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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 Yojna:Per
Drop More Crop (PMKSY-PDMC) in Uttar Pradesh**

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Government of India, New Delhi**

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Preface

Among various input resources in the form of land, labour and capital; through land area under the crop; investments on seeds, manures & fertilizers, pesticides; labour hours/days; in crop cultivation(s), water is an unparalleled resource of its own kind; for the simple reason that, “no crop” can be grown without water, i.e., proper and desired irrigation. Further, owing to its scarcity, water has to be essentially used most optimally and also effectively in the sense, that it is used neither in excess nor as short of required quantum; and that the quantity of water used towards crop irrigation should benefit not only one, but a number of crops to possible extent.

It has been with this initiation; that among various components of PMKSY (Pradhan Mantri Krishi Sinchayee Yojna); the present study corresponds to the “Per Drop More Crop (PDMC)” component of PMKSY; which is effective in the country w.e.f 2015-16; while the present study is being conducted in five states of the country, including Uttar Pradesh; by the Ministry of Agriculture and Farmers Welfare, Govt. of India; as an Evaluation of Micro-Irrigation programme in Improving Water Use Efficiency in India’s Agriculture; towards larger interests of farming community; in terms of (i) Enhancing farmers income through higher crop productions and (ii) Lowering down farmers burden(s) in terms of cost expenses through less (reduced) input application like those of irrigation hours, fertilizers and pesticides application, labour days, fuel and electricity charges etc.; as a result of adopting this most advanced and innovative irrigation technique; i.e., Micro-Irrigation (MI), mainly consisting of drip and sprinkler methods and based on principle of pressurized irrigation,

The present study; which has been conducted in the state of Uttar Pradesh, by the Agro-Economic Research Centre (AERC) Prayagraj, under the overall guidance of the Coordinating Centre; the CMA (Centre of Management in Agriculture), IIM (Indian Institute of Management) Ahmedabad and sponsorship of Ministry of Agriculture and Farmers Welfare, Govt. of India; revealed that as a result of adopting Micro-irrigation (MI), the sample farmers (MI adopters) are benefitted not only in one, but in a number of ways; like (a) Enhancing (i) Crop production (ii) Crop price (iii) Total Sales Revenue (iv) Net Profit/Income and (b) Reducing expenses (costs) on

(i) Seeds/Plants (ii) Fertilizers (Iii) Pesticides (Iv) Diesel (v) Hours of Pumping (vi) Farm Power and Equipment etc; apart from other MI associated benefits, at the farm level.

The study was undertaken under my overall supervision. The Field Survey, Tabulation and Analysis of Data were conducted by Sri Hasib Ahmad, Research Associate, Ms. Twinkle Thapa, Research Fellow and Mr. Gaurav Prajapati, Research Fellow of the Centre; while Shri S.N. Shukla (retired Research Associate of the Centre) also, conducted the field survey of this study. Sri Ovesh Ahmad and Ms. Twinkle Thapa typed the report nicely; while the supervision as well as drafting of the Report was accomplished by Dr. Ashok Kumar, Research Officer (contractual) of the Centre.

I acknowledge, with many thanks, the valuable contributions of all the concerned officials of the State, District, Block, Village levels, to name with Director, Horticulture and Food Processing, Uttar Pradesh, Sri. S.B. Sharma; Joint Director Horticulture (MI), Dr. N.L.M Tripathi; District Horticulture Officer (DHO) Prayagraj, Dr. Pratibha Pandey; Deputy Director, Sri Pankaj Shukla; (Sonbhadra) Sri. S.K. Sharma; DHO (Sonbhadra), Sri. Arun Kumar; DHO (Saharanpur), the sample farmers and all those who assisted and cooperated in this study, selflessly at all the stages and many times, even at their personal inconveniences.

I also express my heartiest thanks to Prof. Vasant P. Gandhi, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad for his constructive comments and valued suggestions given on the draft report.

Any comments and suggestions for improvement in the report, are highly solicited and will be acknowledged most thankfully.

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List of Acronyms

AERC	-	Agro-Economic Research Centre
AERU	-	Agro-Economic Research Unit
AIBP	-	Accelerated Irrigation Benefit Programme
CADWM	-	Command Area Development and Water Management
CEO	-	Chief Executive Officer
CMA	-	Centre for Management in Agriculture
CSS	-	Centrally Sponsored Scheme
DAC&FW	-	Department of Agriculture, Cooperation and Farmers Welfare
DRDA	-	District Rural Development Agency
DIP	-	District Irrigation Programme
DLIC	-	District Level Implementation Committee
GoI	-	Government of India
IDWG	-	Inter Departmental Working Group
IIM	-	Indian Institute of Management
IWMP	-	Integrated Watershed Management Programme
MGNREGA	-	Mahatma Gandhi National Rural Employment Guarantee Act
MoA&FW	-	Ministry of Agriculture and Farmers Welfare
MI	-	Micro-Irrigation
MIS	-	Micro-irrigation System
NEC	-	National Executive Committee

NGO	-	Non-Government Organization
NMMI	-	National Mission on Micro Irrigation
NMSA	-	National Mission on Sustainable Agriculture
NSC	-	National Steering Committee
OFWM	-	On Farm Water Management
OI	-	Other Interventions
PDMC	-	Per Drop More Crop
PMKSY	-	Pradhan Mantri Krishi Sinchayee Yojana
SIP	-	State Irrigation Programme
SLSC	-	State Level Sanctioning Committee

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Executive Summary

Apart from the utility of conventional flow irrigation practice, which ofcourse, can not be ruled out altogether; the ever increasing demand of water towards irrigation of field crops, associated with relatively much low efficiency of conventional irrigation methods, focuses on need for special attention by policy makers and national planners towards initiation of advanced-cum-innovative High-tech irrigation infrastructure, along with its efficient management and action plan. This is an urgent need of the hour, towards raising water use efficiency in respect of crop irrigation as well as its related aspects like those of water-pumping, lifting, harvesting, shifting from water plenty to water scarce areas etc. through use of improved irrigation practices, among which the prime one, based on pressurized water flow irrigation system, is the Micro-Irrigation(MI) technique, mainly consisting of Drip/Sprinkler irrigation device. It is with this motto under consideration, that the present study has been initiated by our national government and is being conducted in five status of India, including Uttar Pradesh:as an evaluation of Per Drop More Crop(PDMC) component of Pradhan Mantri Krishi Sinchayee Yojna(PMKSJ) towards the impact, benefits and challenges of MI system; to the entire farming community in particular and the overall agriculture sector in general, in accelerating India's economic growth.

Objectives of the Study:

The PDMC component of PMKSJ mainly focuses on water use efficiency at the farm level , through precision / Micro (Drip and Sprinkler)irrigation. The main objective of the study is to analyse various benefits of MI to farmers including input use, cost and returns; with following specific 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 crops including water-intensive crops such as sugarcane and banana and if there is employment generation due to MI.

- (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 across states.
- (d) To study overall impact on farmer incomes and cost-benefit in selected crops.
- (e) To identify any issues/problems in the benefit transfer work flow and monitoring by the implementation agency.

Methodology of the study:

(The detailed methodology has been given in the report)

Sampling Framework:

A field survey has been conducted, using a multi(four) stage stratified random sampling with district forming first stage, block/ taluka the second stage, village the third stage and finally the farmer (MI adopter/Non adopter) as the fourth stage “or” the ultimate unit of sampling and conducting the survey, for the agricultural year 2018-19.

As per “MI–sampling plan” of the present study , the selection procedure has been as: 2 districts per state; 2 blocks/ taluka per district; 3 villages/ cluster in each block/ taluka; 8 adopters and 2 non-adopters in each village; which ultimately gives a sample of 96 Adopters + 24 Non-adopters in each state; resulting to a total sample of 120 farmers in the state; while it may also be mentioned that the two districts selected in the state of Uttar Pradesh for the present study, have been the districts Sonbhadra and Saharanpur.

Major Findings of the Study:

To provide enhanced clarity and presentability, the major findings of this study have been summarized and presented under various “sub-headings”, as below:

(a) PDMC in Uttar Pradesh

- (i) The Action Plan Area of PDMC component of PMKSY in U.P., consists of all of its 75 districts and that the MI programmes are equally applicable to Horticulture, Agriculture

and Sugarcane crops, while under other interventions of PDMC (Micro-Irrigation) component, the priority areas by over exploited, critical, semi-critical and Minor Irrigation Department are developed tanks/water source clusters and Member of Parliament (M.P)'s Adopted Villages.

- (ii) In the State of Uttar Pradesh; “Agriculture Department” has been nominated as the Nodal Agency for PMKSY; while “Department of Horticulture and Food Processing” as Implementation agency for PDMC component of PMKSY.
- (iii) On overall basis for the state of Uttar Pradesh; Progressive M.I. coverage upto 2019-20 has been of the order of 277282, area under M.I. during 2019-20 as 56953 ha. and the progressive M.I. as percentage of total irrigated area in 2019-20 has been 1.93%; while of the total adopted area under MI, i.e., 56953 ha, 59.80% has been under Horticulture crops, like Potato, Tomato, Onion, Cauliflower and 40.20% under Agriculture crops, like Wheat, Pulses, Sugarcane, Maize.
- (iv) It is also to be mentioned; that the crops like Mango, Guava, Banana, Citrus, Papaya, Garlic, Ginger, Linseed, Groundnut have also been occupying MI adopted area in the state of Uttar Pradesh, but to a very meagre extent.

(b) Sample MI adopters and their profile

- (i) All MI adopters in the study area (96) started using MI technique w.e.f. 2018-19.
- (ii) Among total MI adopters, majority (59.38%) belonged to small (1-2) ha size, i.e., 1 ha and more but less than 2 ha, followed by Medium (2-10) ha (34.37%) and Marginal (<1 ha) size (6.25%); with no landless/tenant or Large (>10 ha) category farmers.
- (iii) “Tube-well” has been the main source of irrigation for 95.53% of MI adopters; while as per water situation, for 96.88% of farmers there has been no scarcity of water, with 3.12% being subject, to occasional scarcity or excess water situation.
- (iv) Category wise extent of irrigated area being more than 95% in each category; with overall sample average as 97.73% and that the breakup of irrigated area as Micro vs Non Micro has been as 66.86% and 33.14%.
- (v) In respect of rainfall, 82.29% of total MI adopters were subject to average rainfall, while 17.71% had heavy rainfall.

- (vi) With regard to type of soil, majority (62.50%) had Medium soil, 34.37% Heavy Soil and 3.13% Light Soil; while no adopter had Hilly terrain with majority (77.08%) having Flat terrain and 22.92% up & down terrain.

(c) Cropping profile and fertigation: MI adopters

- (i) Among 96 MI adopters (a) The adoption of major kharif crops being as Paddy (80), Maize (20), Chilli (15), Tomato (14) while major rabi crops being Wheat (84), Berseem (19), Chilli (16), Tomato (13) and Mustard (12); with Sugarcane as a perennial crop being grown by 28 farmers.
- (ii) For MI adopters, the average per farmer area under various crops have been as Sugarcane -1.26 ha; Wheat-1.10 ha; Paddy-1.05 ha; Tomato- (0.99 ha in Kharif+1.03 ha in Rabi); Arhar (Tur)-0.85 ha, Maize-0.82 ha; Chilli- (0.41 ha in Kharif+0.50 ha in Rabi); Onion- (0.25 ha in Kharif+ 0.31 ha in Rabi).
- (iii) (a) Under Kharif season; Paddy, Maize, Gourd, Cucumber, Fodder had entire crop area irrigated by Non-Micro sources; while Arhar, Til, Jowar had entire area as unirrigated.
- (iv) Under Rabi season, all crops have been fully irrigated by Micro or Non- Micro sources; except Gram, having partially unirrigated area.
- (v) Crop wise; (a) Drip irrigation has been used for Tomato and Chilli (b) Sprinkler irrigation for Wheat, Pea, Mustard, Berseem and Sugarcane (c) (Drip+Sprinkler) both, for Onion.
- (vi) The extent of fertigation on per farmer area basis, has been highest in Sugarcane (96.00%); followed by Onion (75% in Rabi & 50% in Kharif); Chilli (62% in Rabi & 60% in Kharif); Wheat (58.33%) and Pea (50%).

(d) Impact of MI adoption on change in area, yield and other related factors for major crops.

- (i) It is noteworthy, that in case of all the three major MI adopting crops in the study area, viz Tomato, Wheat and Sugarcane; the extent of farmers reporting for change (Higher Increase/Increase) has been relatively much higher in yield as compared to area.
- (ii) For (a) Tomato, out of 14 reporting farmers, 78.47% record change in yield against that of only 57.14% in area (b) In case of Wheat, out of 84 reporting farmers, 76.19% record change in yield against that of only 40.14% in area; while (c) Out of 28 farmers growing sugarcane, all of them report for change in yield on 100 percent basis, without even a single farmer reporting for change in area.
- (iii) It is emphatically found that the “Adoption of Micro-Irrigation (MI)” has benefitted the farmers (MI-adopters) substantially; not only in one, but in a number of ways, through
 - (a) Enhancing (i) Crop production (ii) Crop price (iii) Total Sales Revenue and (iv) Net Profit/Income.
 - (b) Reducing expenses (costs) on items like (i) Seeds/Plants (ii) Fertilizers (iii) Pesticides (iv) Diesel (v) Hours of Pumping (Irrigation) (vi) Farm Power and Equipments (vii) Labour cost and (viii) The Total Cost.

(e) Drip/Sprinkler irrigation kit details

- (i) Out of total 96 MI adopters; 43 reported for Drip Irrigation Kit/Set and 53 for sprinkler Irrigation Kit/Set; where as it may be clearly stated that a farmer (MI adopter) was allowed to avail only any one of these two, i.e., drip and sprinkler, kits.
- (ii) On average per farmer basis (a) Rs. 132384 has been the total cost for Drip kit, out of which 14.84% was paid by farmer and 85.16% being subsidy. (b) Rs.22531=00 as the cost of sprinkler kit, out of which 70.25% paid by farmer and 29.75% being the subsidy. (c) The total cost of pumps and tube-well cost (only if additional for MI) being respectively as Rs.32933=00 and Rs.9720=00 and were totally paid by farmer as there being no subsidy on these.

- (iii) No maintenance cost has been paid by any of the MI (adopter), due to privilege of three years AMC by the contractor/supplier.

(f) Impact of MI adoption on various factors like Agronomic, Agro-economic and others

- (i) There is strong footage to the fact; that agronomically ; apart from resulting to higher yield/output; MI techniques also reduce water use, fertilizer use, pest problems/pesticide use, weed problems and the labour use; as per reportings by 67% to 96% of total MI users on strongly agree/agree basis.
- (ii) Towards agro-economic potential and effective demand as well; all the stated factors like (a) MI- raises output quality/price; increases profitability; capital cost of MI is not high and (b) Information on MI information is easily available; MI technology is easy to understand/operate; subsidy for MI is easy to get; are supported by 80.63% to 94.79% and 64.59% to 95.83%, of total MI adopters respectively.
- (iii) The responsiveness of farmers in respect of various “Aggregate Supply” and “Distribution” factors like- There are large number of MI equipment supplying companies; the quality and reliability of MI equipment is good; there are large number of dealers; the dealers arrange for subsidy/credit etc., has been found to be relatively a bit low and being to the order of 60.41% to 88.12%.
- (iv) In respect of perceived advantages and disadvantages of Micro-Irrigation, the item “MI results to Higher Yields” is taken as of strong advantage/advantage by all the 96 MI adopters on cent percent basis; while all the other items like Better Output Quality, High output price, Less water need, etc. by 67.71% to 95.83% of total MI adopters; except for items “Easy Marketing of output” and “Employment for Youth”, supported by just 43.75% and 56.25% of total MI adopter farmers.

(g) Farmers (MI adopters) reportings towards larger impact of MI and its related benefits

- (i) Most of the groups/factors have significant extent of favourable reportings by the farmers towards “Larger Impact of Micro-Irrigation” on them. The order of top five, groups/factors as per positive reportings (substantially positive/positive, taken together)

by the farmers has been as (i) Village as a whole-98.96% (ii) Water conservation/availability-98.96% (iii) Environment- 86.46% (iv) Upper caste -82.29% (v) Labour/Poor- 73.96%.

