond	2	0.01
43	Sapota	1.5	0
44	Muskmelon	1	0
45	Marigold	0.67	0
46	Others Crops	12454.28	31.32
Total		39758.77	100

Source: Farmer Welfare and Agriculture Development Department

minimum area under beetroot 5 ha (0.01%), pomegranate, anola and almond 2 ha (0.01%) and sapota 1.5 ha., muskmelon 1 ha. & marigold 0.67 ha (0.00%) respectively in Madhya Pradesh

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CHAPTER - III

SAMPLING, SAMPLE PROFILE & METHODOLOGY

This chapter deals with the data, sampling techniques, selection of districts, selection of crops, analysis of data and concept used for the study.

3.1 The Data

Both primary and secondary data were collected for the study. The primary data were collected from the respondents i.e. adopter and non-adopter of micro irrigation. The data were collected on various aspects viz. age, education, land use pattern, water sources for farming, water situation, type of soil, rainfall situation and year of start using micro irrigation with & without subsidy of the respondents. The primary data collected from the sample respondents for the in agricultural year 2019-20. The secondary data were collected from PMKSY website (https://pmksy.gov.in/), officers of the department of Farmer Welfare and Agriculture Development, Madhya Pradesh and Commissioner Land Record & Settlement, Government of Madhya Pradesh (http://www.landrecords.mp.gov.in/) for the period from 2015 to 2018.

3.2 Sampling Technique

To measure the impact of PMKSY-PDMC a multi stage stratified random sampling method was used for selection of districts, blocks, villages and respondents. In first stage, the districts were selected based on higher irrigated area under different system of micro irrigation. Among all districts of Madhya Pradesh. Dhar district was selected for drip irrigation system and Sagar district was selected for sprinkler irrigation system (Table 3.1). In the second stage from the each selected districts, two blocks having maximum area under micro irrigation namely Badnawar and Manawar were selected in Dhar district and Khurai and Deori blocks were selected from Sagar district. In third stage 3 villages in each selected block were selected randomly from the list of micro irrigation villages. Thus, Bakhatpura, Tilgara & Jabada and Ajanda, Mandwi & Pipriman villages were selected from Badnawar and Manawar blocks, respectively from Dhar district and Silpari, Billaiya, & Khajarhar Chandra and Kushmi, Sisnghpur ganjan & Kaurasa villages were selected from Khurai and Deori blocks respectively from Sagar district for the study.

In the fourth stage, a list of all the adopters and

Source: Farmer Welfare and Agriculture Development Department

Fig.3.1: Selected district in Madhya Pradesh

Table 3.1: Sample Coverage of Adopter and Non- Adopter (number)

Sr. No.	Selected district	Selected block	Selected village	No. of Farmers surveyed	Main MI Crops	Micro irrigation		Micro-Irrigation (Both)	Non-Adopters
						Drip	Sprinkler		
1	Dhar	Badnawar	3	30	Chilli & Ginger	24	0	0	6
		Manawar	3	30		24	0	0	6
2	Sagar	Deori	3	30	Wheat	0	24	0	6
		Khurai	3	30		0	24	0	6
Total		-	12	120	-	48	48	0	24

Source: Field survey

non- adopters in the selected villages was prepared and 8 adopters and 2 non- adopters from each villages were selected constituting 96 adopters and 24 non-adopters from both districts (48 adopters and 12 non-adopters from each district) were selected for the study constituting total sample size of 120 farmers (Table 3.1). The selection of crops was also done on the basis of higher area under drip and sprinkler irrigation used in the crops by

Table 3.2: District-Wise MI Adoption (2017-18/latest year) (In ha)

S. No.	Name of District	Area under Micro Irrigation		Total MI
		Drip	Sprinkler	
1	Dhar	5792	154	5946
2	Burhanpur	2550.9	0	2550.9
3	Khargone	2329.7	0	2329.7
4	Umaria	1786.5	0	1786.5
5	Barwani	1555.72	11.3	1567.02
6	Tikamgarh	1515.5	813.5	2329
7	Shahdol	1063.7	634.2	1697.9
8	Sidhi	999.45	469.14	1468.59
9	Dewas	994.45	30.4	1024.85
10	Alirajpur	933.4	180.6	1114
11	Betul	883.29	373.82	1257.11
12	Anuppur	874.08	3.4	877.48
13	Jhabua	862.6	0	862.6
14	Hoshangabad	723.05	542.01	1265.06
15	Bhopal	638.24	510.9	1149.14
16	Rajgarh	614	18.5	632.5
17	Indore	552.83	435.3	988.13
18	Chhindwara	545	417	962
19	Ratlam	516.7	483	999.7
20	Singrauli	483.88	17.04	500.92
21	Guna	305.04	364.09	669.13
22	Sehore	280	346.1	626.1
23	Damoh	208.8	326	534.8
24	Raisen	186.1	382.7	568.8
25	Harda	185.05	212.59	397.64
26	Satna	139.8	212	351.8
27	Khandwa	128	0	128
28	Jabalpur	111.4	141.6	253
29	Chhatarpur	101.3	93	194.3
30	Ujjain	101.25	146.68	247.93
31	Shivpuri	90.4	1	91.4
32	Datia	88.1	73	161.1
33	Mandsaur	82.15	574.38	656.53
34	Neemuch	80.25	599.5	679.75
35	Sheopur	72.4	91	163.4
36	Ashoknagar	53.2	175.2	228.4
37	Seoni	51.7	165	216.7
38	Vidisha	49.06	431	480.06
39	Sagar	39.2	856	895.2
40	Gwalior	33.8	7.6	41.4
41	Narsinghpur	21.9	30.34	52.24
42	Balaghat	21.31	81	102.31
43	Mandla	20.5	108.17	128.67
44	Agar Malwa	19.5	0	19.5
45	Katni	13	175	188
46	Shajapur	11.8	121.2	133
47	Bhind	3	112	115
48	Morena	3	0	3
49	Dindori	2.1	0	2.1
50	Panna	0.8	119.62	120.42
51	Rewa	0	0	0
Total		28720.9	11042.88	39763.78

cultivators under selected districts. Hence, chilli & ginger and wheat crops were selected under drip and sprinkler system of micro irrigation respectively for the study.

3.3 Analysis of the Data

The following statistical tools were used for the study.

a) Mean

$$X = \Sigma x/n$$

Where,

X = Mean of the variables

Σx = Sum of scores (observation) of variables

n = Total number of respondents

a) Percentage (%) = variable/ Sum of variable

b) Absolute Change = Value of the Current Year- Value of the Base Year

c) Relative Change (%) =Absolute Change/ Value of the Base Yearx100

d) Average Annual Growth Rate (AAGR)= Relative Change/ Number of yearsx100

3.4 Concept Used

a) Cropping intensity

It is the ratio of total cropped area to the net area sown or the number of crops cultivated in a piece of land per annum, considered as cropping intensity.

Cropping intensity (%) = Gross Cropped Area/ Net Area Sownx100

b) Gross Return (Rs/ha) = Value of main product + Value of the by-product

c) Net Return a)= Gross Return - Total Cost of Cultivation

d) Cost of Cultivation (Rs/ha) = Total Material Cost and Total Labour Cost

e) Cost of Production (Q/ha) = Total cost of Cultivation (Rs/ha) /yield (q/ha))

f) Net income (Rs/ha) = Gross income -Total cost of cultivation

g) Per rupee return = Gross income/Total cost of cultivation

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CHAPTER - IV

PROFILE OF SAMPLE RESPONDENTS

This chapter deals with the age & education level, land use pattern, water sources and situation for farming, type and terrain of soil, rainfall situation (2019-20) and cropping profile of adopter and non- adopter. The chapter also deals with year of started using micro-irrigation, and subsidy availed by micro irrigation adopter. The data were analyzed keeping the objective in mind and divided into two following sub-heads.

a) Socio Economic Status of Adopter Respondent

b) Socio Economic Status of Non- Adopter Respondent

4.1 Socio Economic Status of Adopter Respondents

Age & education, land use pattern, water sources & situation of farming, types & terrain of soil, rainfall situation (2019-20) and year started using micro-irrigation & whether availed of subsidy cropping profile were considered under socio economic status of adopter respondents.

Table 4. 1: Age and education level of adopters (years)

Particulars	Number	Percentage to Total
Age		
Under 20	0	0
20-30	8	8.33
30-40	26	27.08
40-50	29	30.21
50-60	19	19.79
Above 60	14	14.58
Total	96	100
Education		
Illiterate	15	15.63
Primary	23	23.96
Middle	19	19.79
10thStd	18	18.75
12thStd	10	10.42
Graduate	8	8.33
Post-Graduation	3	3.13
Technical	0	0
Total	96	100

4.1.1 Age and Education

It is observed from the data presented in table 4.12 that the maximum number respondents belongs to 40 to 50 years (30.21%) followed by 30-40 (27.08%), 50-60 (19.79%), above 60 (14.58%) and 20-30 years (8.33%) age group, while none of them found to be below the age of 20 years.

Thus, almost 91 per cent adopters were found to be above 30 years old. On the other hand, the maximum adopters were found to be educated up-to primary (23.96%) followed by middle (19.79%), 10^{th} standard (18.75%) 12^{th} standard (10.42%) graduate (8.33%) and post graduate (3.13%), while 15.63 per cent adopters were found to be illiterate. None of the adopter got technical education in the area under study. Almost 40 per cent adopters were found to be educated above 10^{th} standard.

4.1.2 Land Use Pattern

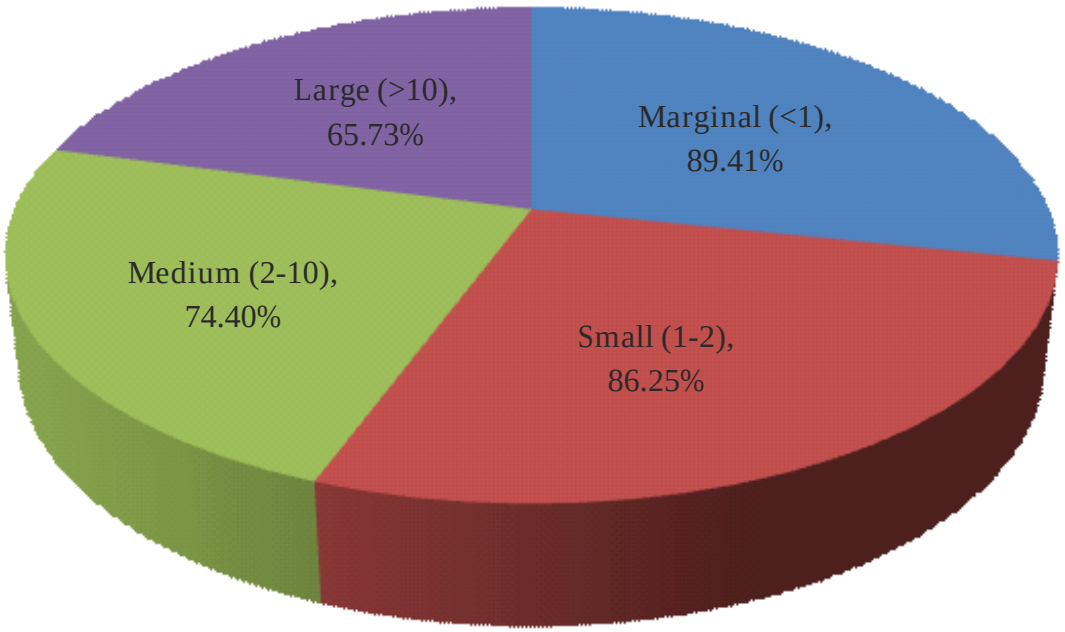
The total area under micro irrigation and non-micro irrigation, un-irrigated area of adopter respondents is presented in table 4.2. It is observed from the data that maximum number of adopters were belong to medium size group (70.83%) followed by small (17.71%), marginal (8.33%) and large (3.13%) size groups.

None of the adopter found to be land less/ tenant. An average adopter was found to operate 3.81 ha land, which was found to be more in case of large (15.76 ha) followed by medium (4.18 ha), small (1.60 ha) and marginal (0.84 ha.) category. The average respondents reported to be 74.54 per cent area under MI, which was found to be more in case of marginal (89.41%) as compared to small (86.25%), medium (74.40%) and larger (65.73%) category (Fig. 4.1). On an average the area under drip

Table 4.2: Land use pattern (hectares)

Group (ha)	Number of Farmers	Percentage	Area Operated in Hectares - Average					
			Total Area/Operated	Micro-Irrigated area			Non-Micro Irrigated	Un-Irrigated
				Total	Drip	Sprinkler		
Landless/Tenant	0	0	0	0	0	0	0	0
Marginal (<1)	8	8.33	0.85	0.76 (89.41)	0..55	0.83	0.09	0
Small (1-2)	17	17.71	1.6	1.38 (86..25)	0.99	1.59	0.22	0
Medium (2-10)	68	70.83	4.18	3.11 (44.40)	2.51	3.88	1.05	0.02
Large (>10)	3	3.13	15.76	10.36 (65.73)	2.38	26.32	5.4	0
Overall/Average	96	100	3.81	2.84 (74.54)	2.23	3.44	0.96	0.01

Source: Field Survey, (Percentage share of MI area to total operated area)



Source: Field Survey

Fig. 4.1: Percentage share of MI area to total operated area

irrigation was found to be maximum in case of large (1.59 ha) followed by medium (1.40 ha), small (0.35 ha) and marginal (0.14 ha) category.

While in sprinkler irrigation system it was found to be maximum area in case of large (8.77 ha) followed by medium (1.71 ha), small (1.03 ha) and marginal (0.62 ha) category. Non-micro irrigated area was also found to be maximum in case of large (5.40 ha) followed by medium (1.05 ha), small (0.22 ha) and marginal (0.09 ha) category, while the average un-irrigated area was found to be 0.02 ha in case of marginal farmer only.

4.1.3 Water Sources and Situation for Farming

Water sources and its situation for farming of adopter respondents are presented in table 4.3. It is observed from the data that out of 96 adopters, maximum were found to well (28.13%) followed by tube well & well (26.04%), tube well (15.63%), tube well & river (9.38%), tube well & check dam (4.17%), well & river lift (4.17%), and canal (4.17%), well & check dam (3.13%), check dam (2.08 %) and tube well & pond (1.04%), well & pond (1.04%) and pond (1.04%), while canal lift, tank, farm pond and percolation sources of water were not found to be used in farming by the adopters in the area under study.

The water was not found to be scarce as reported by 65.63%per cent of adopters, while occasional scarcity, scarcity, accurate scarcity) and excess water situation. Was reported by 15.63, 14.58, 3.13 and 1.04 per cent adopters respectively

Table 4. 3: Water sources and situation for farming of adopter

Items	Number	Percentage to Total
Water Sources		
Canal	4	4.17
Tube well	15	15.63
Tube well & Well	25	26.04
Tube well & River Lift	9	9.38
Tube well & Check Dam	4	4.17
Tube well & Pond	1	1.04
Well	27	28.13
Well & River lift	4	4.17
Well & check Dam	3	3.13
Well & Pond	1	1.04
Pond	1	1.04
Check dam	2	2.08
Total	96	100
Water Situation		
Excess water	1	1.04
No scarcity	63	65.63
Occasional scarcity	15	15.63
Scarcity	14	14.58
Acute scarcity	3	3.13
Total	96	100

Source: Field Survey

4.1.4 Type and Terrain of Soil

The type of soil and terrain for farming as reported by adopters farmers are as presented in table 4.4.It is observed from the data that the maximum number of adopter reported that their area is covered by heavy soil (45.83%) followed by light (40.63%) and medium (13.53%) soil. The flat type of terrain was found to be maximum (85.42%) followed by up & down (11.46%) and hilly area (3.13 %).