- (ii) The mean scores of all the above mentioned five groups/factors have been in the range of 3.81 to 4.23; i.e., above the No Impact mean score of 3.
- (iii) As per reportings of sample farmers (MI Adopters), 96 in number; the four items in order of preference are
 - i. Performance of MI on improving Water Use Efficiency is Excellent/Good: 78.13%
 - ii. Overall performance of Micro-Irrigation (MI) is Excellent/Good: 73.96%
 - iii. Performance of MI in reducing Input cost (such as fertilizers, pesticides, labour/electricity) is Excellent/Good: 70.84%
 - iv. Performance of MI on increasing farm income/profits is Excellent/Good: 65.63%
- (iv) The respective mean scores of above four items as 4.06, 4.13, 3.83, 3.82; are all above the mean satisfactory score of 3, to indicate utility and positive results of MI adoption.
- (v) Among all MI adopters, 94.79% strongly agree/agree to continue the use of MI; while 87.50% strongly agree/agree to further expand the use if MI, irrigation techniques.

(h) Major problems faced by the MI adopter/non-adopter farmers and their suggestion thereof

- (i) The major problems faced by farmers, as on the basis of their strongly agreeing/agreeing (taken together) have been as (i) Lack of Fencing and Damage by Animals; each reported by 69.79% of the total MI adopters. (ii) Poor marketing arrangement-25.00% (iii) High cost of wells/tubewells-20.83% (iv) Lack of knowledge/training for Micro-Irrigation and Land Fragmentation, each corresponding to 19.79% and (v) Lack of own wells/tube-wells and water table going down fast, each reported by 18.75% of sample MI adopters.
- (ii) Among various suggestions by MI adopters, in respect of increasing the Adoption and Impact of Micro-Irrigation; the “TOP 5” on “Strongly Agree/Agree” basis are:

- | | |
|--|----------|
| (a) More Subsidy/Government Assistance | : 97.92% |
| (b) Provision/ Support for Farm Fencing | : 94.79% |
| (c) Better Micro-Irrigation Technology/Equipment | : 92.70% |
| (d) Better Marketing Arrangements | : 91.67% |
| (e) Improved Water Availability | : 88.55% |
- (iii) The three main factors responsible for Non-adoption of MI by “Non-Adopters of MI” have been (i) High Investment Cost of Micro-Irrigation (ii) Crop damage by animals and (iii) Lack of fencing; as reported respectively by 66.67%, 62.50% and 58.33% of total Non-Adopters of MI (24 in number) on “Strongly agree/Agree”; and “non mutually exclusive basis.”
- (iv) On overall basis; while majority of Non-MI Adopters as well do not support Negativity towards MI-adoption, in enhancing crop productions and providing other MI related benefits; the following factors are taken as hindrances by them towards MI Adoption (i) the above mentioned three factors, i.e., High investment cost; lack of fencing; damage by animals followed by (ii) unavailability of MI equipment (ii) High operating cost of MI system (iv) Insufficient subsidy for Micro-Irrigation (v) Unavailability of credit for MI (vi) Lack of enough information for MI (vii) Fragmentation of land (viii) Unsuitability of MI to farmers land and crops grown; as reported by 20% to 50% of total Non-MI Adopters; on non-mutually exclusive basis.
- (v) As a sign of development and prosperity, it may also be well mentioned in respect of “Non MI adopters group”; that (i) There is not even a single non-adopter farmer, who is illiterate and without irrigation facility (ii) Majority of them (66.27%) have Tube-well as major source of irrigation (iii) Among Kharif crops, the major, i.e., Paddy, followed by Maize, Tomato, Chilli, Arhar have cent percent irrigated area except Arhar (iv) Among Rabi crops the dominant one, viz. Wheat, followed by Fodder, Mustard, Gram and Chilli are fully irrigated (v) As a perennial crop Sugarcane, being adopted by 46.83% of total Non-MI adopters, is also 100 percent irrigated.

Policy Implications:

The various policy implications as emerging out on the basis of major findings of the present study are as under:

1. There is wide scope for development of Agriculture, Horticulture and Sugarcane crops in Uttar Pradesh, subject to adoption of Advanced Irrigation techniques like Micro Irrigation; the use of which can increase and even double fold the farmers' incomes, in a number of ways and thus contribute towards state's as well as national economy.
2. As more than 85 percent of MI-adopters support (strongly agree/agree) to continue the use of MI as well as expand it further; it is erstwhile desirable and suggested that this highly advanced Irrigation Technique must be continued and further extended even more, along with its specified subsidies.
3. In view of suggestion by 88.55 percent to 97.92 percent of MI adopters, the following points must be taken for due consideration and care thereof, towards further extension and applicability of MI system, in generation of more income from agriculture sector. (i) More subsidy (Govt. Assistance); (ii) Provision/Support for Farm Fencing, (iii) Better Marketing Arrangements and (iv) Improved Water Availability.
4. Considering (i) Lack of fencing (ii) Damage by animals (iii) Poor Marketing arrangements (iv) High cost of wells/tube-wells (v) Lack of knowledge/Training towards Micro-irrigation (vi) Lack of own well/tube-wells; as the major problems faced by MI adopter farmers; this is earnestly suggested and recommended that the above problems be tackled on priority basis, to make usefulness and applicability of Micro-Irrigation still more effective and beneficial to farming community in particular and the entire country in general; through (i) providing fencing to safeguard damage of crops by animals (ii) Improving Marketing arrangements for MI produced crops (ii) Arranging more demonstration and field trials to improve knowledge levels of farmers in respect of MI (iv) Providing "boring" facilities to farmers, mainly small & marginal, who form the bulk of farming community; to have their own source of water availability in support of crops irrigation, using MI techniques.

5. The study findings for “Non MI adopters group” that (i) On overall sample basis, as well as in each category of farmers, i.e., marginal, small and medium, the entire per farmer operated area is irrigated.(ii) Tube-well-being the main water source of irrigation for 66.27% of all Non- MI adopters (iii) 79.17% of all Non-MI adopters have no scarcity of water; are all most prompting to suggest and recommend that, “ What in fact has to be done is that; The non-MI adopters group has also to be initiated, in the larger interest of the country to adapt MI-technology, to increase per farmer crop productions, as well as get benefitted by other MI associated benefits.
6. On overall basis, special attention has to be given by the concerned Department of Central/State governments and the national planners and policy makers; towards tackling down and solving the under mentioned problems as faced by MI adopters and Non adopters, including a few which are faced commonly by both, i.e., MI adopters and also Non MI adopters; to safeguard the interest of farming community and the country as a whole, in enhancing crop productions and agriculture sector’s contribution to National Economy. (i) Support to farmers for farm fencing, (ii) More subsidy/Govt. assistance, (iii) Better marketing arrangements for MI produced crops, (iv) “Boring facilities” to farmers towards assured irrigation, (v) Training camps/ Field Demonstration to farmers in respect of working and effective operation of MI system and (vi) to account for, in respect of problems, whatsoever, due to land fragmentation, water table going down fast and unpredictable electric supply.
7. Furthermore, as a way forward; PDMC (MI) component of PMKSY, also needs (i) special emphasis in view of its enhanced utility towards reducing conveyance & application losses as compared to conventional flow irrigation practices and (ii) due consideration towards employment for youth in the direction of enhancing MI’s value added applicability.

Chapter–1

Introduction

Water is one of the most precious and vital components of five basic elements, in creation as well as the very existence of Human Life (the Prime one, among innumerable living organisms); viz. Jal, Vayu, Agni, Prithvi, Akash more prominently called as the ‘PanchTatva’. As such, water is to be regarded as an unparalleled resource of its own kind; not only in the field of Agriculture, but practically in every sphere of human life and correspondingly in all application fields thereof. Switching over to agriculture sector with special reference to Crop Production; the concept of “Per Drop More Crop (PDMC)” component of Pradhan Mantri Krishi Sinchayee Yojna (PMKSY), refers to “optimum utilization” of water in the sense that (i) neither a single drop of water should be poured in excess to go as waste, nor (ii) even a single drop of water should fall short of required amount as deficient one; as well as at the same time (iii) every drop of water used should cover not only a single, but a number of crops, to possible extent.

1.1 Implementation

The Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW) is implementing the Per Drop More Crop Component of the Pradhan Mantri Krishi Sinchayee Yojna (PMKSY). This is operational in the country w.e.f. 2015-16. The Per Drop More Crop (PDMC) component focuses mainly on Improving Water Use Efficiency at the Farm Level, through Precision/Micro-irrigation (MI) (Drip and Sprinkler Irrigation). Apart, MI techniques are also expected to, not only a single but a number of benefits in the form of (i) enhanced water use (ii) increase in irrigated area with given quantity of water resources (iii) enhanced productivity (iv) labour cost savings (v) electricity saving and (vi) lesser pumping hours.

- It may also be stated that, most of the states in the country are giving subsidies for installation of MI System. While, as per an Impact Evaluation Study conducted by Global Agriculture System (June, 2014), Maharashtra has shown greatest increase in irrigated area under MI System.
- MI System also serves as rescue to tone up quite low overall irrigation efficiency of India (due to conventional flood irrigation technologies in large parts of country) in comparison to global standards (Vaidyanathan and Sivasubramaniyan; 2004) and to bring it upto mark, to all possible extent.

1.2 Pradhan MantriKrishiSinchayeeYojna (PMKSY):

The Government of India has been implementing centrally sponsored scheme on Micro-irrigation with objective to enhance water use efficiency in the agriculture sector by promoting appropriate technological interventions like “drip and sprinkler irrigation technologies” and encourage the farmers to use Water Saving and Conservation technologies.

The Centrally Sponsored Scheme (CSS) on Micro-irrigation was launched by the Department of Agriculture and Cooperation, Ministry of Agriculture in January 2006. In June 2010, it was up scaled to National Mission on Micro-irrigation (NMMI), which continued till the year 2013-14. From April 1st, 2014 NMMI was subsumed under National Mission on Sustainable Agriculture (NMSA) and implemented as “On Farm Water Management” (OFWM) during 2014-15.

From April 1st, 2015 Micro-irrigation Component of OFWM has been subsumed under Pradhan MantriKrishiSinchayeeYojna (PMKSY) and is implemented as a Centrally Sponsored Scheme on Micro-irrigation during the financial year 2015-16, as per the same pattern of assistance and cost norms as were prevailing under OFWM.

1.3 ‘Motto’ and Components of PMKSY:

Towards the motto of ‘HarKhetKoPani’ and ‘Per Drop More Crop’, an ambitious irrigation development plan was drawn with objective of boosting in a short span of Five Years,

during 2015-16 to 2019, under PMKSY with a massive outlay of Rs. 50,000 crores. The PMKSY has following major components.

1. Accelerated Irrigation Benefit Programme (AIBP) and Command Area Development and Water Management (CADWM).
2. PMKSY (HarKhetKoPani)
3. PMKSY (Per Drop More Crop).
4. PMKSY (Watershed)

While (i) AIBP and CADWM component focusing on faster completion of ongoing major and medium irrigation, including national projects; is implemented by Ministry of Water Resources, River Development and Ganga Rejuvenation (ii) PMKSY (HarKhetKoPani) dealing with source augmentation, distribution, ground water development, lift irrigation, diversion of water from water plenty to water scarce areas, supplementing rain water harvesting beyond IWMP & MGNREGA, repair, restoration, renovation of traditional water; is implemented by Ministry of Water Resources, River Development and Ganga Rejuvenation (iii) PMKSY (Water Shed) component, referring to Ridge Area treatment, drainage line treatment, soil and moisture conservation, water harvesting structure, livelihood support activities and other water shed works, is implemented by Department of Land Resources, M/o Rural Development.

- The Ministry of Agriculture and Farmers Welfare in particular is concerned with, to promote efficient water conveyance and precision water application devices like Drips, Sprinklers, Pivots, Rain Guns in the “farm (jal sanchan) construction” of micro-irrigation structures to supplement source creation activities, extension activities for promotion of scientific moisture conservation and agronomic measures through PDMC component of PMKSY.
- The programme architecture of PMKSY is to adopt a “decentralized state level planning and précised execution” structure that will allow States to draw up their own irrigation plans, based on District Irrigation Plan (DIP) and State Irrigation Plan (SIP), to be operative as convergence platform for all water sector activities including drinking water & sanitation, MGNREGA, application of Science & Technology etc. through

comprehensive plan; under State Level Sanctioning Committees (SLSC) chaired by the Chief Secretary of the State, being vested with the authority to oversee its implementation and sanction projects.

1.4 Per Drop More Crop (Component of PMKSY)

PMKSY (Per Drop More Crop) focuses on (i) micro level storage structures (ii) efficient water conveyance and application (iii) precision irrigation system (iv) toning up of input cost beyond MGNREGA permissible limits (v) secondary storage (vi) water lifting devices (vii) extension activities (viii) coordination and management – being implemented by Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW).

- **Programme Architecture**

Per Drop More Crop (Micro Irrigation) adopts the Institutional Setup and architecture of overall PMKSY frame work. The broad institutional structure as per PMKSY guideline are:

- (i) National Steering Committee (NSC) under the chairmanship of Hon'ble Prime Minister with concerned ministries Union Ministers and Vice-Chairman, NITI Aayog as member – To provide general policy strategic directions for programme implementation and overall supervision, addressing national priorities etc.
- (ii) National Executive Committee (NEC) under chairmanship of Vice-Chairman, NITI Aayog with Secretaries of concerned ministries/department and Chief Secretary of Selected States as members – To oversee programme implementation, allocation of resources, Inter-Ministerial Coordination, monitoring and performance assessment, addressing administrative issues, etc.
- (iii) PMKSY Mission Directorate – Responsible for overall coordination and outcome focused monitoring of all components of PMKSY for achieving target.
- (iv) State Level Sanctioning Committee (SLSC) under chairmanship of Chief Secretary of the state – To sanction projects and activities as recommended by IDWG.
- (v) Inter Departmental Working Group (IDWG) under chairmanship of Agricultural Production Commissioner / Development Commissioner with secretaries of line

- (vi) departments as members – It may take advice/input of MI manufacturers by inviting representatives from manufacturers / micro-irrigation industries as members.
- (vii) District Level Implementation Committee (DLIC) under the chairmanship of Collector/District Magistrate, CEO of ZilaParishad/PD-DRDA, Joint/Deputy Director of line departments in the district and progressive farmers, representatives of MI industry and leading NGO as members – To oversee PMKSY implementation and inter department coordination.

1.5 Programme Utility and the Way Forward:

Apart from usefulness of different components of PMKSY including PDMC, towards enhancing and improving Water Use and its Efficiency in Increasing Crop Productions, its main utility also lies in minimizing conveyance loss and application loss.

(a) Conveyance Loss

The operation and maintenance of irrigation systems is very poor, the water channels are not properly lined and as such, water loss from canals is very high particularly at canal tail ends, apart from general losses. This highlights the improvement in canal operating systems still more as the need of the day.

(b) Application Loss

The water resource use experience has made us widely known that as compared to conventional flow irrigation practice; better irrigation practices through modern irrigation infrastructure and management (i) Can save water use in different crops to the extent of 16 to 69 percent* and (ii) raise crop yield to the extent of 10 to 50 percent.**

As such; as the way forward; this evidently refers to the use of pressurized irrigation means of micro irrigation, drip irrigation, sprinkler irrigation; to cope up with both the above types of water losses and minimizing these to all possible extent.

1.6 Objectives of Per Drop More Crop (Micro Irrigation)

The main objectives of Per Drop More Crop (Micro Irrigation) are as follows:

- Increase the area under micro-irrigation technologies to enhance water use efficiency in the country.
- Increase productivity of crops and income of farmers through precision water management.
- Promote micro-irrigation technologies in water intensive/consuming crops like sugarcane, banana, cotton etc. and extend coverage of field crops under micro-irrigation technologies.
- Make potential use of micro-irrigation systems for promoting fertigation.
- Promote micro-irrigation technologies in water scarce, water stressed and critical ground water blocks/districts.
- Link tube-well/river-lift irrigation projects with micro-irrigation technologies for best use of energy, both for lifting and pressurized irrigation, as far as possible.
- Establish convergence and synergy with activities of ongoing programmes and schemes, particularly with created water source for its potential use, integration of solar energy and pressurized irrigation etc.
- Promote, develop and disseminate micro-irrigation technology for Agriculture and Horticulture development with modern scientific knowledge.
- Create employment opportunities for skilled and unskilled persons, especially Unemployed Youth for installation and maintenance of micro irrigations.