4.1.5 Rainfall Situation

All the farmers reported that during the year 2019-20 there was heavy rain fall in the area under study.

Table 4. 4: Type and Terrain of Soil

Soil	Number	Percentage
Light	39	40.63
Medium	13	13.54
Heavy	44	45.83
Total	96	100
Terrain		
Flat	82	85.42
Up & Down	11	11.46
Hilly	3	3.13
Total	96	100

Source: Field Survey

Table 4. 5: Rainfall situation in the area under study (%)

Rainfall	Number	Percentage
Very heavy	0	0
Heavy	96	100
Average	0	0
Low	0	0
Very low	0	0

Source: Field Survey

4.1.6 Year Started using Micro-Irrigation whether Availed of Subsidy

The maximum number of adopter (39.58%) reported to using micro – irrigation in the last year (2018-19) followed by 2017-18 (32.29%), 2016-17 (25%), 2014-15 (2.08%) and current year 2019-20 (1.04%). Thus, only 2 per cent adopters were found to start micro irrigation before 2016 at their farm in the area under study. It is also observed from the data that all the respondents availed subsidy to purchase micro irrigation equipment and assets at their farms. The cent per cent adopters availed subsidy to purchase micro-irrigation system. (Table 4.6)

Table 4. 6: Year started using micro- irrigation and whether availed of subsidy

When started using Micro-Irrigation	Number	Percentage
Current Year (2019-20)	1	1.04
Last Year (2018-19)	38	39.58
2 years ago (2017-18)	31	32.29
3 years ago(2017-18)	24	25
5 years ago (before 2016)	2	2.08
10 years ago (before 2010)	0	0
More than 10 years	0	0
Overall Average	0	0
Total	96	100
Availed of Subsidy		
Yes	96	100
No	0	0
Total	96	100

Source: Field Survey

4.1.7 Cropping Pattern

An average adopter was found to allocate his 47.91 and 44.11 per cent of GCA (Gross Cropped Area) in kharif and rabi season respectively. He was found to used maximum kharif area in cultivation of soybean (35%) followed by cotton (16%), urad (13%), paddy (4%), chilli (6%), ginger (5%) and other kharif

Table 4. 7: Cropping profile of adopter

S.No.	Particulars	Area (ha)
A. Kharif Crop		
1	Soybean	1.27 (16.57)
2	Urad	0.46 (6.03)
3	Cotton	0.57 (7.50)
4	Paddy	0.15 (1.93)
5	Chilli	0.23 (2.96)
6	Ginger	0.20 (2.55)
7	Summer vegetables	0.75 (9.79)
	Total kharif	3.62 (47.91)
B. Rabi Crop		
1	Wheat	1.32 (17.28)
2	Chick pea	1.01 (13.19)
3	Lentil	0.10 (1.31)
4	Vegetables	0.74 (9.66)
5	Other Rabi	0.20 (2.67)
	Total rabi	3.38 (44.11)
C. Perennial Crop		
1	Lemon	0.34 (4.44)
2	Other Perennial	0.32 (4.18)
	Total perennial	0.66 (8.62)
Gross Cropped Area(GCA)		7.66
Net Cropped Area		3.81
Cropping Intensity (%)		201.14

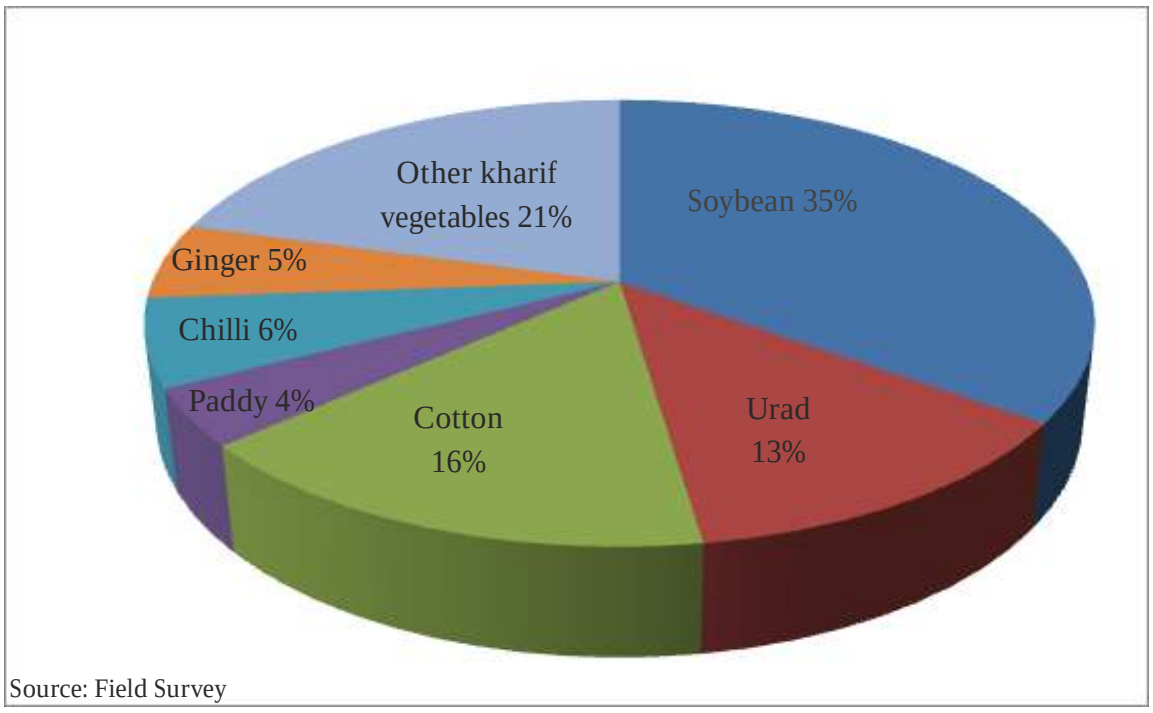


Fig. 4.2: Kharif area under cultivation of an average adopter

vegetables (21%) (Fig 4.2). Wheat was found to be a major rabi crop grown by an average adopter and allocate 39 per cent cultivated area. chickpea (30%), lentil (3%), other rabi (6%), winter vegetables (22%) were other major crops of rabi season cultivated by an average adopter in study area (Fig 4.3).

An average farmer was also found to be devote 7.66 per cent of GCA in cultivation of perennial crops, out of which lemon (4.44%)

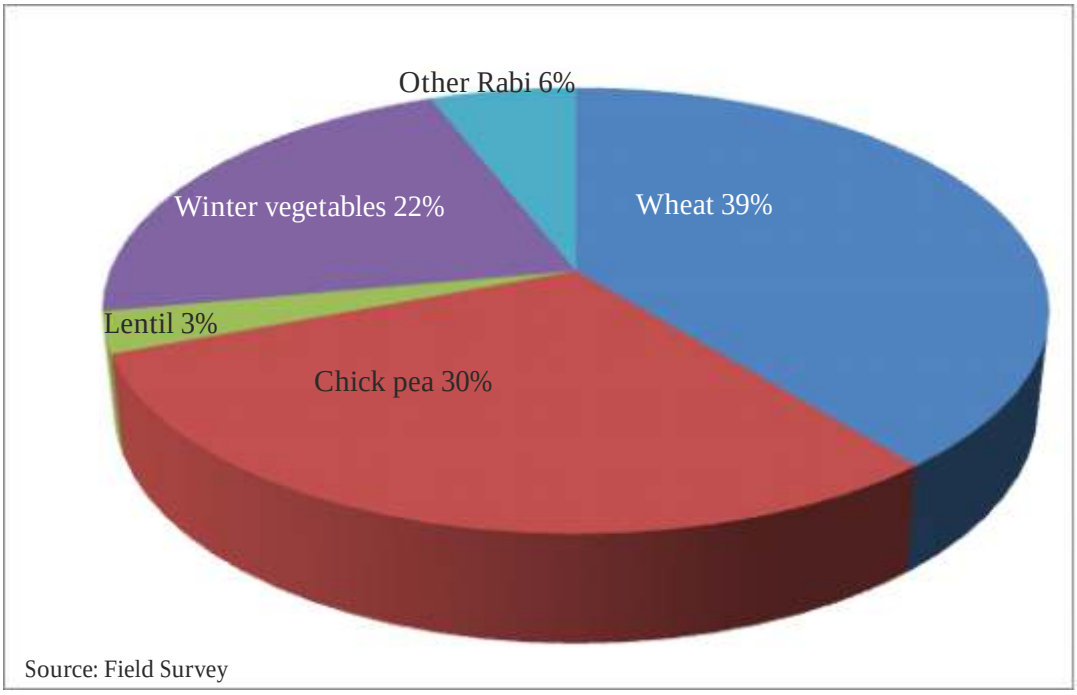


Fig. 4.3: Rabi area under cultivation of an average adopter

was found to be major perennial crop of the area. The cropping intensity of an adopter was found to be 201.17 per cent.

4.2 Socio Economic Status of Non-Adopter

Age & education, land use pattern, water sources & situation of farming, type & terrain of soil and cropping profile were considered under socio economic status of non- adopter respondents.

4.2.1 Age and Education level

Age and education level of non-adopter in presented in table 4.8. The maximum number of respondents were found to be belong 30-40 years (45.83%) followed by 40-50 (25%), 50-60 (12.50%) and 20-30 (8.33%), above 60 (8.33%) year age group, while none of them to be below 20 years age group. It was almost 91 per cent non- adopters were found to be above 30 years old.

On the other hand, the maximum non-adopters were found to be educated up-to middle level (41.67%) followed by primary (25.00%), 10^{th} standard (8.33%) 12^{th} standard (4.17%) and graduate (4.17%), while 16.67 per cent non- adopters were found to be illiterate. None of them was found to have post-graduation and technical education in the area under study. Almost 75 per cent non- adopters were found to be literate in the area under study.

Table 4. 8: Age and education profile of non-adopters

Particulars	Number	Percentage
Age		
Under 20	0	0
20-30	2	8.33
30-40	11	45.83
40-50	6	25
50-60	3	12.5
Above 60	2	8.33
Total	24	100
Education		
Illiterate	4	16.67
Primary	6	25
Middle	10	41.67
10thStd	2	8.33
12thStd	1	4.17
Graduate	1	4.17
Post-Graduation	0	0
Technical	0	0
Total	24	100

Source: Field Survey

4.2.2 Land Use Pattern

The total irrigation and un-irrigated area of non- adopter respondents were observed and presented in table 4.9. It is observed from the data that the maximum number of non-adopter were found to be medium (58.33%) followed by small (29.17%), marginal (8.33%) and large (4.17%) size groups. None of the non-adopter was found to be land less/ tenant.

An average non-adopter was found to be operate 3.86 ha land, which was found to be more in case of large category (26.32 ha) followed by medium (3.83 ha), small (1.62 ha) and marginal (0.71 ha.) category. The irrigation area found to be more in large category (26.32 ha) followed by medium (3.83 ha), small (1.57 ha) and marginal (0.71 ha) category. An average un-irrigated area was found to be 0.05 ha in case of small farmer only.

Table 4. 9: Land profile of non-adopters

Items	Number	Percent	Total Area Average	Area Irrigated Average	Area Un-Irrigated Average
Landless/Tenant	0	0	0	0	0
Marginal (<1)	2	8.33	0.71	0.71	0
Small (1-2)	7	29.17	1.62	1.57	0.05
Medium (2-10)	14	58.33	3.83	3.83	0
Large (>10)	1	4.17	26.32	26.32	0
Total	24	100	32.48	32.43	0.05

Source: Field Survey

4.2.3 Water Sources and Situation for Farming

Water sources and its situation for farming of non-adopter respondents are as presented in table 4.10. It is observed from the data that out of 24 non- adopters, the maximum farmers were found to canal lift (41.67%) followed by tube well (29.17%), canal (16.67%) and well (12.50%). The river lift, tank, farm pond, check dam and percolation sources of water were not used in farming by the non-adopters in the area under study. There was found to be excess water situation in the area. None of them found to be reported occasional scarcity, scarcity, accurate scarcity situation of non –adopter .

Table 4. 10: Water sources and situation for farming of non- adopter

Items	Number	Percentage
Water Source		
Canal	4	16.67
Canal-Lift	10	41.67
River-Lift	0	0
Tube well	7	29.17
Well	3	12.5
Tank	0	0
Pond	0	0
Farm Pond	0	0
Check dam	0	0
Percolation Tank	0	0
Others	0	0
Total	24	100
Water Situation		
Excess water	22	91.67
No scarcity	2	8.33
Occasional scarcity	0	0
Scarcity	0	0
Acute scarcity	0	0
Total	24	100

Source: Field Survey

4.2.4 Type and Terrain of Soil

The type of soil and terrain for farming as reported by non- adopter is presented in table 4.11. It is observed from the data that the maximum number of non-adopter reported that their area is covered by medium soil (54.17%) followed by heavy (25%) and light soil (20.84%). The terrain found to be flat type (79.17%) followed by up & down (16.67%) and hilly area (4.16 %).

Table 4.11 : Type and terrain of soil of non- adopter

Soil	Number	Percentage
Light	5	20.84
Medium	13	54.17
Heavy	6	25
Total	24	100
Terrain		
Flat	19	79.17
Up & Down	4	16.67
Hilly	1	4.16
Total	24	100

Source: Field Survey

4.2.5 Cropping Pattern

An average non- adopter was found to allocate his 46.96 and 52.23 per cent of GCA in kharif and rabi season respectively. He was found to maximum kharif area in cultivation of soybean (60%) followed by urd (20%), cotton (10%), chilli (5%), ginger (4%) and other kharif crops (1%) (Fig 4.4).

Wheat was found to be a major rabi crop grown by an average farmer and allocate 43.00 per cent cultivated area of rabi season. Chickpea (38%), lentil (8%), winter vegetables (8%) were other major crops of rabi season cultivated by an average non-adopter in the area under study (Fig 4.5).

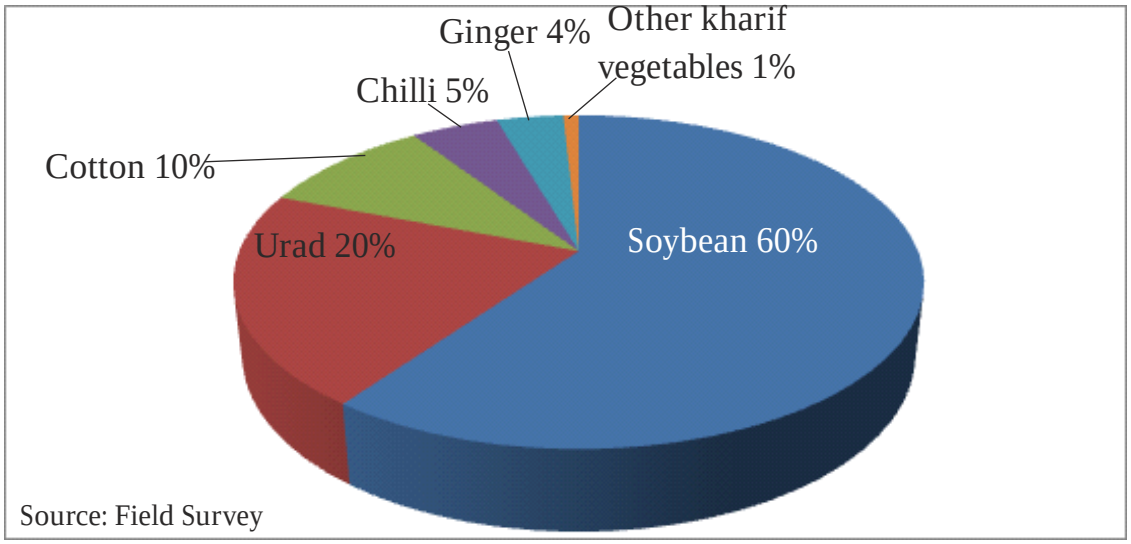


Fig. 4.4: Kharif area under cultivation of an average non- adopter

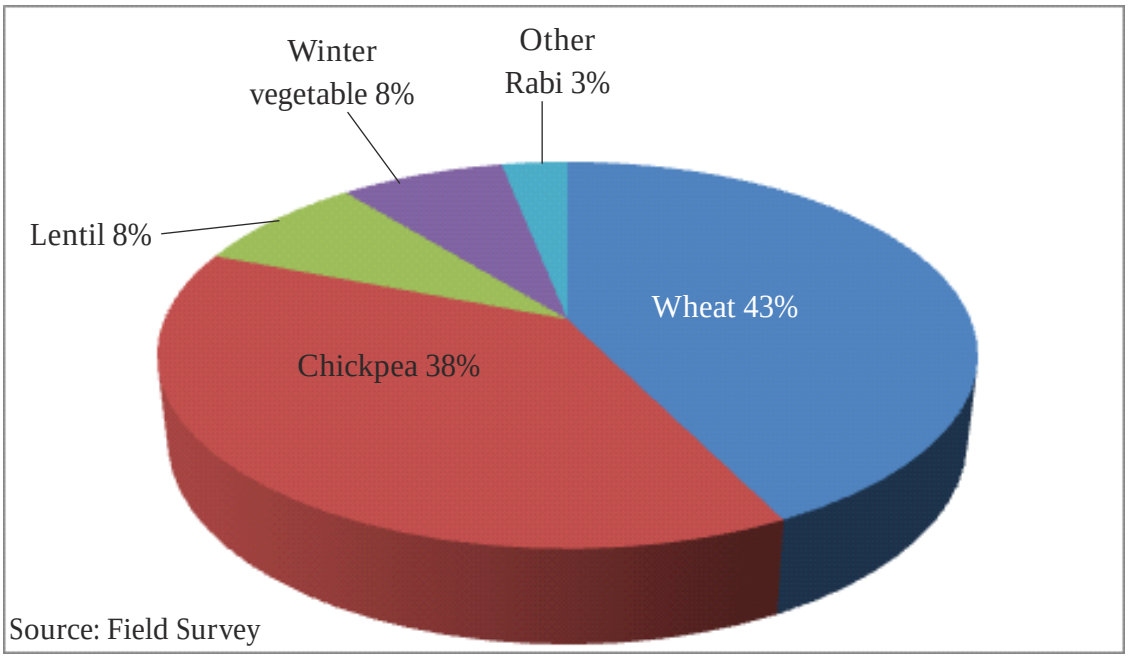


Fig. 4.5: Rabi area under cultivation of an average non- adopter

Table 4. 12: Cropping profile of non-adopter

Sr. No	Particulars	Area (ha)
A. Kharif Crop		
1	Soybean	2.09 (28.21)
2	Urad	0.72 (9.72)
3	Cotton	0.34 (4.59)
4	Chilli	0.17 (2.29)
5	Ginger	0.13 (1.75)
6	Summer vegetables	0.03 (0.40)
	Total kharif	3.48 (46.96)
B. Rabi Crop		
1	Wheat	1.65 (22.27)
2	Chick pea	1.48 (19.97)
3	Lentil	0.32 (4.32)
4	Vegetables	0.30 (4.05)
5	Other Rabi	0.12 (1.62)
	Total rabi	3.87 (52.23)
C. Perennial Crop		
1	Lemon	0.06 (0.81)
2	Total perennial	0.06 (0.81)
Gross Cropped Area(GCA)		7.41
Net Cropped Area		3.86
Cropping Intensity (%)		191.97

Source: Field Survey

An average non-adopter was found to allocate his 0.81 per cent of GCA in cultivation of perennial crops lemon (0.81%) was found to be a major perennial crop of the area. The cropping intensity of an non-adopter was found to be 191.97 per cent in the year.

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CHAPTER - V

IMPACT OF MICRO IRRIGATION IN MADHYA PRADESH

This chapter deals with the initial investment in micro-irrigation, annual maintenance, cropping status & area with and before micro-irrigation, change in area and yield, changes in production, income, input and cost of cultivation of chilli, ginger & wheat with micro irrigation and determinants/factors affecting the adoption of micro-irrigation.

5.1 Initial Investment in Micro Irrigation

An average adopter was found to investe Rs. 178645.83 and Rs. 31932.56 in installment of drip and sprinkler micro irrigation system respectively, in their field for crop production.

In the investment of total funds, the owned capital and subsidy was found to be 41.91 and 58.09 per cent respectively in case of drip irrigation system/ kit, while 61.58 and 38.14 per cent respectively in case of sprinkler irrigation system kit (Table 5.1). It is also observed that only 31.42 per cent respondents taken loan for installment of drip irrigation system on their field. An average adopter was found to invest Rs. 21142.31 for purchase of pump for micro irrigation system. At overall level an average adopter found to invest Rs. 231720.70 for installment of micro irrigation system on his

Table 5.1: Initial capital cost/investment in micro irrigation (Rs. /kit)

Item	No. Reporting	Average for all Reporting			Percent Reporting Loan as Source of Funds
		Amount Paid	Funds Subsidy Amount	Total Cost	
Drip irrigation Kit	48	74875.00 (41.91)	103770.83 (58.09)	178645.83 (100)	31.42
Sprinkler irrigation	48	19665.10 (61.58)	12267.46 (38.42)	31932.56 (100)	0
Filters (Cyclone, Disc, others)	96	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0
Pipes (Micro, Distribution, Drip, PVC, PE, others)	96	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0
Pumps (Avg. 4.50 hp)	96	21142.31 (100)	0.00 (0.00)	21142.31 (100)	0
Tube well cost (only if addl. for MI) (Avg.dept _ft)	96	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0
Total		115682.41 (49.92)	116038.29 (50.08)	231720.70 (100)	-

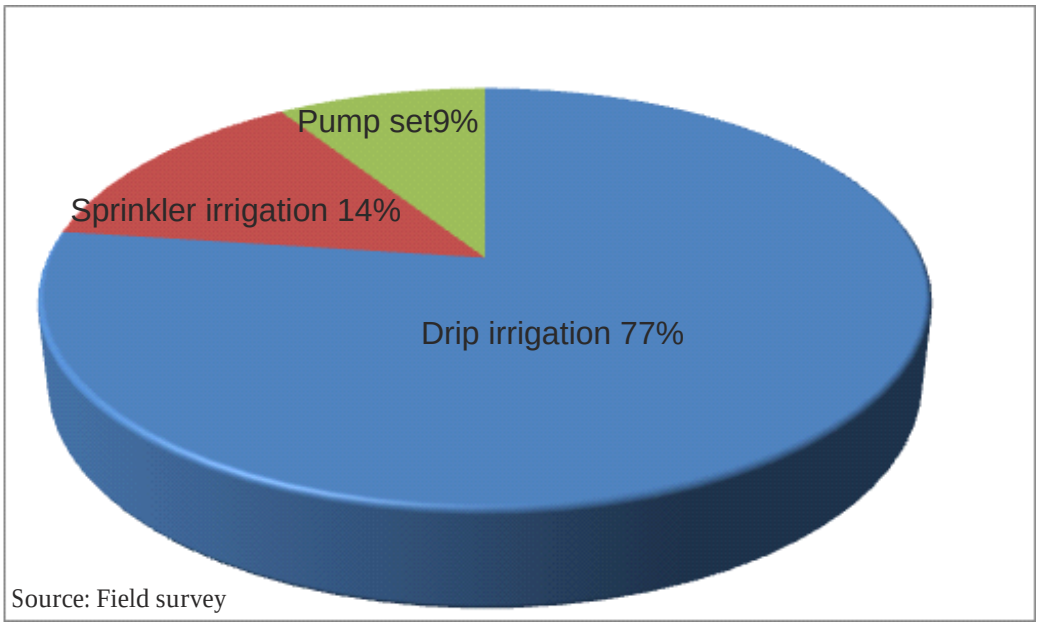


Fig. 5.1: Share of initial capital investment in Micro-irrigation

field, out of which share of drip, sprinkler and pump set was found to be 77.0, 14.0 and 9.0 per cent respectively (Fig.5.1). An average adopter share of owned fund and subsidy was found to be 50-50 percent in the area under study.

5.2 Annual Maintenance Cost of Micro Irrigation

The cost incurred in annual replacement/maintenance of micro-irrigation system by an average adopter in filter, pipes,

Table 5.2 : Annual replacement/maintenance cost of micro irrigation (Rs.)

Item	No. Reporting	Average for all Reporting			Percent reporting Loan as Source of Funds
		Amount Paid (Rs.)	Subsidy Amount	Total Cost	
Filters (Cyclone, Disc, others)	96	2435.29 (35.41)	0.00 (0.00)	2435.29 (35.41)	0.00 (0.00)
Pipes (Micro, Distribution, Drip, PVC, PE, others)	96	1662.28 (24.17)	0.00 (0.00)	1662.28 (24.17)	0.00 (0.00)
Valves	96	652.73 (9.49)	0.00 (0.00)	652.73 (9.49)	0.00 (0.00)
Any other maintenance/ replacement/repairs Charges	96	1327.14 (19.30)	0.00 (0.00)	1327.14 (19.30)	0.00 (0.00)
Any others	96	800.00 (11.63)	0.00 (0.00)	800.00 (11.63)	0.00 (0.00)
Total		6877.44 (100)	0.00 (0.00)	6877.44 (100)	0.00 (0.00)

valves etc. is presented in Table 5.2. The average annual replacement/maintenance cost of micro- irrigation reported by an average respondent was found to be Rs. 6877 out of which maximum cost was found to incurred in filter(35.41%) followed by pipes(24.17%), other maintenance charges(19.30%) and valves (9.49%). None of the farmer was found to report loan as a source of funds for annual replacement and maintenance cost of micro-irrigation in the area under study.

5.3 Source of the Equipment

The source of installation of micro irrigation kit/set and its maintenance by the adopter is presented in Table 5.3.

It is observed from the data that Jain irrigation system Ltd.(26.04%), Pragati irrigation system Pvt. Ltd.(16.67%) and Netafim Pvt. Ltd. (13.54%) were found to be major companies involved in installation of micro-irrigation set/kit as reported by the maximum number of adopters. In maintenance of micro-irrigation the Jain irrigation system Ltd. (30.97%), Netafim Pvt. Ltd. (23.87%) and Kasta Pipes Pvt. Ltd (11.61%) played an important role as reported by the maximum numbers of adopters in the area under study.

Table 5.3 : Companies as source of equipment/parts/service

Micro-irrigation Set/Kit/Initial Capital Items			Micro-irrigation Maintenance		
Company/Brand Name	Number Reporting	Percent	Company/Brand Name	Number Reporting	Percent
Jain Irrigation System Ltd.	25	26.04	Jain Irrigation System Ltd.	48	30.97
Pragati Irrigation Systems Private Limited	16	16.67	Netafim Pvt. Ltd.	37	23.87
Netafim Pvt. Ltd.	13	13.54	Kasta Pipes Pvt. Ltd.	18	11.61
Others (Apolo, Jaldeep and Shakti etc.)	42	43.75	Others (Nimbus, Pragati irrigation Pvt. Ltd. etc.)	52	33.54
Total	96	100	Total	155	100

The Jain irrigation system Ltd. was found to be a major company in installation as well as maintenance of micro-irrigation as reported by 26.04 and 30.97 per cent of adopter, respectively. Pragati irrigation system Pvt. Ltd. (16.67%) followed by Netafim Pvt. Ltd. (13.54%) were also found to be major

companies in installation of micro-irrigation set/kit. The Netafim Pvt. Ltd (23.87%) and Kasta Pipes Pvt. Ltd (11.61%) were found to be major companies providing maintenance of micro-irrigation system in the area under study.

5.4 Cropping Profile and Area with Micro-Irrigation

The data presented in Table 5.4 shows that during kharif season out of 96 adopters the maximum were found to cultivate soybean

Table 5.4 : Cropping profile and area with micro-irrigation

Sr. No	Crop	No. Of Adopters	% of Adopters	Area - Average in ha. (Based on Reporting Adopters)					
				Crop Cultivation	Drip	Sprinkler	Irrigated Non-Micro	Un-irrigated	Fertigation (%)
Kharif Season									
1	Soybean	70	72.92	1.73 (22.47)	0 (0)	0.05 (100)	1.67 (31.81)	0.01 (33.33)	0.00
2	Urad	40	41.67	1.11 (14.42)	0 (0)	0 (0)	1.09 (20.76)	0.02 (66.67)	0.00
3	Cotton	25	26.04	2.21 (28.7)	0.51 (21.7)	0 (0)	1.29 (24.57)	0 (0)	41.49
4	Paddy	15	15.63	0.94 (12.21)	0 (0)	0 (0)	0.94 (17.9)	0 (0)	0.00
5	Chilli	33	34.38	0.66 (8.57)	0.92 (39.15)	0 (0)	0.09 (1.71)	0 (0)	85.60
6	Ginger	35	36.46	0.54 (7.01)	0.56 (23.83)	0 (0)	0.02 (0.38)	0 (0)	95.46
7	Other Kharif	60	62.50	0.51 (6.62)	0.36 (15.32)	0 (0)	0.15(2.86)	0 (0)	70.27
Total Kharif		96	100	7.7 (100)	2.35 (100)	0.05 (100)	5.25 (100)	0.03 (100)	
Rabi Season									
1	Wheat	83	86.46	1.53 (36.6)	0 (0)	1.62 (46.42)	0.41 (37.61)	0 (0)	0.00
2	Chick pea	69	71.88	1.41 (33.73)	0.19 (52.78)	1.12 (32.09)	0.39 (35.78)	0.01 (16.67)	13.33
3	Lentil	16	16.67	0.6 (14.35)	0 (0)	0.53 (15.19)	0.03 (2.75)	0.05 (83.33)	0.00
4	Other Rabi	32	33.33	0.64 (15.31)	0.17 (47.22)	0.22 (6.3)	0.26 (23.85)	0(0)	26.33
Total Rabi				4.18 (100)	0.36 (100)	3.49 (100)	1.09 (100)	0.06 (100)	
Perennial Crop									
1	Lemon	15	15.63	0.8 (40.2)	0.41 (25.63)	0 (0)	0.39 (100)	0 (0)	51.37
2	Other Perennial	12	12.50	1.19 (59.8)	1.19 (74.37)	0	0	0	100
Total Perennial				1.99(100)	1.6 (100)	0 (0)	0.39 (100)	0 (0)	

Source: Field survey

(72.92%) followed by urad (41.67%), cotton (26%) and paddy (15.63%), while 36.46 per cent were found to cultivate ginger followed by chilli (34.38%) as vegetables in the area under study. On an average the maximum area was found to be allocated under cotton (2.21 ha) followed by soybean (1.73 ha), urad (1.11ha) and paddy (0.94 ha), while among vegetables the maximum area was found to be allocated under chilli (0.66 ha) and ginger (0.54 ha) by the adopter of micro irrigation.