1.7 Bird's Eye Overview of State-wise PDMC Beneficiary Count and Area under MI, in India.

It is also erstwhile desirable, to have a bird's eye overview of (i) Count of PDMC beneficiaries, as well as (ii) Area covered under MI; in different states of the country, which are respectively, shown by Figure-1.1* and Figure-1.2**.

Figure-1.1 shows that, as in the year 2017-18. (i) Andhra Pradesh, Gujarat and Telangana record the highest number of PDMC beneficiaries in India; followed by Uttar Pradesh, Chhattisgarh, Madhya Pradesh and Maharashtra. (ii) The state of Uttar Pradesh ranked 4th in the country, in respect of count of PDMC beneficiaries.

Figure-1.2 depicts that, in the year 2017-2018. (i) Karnataka, Andhra Pradesh and Gujarat record the highest area covered under MI, followed by Maharashtra, Tamil Nadu and Telangana and other state like Rajasthan, Madhya Pradesh, Uttar Pradesh.

(ii) The state of Uttar Pradesh stood at rank 9th in the country with regard to area under M.I.

Fig 1.1
State wise Beneficiary Count Report

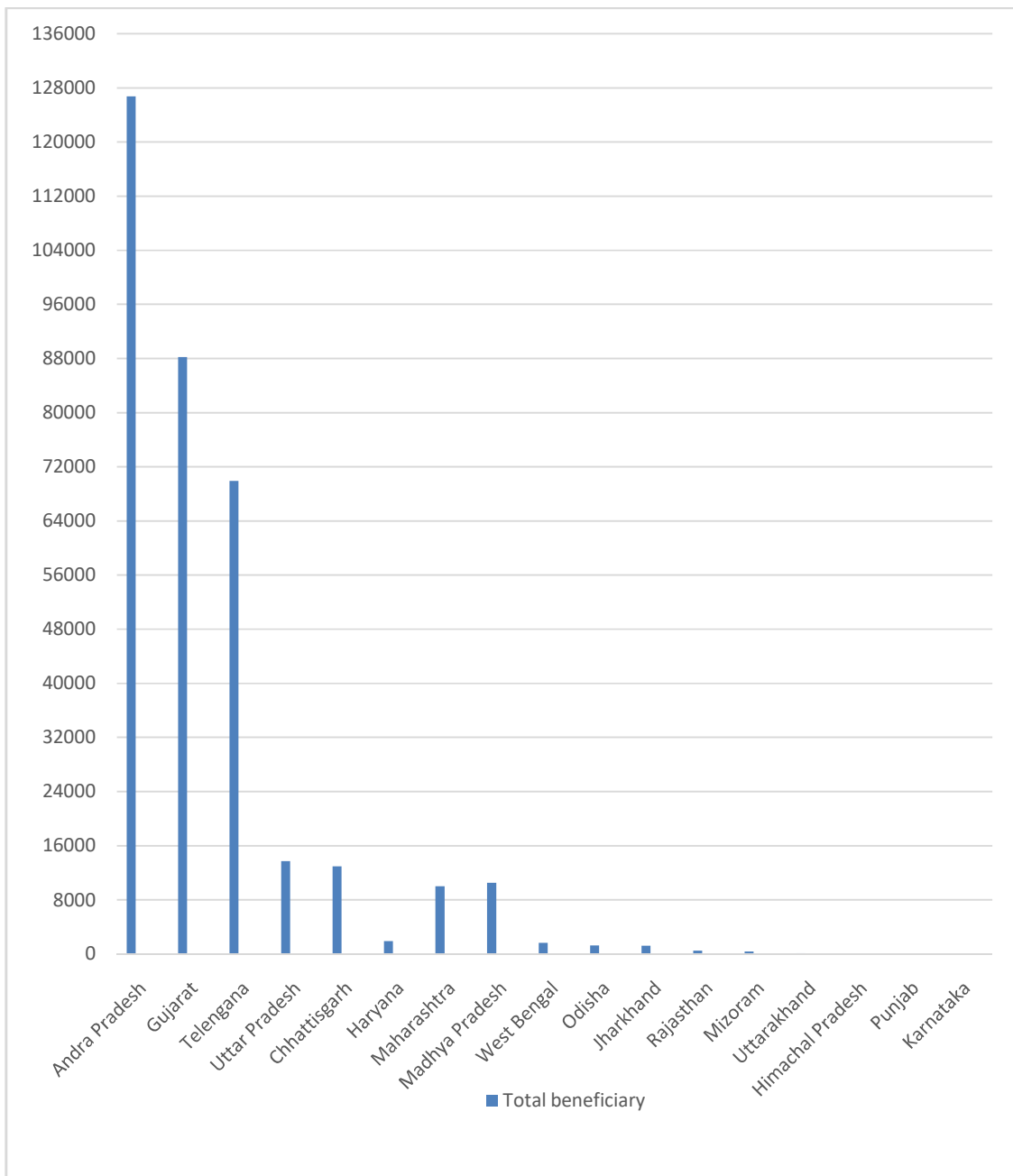
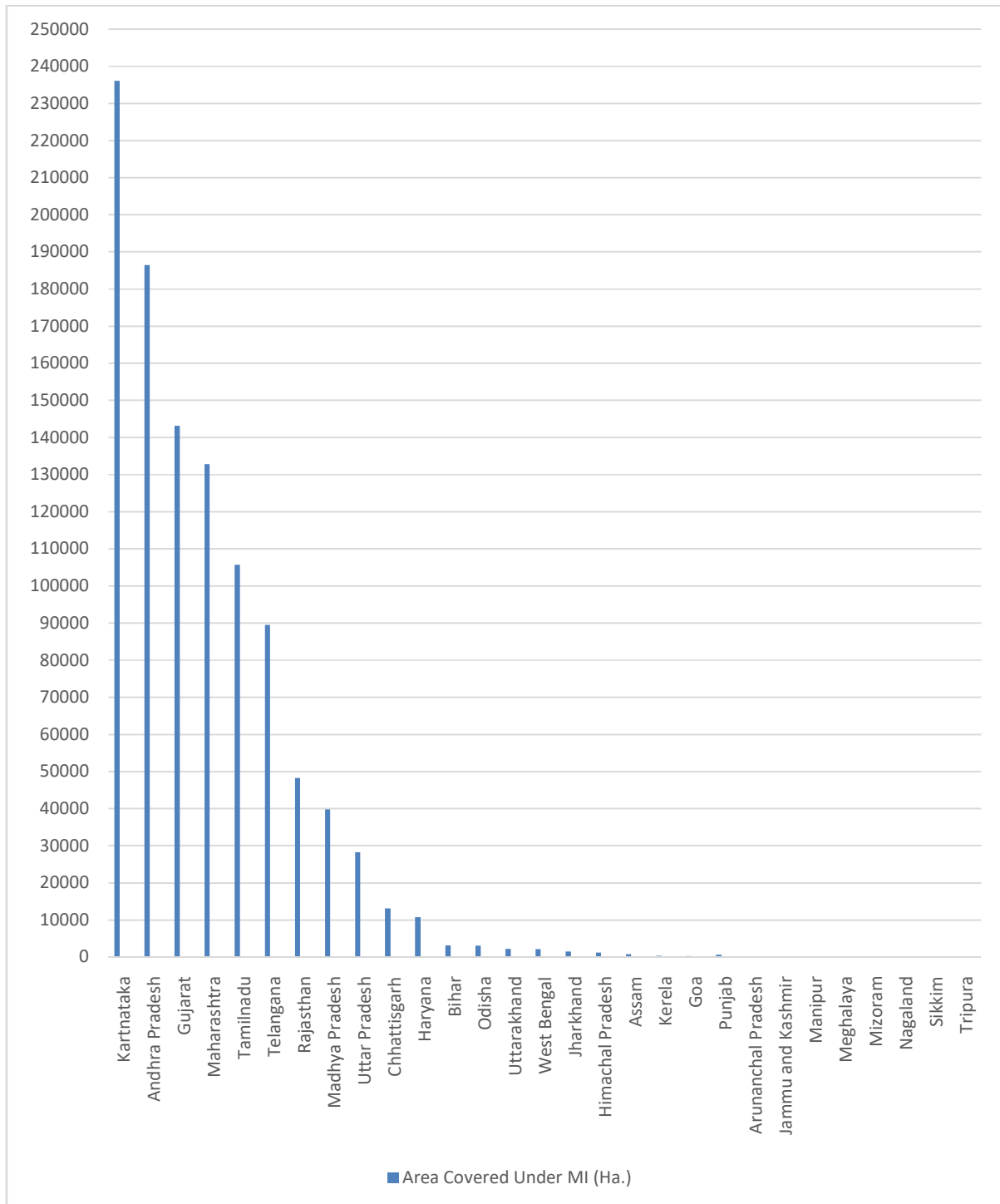


Fig 1.2

Selected State wise Area Covered under Micro Irrigation (Drip and Sprinkler) in India 2017-18



Chapter–2

Study Background, Objectives and Methodology

The present chapter in its attempt, has been mainly designed to throw light on the study background; the details regarding the study and its conduct in the country and the state of Uttar Pradesh; the present study along with its specific objectives and the methodology adopted thereof, including sampling plan; in respect of PMKSY-PDMC scheme implemented in the country, w.e.f. 2015-16.

2.1 Study Background

Apart from the utility of conventional flow irrigation practice; which of course cannot be ruled out altogether; (i) the ever increasing demand of water towards irrigation of field crops, associated with (ii) relatively much low efficiency of conventional irrigation methods; resulted to the need of special attention of policy makers and national planners to focus on the initiation of modern irrigation infrastructure along with its proper management & implementation, for raising water use efficiency in respect of not only one, but all of its aspects like those of water-pumping, lifting, harvesting, shifting from water ample to water scarce areas and like that; through better and high-tech irrigation practices, all basically based on pressurized water flow Irrigation system. In this regard, the following viewpoints may also inevitably, be taken into consideration.

As per Vaidyanathan and Sivasubramaniyan (2004); “Compared to global standard, the overall irrigation efficiency in India is quite low and this is substantially due to the use of conventional flood irrigation techniques used in large parts of India and that in this context, Micro-Irrigation (MI) techniques, including drip and sprinkler irrigation, were introduced as water saving technologies from 2000’s”.

Raman (2010), while assessing the potential for Micro-irrigation (MI) – Drip and Sprinkler irrigation in India through secondary data; estimated that the potential area which can

be brought under MI was 43 million ha and out of this only 3.87 million ha (9 percent) was currently irrigated under MI, thereby indicating a huge scope for covering the rest.

Narayanmoorthy et.al (2016) examined the impact of drip irrigation in vegetable crops and found that ‘Through Drip Irrigation, farmers could reduce the use of water and can substantially increase profits as compared to conventional flood irrigation.

The study by, Namara et.al (2007)with focus on three aspects of Micro-Irrigation (MI): (i) productivity and economic gain (ii) determinants of MI adoption and (iii) impact on poverty; through economic analysis found that “Adoption of MI has resulted in significant productivity and economic gain over the traditional surface irrigation method”.

But, at the same time they also cautioned that it was very important to “Build awareness about (i) How to use MI System (ii) Improve access/availability of MI and (iii) Provide guidance regarding the right crops to grow under MI”.

The findings of Bhamoriya and Mathew (2014)shows that (i) Drip Irrigation has emerged as an important coping mechanism to protect the farmer and agriculture from some major problems that plague agriculture, such as shortage of water, power and labour (ii) Both adopters and non-adopters indicate that the technology is beneficial for improving water efficiency (iii) A positive impact on water table was also observed by many farmers and (iv) It was also reported that the “saved water” is frequently used for expanding the area under agriculture.

2.2 The Present Study

The present study, towards evaluation of PDMC(MI) component of PMKSY is being conducted in five states of the country including Uttar Pradesh. The states in which this study is being conducted are Maharashtra, Telangana, Uttar Pradesh, Madhya Pradesh and Sikkim with respective A.E.R.Cs as in Pune, Visakhapatnam, Prayagraj, Jabalpur and Viswa-Bharti; as conducting centres.

In Uttar Pradesh (i) this study is conducted by A.E.R.C. (Agro Economic Research Centre) Prayagraj; under the overall guidelines of the Coordinator Centre; the CMA (Centre for Management in Agriculture), IIM Ahmedabad (ii) while the districts in which the study has been undertaken have been respectively Sonbhadra and Saharanpur, selected as per set norms of the study and (iii) the period of the study corresponds to the agricultural year 2018-19.

Specific Objectives:

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). The main objective of the study is to analyze various benefits of MI to the farmers including input use, costs and returns; with following specific objectives:

- (f) To examine the savings of various inputs such as water, fertilizers, power, pesticides and labour.
- (g) To examine the enhancement of productivity, quality and other benefits in selected agriculture/horticulture crops including water-intensive crops such as sugarcane and banana and if there is employment generation due to MI.
- (h) 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 across states.
- (i) To study overall impact on farmer incomes and cost-benefit in selected crops.
- (j) To identify any issues/problems in the benefit transfer work flow and monitoring by the implementation agency.

2.3 Nodal Department

As the final outcome, of PMKSY is to ensure access to efficient delivery as well as application of water at every “farm” and thereby enhancing agricultural production and productivity; State Agriculture Department is generally the Nodal Department for implementation of PMKSY (Per Drop More Crop).

Nodal Department in Uttar Pradesh

- As per operational guide lines (2015-16) issued by the Government of India, for implementation of PMKSY; “Agriculture Department (Uttar Pradesh)” has been nominated as the ‘Nodal Agency for execution/implementation of PMKSY in the state; while “Department of Horticulture and Food Processing” is the Execution Agency for Per Drop More Crop (PDMC) (Micro Irrigation) component of PMKSY in the state.
- The “Action Plan Area” of PDMC component of PMKSY in the state; consists of “All the 75 Districts of Uttar Pradesh”, while its implementation/execution is conducted by the state Department of Horticulture and Food Processing, Uttar Pradesh.
- In the state of Uttar Pradesh, Micro-irrigation (MI) programmes are applicable equally to Horticulture, Agriculture and Sugarcane Crops.
- It may also be mentioned that among “other interventions of Per Drop More Crop (Micro Irrigation)” component the priority areas by Atidohit (over exploited), Critical, Semi Critical and Minor Irrigation Department are developed tanks/water source clusters and Member of Parliament (M.P)’s Adopted Villages. However, to make potential use of the available funds for higher water efficiency, these Other Interventions (OI) activities must be linked with Micro-irrigation (MI).

2.4 Methodology*

Prior to initiating methodological steps; it is worth mentioning to take an accord of most cordial visit of Prof. Vasant P. Gandhi, CMA, IIM Ahmedabad, the Coordinator of present study project at All India Level; to a village in Koraon Block of district Prayagraj, accompanied by Research Team of Agro-Economic Research Centre (AERC) Prayagraj and deputed staff of District Horticulture Department on 19/11/2019; a visit planned as a pre survey case study; through the courtesy of District Horticulture Officer (Prayagraj) Dr. Pratibha Pandey and the then Hon. Director, AERC, Prayagraj Prof. S.A. Ansari towards – (i) On –the-Field working of the Micro-irrigation (MI) (Drip/Sprinkler) Project and (ii) Its utility and benefits to farmers, along with its constraints if any, and on the spot problems of MI users and installers in

Drip/Sprinkler installations and their workings. Prof. Gandhi had a round of MI (drip/sprinkler) installations followed by very lively discussions with the MI users, prominent village leaders and farmers of the village on different aspects of MI (Drip/Sprinkler) installations towards enhancing crop production(s) and other benefits thereof; and formed a high opinion about usefulness of MI system to the farming community, not only in a single but in a number of ways. It may also be taken as noteworthy that the “said visit”, apart from highlighting the various aspects in the form of “pros and cons” towards utility and applicability of PDMC-MI (drip/sprinkler) Project as a most improved and efficient irrigation device, to Prof. Gandhi, had also benefited accordingly the AERC Research Team members in undertaking the MI (drip/sprinkler) study field survey in districts Sonbhadra and Saharanpur.

After inspecting “On-the-Field Workings” of Drip and Sprinkler (MI) Installations in the village of Koraon Block of Prayagraj District on 19/11/2019; Prof. Gandhi having discussions with prominent village leaders, MI users and farmers; along with AERC, Prayagraj Research Team Members.