As regards to micro irrigation, the maximum area was found to be irrigated through drip irrigation in kharif season in case of chilli (0.92ha) followed by ginger (0.56 ha) and cotton (0.51ha). The sprinkler was found to be utilized in case of soybean on an average 0.05 ha of cultivated area.

The irrigated area under non-micro irrigation system among kharif crops was found to be ranged between 0.02 (ginger) to 1.67 ha (soybean). The others crop were found to be cotton (1.29 ha), urd (1.09 ha), paddy (0.94 ha) and chilli (0.09%) in the area under study.

During rabi season 87, 72 and 17 per cent adopters were reported to cultivate wheat, chick pea and lentil, respectively on their farms. On an average, the maximum area was found to be allocated by the adopters under wheat (1.53 ha.), chickpea (1.41 ha) and lentil (0.60 ha.). As regards to micro-irrigation an average adopter was found to allocate his more rabi area in sprinkler as compared to drip. He was found to use sprinkler in wheat, chickpea, lentil and other rabi crops in 1.62, 1.12, 0.53 and 0.22 ha of cultivated land, while drip irrigation was found to be used only in chickpea (0.19ha) and other rabi crop (0.17ha).

An average area under non-micro irrigation was found to be varied between 0.03(lentil) to 0.41 ha (wheat). The un- irrigated area was found to be varied between 0.01 and 0.05 hectare in case of chickpea and lentil, respectively. In case of perennial crops lemon was found to be major crop grown by 15.63 per cent of adopters on an average area of 0.08 hectare, out of which 50 percent was found to be under micro-irrigation (drip) and 50 percent under irrigated non-micro irrigation.

The maximum fertigation was found in 95.46 per cent in ginger followed by chilli (85.60%) and cotton (41.49%). While overall fertigation in other kharif crops was found to be 70.27 per cent. The fertigation was found to be practiced in 13.33 per cent area of chick pea, 51.37 in lemon and 26.33 per cent in other rabi crops.

5.5 Cropping Profile and Area before Micro Irrigation

Cropping profile of adopted adopters before adoption of Micro irrigation and allocation area among different crops under

Table 5.5: Cropping profile and area before micro irrigation

Sr. No.	Crop Name	No. of Adopters	% of Adopters	Area -Average in ha. (Based on Reporting Adopters)		
				Total Area	Irrigated Area	Un-Irrigated Area
Kharif Season						
1	Soybean	76.00	79.17	2.01	1.96	0.04
2	Urad	32.00	33.33	1.23	1.19	0.04
3	Paddy	7.00	7.29	0.84	0.84	0.00
4	Cotton	33.00	34.38	2.61	2.43	0.17
5	Chilli	30.00	31.25	0.59	0.00	0.58
6	Ginger	33.00	34.38	0.34	0.34	0.00
7	Other Crops	36.00	37.50	0.55	0.54	0.01
Rabi Season						
1	Wheat	89.00	92.71	1.67	1.67	0.00
2	Chik pea	51.00	53.13	1.66	1.58	0.08
3	Other Crops	4.00	4.17	0.79	0.79	0.00

Source: Field survey

irrigated and un-irrigated situation across seasons are presented in table 5.5. It is observed from the data that during kharif season, out of total (96) adopters the maximum were found to grow soybean (79.17%) followed by cotton (34.38%), ginger(39.38%), urd (33.33%), chilli (31.25%) and paddy (7.29%) in the area under study. An average respondent was found to allocate his maximum area in kharif season under cotton (2.61ha.) followed by Soybean (2.01ha.), urad (1.23ha.) and paddy (0.84ha.). Amongst vegetables he allocate maximum area under chilli (0.59ha.) followed by ginger (0.34 ha). In rabi season an average adopters was found to allocate his maximum area in wheat (1.67ha.) followed by chick pea (1.66 ha.). The maximum area was found to be allocated in cotton (2.43ha.) followed by soybean (1.96ha.), urad (1.19ha.), paddy (0.84ha.) and ginger (0.34ha.). He was also found to allocate his maximum un-irrigated area under cultivation of chilli (0.58ha.) followed by cotton (0.17ha.), soybean (0.04ha) and urad (0.04ha.).

In Rabi season an average respondent was found to allocate his maximum irrigated area in cultivation of wheat (1.67 ha.) followed by chick pea (1.58 ha.) and other crops (0.79 ha.), while under un-irrigated condition. He allocated his maximum cultivated area in production of chick pea (0.08ha.).

5.6 Changes in Area and Yield due to Micro- Irrigation

The various crops were found to be grown by the adopters in the area under study, they observed increase/decrease in area and yield of various crops due to introduction of micro-irrigation in their farm. These were

Table 5.6: Change in area and yield due to micro- irrigation (% HHs)

Sr. No.	Crop	No. of Adopters	% of Adopters	Large Increase	Increase	No change	Decrease	Large Decrease	Mean
Change in Area									
1	Soybean	1	1.04	0	0	100	0	0	3.00
2	Cotton	22	22.92	5	18	55	18	5	3.00
3	Chilli	33	34.38	9	45	45	0	0	3.64
4	Ginger	35	36.46	20	31	49	0	0	3.71
5	Other kharif	64	66.67	8	56	36	0	0	3.72
6	Wheat	48	50.00	13	88	0	0	0	4.13
7	Chick pea	46	47.92	4	48	30	17	0	3.39
8	Other Rabi	23	23.96	4	13	83	0	0	3.22
9	Lemon	13	13.54	0	23	77	0	0	3.29
10	Other Perennial	13	13.54	0	62	38	0	0	3.62
Change in Yield									
1	Soybean	1	1.04	0	100	0	0	0	4.00
2	Cotton	22	22.92	5	59	36	0	0	3.68
3	Chilli	33	34.38	33	61	6	0	0	4.27
4	Ginger	35	36.46	63	34	3	0	0	4.60
5	Other kharif	64	66.67	33	61	6	0	0	4.36
6	Wheat	48	50.00	63	34	3	0	0	3.67
7	Chick pea	46	47.92	25	77	2	0	0	4.28
8	Other Rabi	23	23.96	17	33	50	0	0	3.74
9	Lemon	13	13.54	15	85	4	0	0	3.77
10	Other Perennial	13	13.54	46	46	8	0	0	4.38

Source: Field survey

categories into large increase, increase, no change, decrease, large decrease and the same are presented in table 5.6. It is clear from the data that 50 per cent adopters were found to cultivate wheat followed by chickpea (48%), ginger (36.46%), chilli (34.38%), cotton (22.92%), and lemon (13.54%). It is also observed from the data that more than 20 per cent adopter of micro irrigation reported that their area under cotton, chilli, ginger, wheat, chick pea, other kharif crops, other rabi crops and perennial crops (lemon) was found to be increased and varies from increase to large increase after introduction of micro irrigation in their farms.

The increase in area was reported by majority of adopters growing wheat (88%) followed by chilli (45%), chickpea (48%), ginger (31%) and lemon(23%), while large increase in area was reported by adopter in ginger(20%), followed by wheat (13%), chilli (9%) and other kharif crops (8%) after adoption of micro irrigation facilities on their farms. The cent percent adopters reported no change in area of soybean cultivation after the adoption of nicro irrigation facilities on their farm.

More than 50 per cent adopters reported that after of adoption of micro irrigation facilities on their farms, the yield of all the crops. viz. soybean, cotton, chilli, ginger, wheat, chick

pea other kharif crops, other rabi crop, perennial crop including lemon was found to be increased and varies between increased to large increase in the area under study. None of adopters reported decrease or large decrease in yield across all the crops after adoption of micro irrigation facilities on their farms.

5.7 Changes in Production, Income, Input and Cost of Cultivation

Change occurred after adoption ofmicro-irrigation facilities by the adopters in production, income, input and cost of cultivation of all selected crops viz. chilli, ginger and wheat separately and in total was analyzed for the study.

5.7.1 Chilli

After adoption of MI facilities (Drip), the production of chilli of an average adopters was found to be increased by 54.24 per cent from 118 (without MI) to 182 q/ha (with MI), in the area under study. His total sale value of the product (Gross Return) was also found to be increased by 87.19 per cent from Rs. 228684 (without MI) to 428064/ha (with MI), while the

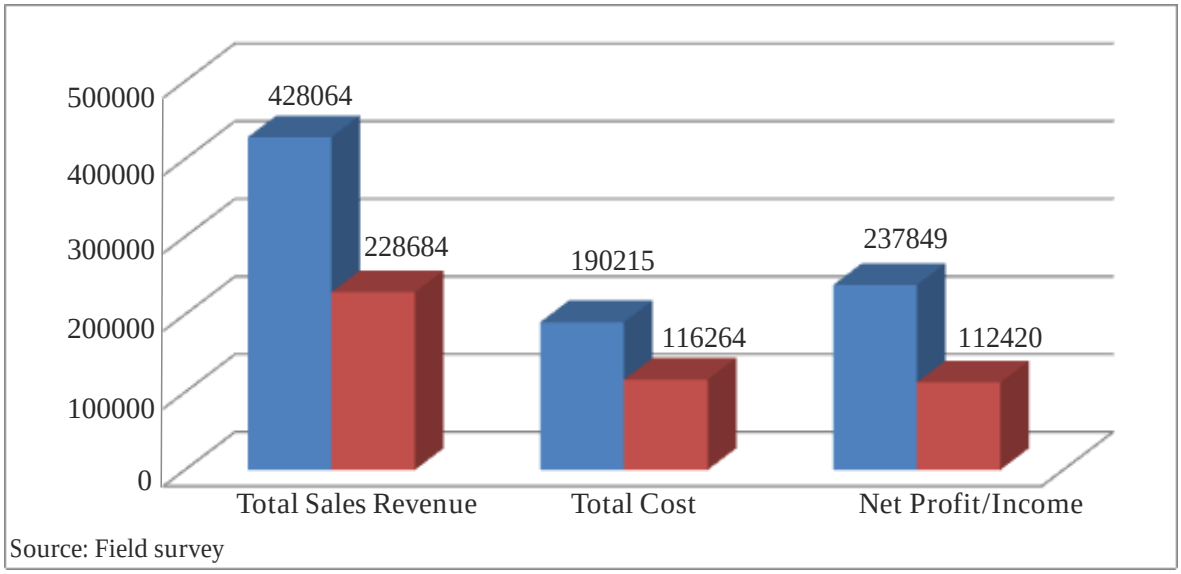
Table 5.7: Changes in production, incomes, inputs and cost with micro- irrigation of Chilli (Rs/ha)

Particulars (n=33)	With MI	Without MI	%Δ Over Without MI
Production (q)	182	118	54.24
Price (Rs)	2352	1938	21.36
Total Sales Revenue	428064	228684	87.19
Cost of Cultivation			
Seeds/Plants Cost	21866 (11.5)	15659 (13.47)	39.64
Fertilizer Cost	28414 (14.94)	19333 (16.63)	46.97
Farm Yard Manure/Organic Manures	4226 (2.22)	3843 (3.31)	9.97
Pesticides Cost	32581 (17.13)	23532 (20.24)	38.45
Cost of Irrigation			
Electricity Cost	2435 (1.28)	3867 (3.32)	-37.03
Diesel Cost	0.00 (0)	0.00 (0)	0.00
No of Irrigations	55	15	266.67
Hours of Pumping	412	612	-32.68
Farm power & Equipment Cost	16502 (8.68)	8158 (7.02)	102.28
Total man-days	317	239	32.64
Labour Cost	51163 (26.9)	32756 (28.17)	56.19
Marketing Cost	18200 (9.57)	9116 (7.84)	99.65
Other Costs			
Mulching	14828 (7.8)	00 (0)	0.00
Stacking	15672 (8.24)	10810 (9.3)	44.98
Total Cost	190215 (100)	116264 (100)	63.61
Net Profit/ Income	237849	112420	111.57
Cost of Production	1045.14	985.29	6.07
Per Rupee Return	2.25	1.97	14.41

Source: Field survey

price of product was increased by 21.36 percent after adoption of MI facilities in his farm.

After adoption of MI facilities all the expenditures on cultivation of chilli were found to be increased i.e. seeds/plants cost (39.64 %), fertilizer cost (46.97%) FYM/organic manure (9.97%), pesticide cost (38.45%), other cost (63.61%), farm power/equipment cost (102.28%), labour cost (56.19%) and marketing cost (99.65%) except cost of irrigation (-37.03%) in an average beneficiaries farm. The per rupee return over the expenditure of Rs 1.00 was also found to be increased by 14.41 per cent from Rs. 1.97 (without MI) to 2.25 (with MI) after adoption of MI technology in an average chilli grower farm. The cost of production of chilli was found to be increases by 6.07 per cent from Rs 985.29 (without MI) to 1045.14/q (with MI) after adoption of micro-irrigation in the area under study.



Source: Field survey

Fig. 5.2:Total sales revenue, total cost and net profit of chilli cultivation in with MI and without MI

5.7.2 Ginger

After adoption of MI facilities (Drip) the production of ginger of an average farmer was found to be increased by 22.56 per cent from 133 (without MI) to 163 q/ha (with MI) in the area under study. The sale value of the product (Gross Return) was also found to be increased by 116.26 per cent from Rs. 540113 (without MI) to 1168058/ha (with MI), while the price of the product was increased by 76.46 per cent after adoption of MI facilities in his farm.

After adoption of MI facilities all the expenditures on cultivation of ginger were found to be increased i.e. seeds/plants cost (159.37 %), fertilizer cost (53.49%) FYM/organic manure (40.71%), pesticide cost (84.85%), farm power/equipment cost (61.25%), labour cost (23.66%) and marketing cost (10.52%) except cost of irrigation (-55.42%) in an average beneficiaries farm. The per rupee return over the expenditure of Rs 1.00 was

Table 5.8: Changes in production, incomes, inputs and costs with micro-irrigation of Ginger (Rs/ha)

Particulars (n=31)	With MI	Without MI	%Δ Over Without MI
Production (q)	163	133	22.56
Price	7166	4061	76.46
Total Sales Revenue	1168058	540113	116.26
Cost of Cultivation			
Seeds/Plants cost	164821 (58.16)	63547 (41.87)	159.37
Fertilizer Cost	18361 (6.48)	11962 (7.88)	53.49
Farm Yard Manu re/Organic Cost	13647 (4.82)	9699 (6.39)	40.71
Pesticides Cost	16326 (5.76)	8832 (5.82)	84.85
Cost of Irrigation			
Electricity Cost	1418 (0.5)	3181 (2.1)	-55.42
No of Irrigations	70	15	366.67
Hours of Pumping	468	617	-24.15
Farm power & Equipment Cost	14095 (4.97)	8741 (5.76)	61.25
Total Man-days	246	265	-7.17
Labour Cost	38424 (13.56)	31072 (20.47)	23.66
Marketing Cost	16300 (5.75)	14749 (9.72)	10.52
Total Cost	283392 (100)	151783 (100)	86.71
Net Profit/ Income	884666	388330	127.81
Cost of Production	1738.6	1141.23	52.35
Per Rupee Return	4.12	3.56	15.83

Source: Field survey

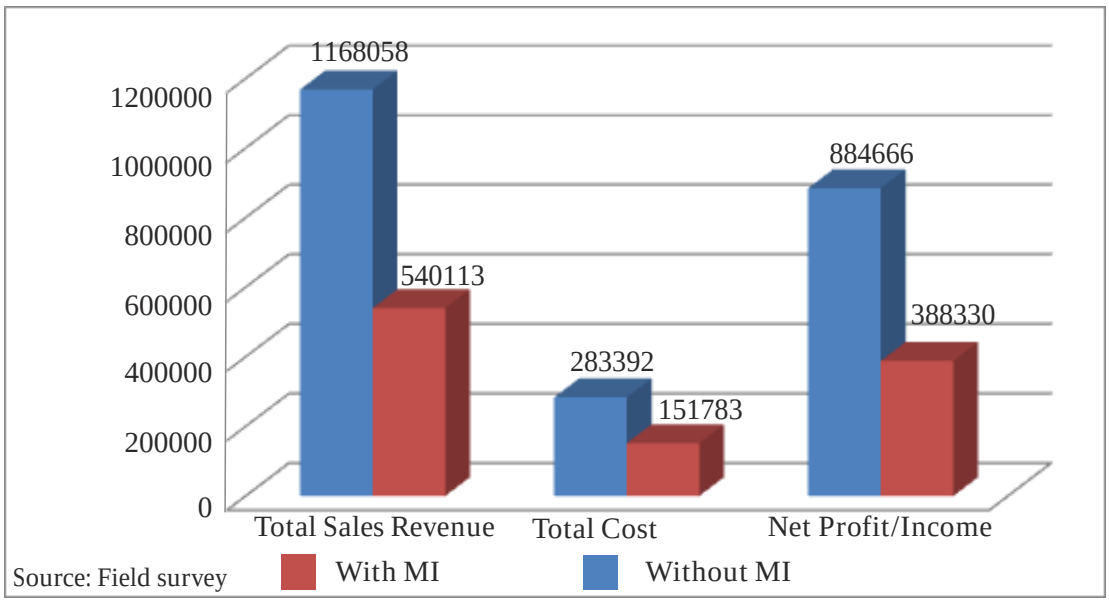


Fig. 5.3: Total sales revenue, total cost and net profit of ginger cultivation in with MI and without MI

increased by 15.83 per cent from Rs. 3.56 (without MI) to 4.12 (with MI) after adoption of MI technology in an average ginger grower farm. The cost of production of ginger was found to be increased by 52.35 per cent from Rs. 1141.23 (without MI) to 1738.6 Rs./q (with MI) after adoption of micro-irrigation in the area under study.

5.7.3 Wheat

After adoption of MI facilities (Sprinkler) the production of wheat of an average farmer was found to be increased by 10.53 per cent from 38 (without MI) to 42 q/ha (with MI) in the area under study. The sale value of the product (gross return) was also found to be increased by 21.65 per cent from Rs. 63802 (without MI) to 77616/ha (with MI), while the

Table 5.9: Changes in production, incomes, inputs and cost with micro-irrigation of Wheat (Rs/ha)

Particulars (n=48)	With MI	Without MI	%Δ Over Without MI
Production (q)	42	38	10.53
Price	1848	1679	10.07
Total Sales Revenue	77616	63802	21.65
Cost of Cultivation			
Seeds/Plants Cost	5240 (17.03)	4444 (15.34)	17.91
Fertilizer Cost	5766 (18.74)	5172 (17.86)	11.48
Farm Yard Manure/Organic Cost	1752 (5.69)	910 (3.14)	92.53
Pesticides Cost	811 (2.64)	1352 (4.67)	-40.01
Cost of Irrigation			
Electricity Cost	1838 (5.97)	2067 (7.14)	-11.08
Water Charge Paid	37 (0.12)	32 (0.11)	15.63
Diesel Cost	1330 (4.32)	1162 (4.01)	14.46
No of Irrigations	6	6	0.00
Hours of Pumping	92	283	-67.49
Farm Power & Equipment Cost	5581 (18.14)	5801 (20.03)	-3.79
Total Man-days	40	43	-6.98
Labour Cost	7530 (24.47)	7365 (25.43)	2.24
Marketing Cost	888 (2.89)	657 (2.27)	35.16
Total Cost	30773 (100)	28962 (100)	6.25
Net Profit/ Income	46843	34840	34.45
Cost of Production	732.69	762.16	-3.87
Per Rupee Return	2.52	2.20	14.49

Source: Field survey

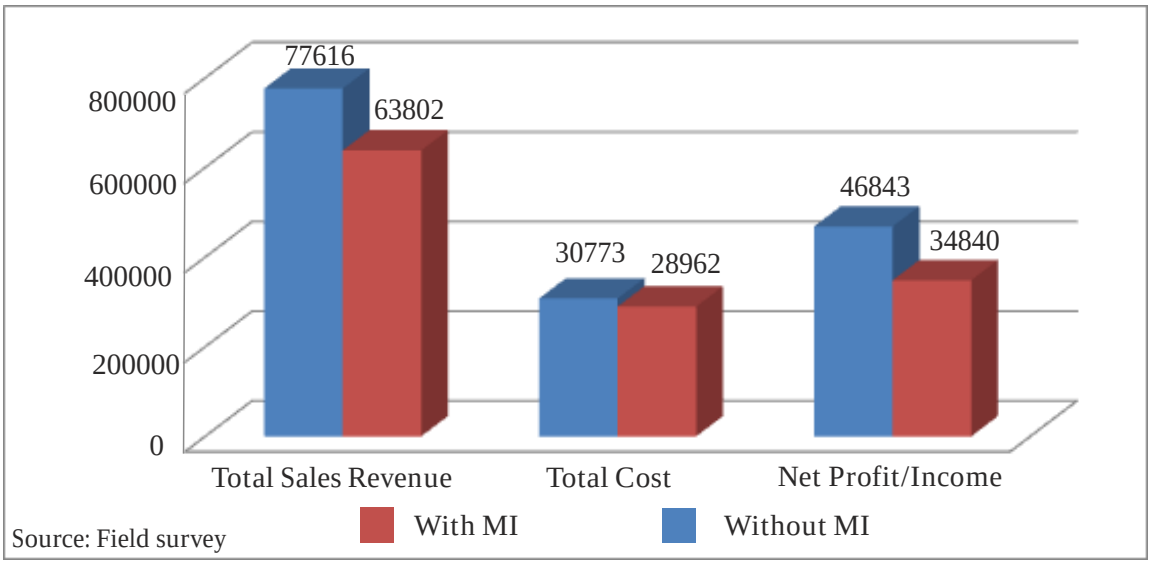


Fig. 5.4: Total sales revenue, total cost and net profit of wheat cultivation in with MI and without MI

price of the product was increased by 10.07 percent only after adoption of MI facilities in his farm.

After adoption of MI facilities all the expenditure on cultivation of wheat was found to be increased i.e. seeds/plants cost (17.91 %), fertilizer cost (11.48%) FYM/organic manure (92.53%), labour cost (2.24%) and marketing cost (35.16%) except cost of pesticide (-40.01%), irrigation cost (-11.08%) and farm power/equipment cost (-3.79%), on an average adopters. The per rupee return over the expenditure of Rs 1.00 was also increased by 14.49 per cent from Rs. 2.20 (without MI) to 2.52 (with MI) after adoption of MI technology in an average wheat grower farm. The cost of production of wheat was found to be decreases by -3.87 per cent from Rs 762.16 (without MI) to 732.69 Rs/q (with MI) after adoption of Micro-irrigation facility in the area under study.

5.7.4 All Major Crops

After adoption of MI facilities the production of all major crops of an average farmer was found to be increased by 33.91 per cent from 96 (without MI) to 129 q/ha (with MI) in the area under study. His total sale value of the product (Gross Return) was also found to be increased by 98.23 per cent from Rs. 246549 (without MI) to 488738/ha (with MI), while price of the product was increased by 48.03 percent after adoption of MI facilities in his farm.

After adoption of MI facilities all the expenditures on cultivation of all major crops were found to be increased i.e. seeds/plants cost (129.44 %), fertilizer cost (44.08%) FYM/organic manure (35.79%), pesticide cost (47.46%), other stacking cost (44.98%), farm power/equipment cost (59.37%), labour cost (36.41%) and marketing cost (44.31%) except cost of irrigation (-37.56%) in an average

Table 5.10: Changes in production, incomes, inputs and cost with micro irrigation of major crops (Rs/ha)

Particulars	Chilli		Ginger		Wheat		All Crop	
	n=33		n=31		n=48		n=112	
	With MI	Without MI	With MI	Without MI	With MI	Without MI	With MI	Without MI
Production (q)	182 (54.24)	118	163 (22.56)	133	42 (10.53)	38	129 (33.91)	96
Price	2352 (21.36)	1938	7166 (76.46)	4061	1848 (10.07)	1679	3789 (48.03)	2559
Total Sales Revenue	428064 (87.19)	228684	1168058 (116.26)	540113	77616 (21.65)	63802	488781 (98.96)	245664
Cost of Cultivation								
Seeds/Plants Cost	21866 (39.64)	15659	164821 (159.37)	63547	5240 (17.91)	4444	63976 (129.44)	27883
Fertilizer Cost	28414 (46.97)	19333	18361 (53.49)	11962	5766 (11.48)	5172	17514 (44.08)	12156
Farm Yard Manure/Organic Cost	42269.97 (9.97)	3843	13647 (40.71)	9699	1752 (92.53)	910	6542 (35.79)	4817
Pesticides Cost	32581 (38.45)	23532	16326 (84.85)	8832	811 (-40.01)	1352	16573 (47.46)	11239
Cost of Irrigation								
Electricity Cost	2435 (37.03)	3867	1418 (-55.82)	3181	1838 (-11.08)	2067	1897 (-37.56)	3038
Water Charge paid	0.00	0.00	0.00	0.00	37 (15.63)	32	12 (15.63)	11
Diesel Cost	0.00	0.00	0.00	0.00	1330 (14.46)	1162	443 (14.46)	387
No of Irrigations	55 (266.67)	15	70 (266.67)	15	6 (0.00)	6	44 (263.89)	12
Hours of Pumping	412 (-32.68)	612	468 (-24.15)	617	92 (-67.49)	283	324 (-35.71)	504
Farm Power & Equipment Cost	16502 (102.28)	8158	14095 (61.25)	8741	5581 (-3.79)	5801	12059 (59.37)	7567
Total Man-days	317 (32.64)	239	246 (7.17)	265	40 (-6.98)	43	201 (10.24)	182
Labour Cost	51163 (56.19)	32756	38424 (23.66)	31072	7530 (2.24)	7365	32372 936.41)	23731
Marketing Cost	18200 (99.65)	9116	16300 (10.52	14749	888 (35.16)	657	11796 (44.31)	8174
Other Cost								
Mulching	14828	00	0.00	0.00	0.00	0.00	4943	0
Stacking	15672 (44.98)	10810	0.00	0.00	0.00	0.00	5224 (44.98	3603
Total Cost	190215 (63.61)	116264	283392 (86.71)	151783	30773 (6.25)	28962	173351 (68.95)	102606
Net Profit/ Income	237849 (111.57)	112420	884666 (127.81)	388330	46843 (34.45)	34840	315430 (120.49)	143058
Cost of Production	1045.14 (6.07)	985.29	1738.6 (52.35)	1141.23	732.69 (3.87)	762.16	1344 (25.72)	1069
Per Rupee Return	2.25 (14.41)	1.97	4.12 (15.83)	3.56	2.52 (14.49)	2.2	2.82 (17.33)	2.40

Source: Field survey, (Figure in parenthesis show percentage change over without MI)

beneficiary's farm. The per rupee return over the expenditure of Rs 1.00 was also found to be increased by 17.33 per cent from Rs. 2.40 (without MI) to 2.82 (with MI) after adoption of MI technology on an average adopter's farm. The cost of production was found to be increased by 25.72 per cent from Rs. 1069 (without MI) to 1344 Rs./q (with MI) in the area under study.

5.8 Determinants/Factors Affecting the Adoption of MI

The various opinion of the respondents were observed with respect to agronomical potential, agro-economic potential, effective demand, aggregate supply and distribution of micro-irrigation system, across various factors affecting the adoption of micro-irrigation and categorized into different categories (Strongly agree, agree, partially agree, disagree) and presented in Table 5.11 along with their scores.

Table 5.11: Determinants/factors affecting the adoption of micro irrigation (%)

S. No.	Factors	Strongly Agree	Agree	Partially Agree/ Disagree	Disagree	Strongly Disagree	Mean	No. reporting
		5	4	3	2	1		
Agronomic Potential								
1	Micro irrigation increases yield/output	33.33	65.63	1.04	0.00	0.00	4.32	96
2	Micro irrigation saves water/ reduces water use	50.00	47.92	2.08	0.00	0.00	4.48	96
3	Micro irrigation reduces fertilizer use	13.54	36.46	36.46	11.46	2.08	3.48	96
4	Micro irrigation reduces pest problems/ pesticide use	0.00	19.79	63.54	15.63	1.04	3.02	96
5	Micro irrigation reduces weed problem	12.50	59.38	25.00	3.13	0.00	3.81	96
6	Micro irrigation reduces labour use	21.88	38.54	36.46	2.08	1.04	3.78	96
Agro- Economic Potential								
1	Capital cost of Micro irrigation is not high	5.21	16.67	29.17	27.08	21.88	2.56	96
2	Micro irrigation raises output quality/profit	15.63	57.29	27.08	0.00	0.00	3.89	96
3	Micro irrigation reduces input use/costs	10.42	32.29	46.88	9.38	1.04	3.42	96
4	Micro irrigation increases profitability/incomes	14.58	63.54	21.88	0.00	0.00	3.93	96
5	Subsidy on Micro irrigation is substantial /important	28.13	51.04	19.79	1.04	0.00	4.06	96
Effective Demand								
1	Information on Micro irrigation is easily available	21.88	55.21	21.88	1.04	0.00	3.98	96
2	Micro irrigation technology is easy to understand and operate	17.71	64.58	17.71	0.00	0.00	4.00	96
3	Subsidy for Micro irrigation is easy to get	8.33	29.17	44.79	12.50	5.21	3.23	96
4	Finance for Micro irrigation is easy to get	5.21	41.67	25.00	28.13	0.00	3.24	96
5	Electricity supply for Micro irrigation is available/reliable	15.63	62.50	16.67	4.17	1.04	3.88	96
6	Water supply for Micro irrigation is sufficient	39.58	42.71	15.63	2.08	0.00	4.20	96
Aggregate Supply								
1	There are a large number of companies supplying Micro irrigation equipment	14.58	54.17	30.21	1.04	0.00	3.82	96
2	The quality and reliability of the Micro irrigation equipment is good	9.38	51.04	38.54	1.04	0.00	3.69	96
Distribution								
1	There are a number of Micro irrigation dealers located nearby	7.29	52.08	40.63	0.00	0.00	3.67	96
2	The dealers provide good quality products you can trust	14.58	54.17	29.17	2.08	0.00	3.81	96
3	The dealers charge a reasonable price	7.29	48.96	39.58	4.17	0.00	3.59	96
4	The dealers arrange for subsidy/credit	20.83	63.54	14.58	1.04	0.00	4.04	96
5	The dealers provides after sales service	8.33	53.13	31.25	6.25	1.04	3.61	96

Source: Field survey

5.8.1 Agronomic Potential

More than 60 per cent of adopters were found to be agree and strongly agree in expressing that increase in output/yield of crops (98.96%) and reduced use of water (97.92%), fertigation and problem of weeds (71.88%) on their fields after introduction of micro irrigation facilities. The majority of respondents partially disagree with the statement that Micro irrigation reduces pest problem/pesticide used (63.54%).