Methodological Steps:

The various methodological steps like (i) Sampling plan, (ii) Selection details, (iii) The data and source of data, (iv) Reference period and (v) Analytical frame; are enlisted as under.

(i) Sampling Plan

- The sampling plan corresponding to the present study, comprised of a multi (four) stage Stratified Random Sampling, with district forming the first stage, block/taluka the second stage, village the third stage and finally the farmer (MI adopter/Non-adopter) as the fourth stage “or” ultimate unit of sampling; as per following MI Sampling plan of the study.
- 2 districts per state; 2 block/talukas per district; 3 villages/cluster in each block/taluka; 8 adopters and 2 Non-adopters in each village; which ultimately gives 96 adopters+24 Non-adopters in each state = A total of 120 farmers per state as illustrated under; in Table-2.1

Table-2.1
Micro-irrigation Sampling Plan for State (120 Farmers)

State												Total per state
District 1						District 2						2 districts
Block/Taluka 1			Block/Taluka 2			Block/Taluka 3			Block/Taluka 4			4 blocks
Village/Cluster 1	Village/Cluster 2	Village/Cluster 3	Village/Cluster 4	Village/Cluster 5	Village/Cluster 6	Village/Cluster 7	Village/Cluster 8	Village/Cluster 9	Village/Cluster 10	Village/Cluster 11	Village/Cluster 12	12 villages/Clusters
10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	10 Farmers	120 farmers
8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	8 Adopters + 2 Non-Adopters	96 Adopters + 24 non-adopters = 120 farmers

(ii) Selection of Districts and other Sampling Units Itinerary:

The PDMC-Micro-irrigation Project, under umbrella of PMKSY, is being implemented in all the 75 districts of Uttar Pradesh. since 2015-16 focusing Bundelkhand, Vindhya Region, over exploited, critical, semi critical, blocks and water scarce areas of the state.

As per secondary data based suggestion by Prof. Vasant P. Gandhi, CMA, IIM, Ahmedabad (the Coordinator of the present study) as well as subsequent recommendation of the Director of Horticulture and Food Processing Uttar Pradesh Shri S.B. Sharma along with Joint Director Horticulture (MI) Dr. N.L.M. Tripathi; among five suggested districts of Jhansi, Sonbhadra, Saharanpur, Bijnor and Meerut, finally two districts viz. Sonbhadra and Saharanpur were selected for undertaking this (Micro Irrigation)Evaluation Programme study in the state of Uttar Pradesh; in view of most suitability of these two districts in respect of significant number** of farmers with regard to MI users as also non-users and other aspects in view of set objectives of the study.

The details of selected villages, farmers (adopters and non-adopters of MI), installed MI system and the corresponding crops in implementation of the present study are outlined as under in the Table-2.2.

As per Table-2.2; (i) the adopted sampling plan in the present study refers to a total sample of 2 districts, 4 taluka, 12 villages and 120 farmers (96 adopter + 24 non-adopters); respectively and that (ii) the crops grown as under the MI (Drip/Sprinkler) installations have been respectively Chilli, Tomato, Wheat and Sugarcane; as reported by selected 96 MI adopters in the present study area.

Table-2.2
Selection Details

S. No.	District	Taluka/Block	Name of selected Villages	Selected Number			MI System	Crop
				Farmer s	Adopte r	Non-Adopte r		
1	Sonbhadra	Robertsganj	Manpur	10	8	2	Drip	Chilli
			Ganrahi	10	8	2	Drip	Tomato
			Lohra	10	8	2	Sprinkler	Wheat
		Ghodrawal	Pagiya	10	8	2	Sprinkler	Wheat
			Bar	10	8	2	Sprinkler	Wheat
			Khairpur	10	8	2	Sprinkler	Wheat
2	Saharanpur	Deoband	Kurdi	15	12	3	Drip	Sugarcane
			Ranmolpur	6	5	1	Drip	Sugarcane
			Gangoli Gujar/ Nandonpur	9	7	2	Drip	Sugarcane
		Behat	Bhaguwella	14	12	2	Sprinkler	Wheat
			KaluwalaPaharpur	11	9	2	Drip/ Sprinkler	Sugarcane / Wheat
			Samaspur	5	3	2	Sprinkler	Wheat
Total	2	4	12	120	96	24	-	-

(iii) The Data and the Source of Data

In the present study, both the types of data, i.e., the primary data as also the secondary data, have been used for data analysis in view of set objectives of the study. The primary data in respect of structural and cropping profile of selected farmers (MI adopters/non-adopters) as also their view points in respect of different aspects of MI (drip/sprinkler) systems, were collected by personal interview of AERC Prayagraj Research Team with them; while the secondary data was procured from corresponding sources at state and district headquarters level like office of Director of Horticulture and Food Processing Uttar Pradesh, Lucknow; District Horticulture Officers of Prayagraj, Sonbhadra and Saharanpur; Directorate of Agri Statistics and Crop

Insurance, Uttar Pradesh, Lucknow; apart from various publications of Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Govt. of India, New Delhi and Guidelines data provided by the Coordinator Centre, i.e., CMA, IIM Ahmedabad, which all have been duly acknowledged.

(iv) Reference Period

The present study refers to the agricultural year 2018-19.

(v) Analytical Framework

The analytical framework for the analysis of the collected data mainly consisted of tabular analysis supported by suitable diagrams and graphs; while the interpretation in respect of tabular analysis, are mainly based on Average Values, i.e., per farmer (adopter/ non-adopter) mean values. The mean score as on the basis of viewpoints (responsiveness) of MI (adopters/ non-adopters) referring to (i) strongly agree (score 5) (ii) agree (score 4), (iii) partially agree/disagree (score 3), (iv) disagree (score 2) and (v) strongly disagree (score 1) corresponding to “each of the item/ factor” under various heads like initial capital cost, determinant factors etc.; has been worked out using the following weighted mean formula concept:

$$\begin{aligned} \text{Mean (weighted mean) score} &= \bar{X}_w \\ &= \frac{W_1X_1+W_2X_2+W_3X_3+W_4X_4+W_5X_5}{W_1+W_2+W_3+W_4+W_5} \\ &= \frac{\sum W_iX_i}{\sum W_i} \quad (i= 1, 2, \dots, 5) \end{aligned}$$

where, variable (X) : $X_1= (5)$, $X_2= (4)$, $X_3= (3)$, $X_4= (2)$ and $X_5= (1)$

Weight (W) = W_1 = number of respondents under X_1 (strongly agree)
 = W_2 = number of respondents under X_2 (agree)
 = W_3 = number of respondents under X_3 (partially agree/ disagree)
 = W_4 = number of respondents under X_4 (disagree)
 = W_5 = number of respondents under X_5 (strongly disagree)

corresponding to each statement/ item/ factor.

Illustration:

Factor/Statement	Opinion Score (X)				
	strongly agree (X ₁ =5)	Agree (X ₂ = 4)	partially agree/ disagree (X ₃ = 3)	Disagree (X ₄ = 2)	strongly disagree (X ₅ = 1)
Micro-irrigation increases yield/output (No. of respondents) (W)	36 (W ₁ =36)	60 (W ₂ =60)	0 (W ₃ =0)	0 (W ₄ =0)	0 (W ₅ =0)

$$\text{Mean (Weighted Mean Score)} = \bar{X}_w$$

$$= \frac{36.5+60.4+0.3+0.2+0.1}{36+60+0+0+0}$$

$$= \frac{420}{96}$$

$$= 4.37$$

It may also be stated that land profile and water sources in relation to micro-irrigation of MI adopters and land area and irrigation of MI non-adopters, has also been given group (farm size in ha.) wise; as (i) landless/ tenant (ii) marginal (<1 ha), i.e., less than 1 ha. (iii) small (1-2) ha. i.e., 1ha and more but less than 2 ha. (iv) medium (2-10) ha i.e., 2 ha to 10ha. and (v) large (>10 ha), i.e., more than 10 ha.

Chapter-3

Profile of Micro-Irrigation Adoption in the State

The profile of micro-irrigation adoption in Uttar Pradesh; a secondary data based analytical approach, covering factors like year wise growth of micro-irrigation in the state, district wise and crop wise MI adoption in the state, along with few other details have been attempted in this chapter.

3.1 Year wise growth of micro irrigation

The year wise details of micro-irrigation (MI) growth in the state of Uttar Pradesh for the quinquennial period 2014-15 to 2019-20 are shown in the Table-3.1.

The observations of the Table-3.1 record that (i) All four factors studied in the Table with regard to MI viz. (a) expenditure under PMKSY-PDMC-MI (b) Area under MI (c) Number of beneficiaries and (d) Progressive MI as percentage of total irrigated area; have shown a continuous rising trend during the entire five-year period of 2014-15 to 2019-20 except for a short decline during the year 2015-16 over 2014-15, for one reason or the other. (ii) The respective values of these factors in the year 2019-20 have been recorded as Rs. 19393.39, 56953 ha, 41930 and 1.92 percent as compared to those of Rs. 629.27, 2330 ha, 2349 and 0.50 percent in the year 2014-15. (iii) The first three factors have taken remarkable rise in the year 2016-17 over that of 2015-16 while all the above four factors have taken a great initiative in the year 2018-19 as compared to the year 2017-18. (iv) The annual growth rates of expenditure under PMKSY-PDMC-MI, area under micro irrigation, number of beneficiaries and progressive MI as % of total irrigated area; in the current year, i.e., 2019-20 over that of previous year, i.e. 2018-19, are respectively found as 29.41 percent, 3.41 percent, 9.23 percent and 38.13 percent. The related data are shown in Table-3.1.

Table-3.1
Year-wise growth of Micro-Irrigation in the State – Uttar Pradesh

(Area in hectare)

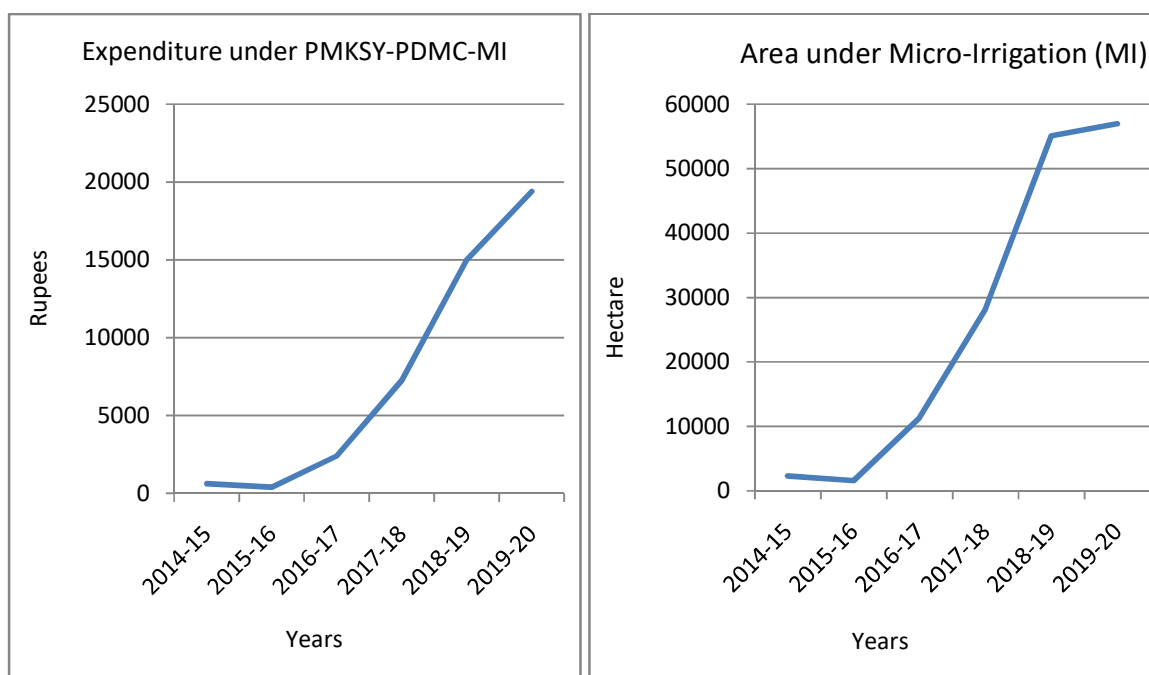
Year	Expenditure under PMKSY-PDMC-MI	Area under Micro-Irrigation (MI) (ha)	Number of beneficiaries	Progressive MI as % of total Irrigated area
2014-15	629.27	2330	2349	0.50
2015-16	411.78	1597	1486	0.54
2016-17	2412.57	11312	9449	0.61
2017-18	7262.55	28235	20044	0.89
2018-19	14986.18	55074	38387	1.39
2019-20	19393.39	56953	41930	1.92
Annual Growth Rate	29.41%	3.41%	9.23%	38.13%

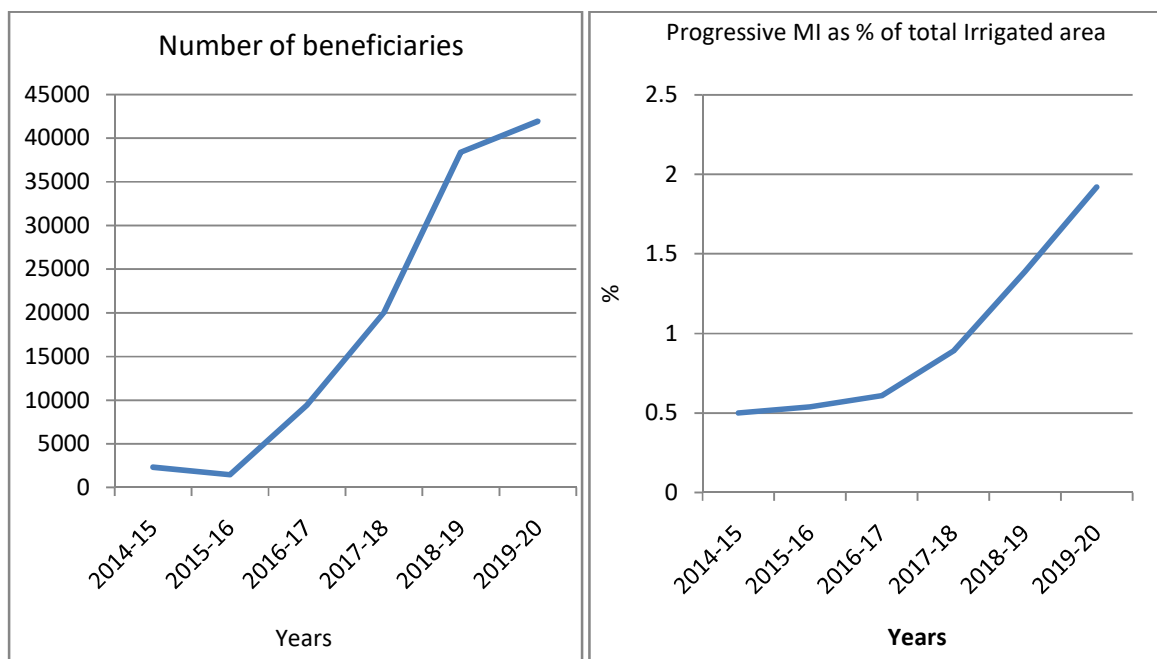
Source: Department of Horticulture and Food Processing, Uttar Pradesh

Note: Annual growth rates refer to those in the current year (2019-20) over previous year (2018-19)

Fig 3.1

Year-wise growth of Micro-irrigation in Uttar Pradesh





3.2 District-wise MI adoption

The details of district wise MI adoption like progressive MI coverage up to 2019-20, area under MI and progressive MI as percentage of total irrigated area are shown in the Table-3.2 for the year 2019-20.