5.8.2 Agro -Economic Potential

More than 40 per cent adopters were agree and strongly agreed and expressed micro irrigation facilities raised output quality (72.92%), profitability/income (78.12%) and reduces input use & cost of input (42.71%),they also expressed that the subsidy on MI is substantial/important (79.17%).

5.8.3 Effective Demand

In the area under study more than 45 per cent of adopters were found to be agree and strongly agree and expressed information of micro irrigation is easily available (77.09%), technology of micro irrigation understandable and operational (82.29%), proper financial facilities, supply of electricity is available and reliable and water supply is sufficient (78.13%) for adoption of micro irrigation facilities in their farm. 44.79 per cent adopters partially agreed upon easy availability of subsidy for Micro irrigation, while 37.50 per cent agreed and strongly agreed with easily available subsidy for Micro- irrigation.

5.8.4 Aggregate Supply

In the area under study more than 60 per cent adopters were found to be agreed and strongly agreed in expressing supply of micro irrigation equipment is sufficient as there were large number of companies for the supply of Micro-irrigation equipment (68.75%) and the quality of these equipment was also good (60.42%).

5.8.5 Distribution

In the area under study the majority of adopters were found to be agreed and partially agreed with the distribution of micro irrigation facilities as there are large number of dealers located nearby (59.37%), dealer provide good quality products(68.75%), charge reasonable price (56.25%) also arranged subsidy/credit (84.37%) and provides after sale services (61.46%) for distribution of micro irrigation equipment.

As for as the mean score of the scale for the determinants/factors affecting with respect to agronomic potential are concern, the mean score of the factors like increases yield/output (4.32), followed by reduces weeds problem (3.81), labour use (3.78) and water use (3.48)

were found to be nearer to 4 or more than 4. Hence, these were found to be major determinates of agronomical potential for adoption of micro-irrigation. In case of agro economical potential the majority of respondents were found to be agreed upon subsidy on micro irrigation is substantial /important (4.06) followed by micro-irrigation increase profit (3.93) quality of product (3.89) and reduces input use/cost (3.42). Water supply of micro-irrigation is sufficient (4.20) followed by easy to understand (4.00), its information easily available (3.98), and electricity is available and reliable in the area were found to be major factors in creating effective demand for adoption of micro-irrigation. As for as the aggregate supply in adoption of micro-irrigation is concerned the major factors were found to be large number of companies supply its equipment (3.82), with a good quality and reliability (3.69), created favorable environment in adoption of micro-irrigation. A number of micro-irrigation dealers located near (3.67) and arrange subsidy/credit (4.04) to provide good quality equipment (3.81) at reasonable price leading to horizontal expansion of micro-irrigation technology with enabling environment to adopt micro-irrigation in the area under study.

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CHAPTER - VI

CHALLENGES OF MICRO IRRIGATION

This chapter deals with the problems in relation to micro irrigation, reasons of non-adoption of micro irrigation, overall assessment of micro irrigation and suggestions for increasing the adoption of micro irrigation facilities at farmers' field.

6.1 Major Problem's in Relation to Micro-Irrigation

The major problems faced by respondents and their response in terms of strongly agree, agree, partially agree, disagree and strongly disagree across various problems are mentioned in Table 6.1.

The majority of adopters were found to strongly agree with the problems such as lack of fencing (58.33%), land fragmentation (46.88%), damage of crop and micro irrigation equipment (45.83%), difficulties getting proper government support (30.21%), poor marketing arrangement of crop produce (19.79%) and water table going down (14.58).

The majority of adopters were agreed with high cost of wells and tube-wells (57.29%), while around 45 percent adopters were found to

Table 6. 1: Major problems faced by adopters in relation to micro-irrigation (%)

S.No.	Problems	Strongly Agree	Agree	Partially Agree/Disagree	Disagree	Strongly Disagree	Mean	No. of Reporting
		5	4	3	2	1		
1	Poor quality of micro irrigation equipment	12.50	46.88	32.29	8.33	0.00	3.64	96
2	High need/cost of maintenance in micro irrigation	10.42	43.75	36.46	9.38	0.00	3.55	96
3	Inadequate water	1.04	11.46	33.33	43.75	10.42	2.49	96
4	Poor water quality	0.00	8.33	25.00	36.46	30.21	2.11	96
5	Difficulty in obtaining government subsidy & support	20.83	46.88	20.83	9.38	2.08	3.75	96
6	Unreliable electricity supply	3.13	11.46	23.96	36.46	25.00	2.31	96
7	Lack of credit	7.29	40.63	42.71	9.38	0.00	3.46	96
8	Lack of own wells/tube wells	1.04	13.54	39.58	29.17	16.67	2.53	96
9	High cost of wells/tube-wells	9.38	57.29	18.75	14.58	0.00	3.61	96
10	Water table going down fast	14.58	20.83	50.00	13.54	1.04	3.34	96
11	Lack of knowledge/training for micro irrigation	2.08	13.54	42.71	41.67	0.00	2.76	96
12	Lack of government support	6.25	12.50	34.38	34.38	12.50	2.66	96
13	Difficulty in getting government support	30.21	34.38	27.08	8.33	0.00	3.86	96
14	Lack of micro irrigation dealers in area	1.04	17.71	57.29	17.71	6.25	2.90	96
15	Poor after sales service	6.25	45.83	39.58	6.25	2.08	3.48	96
16	Low output price/profitability	1.04	13.54	43.75	39.58	2.08	2.72	96
17	Poor marketing arrangements	19.79	36.46	37.50	6.25	0.00	3.70	96
18	Land fragmentation	46.88	33.33	16.67	3.13	0.00	4.24	96
19	Damage by animals	45.83	23.96	27.08	3.13	0.00	4.13	96
20	Lack of fencing	58.33	26.04	9.38	6.25	0.00	4.36	96

agreed with the problem such as poor quality of micro-irrigation equipment difficulty in obtaining government subsidy and support, poor after sale services of dealer of micro-irrigation equipments, high cost of maintaining of micro-irrigation and lack of credit facilities (35%) poor market arrangement (36.46%) and land fragmentation (33.33%).

The 57.29 percent respondents were found to partially agree upon lack of micro-irrigation dealers in the area and water table going down fast (50%) percent, low output price/profitability (43.75%), lack of credit facilities (42.71%), lack of knowledge/training facilities (42.7%), lack of own wells/tube-wells (39.58%), poor after sale services of dealer of micro-irrigation equipments (39.58%), poor market arrangement (37.50%), high cost of maintenance of micro-irrigation (36.46%).

Around 35 percent opined that there is lack of government support, in adequate water and poor quality of micro-irrigation equipments. The 43.75 percent respondent were found to disagree upon inadequate water supply , lack of knowledge/training for micro-irrigation (41.67%) followed by low output price/profitability (39.58%), unreliable electricity supply and poor quality of water (36.46%) lack of government support (34.38%) and lack of own well and tube-wells support (29.17%).

Hence, it can be concluded that more than 50% of adopters were found to be agreed and strongly agreed with the problem of poor quality of micro irrigation equipment, high need/cost of maintenance of micro irrigation equipments, difficulty in obtaining govt. subsidies and support, lack of credit supply, high cost of well and tube-well, poor after sell services by the dealer, poor marketing arrangement, fragmentation of land, lack of fencing and damage of micro irrigation system by animals. The majority of them disagree and strongly disagree with the problem of inadequate water, poor quality of water, unreliable electric supply and lack of govt. support. They were partially agreed and disagreed with the statements like water table going down fast, lack of micro irrigation dealers and low output price and profitability.

The major problems faced by the adopters in relation to MI were lack of fencing (4.36), micro irrigation structure damage by animal (4.13), land fragmentation (4.13), difficulties in obtaining government subsidy and support (3.75), poor marketing arrangement (3.70), poor quality of Micro irrigation equipment (3.64), high cost of well/ tube well (3.61), lack of government support (3.56), high need/cost of maintenance in Micro irrigation (3.55), lack of credit facilities (3.46) and poor after sale services (3.45). The mean

score of above mentioned problems were found to be near to 4 or more than 4, indicates major problems on which majority of adopters were agreed in the area under study.

6.2 Reasons For Non-Adoption

The various reasons for non-adoption of micro-irrigation measured in scale of strongly agree to strongly disagree as reported by the non-adopter farmers were observed and listed in table 6.2. The majority of non-adopters strongly agreed with the problems like enough information about micro irrigation is not available (41.67%), lack of micro-irrigation equipments in the market (45.83%), high investment cost of micro-irrigation kit (41.67%) and credit for micro-irrigation was not available (25%), high operating cost of micro-irrigation (20.83%) and lack of information of fencing protection of wild animals (20.83%), while more than 20 non-adopters were found to be agreed on the problems like high operating cost of micro-irrigation (37.50%), subsidy for micro-irrigation is not available (37.50%), subsidy for micro-irrigation is not sufficient (29.17%) and fragmentation of land (25.00%). The more than 30 per cent of non-adopter partially agreed with the problem like no market for micro-irrigation products (41.67%), micro irrigation is not

Table 6. 2: Reasons for non-adoption (%)

S. No.	Item	Strongly Agree	Agree	Partially Agree/Disagree	Disagree	Strongly Disagree	Mean	No. reporting
		5	4	3	2	1		
1	Micro irrigation equipment not available	45.83	20.83	20.83	12.50	0.00	4.00	24
2	High investment cost of micro irrigation	41.67	16.67	16.67	20.83	4.17	3.71	24
3	High operating cost of micro irrigation	20.83	37.50	16.67	20.83	4.17	3.50	24
4	Subsidy for micro irrigation not available	16.67	37.50	12.50	29.17	4.17	3.33	24
5	Subsidy for micro irrigation not sufficient	16.67	25.00	12.50	29.17	16.67	2.96	24
6	Credit for micro irrigation not available	25.00	29.17	20.83	20.83	4.17	3.50	24
7	Not enough information about micro irrigation not available	41.67	12.50	25.00	20.83	0.00	3.75	24
8	Micro irrigation is not profitable	4.17	12.50	8.33	54.17	20.83	2.25	24
9	No market for micro irrigation crops	8.33	4.17	37.50	41.67	8.33	2.63	24
10	Micro irrigation is not suitable to crops grown	0.00	4.17	33.33	29.17	33.33	2.08	24
11	Micro irrigation is not suitable for your land	8.33	4.17	37.50	20.83	29.17	2.42	24
12	You prefer traditional irrigation	8.33	29.17	16.67	25.00	20.83	2.79	24
13	Inadequate water availability	0.00	0.00	8.33	70.83	20.83	1.87	24
14	Fragmentation of land	4.17	25.00	29.17	25.00	16.67	2.75	24
15	Crop damage by animals	12.50	8.33	37.50	37.50	4.17	2.87	24
16	Lack of fencing protection	20.83	8.33	29.17	29.17	12.50	2.96	24
17	Other	8.33	16.67	16.67	58.33	0.00	2.75	24

suitable for our land (29.17%), micro-irrigation is more suitable to crop growth (43.33%) and crop damage by the animals (37.50%).

The main reason on which majority of respondents were found to be agreed for non-adoption of micro irrigation on their fields were micro irrigation equipment are not available (4.00), lack of enough information (3.75), high investment cost (3.71), high operating cost (3.50), and unavailability of credit for micro irrigation (3.50) as mean score of these reasons were found to be nearer to 4.00 or 4.00.

6.3 Overall Assessment of Micro-Irrigation

The overall assessment of micro-irrigation of the adopters in terms of excellent, good, satisfactory, somewhat poor and very poor with respect to performance of micro-irrigation, improving water use efficiency, reducing input cost and increasing income/profit along with this their level of adoption and expansions of technology in future was observed in terms of strongly agree, agree, partially agree/ disagree, disagree/strongly disagree were measured and presented in table 6.3.

The overall performance of micro-irrigation and performance of improving water use efficiency were found to be reported excellent (45.83%) and good (50%), while performance of reducing input cost was found to be satisfactory as reported by 45.83 per cent respondents followed by good (36.46%), somewhat poor (10.42%) and excellent (5.21%). The performance on increasing income/profit was found to be good, satisfactory and excellent as reported by 62.50, 22.92 and 12.50 per cent respondents respectively.

As for as the mean score of the scale is concerned to the overall assessment of micro

Table 6. 4: Future Prospect of Micro-Irrigation as Suggested by Farmers (%)

S. No.	Item	Excellent	Good	Satisfactory	Somewhat Poor	Very Poor	Mean	No. Reporting
		5	4	3	2	1		
1	Overall performance of micro irrigation	45.8	50	4.17	0	0	4.42	96
2	Performance on Improving Water Use Efficiency	53.1	45.8	1.04	0	0	4.52	96
3	Performance on reducing input cost (such as Fertilizers, Pesticides, Labour, Electricity)	5.21	36.5	45.8	10.4	2.08	3.32	96
4	Performance on increasing incomes/Profits	12.5	62.5	22.9	2.08	0	3.85	96

Table 6. 3: Overall assessment of micro-irrigation by the farmers (%)

S.No.	Item	Strongly Agree	Agree	Partially Agree / Disagree	Disagree	Strongly Disagree	Mean	No. Reporting
1	Will you adopt/continue to use micro irrigation?	55.21	40.63	4.17	0	0	4.51	96
2	Will you expand micro irrigation use?	22.92	71.88	5.21	0	0	4.18	96

irrigation by the respondents the majority of them reported that the overall performance of micro irrigation (4.42) was found to be good to excellent as it is improving water use efficiency (4.52), increasing income and profit (3.85) and reduces cost of inputs (3.32) in cultivation of crops in the area under study.

The adopters were found to be strongly agree (55.21%) and agree (40.63%) with the statement that they will adopt and continue to use micro-irrigation, while 71.88 and 22.92 per cent adopters found to be agree and strongly agree in expanding the use of micro-irrigation in future course of action (Table 6.4). Thus, the overall performance of micro irrigation in the area under study was found to be excellent and good with respect to improved water use efficiency and increasing farmers' income and profit.

As for as the mean score of the scale is concerned, they were found to be 4.51 and 4.18 which confirms that adopters are strongly agree and agree in adopting and continue to use of micro irrigation and its expansion in future course of action.

6.4 Suggestion for Increasing Adoption of Micro-Irrigation

The various suggestions given by the respondents for increasing the adoption of micro-irrigation were measured in the scale of strongly agree to strongly disagree and presented in Table 5.4

The majority of adopters were found to be strongly agree and agree with the statement that there should be lower price of micro-irrigation equipments (85.42%), more subsidy/government assistance (85.42%), provision/support for farm fencing (84.38%), better market arrangement (85.42%), easier process of getting subsidy/government assistance (85.42%), better micro-irrigation technology/equipments (96.87%), improving water availability (72.92%) and more loan/credit facilities (69.79%) for micro irrigation system in the area under study. Only 50 per cent adopters were found to be partially agree and opined that there should be better training for micro-irrigation for the farmers in the area under study.

Table 6. 5: Suggestions for increasing the adoption and impact of micro irrigation (%)

S. No.	Item	Strongly Agree	Agree	Partially Agree/ Disagree	Disagree	Strongly Disagree	Mean	No. Reporting
		5	4	3	2	1		
1	Better micro irrigation technology /equipment	45.83	51	2.08	1.04	0	4.4	96
2	Lower price of micro irrigation	57.29	28.1	14.58	0	0	4.4	96
3	More subsidy/ government assistance	55.21	30.2	13.54	1.04	0	4.4	96
4	Easier process for getting subsidy/ government assistance	47.92	33.3	16.67	2.08	0	4.3	96
5	More loans/ credit	23.96	45.8	28.13	2.08	0	3.9	96
6	Improve water availability	28.13	44.8	25	2.08	0	4	96
7	Improve water availability	9.38	30.2	50	10.4	0	3.4	96
8	Provision/support for farm fencing	55.21	29.2	12.5	3.13	0	4.4	96
9	Better marketing arrangements	54.17	31.3	13.54	1.04	0	4.4	96

As for as the mean score of the suggestion of respondents for increasing the adoption and impact of micro irrigation is concerned it was found to be more than 4 or nearer to 4. Hence, it can be concluded that the adopters were found to be strongly agree and agree with these suggestion.

6.5 Perceived Advantages and Disadvantages of Micro-Irrigation

The majority of respondents reported that micro irrigation facilities are advantageous and strongly advantageous for higher yields (79.17%) followed by better quality (87.5%), high output price (63.54%), lower input cost (51.04%), less water need (89.58%), less labour need (72.92%), less weed problem (75%), less pest problem (42.71%), less fertilizers need (46.87%), easy marketing of output (29.17%), higher profit (83.34%), less risk/ uncertainty (40.63%) and employment for youth & others (17.71%) (Table 6.5)

As for as the mean score of these items are concerned, it is found to be nearer to 4 or more than 4 except less pest problem (3.34) revealed that micro irrigation found to be advantageous and strongly advantageous for them as it reduces water need (4.35), provide higher yield (4.10), batter quality of product

Table 6. 6: Perceived advantages and disadvantages of micro-irrigation (%)

S. No.	Item	Strong Advantage	Advantage	No Difference	Disadvantage	Strong Disadvantage	Mean	No. Reporting
		5	4	3	2	1		
1	Higher Yields	31.25	47.92	20.83	0	0	4.1	96
2	Better Quality	19.79	67.71	11.46	1.04	0	4.06	96
3	High output price	7.29	56.25	35.42	1.04	0	3.7	96
4	Lower input cost	7.29	43.75	36.46	12.5	0	3.46	96
5	Less water need	45.83	43.75	10.42	0	0	4.35	96
6	Less labour need	26.04	46.88	23.96	2.08	1.04	3.95	96
7	Less weed problem	18.75	56.25	25	0	0	3.94	96
8	Less pest problem	3.13	39.58	46.88	9.38	1.04	3.34	96
9	Less fertilizers need	14.58	32.29	42.71	8.33	2.08	3.49	96
10	Easy marketing of output	5.21	23.96	58.33	12.5	0	3.22	96
11	Higher Profit	15.63	67.71	16.67	0	0	3.99	96
12	Less risk/ Uncertainty	5.21	35.42	57.29	2.08	0	3.44	96
13	Employment for youth	2.08	15.63	65.63	16.67	0	3.03	96
Overall		14.58	63.54	21.88	0	0	3.93	96

(4.06) and reduces labour (3.95) and weeds (3.94). Adopters also fetches high output price (3.70) with lower input cost in production of crops in the area under study.

6.6 Impact of Micro-Irrigation

The large impact of micro-irrigation on village as a whole, water conservation, women, upper caste, lower caste, labour, tribal, young/youth farmers, upland farmers and low land farmers participation and environment as a whole were observed and presented in table 6.6. The impact of micro-irrigation was found to be positive in the area under study as none of the adopters reported that the impact of micro-irrigation was negative and substantially negative. The impact was found to be substantially positive in water conservation/ availability and environment as reported by 36.46 and 34.38 per cent adopters, respectively. Around 22 per cent adopters reported that there is substantially positive response by young adopters/youth, upland and low land adopters. The substantially positive impact was also observed in case of women upper caste, lower caste, labour/poor and tribal between 5 to 10 percent.

The mean score of all these items were found to be nearer to 4 or more than 4. Hence,

Table 6. 7: Larger impact of micro irrigation (%)

S. No.	Impact on	Substantially positive	Positive	No Impact	Negative	Substantially Negative	Mean	No. reporting
		5	4	3	2	1		
1	Village as a whole	41.67	41.67	16.67	0	0	4.08	96
2	Water conservation/availability	36.46	57.29	6.25	0	0	4.13	96
3	Women	5.21	52.08	42.71	0	0	3.48	96
4	Upper Caste	9.38	52.08	38.54	0	0	3.56	96
5	Lower Caste	7.29	53.13	39.58	0	0	3.53	96
6	Labour/Poor	8.33	39.58	52.08	0	0	3.45	96
7	Tribal	9.38	33.33	57.29	0	0	3.38	96
8	Young farmers/Youth	21.88	59.38	18.75	0	0	3.87	96
9	Upland farmers	20.83	36.46	42.71	0	0	3.66	96
10	Lowland farmers	22.92	51.04	26.04	0	0	3.81	96
11	Environment	34.38	31.25	34.38	0	0	3.85	96

micro-irrigation gave positive impact on village, water conservation, women, upper caste, lower caste, rural youth & farmers and upland & low land farmers with improvement of overall environment of villages in the area under study.

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CHAPTER - VII

CONCLUSION AND POLICY IMPLICATION

This chapter deals with major finding of the study which is classified under various of head such as adoption of micro irrigation in Madhya Pradesh, socio-economic status of the respondents, impact of micro irrigation in farmers' field, challenges of micro irrigation and overall impact of PMKSY-PDMC. The conclusion and policy implication are also covered in this chapter.

7.1 Major Findings

The major findings related to adoption of micro irrigation, socio-economic status of adopter and non-adopter, impact of micro irrigation and challenges of micro irrigation are given in this sub-heads

7.1.1 Adoption of Micro Irrigation

- Madhya Pradesh is found to be a leading state with respect to micro irrigated area under PDMC with total micro irrigation area of 39758 hectares, which was 0.31 percent of gross irrigated area of Madhya Pradesh 2018. Dhar was found to be a leading district under micro irrigation having 17.96 percent of micro irrigated area to total micro irrigated area of the state. The area under micro Irrigation was found to vary between 2.10 (Dindori) to 5946 (Dhar) ha. except Rewa. All the districts were found to have area under micro irrigation with the State (total of 39758.77 ha). The percent MI to total irrigated area of district was found to be maximum in Anupur (14.15%) followed by Shahdol (3.27%), Umaria (3.04%) ,Burhanpur and Alirajpur (2.97% each), Sidhi (1.56%) ,Dhar (1.33%), Jhabua (1.18%), Singrouli (1.03%) while other districts were found to have less than 1 percent area under micro irrigation to total irrigated area of districts. In state it was found to be only 0.31 percent. This indicates that the area under MI to total irrigated area of district was found to be more in western part followed by eastern and southern part of the sState.
- The highest area under micro irrigation was found to be covered by green chilli (14.89%) followed by tomato (12.38%), banana (6.48%), onion (4.85%), garlic (4.61%), potato (4.48%), peas (3.33%), okara (3.16%), coriander seeds (2.69%), brinjal (2.35%) and cabbage (2.0%), while the minimum area under beetroot (0.01%), pomegranate, anola and almond (0.01%).

7.1.2 Socio-economic status of the respondents

The socio-economic statuses of adopter and non-adopters are described under the sub-head.

7.1.2.1 Adopters

- The maximum number of adopters were found to belong under 40 to 50 years (30.21%) age group followed by 30-40 (27.08%), 50-60 (19.79%), above 60 (14.58%) and 20-30 years (8.33%) age group, none of the adopters was found below the 20 years age group. Almost 91 per cent adopters were found to be above 30 years.
- The maximum adopters were found to be educated up-to primary education (23.96%) followed by middle (19.79%), 10th standard (18.75%) 12th standard (10.42%) graduate (8.33%) and post graduate (3.13%), while 15.63 percent adopters were found to be illiterate. The maximum number of adopters were belongs to medium size group (70.83%) followed by small (17.71%), marginal (8.33%) and large (3.13%) size groups.
- None of the adopters was found to be land less/ tenant. An average adopters was found to operate 3.81 ha land, which was found to be more in case of large (15.76 ha) followed by medium (4.18 ha), small (1.60 ha) and marginal (0.84 ha.) categories.
- The average adopters had 74.54 % area under MI, which was found to be more in case of marginal (88.37%) followed by small (86.25%), medium (74.40%) and larger (65.74%) categories. The area irrigation was found to be maximum in case of large (1.59 ha) followed by medium (1.40 ha), small (0.35 ha) and marginal (0.14 ha) categories.
- The area under drip irrigation system was found to be maximum in case of large (1.59 ha) followed by medium (1.40 ha), small (.35 ha) and marginal (0.14 ha) categories. The area under sprinkler irrigation system was also found to be maximum in case of large (8.77 ha) followed by medium (1.71 ha), small (1.03 ha) and marginal (0.62 ha) categories of adopters.
- Out of 96 adopters, maximum were found to use well (28.13%) followed by tube well & well (26.04%), tube well (15.63%), tube well & river (9.38%), tube well & check dam (4.17%), well & river lift (4.17%), and canal (4.17%), well & check dam (3.13%), check dam (2.08 %) and tube well & pond (1.04%), well & pond (1.04%) and pond (1.04%).
- The maximum number of adopter reported that their area was covered by heavy soil (45.83%) followed by low (40.63%) and medium (13.53%) soil. None of the adopter was found to operate light, average and very low type of soil for crop husbandry. The majority of area was found to be flat type (85.42%) followed by up & down (11.46%) and hilly terrain (3.13 %). The maximum number of adopters (39.58%) adopted micro –irrigation in the last year (2018-19) followed by 2017-18 (32.29%), 2016-17 (25%), 2014-15 (2.08%) and current year

2019-20 (1.04%). Only 2 per cent adopters were started micro irrigation before 2016 on their farm in the area under study.

- All the respondents availed subsidy to purchase micro irrigation equipments and assets on their farms. The cent per cent adopters got subsidy for purchase of micro-irrigation system.
- An average adopter was found to allocate his 47.91 and 44.11 per cent of GCA in kharif and rabi season, respectively. He was found to use his maximum kharif area in cultivation of soybean (35%) followed by cotton (16%), urad (13%), paddy (4%), chilli (6%), ginger (5%) and other kharif vegetables (21%). Wheat was found to be a major rabi crop grown by an average adopter and allocated 39 per cent cultivated area of rabi season. Chickpea (30%), lentil (3%), other rabi (6%), winter vegetables (22%) were other major crops of rabi season cultivated by an average adopter in study area. An average adopter was also found to allocate is 7.66 per cent of GCA in cultivation of perennial crops. Out of which lemon (4.44%) was found to be a major perennial crop of the area. The cropping intensity of an adopted respondents was found to be 201.17 per cent.

7.1.2.2 Non- adopter farmers

- The maximum number of non-adopter belong to 30-40 years (45.83%) age group followed by 40-50 (25%), 50-60 (12.50%) and 20-30 (8.33%), above 60 (8.33%) year age group, while none of the non-adopted was found to be 20 years age group. Almost 91 per cent non-adopters were found to be above 30 years old.
- The maximum non- adopters were found to be educated up-to middle education (41.67%) followed by primary (25.00%), 10^{th} standard (8.33%) 12^{th} standard (4.17%) and graduate (4.17%) while 16.67 per cent non-adopters were found to be illiterate. None of the non-adopters was found to be educated up-to post-graduation and technical education. The maximum number of non-adopters belongs to medium (58.33%) followed by small (29.17%), marginal (8.33%) and large (4.17%) size groups. None of the non-adopters was found to be land less/ tenant.
- An average non-adopter was found to operate 3.86 ha land, which was found to be more in case of large (26.32 ha) followed by medium (3.83 ha), small (1.62 ha) and marginal (0.71 ha.) size groups. The irrigated area was found to be more in large (26.32 ha) followed by medium (3.83 ha), small (1.57 ha) and marginal (0.71 ha) size groups.
- Out of 24 non-adopters, the maximum were found to use canal lift (41.67%) followed by tube well (29.17%), canal (16.67%) and well

(12.50%). The excess water situation was found in 91.67 per cent area followed by no scarcity 8.33 per cent. None of the non-adopter was found to come across occasional scarcity, scarcity, accurate scarcity situation.

- The maximum number of non-adopters reported that their area covered by average soil (29.17%) followed by heavy (25%), medium (25%), light (16.67%) and low (4.17) soil. None of the non-adopter was found to operate very low type of soil for crop husbandry. The terrain was found to be flat type (79.17%) followed by up & down (16.67%) and hilly area (4.16 %).
- An average non-adopter was found to allocate his 46.96 and 52.23 per cent of GCA in kharif and rabi season respectively. He was found to use maximum kharif area in cultivation of soybean (60%) followed by urad (20%), cotton (10%), chilli (5%), ginger (4%) and other kharif crops (1%). Wheat was found to be a major rabi crop grown by an average non-adopter in which he allocate 22.27 per cent cultivated area of rabi season. Chickpea (19.97%), lentil (4.32%), winter vegetables (4.05%) were other major crops of rabi season cultivated in an average non-adopter farms in the area under study. An average non-adopter was also found to allocate his 0.81 per cent of GCA in cultivation of perennial crops, in which lemon (0.81%) was found to be a major perennial crop of the area. The cropping intensity of an non-adopter was found to be 191.97 per cent in the year.

7.1.3 Impact of micro irrigation

- An average adopter was found to investe Rs. 178645.83 and Rs. 31932.56 in installment of drip and sprinkler micro irrigation system, respectively, in their fields for crop production.
- The owned capital and subsidy were found to be 41.91 and 58.09 per cent in case of drip irrigation system/kit, while 61.58 and 38.52 per cent in case of sprinkler irrigation system kit, respectively in total funds invested. An average adopters share of owned fund and subsidy was found to be 50-50 percent in the area under study. An average adopter was found to be investe Rs. 6877 in maintenance of MI, out of which maximum cost was found to be incurred in filter (35.41%) followed by pipes (24.17%), other maintenance charges (19.30%) and valves (9.49%). None of the adopters was found to reported loan as a source of funds for annual replacement and maintenance cost of micro-irrigation in the area under study.
- The irrigation system Ltd. (26.04%), Pragati irrigation system Pvt. Ltd.(16.67%) and Netafim Pvt. Ltd. (13.54%) were found to be major companies involved in installation of

Micro-irrigation set/kit as reported by the maximum number of adopters.