The recorded data of the Table-3.2 in respect of above mentioned factors show that (i) The top five districts among all the 75 districts of Uttar Pradesh (a)(i) In respect of progressive MI coverage up to 2019-20 have been in order as Jhansi, Jalaun, Banda, Hamirpur and Chitrakoot (all these located in Bundelkhand region of Uttar Pradesh) with respective values as 32716, 27876, 22454, 21202 and 16265 a(ii) the ranks of Sonbhadra and Saharanpur, the two districts selected under study, in respect of progressive MI coverage up to 2019-20, have respectively been as 9Th and 20Th, among 75 districts of Uttar Pradesh.(b) In case of area under MI during 2019-20, these have been as Jhansi, Jalaun, Banda, Mirzapur and Hamirpur with respective values as 4189ha, 4075 ha, 3495 ha, 2875 ha and 2856 ha and (c) with regard to progressive MI as percentage of total irrigated area as in 2019-20 the top five districts are recorded as Chitrakoot (21.69%), Hamirpur (14.13%), Sonbhadra (14.07%), Banda (13.69%) and Mahoba (11.28%). (ii) The respective values of these three factors in the districts under

present study viz. Sonbhadra and Saharanpur are found as 6611, 2476 ha; 1950 ha., 455 ha. and 14.07%, 0.96% (iii) The district wise range of variation in respect of these factors have respectively been as 414 (Gautam Buddha Nagar) to 32716 (Jhansi); 72 ha(Lucknow) to 4189 ha (Jhansi) and 0.19% (Kheri) to 21.69% (Chitrakoot).(iv) On overall basis for the state of Uttar Pradesh as a whole, progressive MI coverage upto 2019-20 has been of the order of 277282, area under MI during 2019-20 is recorded as 56953 ha and the progressive MI as percentage of total irrigated area in 2019-20 has been 1.93%. The related data are shown in Table-3.2.

Table-3.2
District-wise MI Adoption (2019-20)

(Area in hectare)

Sl. No.	District Name	Progressive MI coverage up to 2019-20	Area under MI during 2019-20 (ha)	Progressive MI as % of total irrigated area
1	Agra	2404	634	0.97
2	Aligarh	828	319	0.27
3	Allahabad	4175	1018	1.56
4	Ambedkar Nagar	2270	994	1.40
5	Amethi	1029	464	0.79
6	Amroha	1402	256	0.82
7	Auraiya	915	455	0.69
8	Azamgarh	1785	573	0.63
9	Baghpat	744	208	0.69
10	Bahraich	2179	620	1.06
11	Ballia	1961	534	1.08
12	Balrampur	2494	997	2.54
13	Banda	22454	3495	13.69
14	Barabanki	828	462	0.36
15	Bareilly	1089	267	0.34
16	Basti	2166	898	1.13
17	Bijnor	1261	329	0.41
18	Budaun	1215	258	0.36
19	Bulandshahr	1127	231	0.38
20	Chandauli	4090	729	3.20
21	Chitrakoot	16265	2185	21.69
22	Deoria	1777	704	0.96
23	Etah	481	114	0.26
24	Etawah	1572	516	1.13
25	Faizabad	1364	391	0.89
26	Farrukhabad	1066	326	0.78
27	Fatehpur	1550	527	0.73
28	Firozabad	1135	336	0.65
29	Gautam Buddha Nagar	414	153	0.65
30	Ghaziabad	1267	204	2.48

31	Ghazipur	3275	707	1.40
32	Gonad	1176	351	0.46
33	Gorakhpur	2581	972	1.26
34	Hamirpur	21202	2856	14.13
35	Hapur	603	210	0.69
36	Hardoi	1687	718	0.42
37	Hathras	672	235	0.45
38	Jalaun	27876	4075	10.93
39	Jaunpur	4522	1370	1.82
40	Jhansi	32716	4189	10.55
41	Kannauj	1455	509	1.12
42	Kanpur Dehat	976	424	0.63
43	Kanpur Nagar	914	350	0.69
44	Kasganj	594	245	0.42
45	Kaushambi	3771	728	3.81
46	Kheri	828	306	0.19
47	Kushi Nagar	2185	751	1.13
48	Lalitpur	16005	1085	5.50
49	Lucknow	1086	72	0.86
50	Maharajganj	1793	684	1.05
51	Mahoba	14102	1743	11.28
52	Manipur	926	187	0.46
53	Mathura	1486	351	0.55
54	Mau	1065	299	0.93
55	Meerut	1471	414	0.75
56	Mirzapur	9705	2875	6.34
57	Moradabad	1249	320	0.69
58	Muzaffarnagar	852	267	0.40
59	Pilibhit	1177	351	0.50
60	Pratapgarh	3532	902	1.93
61	Rae Bareli	1614	373	0.78
62	Rampur	1743	392	0.92
63	Saharanpur	2476	455	0.96
64	Sambhal	1038	394	0.52
65	SantKabeer Nagar	1175	379	1.16
66	SantRavidas Nagar	4968	1175	8.42
67	Shahjahanpur	1079	231	0.33
68	Shamli	330	95	0.31
69	Shravasti	1549	726	2.09
70	Siddharth Nagar	2377	949	1.19
71	Sitapur	1378	575	0.34
72	Sonbhadra	6611	1950	14.07
73	Sultanpur	2506	812	1.68
74	Unnao	1888	426	0.64
75	Varanasi	1761	278	2.17
	Total	277282	56953	1.93

Source: Department of Horticulture and Food Processing, Uttar Pradesh

3.3 Crop wise adoption of MI

The crop wise adoption of micro-irrigation in the state of Uttar Pradesh, for the year 2019-20 has been shown in the Table-3.3.

The Table-3.3 depicts that

- (i) In the year 2019-20, the total area being adopted under micro-irrigation in the state of Uttar Pradesh has been 56953 hectares; out of which 34059 hectares (59.80 percent) is under horticulture crops and 22894 hectares (40.20 per cent) under agriculture crops.
- (ii) Among horticulture crops (a) the major crops have been Potato, Tomato, Onion, Cauliflower and Brinjal sharing 16.34 percent, 4.67 percent, 3.18 percent, 2.41 percent and 0.68 percent of total (Horticulture + Agriculture) crops area under micro irrigation; with crops Mango, guava, Banana, Citrus, Papaya, Garlic, Ginger also sharing area under micro-irrigation to some or very little extent, while (b) 'other crops' (leafy veg + pea) occupying 17474 hectare (30.68 percent) of total (Horti+ Agri) area under micro irrigation.
- (iii) Among agriculture crops (a) The main ones are wheat, pulses, sugarcane, maize and Bajra sharing 12.95 percent, 9.21 percent, 5.68 percent, 2.77 percent and 2.58 percent of total (Horti + Agri) crops area under micro irrigation; while (b) crops Linseed, Rice, Groundnut also covering area under micro-irrigation but to a very meagre extent whereas 'other crops' covering 5.05 percent of total (Horti + Agri) crops area under micro-irrigation. The corresponding data are displayed in Table-3.3.

Table-3.3
Crop-wise Adoption of MI (2019-20)

(Area in hectare)

Sl. No.	Crop Name	Area under Micro-irrigation (ha)	Percent
	Horticulture Crops		
1	Mango	12	0.02
2	Guava	28	0.05
3	Banana	224	0.39
4	Citrus	4	0.01
5	Papaya	14	0.02
6	Potato	9306	16.34
7	Onion	1810	3.18
8	Garlic	769	1.35
9	Ginger	5	0.01
10	Cauliflower	1370	2.41
11	Tomato	2658	4.67
12	Brinjal	385	0.68
13	Other Crops (Leafy Veg.+Pea)	17474	30.68
	Total Horticulture Crops	34059	59.80
	Agriculture Crops		
1	Sugarcane	3236	5.68
2	Wheat	7376	12.95
3	Maize	1575	2.77
4	Linseed	464	0.81
5	Rice	459	0.81
6	Groundnut	54	0.09
7	Bajra	1472	2.58
8	Pulses	5246	9.21
9	Oil crops	138	0.24
10	Other Crops	2874	5.05
	Total Agriculture Crops	22894	40.20
	Grand Total (Horti.+Agri.)	56953	100.00

Source: Department of Horticulture and Food Processing, Uttar Pradesh

Further, a few details in respect of micro (drip/sprinkler) irrigation in Uttar Pradesh under PMKSY-PDMC-MI Scheme¹ are presented as under.

- To recall, it may be mentioned that (i) For implementation of PMKSY; State's Agriculture Department is nominated as the nodal agency in U.P. while the Department of Horticulture and Food Processing as the implementation agency of PDMC (micro

irrigation) programme of PMKSY and that (ii) the work area for implementation and action plan of micro-irrigation (drip/sprinkler irrigation) comprise of all the 75 districts of Uttar Pradesh.

- There is wide scope for development of agriculture, horticulture and sugarcane in the state of Uttar Pradesh. What is needed in this regard is adoption of advanced techniques, of which M.I is prime one; towards qualitative cum quantitative production of Agriculture and Horticulture crops, in enhancing farmers' income.
- To achieve the objective of 'doubling' farmers income in five years, micro-irrigation programme can be very fruitful. MI advanced techniques can increase farmers' incomes in a number of ways and contribute to states as well as country's development.
- As per "SankalpPatra 2017", 50 lakh farmers were targeted to be benefitted in U.P by 'Drip and Sprinkler' irrigation. To make this modern technique more popular and to reduce the burden on farmers, towards water conservation, more production and productivity, more income; the Uttar Pradesh state government as on 12.07.2017 apart from compulsory state government's share in grants, has increased it further by additional 35-35 percent basis share grant to small & marginal and other farmers, respectively on PDMC (Per Drop More Crop- Micro Irrigation) component of PMKSY (Pradhan Mantri Krishi Sinchayee Yojna)
- Extending this plan/ scheme for another five years as well i.e. 2016-17 to 2021-22; small and marginal farmers were benefitted through grant-in- aids to the extent of 90 percent of unit cost and other category of farmers to the extent of 80 percent of the unit cost. This system has been implemented in all the districts of Uttar Pradesh and is equally effective for Horticulture, Agriculture and Sugarcane.
- The priority areas under "Other Interventions" of Per Drop More Crop (micro-irrigation) by over exploited, critical, semi critical, minor irrigation department, are developed tanks/water source clusters, Member of Parliament's Adopted Villages; while:

The details of physical and financial progress under PMKSY for Horticulture and Agriculture Department for the years 2018-19 and 2019-20 may be viewed from the-Table-3.4.

Table-3.4

Physical and Financial Progress of Horticulture and Agriculture Departments in Uttar Pradesh; under Pradhan MantriKrishiSinchayeeYojana (PMKSY) – Per Drop More Crop (PDMC) – Micro-irrigation (MI)/Other Interventions (OI): For the Year 2018-19 and 2019-20

(Figures in Crores of Rs.)

Details		Year 2018-19 (March 2019)		Year 2019-20 (August 2019)	
		Horticulture (PDMC-MI)	Agriculture (PDMC-OI)	Horticulture (PDMC-MI)	Agriculture (PDMC-OI)
Approved Central Share by Govt. of India		75.00	40.00	-	-
Sanctioned Amount by SLSC		206.85	63.55	227.13	145.31
Amount Realloted by Central Govt.		11.11	15.91	20.70	13.74
Amount Released by Central Govt.		63.87	24.01	38.36	9.72
Financial Sanction Received from Govt.	Central Share	54.86	37.62	50.78	13.74
	State Share	96.33	25.09	89.07	8.76
	Total	151.19	62.71	139.85	22.50
Physical	Target	55518 ha	5000 (number)	57403 ha	7000 (number)
	Achievement	55074 ha	5000 (number)	6320 ha	1969 (number)
Financial	Allotted	151.19	48.77	139.85	22.50
	Expenditure	149.86	43.63	15.13	7.25
Progress		-	-	Work under progress	1969 Field Tanks work completed and work of 952 Field Tanks under Progress

Source: Department of Horticulture and Food Processing, Uttar Pradesh

Chapter-4

Study Sampling and Sample Profile

The present chapter describes details of study sampling and sample profile, like sample coverage, details of age and education of adopters of Micro-irrigation (MI) techniques.

4.1 Sample Coverage

The details of sample coverage, adopters of micro-irrigation (Drip and sprinkler), as also non adopters in the sample under study; are displayed as under

- (i) The two districts covered under the study are respectively Sonbhadra and Saharanpur, each corresponding to a sample of 6 villages, to result into Total sample of 12 villages in the study.
- (ii) In all 120 sample respondents have been selected, of which 96 are adopters of micro-irrigation and 24 Non adopters of micro irrigation.
- (iii) District wise there are 48 adopters and 12 non adopters in each of the two districts.
- (iv) On overall basis among 96 adopters, 37(38.54percent) adopted drip irrigation while 59(61.46percent) adopted sprinkler.
- (v) District wise breakup of drip and sprinkler has been respectively as 35.42percent and 64.58percent in district Sonbhadra and 41.67percent and 58.33percent in district Saharanpur.

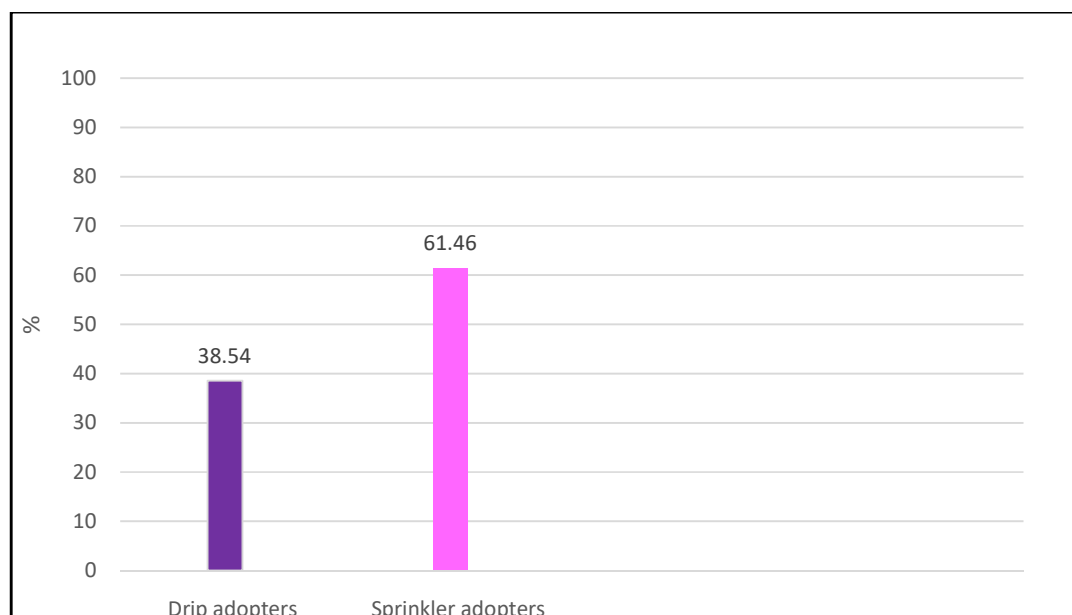
The above reportings reflect that, there are more adopters of sprinkler as compared to drip irrigation; where as it may be noted that MI adopter was given only one facility, i.e. drip irrigation or sprinkler irrigation facility and not the both. The related data are shown in Table 4.1.

Table-4.1
Sample coverage

Sr. No.	District surveyed	No. of Village	No. of Farmers surveyed	Drip	Sprinkler	Micro-Irrigation (Both)	Non-Adopters
1	SONBHADRA	6	48	17 (35.42)	31 (64.58)	48 (100.00)	12
2	SAHARANPUR	6	48	20 (41.67)	28 (58.33)	48 (100.00)	12
Total	-	12	96	37 (38.54)	59 (61.46)	96 (100.00)	24

Note: Figures in parentheses are percentages

Figure- 4.1
Drip and Sprinkler MI Adopters (%)



4.2 Age of Adopters

The details of age of adopters has been shown in the Table 4.2

The Table-4.2, shows that (i) The maximum, i.e., 37(38.55 percent) adopters belong to age group (40-50) years, followed by those of above 60 years, as 26(27.08 percent) adopters (ii) Next to these are in the age groups (30-40) years and (50-60) with respective percentages as

18.75 percent and 14.58 percent and that (iii) There are no adopters at all in the age group of under 20 years, while a very meagre percentage, i.e., 1.04 percent of the age group (20-30) years.

On the whole age groups 30 -40 years, 40 - 50 years and above 60 years, constitute major part, i.e., 84.38 percent of all the 96 adopters. The related data are given in Table 4.2

Table-4.2
Age of adopters

Age (in years)	Number	Percent
Under 20	00	0.00
20-30	01	1.04
30-40	18	18.75
40-50	37	38.55
50-60	14	14.58
Above 60	26	27.08
Total	96	100.00

4.3 Education of Adopters

Educational details of the adopters of MI record that (i) highest number of adopters i.e. 28 (29.17 percent) have education up to 10th standard, followed by those of graduates as 20 i.e. 20.83 percent, which on combined basis work out to be 50 percent of all MI adopters (ii) Next to these are adopters with education up to 12th standard (12.50 percent), middle school (10.42 percent) and primary level education (9.37 percent) (iii) While a few have post graduate (5.21 percent) and technical education (1.04 percent) as well, but still there are 11.46 percent of adopters as illiterate.