- As regards to micro irrigation in kharif season, the maximum area was found to be irrigated through drip irrigation in case of chilli (0.92ha) followed by ginger (0.56 ha) and cotton (0.51ha). As regards to micro-irrigation an average adopter was found to allocate his more rabi area in sprinkler as compared to drip. He was found to use sprinkler in wheat, chickpea, lentil and other rabi crops in 1.62, 1.12, 0.53 and 0.22 ha of cultivated land, while drip irrigation was found to be used only in chickpea (0.19ha) and other rabi crop (0.17ha) only.
- The maximum fertigation was found in 95.46 per cent in ginger followed by chilli (85.60%) and cotton (41.49%). While overall fertigation in other kharif crops was found to be 70.27 per cent. The fertigation was found to be practiced in 13.33 per cent area of chick pea, 51.37 in lemon and 26.33 per cent in other rabi crops.
- More than 20 per cent adopter of micro irrigation reported that their area under cotton, chilli, ginger, wheat, chickpea, other kharif crops, other rabi crops and perennial crops (lemon) was found to be increased which range between increase to large increase after introduction of micro irrigation in their farms.
- More than 50 per cent adopters reported that after of adoption micro irrigation facilities on their farm the yield of all the crops. viz. soybean, cotton, chilli, ginger, wheat, chickpea other kharif crops, other rabi crop, perennial crop including lemon was found to be increased and ranged between increased to large increase in the area under study. None of adopters reported that the yield of any crop was decreased to large decrease after adoption of micro irrigation facilities on their farms.
- After adoption of MI facilities the production of all major crops of an average adopters was found to be increased by 33.91 per cent from 96 (without MI) to 129 q/ha (with MI) in the area under study. His total sale value of the product (gross return) was also found to be increased by 98.96 per cent from Rs. 245664 (without MI) to 488781/ha (with MI), while price of the product was increased by 48.03 per cent only after adoption of MI facilities in his farm.
- After adoption of MI facilities all the expenditures on cultivation of all major crops was found to be increased i.e. seeds/plants cost (129.44 %), fertilizer cost (44.08%) FYM/organic manure (35.79%), pesticide cost (47.46%), other stacking cost (44.98%), farm power/equipment cost (59.37%), labour cost (36.41%) and

marketing cost (44.31%) except cost of irrigation (-37.56%) in an average beneficiary's farm. This might be due to after adoption of micro irrigation facilities the beneficiaries came across in close contact with technical and scientific personals and could be able to start adopting improving technology for cultivation of the crops, adopt improved verities of seed, superior quality of pesticide, micro nutrient with fertilizer, fertigation etc. with more focus and intensive surveillance with higher interest in producing quality products. Further, assured irrigation during crop growth period encouraged adopters to invest in superior quality of inputs in cultivation of crops without hesitation. The per rupee return over the expenditure of Rs. 1.00 was found to be increased 17.33 per cent from Rs. 2.40 (without MI) to 2.82 (with MI) after adoption of MI technology on an average adopters farm. The cost of production was found to be increased by 25.72 per cent from Rs. 1069 (without MI) to 1344 Rs./q (with MI) in the area under study.

- More than 60 per cent of adopter were agreed and strongly agreed that output/yield of crops was increased by 98.96 per cent after introduction of micro irrigation increases with reduced use of water (97.92%), fertigation and problem of weeds (71.88%) on their fields. The majority of respondents partially disagree with the statement that micro irrigation reduces pest problem/pesticide used (63.54%).
- More than 40 per cent adopter were agreed and strongly agreed with micro irrigation facilities raised output quality (72.92%), profitability/income (78.12%) and reduces input use & cost of input (42.71%).
- More than 45 per cent of adopters were agreed and strongly agreed upon information of micro irrigation is easily available(77.09%), technology of micro irrigation understandable and operational (82.29%), proper financial facilities, supply of electricity in available and reliable and water supply in sufficient (78.13%) for adoption of micro irrigation facilities on their farm. The 44.79 per cent adopters partially agree, while 37.50 per cent were strongly agree on easily available subsidy for micro- irrigation.
- More than 60 per cent adopters were found to be agree and strongly agree with the statement that supply of micro irrigation equipment is sufficient as there were found to be large number of companies for the supply of micro-irrigation equipments (68.75%) and the quality of these equipments also good (60.42%).
- The majority of respondents were agree and partially agree with the distribution of micro irrigation facilities as there are large number

of dealers located nearby (59.37%), dealer provide good quality products(68.75%), and charge reasonable price (56.25%) and also arranged subsidy/credit (84.37%) and provides after sale services (61.46%) for micro irrigation equipments.

- The majority of adopters were agree with high cost of wells and tube-wells (57.29%), while around 45 percent respondents were found to be agree with the problem such as poor quality of micro-irrigation equipment difficulty in obtaining government subsidy and support, poor after sale services from dealer of micro-irrigation equipments, high cost of maintaining of micro-irrigation and lack of credit facilities around (35%) poor market arrangement (36.46%) and land fragmentation (33.33%).

7.1.4 Challenges of micro irrigation

- More than 50% of adopters agreed and strongly agreed with the problem of poor quality of micro irrigation equipment, high need/cost of maintenance of micro irrigation equipments, difficulty in obtaining govt. subsidies and support, high cost of well and tube-well, poor after sell services by the dealer, poor marketing arrangement, fragmentation of land, lack of fencing & damage of micro irrigation system by animals, not enough information about micro irrigation is available (41.67%), lack of micro-irrigation equipment's in the market (45.83%), high investment cost of micro-irrigation kit (41.67%) credit for micro-irrigation was not available (25%), and high operating cost of micro-irrigation (20.83%). The majority of them disagree and strongly disagree with the problem of inadequate water, poor quality of water, unreliable electric supply and lack of govt. support. They were partial agree and disagree with the statements like water table doing down fast, lack of micro irrigation dealers and low output price and profitability.

7.1.5 Overall impact of micro irrigation

- The majority of adopter of micro irrigation beneficiaries under PYKSY-PDMC agreed and strongly agreed to expand the use of micro-irrigation in future course of action. The overall performance of micro irrigation in the area under study was found to be excellent and good with respect to improved water use efficiency and increasing in farmer's income and profit. The majority of respondents were found to be strongly agreed and agreed with the statement that there should be lower price of micro-irrigation equipments (85.42%), more subsidy/Government assistance (85.42%), provision/support for farm fencing (84.38%), better market arrangement

(85.42%), easier process of getting subsidy/Government assistance (85.42%), better Micro-irrigation technology/ equipment (96.87%), improving water availability (72.92%) and more loan/credit facilities (69.79%), better training for micro-irrigation for the farmers in the area under study.

- Micro irrigation facilities provided under PMKSY-PDMC were found to be advantageous and strongly advantageous for higher yields (79.17%) followed by better quality (87.5%), high output price (63.54%), lower input cost (51.04%), less water need (89.58%), less labour need (72.92%), less weed problem (75%), less pest problem (42.71%), less fertilizers need (46.87%), easy marketing of output (29.17%), higher profit (83.34%), less risk/ uncertainty (40.63%) and employment for youth & others (17.71%) as reported by majority of adopters.
- The overall impact of micro-irrigation was found to be positive in the area under study as none of the adopters reported that the impact of micro-irrigation was negative and substantially negative. micro-irrigation gave positive impact on water conservation, women, upper caste, lower caste, rural youth & farmers and upland & low land farmers with improvement of overall environment of villages in the area under study.

7.2 Conclusion and Policy Implication

It can be concluded from the above findings that:

- ☑ Madhya Pradesh is one of the leading state in successfully introduction of micro irrigation facilities at farmers' field under PMKSY - PDMC in all most all the districts to ensure food security for the growing population in the face of climatic change, scare and limited water & land resources and to provide irrigation to every farm through improvement of water use efficiency. Government of Madhya Pradesh done excellent efforts in creating MI facilities through providing subsidy, equipments, technical knowledge etc. to beneficiaries under the programme. Although, farmers of Anuppur, Shahdol, Umaria, Burhanpur, Alirajpur, Sidhi, Dhar, Jhabua and Singroli were found to be benefitted more than rest of the districts. Hence, efforts should be made in such a way that across district of the State will be benefitted by such an excellent programme of the Govt. of India.
- ☑ There was remarkable difference found between adopters and non-adopters with respect to their age, educational status, land use, cropping pattern, cropping intensity, type of soil, terrain of land, irrigated area. But after the adoption of MI facilities by the

adopters on their fields the area under commercial crops viz. chilli, tomato, ginger, etc. was found to be increased manifolds as compared to non- adopters. The yield of all the crops i.e. agricultural, horticultural, and perennial crops was also found to be increased in the area under study. With the results of the increased in the area and yield of the crops, the production of all the crops cultivated by adopters also found to be increased by33.91 per cent as compared to non-adopters. The total sale value of the products was also found to be increased by 98.23 per cent, while price of the product was increased by 48.03 per cent only after adoption of MI facilities on their farms.

- ☑ After adoption on MI facilities in cultivation of crops, the expenditure on cost of irrigation was found to be decreased by 37.56 per cent after adoption MI facilities due to improvement in quality of output. Although, the expenditure of all the other items viz. seed, fertilizer, manures, pesticides, labour etc. were found to be increased but the per rupee return on investment of Re. 1.00 increased by 17.77 per cent from Rs. 2.40 to 2.82 after adoption of MI technology in the farms. It is also clear from the finding that introduction of MI facilities in adopters fields capital intensive which raised profitability, income of adopters.
- ☑ It is easy to adopt MI facilities by adopters as information on micro irrigation is easily available to the fallow farmers, it is understandable and operational, with proper financial facilities with supply of electricity, reliable water supply and sufficient micro irrigation equipment. A large number of dealers also located nearby & charges reasonable price & provide after sale services with quality MI equipment in the area under study.
- ☑ The major problems faced by adopters of MI facilities in the area under study as reported by majority of adopters were high cost of wells and tube wells, difficulty in obtaining Govt. subsidy and support, high cost of maintenance of MI equipment, non-availability of loan for maintenance of MI equipment's poor marketing arrangement, fragmentation of land, lack of fencing and damage of MI system by animals.
- ☑ MI facilities are advantageous for higher yield, better quality of products, high output price, less water, labour, fertilizer etc. need, easy marketing of out- put, less risk/ uncertainty at provide employment for youths and others.
- ☑ After adoption of micro irrigation by the adopters they sifted from low value to high value crops, thereby change in cropping pattern of the area. This calls for building a

new market infrastructure including efficient cold, supply and value chain management, farm get level processing and bringing institutional reform in place for establishing efficient economic environment in the area under study. Which not only ensure remunerative prices for farming communities but also provide nonfarm employment avenues for youth in a big way.

- ☑ The impact of PMKSY-PDMC was found to be positive on water conservation, participation of women, upper caste, lower caste, rural youth, upland and low land farmers with improvement of overall environment in the area under study through optimal utilization of scare and limited water and land resources, fertigation and water use efficiency of farmers field. Hence, overall impact of PMKSY, PDMC is found to be positive in case of water conservation and overall environment of the village. Efforts should be made to promote MI in all the districts of the State with proper awareness of programme. Efforts should also be made to lower down the price of MI equipment's in order to reduce the subsidy in a gradual manner for the horizontal expansion of the technology on large scale, provision/ support for farm fencing, easier process getting subsidy/Govt assistance for latest and improved MI technology/ equipment's and better training for MI for the farmers is required for betterment of programme as majority of the adopters strongly agreed to expand the use of MI in future course of action.

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ANNEXURE-I

COMMENTS AND ACTION TAKEN REPORT

Comments from Centre for Management in Agriculture, Indian Institute of Management Ahmedabad, Project Coordinator: Prof. Vasant Gandhi

(I) Title of the Draft Report Examined: Improving Water Use Efficiency in India's Agriculture: Benefits, Impact and Challenges of Micro-Irrigation - Under PMKSY-PDMC in Madhya Pradesh (Pradhan Mantri Krishi Sinchayee Yojana- Per Drop More Crop)

(II) Date of Receipt of the DRAFT Report: October 23, 2020

(III) Date of Dispatch of the Comments: December 21, 2020

(IV) A. General Comments

1. Given the topic and objectives, this is a very important study for India's agriculture, the government, and the efficient use of scarce natural resources. Water use efficiency and productivity are poor in India and there is a great need and scope for improvement. Micro irrigation is a very promising and highly efficient water saving technology. With the need for and the government objective of substantially increasing its use, it is very important to understand the factors affecting its adoption, the impact, and the performance of the PMKSY-PDMC scheme for its promotion in helping the adoption of micro irrigation in the state of Madhya Pradesh.

2. The study objectives are appropriate and sound. They cover all the important aspects including adoption of micro irrigation, and its efficiency in saving water and other inputs. They also include examining the impact of micro-irrigation on crop productivity, input use, incomes and development in Madhya Pradesh, also touching upon the constraints of the non-adopters of micro-irrigation.

3. The presentation of the study including maps, data analysis, and findings is in general very well done.

4. The title of report may be edited slightly to bring it in line with that in the proposal: Improving Water Use Efficiency in India's Agriculture: The Impact, Benefits and Challenges of Micro-Irrigation under the Pradhan Mantri Krishi Sinchayee Yojana: Per Drop More Crop (PMKSY-PDMC) in Madhya Pradesh.

Action: Corrected as Suggested

B. Comments on the Methodology and Analysis Presentation

1. Kindly make and include a brief executive summary of the report in the beginning. This is necessary and useful for the readers to get a quick idea about the report.

Action: Corrected as Suggested

2. Page 4 – If possible, please update some statistics, such as of area under MI in India to the latest and its percentage share of irrigated area - it is close to 13 per cent of irrigated area now. The data is more than 12 million hectares under MI (see economic survey) or mention the reference year of the data and source.

Action: Corrected as Suggested

3. Page 5-10 – It is suggested that Sections 1.3, 1.4 & 1.5 related to sampling may be shifted to Chapter 3 which can be retitled to Sampling, Sample Profile and Methodology. Thus, discussion of the sample survey and analysis of its data starts entirely after the Overview chapter, which is better for sequence and continuity.

Action: Corrected as Suggested

4. Page 7, Table 1.2: Instead of "Crop selected" state "Main MI Crop", since the crop is not selected in the sampling, but only the district, block & village. Crop are observed & reported.

Action: Corrected as Suggested

5. Page 30 Table 3.2 – Please recheck the data in the Table for micro-irrigation total, drip and sprinkler in 5th, 6th and 7th columns as the data seem to be adding up for different categories, rather should be mean areas. Mean areas for total micro irrigation, drip irrigation and sprinkler irrigation needs not be adding up but it should be varying.

Action: Corrected as Suggested

6. Page 31 Table 3.4 - Categories of soil type are only three Light Medium Heavy, there was an error in codes, you might like to correct the data and table on the basis that codes for average, low and very low are basically "Light, Medium, Heavy" type soil category. Similar correction needs to be done for Page 38 Table 3.11. Also correct the write up according to that.

Action: Corrected as Suggested

7. Page 45 Table 4.4 – Please give the percentage distribution of the area under each crop: under MI, drip, sprinkler, non-MI and unirrigated. This is very important to show the MI adoption levels in each of the crops. The Table can be extended or a separate Table added.

Action: Corrected as Suggested

8. Page 54 Table 4.11 – In many Tables using the data from the 5 to 1 Likert scale values, the mean values are not correctly calculated. Weighted mean should be taken and not mean percentage. The mean values will come out between 5 and 1. Please change these. Same change is also needed from Page 57 onwards in Table 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, and 5.7. Please check for any other similar errors. (Note, for example, that the mean values are correctly calculated in Table 4.6 on page 47)

Action: Corrected as Suggested

9. In summary section, you need not extensively repeat from the Introduction e.g. objectives, data and methodology. You may focus on key findings and conclusions.

Action: Corrected as Suggested

10. Any qualitative/ informal observations from the farmers or field surveyors regarding MI implementation can be added.

Action: Corrected as Suggested

11. Page 73 - In the conclusion section some observations/ possible answers to questions/ findings can be added - why there is an increase in cost of cultivation., any observations from field/ farmers on why there is an increase in various costs like fertilizers, seeds, and pesticides. You

can add any reasons or "why" observations to improve the understanding. For example - Why there is more fertilizer use? Why there is more pesticide use and cost?

Action: Corrected as Suggested

12. If you have some photographs from the field, they could be added to the cover and other parts of the report. If the field team saw some innovation in the use/ methods such as solar based drip irrigation or any other, they could be added.

Action: Corrected as Suggested

(V) Overall View on Acceptability of the Report

The report presents the study and its findings very well. It is substantial, useful and should be accepted. If some of the suggestions and comments given above can be addressed, it will help to further improve the report.

Agro Economic Research Centre for Madhya Pradesh & Chattishgarh

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) 482 004

E-mail: aerc_jbp@yahoo.co.in, Web: www.aerc.jnkvv.org