On overall basis this gives a satisfactory setup of literacy status of adopters, but with serious need to make efforts, furthermore, to wipe out illiteracy completely. The corresponding data is shown in Table 4.3.

Table-4.3
Education of adopters

	Number	Percent
Illiterate	11	11.46
Primary	09	9.37
Middle	10	10.42
10thStd	28	29.17
12thStd	12	12.5
Graduate	20	20.83
Post-Graduation	05	5.21
Technical	01	1.04
	96	100.00

Chapter-5

Land Area and Water Sources in Relation to Micro Irrigation

This chapter attempts to highlight land area and water sources in relation to micro irrigation, under study area, comprising of twin districts of Sonbhadra and Saharanpur, in the state of Uttar Pradesh. The characteristics highlighted are land area, water sources, water situation for farming, type of soil, type of terrain, rainfall situation, year started using micro-irrigation and whether availed subsidy.

5.1 Land Area

The group (i.e. size offarm- landless/tenant, marginal, small, medium, large) wise details of number of farmers (adopters of MI), total operated area, micro (drip/sprinkler) irrigated area, non-micro irrigated area as also un-irrigated area; are highlighted in the Table-5.1.

The observations of the Table -5.1 record that (i) Out of total 96 adopters of MI; maximum (59.38 percent) belong to small category (1-2) ha, i.e., 1 ha. and above but less than 2ha.farmers; followed by medium category (2-10) ha, i.e., 2ha to 10 ha size farmers (34.37 percent) and marginal (less than 1ha) farmers (6.25 percent), respectively; while there are no adopters at all in the landless/tenant group or large (more than 10ha) MI farmers group. (ii) On overall basis, average per farmer (MI adopter) total operated area works out to be 1.76 ha, with respective averages of marginal, small and medium group farmers as 0.68 ha, 1.22 ha and 2.90 ha. (iii) The average per farmer total micro irrigated area has been recorded as 1.15 ha for the entire sample with respective marginal, small and medium group averages as 0.66 ha, 0.93 ha and 1.62 ha. (iv) In marginal and medium groups, drip irrigated area is more than sprinkler irrigated area, while in small group sprinkler irrigation area exceeds drip irrigation area. (v) On overall basis, sprinkler average irrigated area exceeds that of drip irrigated average. (vi) As compared to micro irrigated average of 1.15 ha, the corresponding non micro irrigated average is 0.57 ha; while group wise as well, MI irrigated average has been higher than corresponding non MI irrigated average, while (vii) the extent of un-irrigated area has been very meagre and almost negligible, on overall as well as group wise basis. The related data are shown in Table-5.1.

**Table-5.1
Land Area (Hectares)**

Group (ha)	Number of Farmers	Per cent (%)	Area Operated in Hectares – Average					Non-Micro Irrigated	Un-Irrigated
			Total Area Operated	Micro-Irrigated area					
				Total	Drip	Sprinkler			
Landless/Tenant	00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	
Marginal (<1)	06	6.25	0.68	0.66	0.53	0.13	0.02	0.00	
Small (1-2)	57	59.38	1.22	0.93	0.31	0.62	0.28	0.01	
Medium (2-10)	33	34.37	2.90	1.62	0.85	0.77	1.17	0.11	
Large (>10)	00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	96	100.00	1.76	1.15	0.51	0.64	0.57	0.04	

Note: In the Table-5.1, average refers to Per Farmer Average

Further, to have still more clarity in respect of micro-irrigation (MI) details, the Table - 5.1 is supplemented here with by the Table -5.1(a) displaying percentage breakup details accordingly.

The data of the Table -5.1(a) clearly results to that (i) On overall sample basis, as well as group wise, extent of irrigation of operated area of MI adopters has been over 95 percent; with overall sample recording as 97.73 percent irrigated area, ranging in different groups from 96.21 percent to 100 percent (ii) Small (1-2) ha group farmers recorded highest percentage (99.18 percent) of micro irrigated area, followed by marginal (97.06 percent) and medium category farmers (58.06 percent) ; with total sample percentage of micro irrigated area as 66.86 percent as compared to 33.14 percent non micro irrigated area and that (iii) On overall sample basis, sprinkler has an edge over drip irrigation with respective percentage of irrigated area as 55.65 percent (sprinkler) as compared to 44.35 percent (drip). (iv) Group wise drip is dominating in marginal and medium categories of farmers, while sprinkler is dominant over drip in case of small category farmers; although need not to say that both of these, i.e., drip and sprinkler irrigation techniques have their own utility as advanced irrigation practice. The corresponding data are presented in Table-5.1(a).

Table-5.1(a)

Percentage Breakup Details

Group (ha)	Area in Hectares (Average)								
	Operated			Irrigated			Micro Irrigated		
	Irrigated	Un-irrigated	Total	Micro	Non-Micro	Total	Drip	Sprinkler	Total
Landless	-	-	-	-	-	-	-	-	-
Marginal (<1)	100.00	0.00	100.00	97.06	2.94	100.00	80.30	19.70	100.00
Small (1-2)	99.18	0.82	100.00	99.18	0.82	100.00	33.33	66.67	100.00
Medium (2-10)	96.21	3.79	100.00	58.06	41.94	100.00	52.47	47.53	100.00
Large (>10)	-	-	-	-	-	-	-	-	-
Total	97.73	2.27	100.00	66.86	33.14	100.00	44.35	55.65	100.00

Figure-5.1
Extent of Irrigated and Unirrigated area (%) (MI adopters)

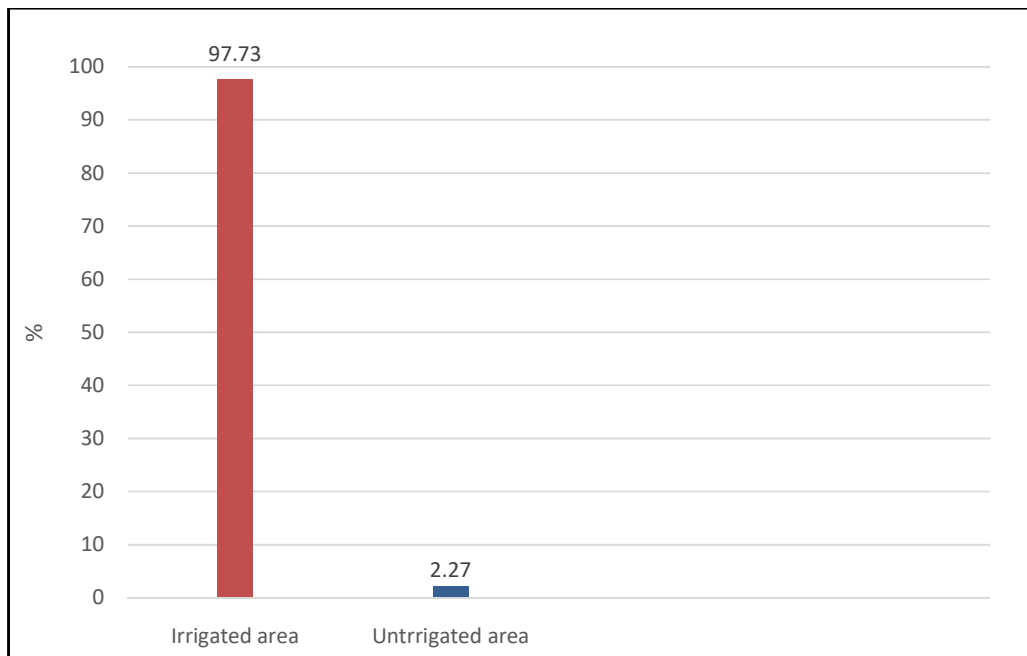


Figure-5.2
Extent of Micro and Non micro irrigated area (%) (MI adopters)

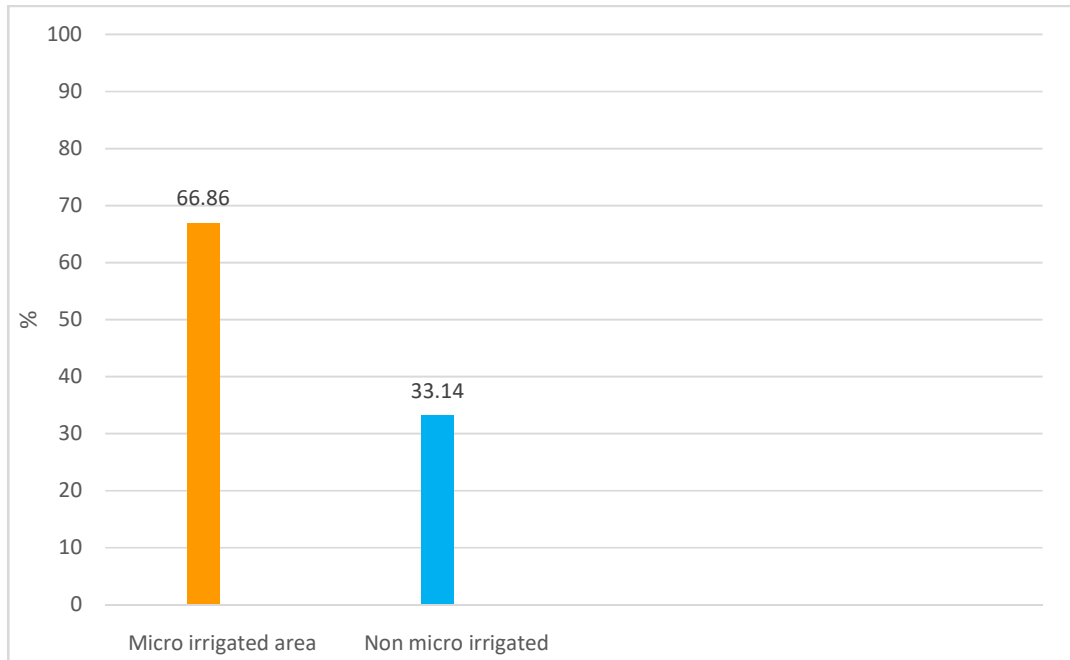
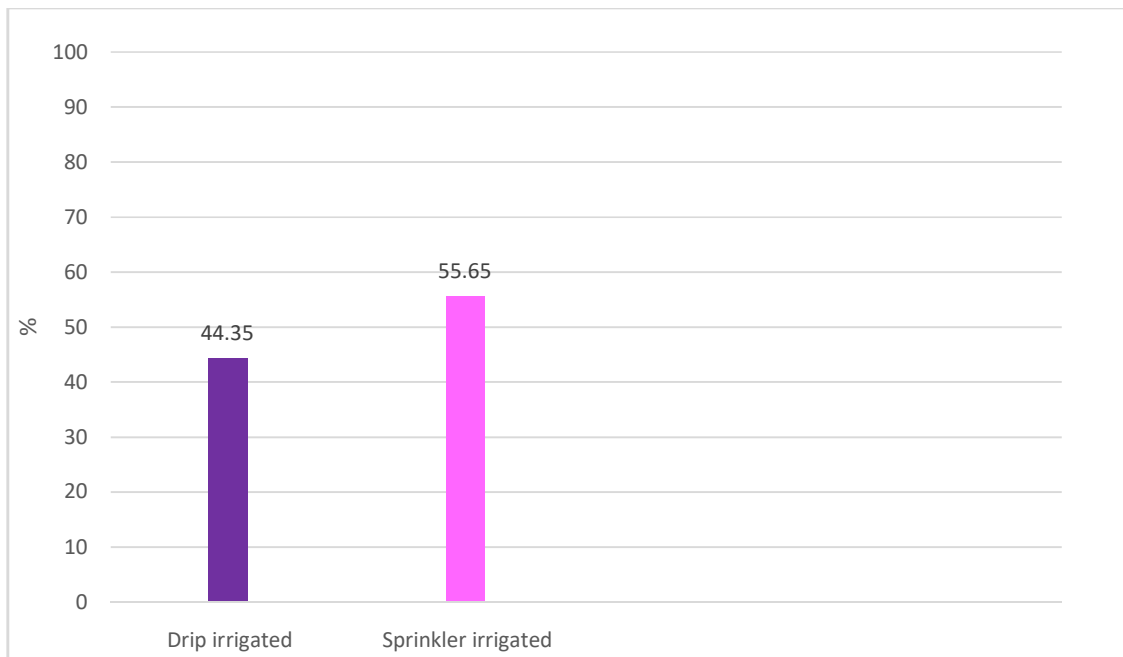


Figure-5.3
Drip V/S Sprinkler Irrigated area (%) (MI adopters)



5.2 Water Source

The details of available water sources to the sample farmers (MI adopters) in the study area, are displayed in the Table -5.2.

The Table -5.2, clearly shows that the major water sources for irrigation to MI adopters is the tube-well and is accounted for by 95.83 percent of the total 96 adopters; while the remaining 4.17 percent of adopters depend upon other sources of water (submersible, water pump). The concerned data is shown in Table-5.2.

Table-5.2
Water sources

Source	Number	Percent (%)
Canal	00	0.00
Canal-Lift	00	0.00
River-Lift	00	0.00
Tube-well	92	95.83
Well	00	0.00
Tank	00	0.00
Pond	00	0.00
Farm Pond	00	0.00
Check dam	00	0.00
Percolation Tank	00	0.00
Others (Submersible water pump)	04	4.17
All	96	100.00

5.3 Water Situation for Farming

The Table -5.3 displays water situation for MI adopter farmers of the study area and it is evidently seen from the Table -5.3 that for 96.88 percent of total MI adopters (96) there is no scarcity of water; while 2.08 percent have excess water situation with 1.04 percent facing occasional scarcity.

This clearly shows that, with tube-well as the available sources of irrigation, MI adopters in the study area have no water scarcity problem. The related data are showing in Table-5.3.

Table-5.3
Water situation for farming

Water situation	Number	Percent (%)
Excess water	02	2.08
No scarcity	93	96.88
Occasional scarcity	01	1.04
Scarcity	00	0.00
Acute scarcity	00	0.00
All	96	100.00

5.4 Type of Soil

The type of soil of land (field area) of MI adopters detailed in the Table-5.4, displays that majority (62.50 percent) of MI adopters have medium type of soil, followed by 34.37 percent with heavy type soil and the remaining 3.13 percent having light soil. The related data can be visualized in Table-5.4.

Table-5.4
Type of Soil

Soil	Number	Percent (%)
Light	03	3.13
Medium	60	62.50
Heavy	33	34.37
All	96	100.00

5.5 Type of Terrain

The Table -5.5 below presents the type of terrain, in respect of MI adopters and results to that 77.08 percent of MI adopters in the study area have flat terrain and 22.92 percent up and down terrain, while there is no adopter with hilly terrain. The data may be seen in Table-5.5.

Table-5.5
Type of Terrain

Terrain	Number	Percent (%)
Flat	74	77.08
Up & Down	22	22.92
Hilly	00	00.00
All	96	100.00

5.6 Rainfall Situation (2019-20)

The breakup of total 96 adopters, according to rainfall status shows that (i) 82.29 percent of total adopters were subject to average rainfall, while 17.71 percent had heavy rainfall and that (ii) No adopter suffered from very heavy or low or very low rainfall. This evidently results that rainfall status is no problem to MI adopters of the study area. The related data are presented in Table-5.6.

Table-5.6
Rainfall situation (2019-20)

Rainfall	Number	Per cent (%)
Very heavy	00	0.00
Heavy	17	17.71
Average	79	82.29
Low	00	0.00
Very low	00	0.00
All	96	100.00

5.7 Year Started Using Micro-Irrigation

The year of starting of using micro-irrigation in the study area of Uttar Pradesh, shows that all the 96 MI adopters selected in the present study, started using micro-irrigation on cent percent basis w.e.f. the year, 2018-19. The data is shown in Table-5.7.

Table-5.7
Year started using micro-irrigation

When started using micro-irrigation	Number	Percent (%)
Current Year (2019-20)	00	0.00
Last Year (2018-19)	96	100.00
2 years ago	00	0.00
3 years ago	00	0.00
5 years ago	00	0.00
10 years ago	00	0.00
More than 10 years	00	0.00
Overall Average	00	0.00
All	96	100.00

5.8 Whether Availed of Subsidy

With respect to availing of the subsidy, all the 96 adopters of MI, selected in the study, availed of the subsidy on 100 percent basis. The corresponding data is shown in Table-5.8.

Table-5.8
Whether Availed of Subsidy

Availed of subsidy	Number	Percent (%)
Yes	96	100.00
No	0	0.00

This clearly results to the importance and need of subsidies, to MI adopters in implementation of MI schemes and programmes, towards enhancing their crop production(s) as well as other associated benefits.

Chapter-6

Cropping Profile and Changes

This chapter has been designed to study cropping profile and changes thereof due to micro-irrigation by studying (i) cropping profile and area with micro-irrigation and (ii) cropping profile and area before micro irrigation, along with (iii) change in area and yield due to micro irrigation.

6.1 Cropping profile and area with micro irrigation

The crop wise details of cropping profile for various (i) kharif crops viz. Paddy, Maize, Tomato, Chilli, Til, Jowar, Onion, Gourd, Cucumber, Fodder and Arhar (ii) Rabi crops, i.e., Wheat, Tomato, Chilli, Gram, Pea, Mustard, Berseem, Onion and Potato and (iii) the perennial crop Sugarcane, presented in the Table-6.1 shows that (i) under kharif crop, maximum farmers are reporting for Paddy (80) followed by Maize (20), Chilli (15), Tomato (14), Fodder (14) and other crops like Arhar, Jowar, Til, Onion, Gourd, Cucumber each reported by just 1 to 3 farmers (ii) under rabi crops, Wheat accounts for highest number of farmers (84) followed by Berseem (19), Chilli (16), Tomato (13), Mustard (12) and other crops like Gram, Pea, Onion and Potato, each reported by 2 to 12 farmers (iii) Sugarcane as a perennial crop is reported by 28 farmers (iv) The average per farmer area under various crops has been in order as 1.26 ha (sugarcane), 1.10 ha (wheat), 1.08 ha (Paddy), 1.03 ha (Tomato rabi), 0.99 ha (Tomato kharif), 0.83 ha (Arhar), 0.82 ha (Maize), 0.53 ha (Jowar), 0.50 ha (Chilli- rabi season), 0.50 ha (Pea), 0.50 ha (Potato), 0.49 ha (Mustard), 0.41 ha (Chillikharif season); followed by Gram (0.34 ha), Onion (0.31 ha) rabi season, Til and Onion (kharif) each 0.25 ha, Berseem (0.21 ha) and Gourd and Cucumber (each 0.20 ha). (v) Under kharif season, out of total 11 crops grown, drip irrigation has been used in 3 crops viz. Tomato, Chilli and Onion, while sprinkler has not been used in case of any crop. (vi) Under rabi season among 9 crops grown, drip and sprinkler both have been used for Onion, while only drip in case of Tomato and Chilli and only sprinkler in case of Wheat, Pea, Mustard and Berseem, while for the perennial crop sugarcane, drip irrigation has been used (vii) Under kharif crops (a) in case of Tomato, Chilli and Onion, the distribution of micro (drip) irrigated and

non-micro irrigated area, has respectively been as 0.26 ha and 0.73 ha; 0.33 ha and 0.08 ha and 0.13 ha and 0.12 ha. (b) For crops Paddy, Maize, Gourd, Cucumber and Fodder the entire area is irrigated as non-micro irrigated area (c) For Til, Jowar and Arhar the “entire area is unirrigated.” (viii) Under rabi season crops (a) All crops are fully irrigated either by micro or non-micro-irrigation methods; except for Gram which has partly unirrigated area but to a smaller extent. (b) The distribution of micro and non-micro irrigated area has been as 0.70 ha and 0.40 ha for wheat; 0.28 ha and 0.75 ha for Tomato; 0.35 ha and 0.15 ha for chilli; 0.00 ha and 0.28 ha for Gram, 0.25 ha and 0.25 ha for Pea; 0.07 ha and 0.42 ha for Mustard; 0.01 ha and 0.20 ha for Berseem, 0.19 ha and 0.06 ha for Onion; 0.00 ha and 0.50 ha for Potato and 1.16 ha and 0.10 ha for sugarcane.(ix) The extent of fertigation has been highest in case of sugarcane (96.00 percent) followed by Onion (75.00 percent), Chilli (62.50 percent) (rabi season), Tomato (61.54 percent) (rabi season), Chilli (60.00 percent) (kharif season), Wheat (58.33 percent), Tomato (57.14 percent) (kharif season), Onion (50.00 percent); Pea (50.00 percent) and Mustard (8.00 percent); with no fertigation to any other crop i.e. Paddy, Maize, Til, Jowar, Gourd, Cucumber, Fodder, Arhar, Gram, Berseem, Potato. The related data are given in Table-6.1.

Table-6.1
Cropping profile and area with micro-irrigation

Sr. No	Crop name	Season Kharif/Rabi/other	No. of farmers reporting	Area - average in hectares (based on reporting farmers)					
				Area under the crop	Drip area	Sprinkler area	Irrigated Non-Micro area	Un-irrigated area	Fertigation (%)
1	Paddy	Kharif	80	1.08	0.00	0.00	1.08	0.00	0.00
2	Maize	Kharif	20	0.82	0.00	0.00	0.82	0.00	0.00
3	Tomato	Kharif	14	0.99	0.26	0.00	0.73	0.00	57.14
4	Chilli	Kharif	15	0.41	0.33	0.00	0.08	0.00	60.00
5	Til	Kharif	01	0.25	0.00	0.00	0.00	0.25	0.00
6	Jowar	Kharif	03	0.53	0.00	0.00	0.00	0.53	0.00
7	Onion	Kharif	02	0.25	0.13	0.00	0.12	0.00	50.00
8	Gourd	Kharif	01	0.20	0.00	0.00	0.20	0.00	0.00
9	Cucumber	Kharif	01	0.20	0.00	0.00	0.20	0.00	0.00
10	Fodder	Kharif	14	0.24	0.00	0.00	0.24	0.00	0.00
11	Arhar	Kharif	03	0.83	0.00	0.00	0.00	0.83	0.00

Sr. No	Crop name	Season Kharif/Rabi/other	No. of farmers reporting	Area - average in hectares (based on reporting farmers)					
				Area under the crop	Drip area	Sprinkler area	Irrigated Non-Micro area	Un-irrigated area	Fertigation (%)
1	Sugarcane	Perennial	28	1.26	1.16	0.00	0.10	0.00	96.00
1	Wheat	Rabi	84	1.10	0.00	0.70	0.40	0.00	58.33
2	Tomato	Rabi	13	1.03	0.28	0.00	0.75	0.00	61.54
3	Chilli	Rabi	16	0.50	0.35	0.00	0.15	0.00	62.50
4	Gram	Rabi	08	0.34	0.00	0.00	0.28	0.06	0.00
5	Pea	Rabi	04	0.50	0.00	0.25	0.25	0.00	50.00
6	Mustard	Rabi	12	0.49	0.00	0.07	0.42	0.00	8.00
7	Barseem	Rabi	19	0.21	0.00	0.01	0.20	0.00	0.00
8	Onion	Rabi	04	0.31	0.06	0.19	0.06	0.00	75.00
9	Potato	Rabi	02	0.50	0.00	0.00	0.50	0.00	0.00

6.2 Cropping Profile and Area before Micro irrigation

The cropping profile and area, before adoption of micro-irrigation given in the Table-6.2, depicts that (i) Under kharif season (a) the adoption of various crops prior to MI practices in terms of number of farmers, have been in order as Paddy (78), Maize (23), Fodder (12), Chilli (9), Tomato (9), Jowar and Arhar (3 each) while Onion and Til (1 each). On per farmer average area basis, the order of crops have been as Tomato (1.29 ha), Paddy (1.20 ha), Maize (0.79 ha), Bajra, Jowar, Onion, Arhar (each 0.50 ha), Chilli (0.37 ha), Til (0.25ha) and Fodder (0.18ha). While the crops Paddy, Maize, Chilli, Fodder, Onion and Tomato are fully irrigated; those of Bajra, Jowar, Til and Arhar have been fully unirrigated. (ii) As a perennial crop sugarcane is fully irrigated (iii) Under rabi season (a) highest number of adopters were in case of Wheat (83) followed by Berseem (14), Tomato and Chilli (each 9), Mustard (8), Pea (7), Onion (3) and Potato (only 1). (b) On per farmer average area basis, Tomato is at top (1.35ha) followed by Wheat (1.25ha), Potato (0.75 ha), Mustard (0.52 ha), Gram, Pea and Onion (each 0.50ha), Chilli (0.40ha) and Berseem (0.15ha). (c) All the crops have been fully irrigated except Gram being partially irrigated and partly unirrigated. The related data are presented in Table-6.2.

Table-6.2
Cropping profile and area before micro irrigation

Sr. No.	Crop name	Season Kharif/Rabi/ other	No. of farmers reporting	Area – average in hectares for reporting farmers		
				Total area	Irrigated area	Un-irrigated area
1	Paddy	Kharif	78	1.20	1.20	0.00
2	Maize	Kharif	23	0.79	0.79	0.00
3	Bajra	Kharif	01	0.50	0.00	0.50
4	Jowar	Kharif	03	0.50	0.00	0.50
5	Chilli	Kharif	09	0.37	0.37	0.00
6	Fodder	Kharif	12	0.18	0.18	0.00
7	Onion	Kharif	01	0.50	0.50	0.00
8	Tomato	Kharif	09	1.29	1.29	0.00
9	Till	Kharif	01	0.25	0.00	0.25
10	Arhar	Kharif	03	0.50	0.00	0.50
1	Sugarcane	Perennial	28	1.23	1.23	0.00
1	Wheat	Rabi	83	1.25	1.25	0.00
2	Tomato	Rabi	09	1.35	1.35	0.00
3	Chilli	Rabi	09	0.40	0.40	0.00
4	Gram	Rabi	03	0.50	0.33	0.17
5	Pea	Rabi	07	0.50	0.50	0.00
6	Mustard	Rabi	08	0.52	0.52	0.00
7	Barseem	Rabi	14	0.15	0.15	0.00
8	Onion	Rabi	03	0.50	0.50	0.00
9	Potato	Rabi	01	0.75	0.75	0.00

6.3 Cropping profile and irrigated area before and after Micro-Irrigation

The observations of Table-6.3 in respect of changes in cropping profile and irrigated area; as before and after Micro-Irrigation (MI) shows that: (a) In respect of crop area (i) The crops recording positive changes have been Maize, Chilli, Jowar, Fodder, Arhar, Sugarcane and Berseem to the extent of 2.30% (Sugarcane) to 66.00% (Arhar); while those with negative changes have been Paddy, Tomato, Onion, Wheat, Tomato, Gram, Mustard and Potato in the range of (-)5.77% (Mustard) to (-)50.00% (Onion) (ii) the crops Til and Pea did not record any change (b) No change is recorded with regard to extent of area irrigated; in case of any of the crop, i.e., the crop which are 100 percent irrigated after MI were 100 percent irrigated before MI

as well; while a few have been totally unirrigated, before as well as after MI; except in case of gram whose extent of irrigation has changed. The related data are given in Table-6.3.

Table-6.3
Cropping Profile and Irrigated Area: Before and After Micro-Irrigation

(Area in ha)

Season	Crop Name	Per Farm Area under crop (ha)			Per Farm Irrigated Area under crop (ha)		Extent of Area Irrigated (%)	
		Before MI	After MI	% Change	Before MI	After MI	Before MI	After MI
Kharif	Paddy	1.20	1.08	(-)10.00	1.20	1.08	100.00	100.00
	Maize	0.79	0.82	3.80	0.79	0.82	100.00	100.00
	Tomato	1.29	0.99	(-)23.20	1.29	0.99	100.00	100.00
	Chilli	0.37	0.41	10.81	0.37	0.41	100.00	100.00
	Til	0.25	0.25	0.00	0.00	0.00	0.00	0.00
	Jowar	0.50	0.53	6.00	0.00	0.00	0.00	0.00
	Onion	0.50	0.25	(-)50.00	0.50	0.25	100.00	100.00
	Fodder	0.18	0.24	33.33	0.18	0.24	100.00	100.00
	Arhar	0.50	0.83	66.00	0.00	0.00	0.00	0.00
	Perennial	Sugarcane	1.23	1.26	2.30	1.23	1.26	100.00
Rabi	Wheat	1.25	1.10	(-)12.00	1.25	1.10	100.00	100.00
	Tomato	1.35	1.03	(-)23.70	1.35	1.03	100.00	100.00
	Chilli	0.40	0.50	25.00	0.40	0.50	100.00	100.00
	Gram	0.50	0.34	(-)32.00	0.33	0.28	34.00	17.65
	Pea	0.50	0.50	0.00	0.50	0.50	100.00	100.00
	Mustard	0.52	0.49	(-)5.77	0.52	0.49	100.00	100.00
	Barseem	0.15	0.21	40.00	0.15	0.21	100.00	100.00
	Onion	0.50	0.31	(-)38.00	0.50	0.31	100.00	100.00
	Potato	0.75	0.50	(-)33.33	0.75	0.50	100.00	100.00

6.4 Change in area and yield due to micro irrigation

The crop wise (tomato, wheat, sugarcane- the three major crops) observations in respect of change in area and yield, due to Micro-Irrigation show that the number of reporting farmers have been as; 14 for Tomato, 84 for Wheat and 28 for Sugarcane, respectively. No farmer has been reported in the category of; either large decrease in area or decrease in area, due to micro irrigation, corresponding to any of the three crops i.e. Tomato, Wheat and Sugarcane. For crop Tomato (i) Out of 14 reporting farmers; 4 (28.57 percent) corresponds to large increase, 4 (28.57 percent) to increase and 6 (42.56 percent) to no change; in area due to micro irrigation; while (ii) In respect of yield, respective reporting have been as 3 (21.43 percent) for large increase, 8 (57.14 percent) for increase and 3(21.43 percent) for no change. (iii) Majority (78.57 percent) of total reporting farmers, result to positive change in yield (increase and large increase) in Tomato.

(iv) The corresponding mean scores in case of area and yield of Tomato have been as 3.85 and 4.00; which are both above “no change” score of 3; which indicate that there have been enhancements in area and also in yield of Tomato, due to micro irrigation. For crop Wheat (i) Out of 84 reporting farmers, majority of them 50 (59.52 percent) report no change in area; whereas 16(19.05 percent) report for large increase and 18 (21.43 percent) for increase, i.e., 34 farmers (40.48 percent) reporting upward change in area of Wheat (increase/large increase); while (ii) In respect of yield; 64 farmers (76.19 percent) of total reporting farmers show enhancements (large increase/increase) in yield, whereas 20 farmers (23.81 percent) record no change in yield, as a result of micro irrigation. (iii) The mean scores of area and yield, in case of crop Wheat as well, have been above 3 (score of no change) with respective values as 3.60 for area and 3.88 for yield; thereby indicating increasing trend in area as well as in yield of Wheat, due to micro irrigation. For crop Sugarcane (i) There has been no change at all in the area under Sugarcane due to micro irrigation; as out of total 28 reporting farmers for this crop; all of them correspond to the category of “no change” in area, on 100 percent basis. But, in respect of yield; all the 28 farmers report enhancement (large increase/ increase) in Sugarcane yield due to micro-irrigation on cent percent (100 percent) basis. (ii) Mean score wise as well, the mean score of 3 in case of area under Sugarcane indicated ‘no change’ in area under the crop; while in case of yield the mean score of 4.07 (above 3) indicated change in positive direction, i.e., towards increase. The corresponding data are shown in Table-6.4.

Table-6.4
Change in area and yield due to Micro irrigation

Sr. No.	Crop name	No. of farmers reporting	Change in Area due to Micro-irrigation (%)						Mean	Change in Yield due to Micro-irrigation (%)						Mean
			5	4	3	2	1	5		4	3	2	1			
1	Tomato	14 (100.00)	4 (28.57)	4 (28.57)	6 (42.86)	0 (0.00)	0 (0.00)	3.85	3 (21.43)	8 (57.14)	3 (21.43)	0 (0.00)	0 (0.00)	4.00		
2	Wheat	84 (100.00)	16 (19.05)	18 (21.43)	50 (59.52)	0 (0.00)	0 (0.00)	3.60	10 (11.90)	54 (64.29)	20 (23.81)	0 (0.00)	0 (0.00)	3.88		
3	Sugarcane	28 (100.00)	0 (0.00)	0 (0.00)	28 (100.00)	0 (0.00)	0 (0.00)	3.00	2 (7.14)	26 (92.86)	0 (0.00)	0 (0.00)	0 (0.00)	4.07		

Scale: Large Increase =5 Increase =4 No Change =3 Decrease =2 Large Decrease =1

Note: The respective percentages are shown in parenthesis

Thus, it can be very well said that in case of (i) Tomato; out of 14 reporting farmers, 57.14 percent report for change (increase/ large increase) and 42.86 percent do not report for any change in area, while 78.47 percent report for change (increase/ large increase) and 21.53 percent do not report for any change in yield (ii) Wheat; out of 84 reporting farmers, 40.48 percent report for change (increase/ large increase) and 59.52 percent do not report for any change in area; while 76.19 percent show change (increase/ large increase) and 23.81 percent do not show any change in yield. (iii) Sugarcane; out of 28 reporting farmers “not even a single farmer” reports for change in area; while all the 28 farmers report for positive change (increase/ large increase) in yield on 100 percent basis; which clearly results to that “In spite of relative less or no change in area, the farmers are reporting larger increase in yields of all the three crops, i.e., Tomato, Wheat and Sugarcane, due to MI adoption.

Chapter-7

Changes in Incomes and Farm Economics with Micro-Irrigation

An attempt has been made in the present chapter, to highlight the changes in production, incomes, inputs and costs; as a result of adopting micro-irrigation (MI) advanced techniques of irrigation. The changes have been studied for the major crops Tomato, Wheat and Sugarcane along with Total/ All crops, as with micro-irrigation and without micro irrigation.

The various items, for which these changes have been studied comprise of – Area, Production, Yield, Price, Total Sales Revenue, Seeds/ Plants costs, Fertilizer cost, Farm Yard Manure (FYM)/ Organic cost, Pesticide cost, Electricity cost, Diesel cost, Water charges paid, Number of Irrigations, Hours of Pumping, Farm power and Equipment cost, Total Man days, Labour cost, Marketing cost, Total cost and Net Profit/ Income.











AERC, Prayagraj Research Team discussing various aspects of MI Adoption, with selected respondents and village leaders in the Study area.

The details of above mentioned items, for crops Tomato, Wheat, Sugarcane and Total/all crops, as with MI and without MI are presented in the Table 7.1 while (i) the different averages in this Table refers to per farmer average values and (ii) The crop wise reporting have been as 14 for Tomato, 84 for Wheat, 28 for Sugarcane and 126 corresponding to Total/ All crops, respectively.

The observations of the Table 7.1 for different items result to as under:

- (a) **Area-** The per farmer average areas with MI and without MI have respectively been as 0.99 ha and 0.83 ha for Tomato; 1.10 ha and 1.23 ha for Wheat; 1.26ha and 1.23 ha for sugarcane and 1.12 ha and 1.19 ha for All crops/ Total.

For crop Tomato and Sugarcane, with MI per farmer average area has exceeded that of without MI by 19.28 percent and 2.44 percent respectively; while for Wheat and total/ all crops it has slightly reduced by 10.57 percent and 5.88 percent.

- (b) **Production** – The per farmer average production with MI and without MI are respectively, reported as 189.78 ql and 141.07 ql for Tomato, 25.23 ql and 20.65 ql for Wheat; 1035.68 ql and 890.00 ql for Sugarcane and 260.06 ql and 227.23 ql for All crops/ Total.

For each of the three crops, as also for all crops; with MI productions have been more than the corresponding without MI productions. This shows effectiveness of micro-irrigation in enhancing crop productions of all the three crops, i.e., Tomato, Wheat and Sugarcane as well as for All crops/ Total. The MI adoption has increased productions to the extent of 14.45 percent (All crops/ Total) to 34.53 percent (Tomato).

- (c) **Yield**- The per hectare average yield with MI and without MI are respectively recorded as 191.70 ql/ha and 169.96 ql/ha for Tomato, 22.94 ql/ha and 16.79 ql/ha for Wheat, 821.97 ql/ha and 723.54 ql/ha for Sugarcane and 232.20 ql/ha and 190.95 ql/ha for all crops/Total. With MI yield has been higher than the corresponding without MI yield, for each of the three crops. as well as for all crops/ total. The MI adoption has thus enhanced the crop yield for individual and also total/ All crops to the extent of 12.79 percent (Tomato) to 36.63 percent (Wheat).

- (d) **Price**- The per quintal prices with MI and without MI are respectively noted as 1590 Rs/ql and 1490 Rs/ql for Tomato; Rs 1742 Rs/ql and Rs 1745 Rs/ql for Wheat; Rs 312/ql and Rs 312/ql for Sugarcane and Rs 3644/ql and Rs 3547/ql for All crops/ Total.

With MI prices have increased as compared to without MI prices, for crop Tomato and All crops/ Total; while for Wheat and Sugarcane, with MI and without MI prices have been almost the same.

- (e) **Total Sales Revenue** – The average per farmer total sales revenues, with MI and without MI have respectively been as Rs 301759 and Rs 210196 for Tomato; Rs 43957 and Rs 36030 for Wheat; Rs 323131 and Rs 277680 for Sugarcane and Rs 134640 and Rs 109081 for All crops/ Total.

For each of the three crops as well as for all crops/ total with MI total sales revenue have been much higher than those of without MI total sales revenues and the extent of increase in total sales revenues as a result of MI adoption has been as of the order of 16.37 percent (Sugarcane) to 43.56 percent (Tomato).

- (f) **Seeds/ Plants Cost** – The per farmer average seeds/ plants cost, with MI and without MI respectively works out to be Rs 7486 and Rs 8586 for Tomato; Rs 3081 and Rs 3305 for Wheat; Rs 16780 and Rs 17741 for Sugarcane and Rs 6615 and Rs 3925 for All crops/ Total.

For all the three crops, the with MI seeds/plant cost are much less as compared to corresponding without MI seeds/plants costs; which shows that adoption of MI leads to “less” seeds/plants costs for Tomato, Wheat and Sugarcane, as compared to non-MI adoption and thus reducing the burden of farmers to the extent of 5.42 percent to 12.81 percent, in terms of costs of seeds/plants.

- (g) **Fertilizers Cost** – The per farmer average fertilizers cost, with MI and without MI respectively, comes as Rs 25179 and Rs 32564 for Tomato; Rs 3353 and Rs 3698 for Wheat; Rs 11846 and Rs 12797 for Sugarcane and Rs 7665 and Rs 8926 for All crops/ Total.

In case of fertilizers, for all the three crops viz. Tomato, Wheat and Sugarcane as well as for All crops/ Total, MI adopters have to pay less costs as compared to non-MI adopters to the extent of 7.43 percent(Sugarcane) to 22.68 percent(Tomato).

- (h) **Farm Yard Manure/ Organic Cost-** The per farmer average FYM/ organic cost with MI and without MI respectively, is worked out to be Rs.2843 and Rs. 3486 for Tomato; Rs 1161 and Rs. 1100 for Wheat; Rs.4894 and Rs. 4955 for Sugarcane and Rs. 2177 and Rs. 2222 for All crops/ Total.

In case of FYM/ organic costs, there have been only slight variations in with and without MI costs, though in general except for crop wheat where with MI FYM cost is slightly more than without MI FYM cost; in all other crops (Tomato and Sugarcane) as also All crops/ Total with MI, FYM costs are lower than corresponding without MI costs.

- (i) **Pesticides Cost-** The per farmer average pesticides cost with MI and without MI respectively, have been found out to be Rs.8200 and Rs.10379 for Tomato; Rs. 1030 and Rs. 1370 for Wheat; Rs. 6989 and Rs. 8071 for Sugarcane and Rs. 3151 and Rs. 3860 for All crops/ Total.

The data records that, MI adoption has substantially reduced pesticides costs in all the three crops(Tomato, Wheat, Sugarcane) and also All crops/ Total; reducing the burden of

farmers towards pesticides cost to the extent of 13.41 percent(Sugarcane) to 24.82 percent(Wheat).

- (j) **Electricity Cost-** The per farmer average electricity charge, a farmer has to pay with MI and without MI respectively, is found out to be Rs. 1772 and Rs. 1857 for Tomato; Rs. 1630 and Rs. 1625 for Wheat; Rs. 6546 and Rs. 7341 for Sugarcane and Rs. 2738 and Rs. 2925 for All crops/ Total.

For crop Wheat, with and without MI electricity charges are almost the same but for Tomato, Sugarcane and All crops/ Total with MI electricity charges are less than those of corresponding without MI electricity charges. As compared to non-MI adopter an MI adopter has to pay less electricity charge to the extent of 4.58 percent (Tomato) to 11.07 percent(Sugarcane).

- (k) **Diesel Cost-** The per farmer average diesel cost with MI and without MI respectively is found as Rs. 214 and Rs. 300 for Tomato; Rs. 91 and Rs. 89 for Wheat; Rs. 1207 and Rs. 1671 for Sugarcane and Rs. 358 and Rs. 464 for All crops/ Total.

For crop Wheat, like electricity cost, diesel cost is also almost the same whether with MI or without MI. While for Tomato, Sugarcane as also for All crops/ Total diesel costs are found to be less with MI as compared to those without MI. A farmer adopting MI has to pay less diesel cost as compared to non-MI adopter, to the extent of 22.84 percent (all crops/ total) to 28.67 percent (Tomato).

- (l) **Number of Irrigations-**The per farmer average number of irrigations with MI and without MI respectively, comes as 3 and 6 for Tomato; 3 and 3 for Wheat; 10 and 11 for Sugarcane and 4 and 5 for All crops/ Total.

For crops Wheat and Sugarcane as well as All crops/ Total with and without MI number of irrigations have been the same or almost same while for Tomato with MI number of irrigations is just the half of that of without MI number of irrigations.

- (m) **Hours of Pumping-** Irrespective of number of irrigations the average per farmer hours of irrigation have significantly reduced with MI as compared to without MI for all the three crops, i.e., Tomato, Wheat and Sugarcane as well as for All crops/ Total. The recorded per farmer average hours of pumping with MI and without MI respectively have been as 22 and 35 for Tomato; 27 and 42 for Wheat; 59 and 150 for Sugarcane and 34 and 65 for All crops/ Total.

This shows that, adoption of MI has resulted a farmer to “less” number of hours of pumping to the extent of 37.14 percent for Tomato; 35.71 percent for Wheat; 60.67 percent for Sugarcane and 47.69 percent for All crops/ Total.

- (n) **Farm Power and Equipment Cost-** The average per farmer, farm power and equipment cost, with MI and without MI are respectively recorded as Rs. 3407 and Rs.4607 for Tomato; Rs.3533 and Rs. 3606 for Wheat; Rs. 7582 and Rs. 7730 for Sugarcane and Rs. 4418 and Rs. 4657 for All crops/ Total.

For all the three crops individually as well as for All crops/ Total with MI farm power and equipment costs are lower than those of without MI. The reduction in the cost has been of the order of 1.91 percent (Sugarcane) to 26.05 percent(Tomato).

- (o) **Total Man Days-** The average per farmer total man days with MI and without MI; are respectively recorded as 102 and 118 for Tomato; 51 and 59 for Wheat: 193 and 199 for Sugarcane and 88 and 96 for All crops/ Total.

It is noticed that with MI average total man days are all less than the corresponding without MI values crop wise as well as for All crops/ Total. With MI, these are reduced to the extent of 3.01 percent (Sugarcane) to 13.56 percent (Tomato).

- (p) **Labor Cost-** The average per farmer, labour cost, with MI and without MI are respectively reported as Rs. 20403 and Rs.22503 for Tomato; Rs.11119 and Rs. 12552 for Wheat; Rs. 49246 and Rs. 59821 for Sugarcane and Rs. 30623 and Rs. 23962 for All crops/ Total.

Thus, it is clearly seen that average per farmer labour cost with MI adoption is reduced to the extent of 9.32 percent for Tomato; 11.42 percent for Wheat and 17.68 percent for Sugarcane as compared to corresponding labour cost without MI adoption; while in case of All crops/ Total without MI labour cost has been lower than with MI labour cost.

- (q) **Marketing-** As different from other items the average per farmer marketing cost with MI is found to be higher than the corresponding marketing cost without MI, in case of each of the three crops(Tomato, Wheat and Sugarcane) as well as for All crops/ Total; with respective values as Rs. 4774 and Rs. 2596 for Tomato; Rs. 589 and Rs.505 for Wheat; Rs. 21274 and Rs. 18425 for Sugarcane and Rs. 5650 and Rs. 4720 for all crops/ total.

This is mainly due to difference of respective average per farmer crop productions, as in case of with and without MI. The with MI Marketing cost has been exceeding that of

corresponding without MI Marketing Cost, to the extent of 15.46 percent(Sugarcane) to 83.90 percent(Tomato).

(r) **Other Costs-** The other costs are very nominal with relatively very meagre amounts. The average per farmer, other costs, with MI and without MI is respectively reported as Rs. 36 and Rs.14 for Tomato; Rs.36 and Rs. 44.52 for Wheat; Rs. 12 and Rs. 12 for Sugarcane and Rs. 294 and Rs.309 for All crops/ Total.

(s) **Total Cost-** With adoption of micro-irrigation (MI) farmers are benefited to a great extent in terms of “paying(incurring) much less total cost, as compared to non-MI adopted farmers”; since average per farmer total cost with MI has been considerably low as compared to corresponding without MI average per farmer cost, in case of each crop i.e. Tomato, Wheat, Sugarcane and also All crops/ Total.

The with MI costs are lower than corresponding without MI costs to the extent 14.69 percent in Tomato; 7.12 percent in Wheat; 8.76 percent in Sugarcane and 9.29 percent in case of All crops/ Total. Whereas, the respective with MI and without MI average per farmer costs are respectively reported as Rs. 74314 and Rs. 87106 for Tomato; Rs. 25630 and Rs. 27594 for Wheat; Rs.127566 and Rs. 139819 for Sugarcane and Rs. 53692 and Rs. 59145 for All crops/ Total.

(t) **Net Profit/Income-** The adoption of micro-irrigation apart from lowering down the average per farmer total cost has also enhanced the average per farmer net profit/income to a significant extent for Tomato, Wheat, Sugarcane crops individually as well as for All crops/ Total.

As compared to average per farmer without MI Net profit/income, with MI average per farmer Net profit/income has increased to the extent of 84.78 percent for Tomato; 117.26 percent for Wheat; 41.86 percent for Sugarcane and 62.10 percent for all crops/total.

It may be noted that average per farmer net profit/income with MI and without MI have respectively been as Rs. 227446 and Rs. 123090 for Tomato; Rs. 18328 and Rs. 8436 for Wheat; Rs. 195566 and Rs. 137861 for Sugarcane and Rs. 80949 and Rs. 49937 for all crops/ total. All the related data are given in Table 7.1 and 7.1(a).

Table-7.1

Changes in production, incomes, inputs and costs with micro-irrigation for major crops

Item (approp. units)	Tomato		Wheat		Sugarcane		All Crops/Total	
	No. reporting 14		No. reporting 84		No. reporting 28		No. reporting 126	
	With MI	Without MI	With MI	Without MI	With MI	Without MI	With MI	Without MI
Average for reporting farmers								
Area (ha)	0.99	0.83	1.10	1.23	1.26	1.23	1.12	1.19
Production (Ql)	189.78	141.07	25.23	20.65	1035.68	890.00	260.06	227.23
PriceRs./Ql	1590	1490	1742	1745	312	312	3644	3547
Total Sales Revenue	301759	210196	43957	36030	323131	277680	134640	109081
Cost of Production	191.70	169.96	22.94	16.79	821.97	723.58	232.20	190.95
Seeds/Plants cost	7486	8586	3081	3305	16780	17741	6615	3925
Fertilizer cost	25179	32564	3353	3698	11846	12797	7665	8926
Farm Yard Manure/Organic cost	2843	3486	1161	1100	4894	4955	2177	2222
Pesticides cost	8200	10379	1030	1370	6989	8071	3151	3860
Cost of Irrigation								
Electricity cost	1772	1857	1630	1625	6546	7361	2738	2925
Diesel cost	214	300	91	89	1207	1671	358	464
Water Charges paid								
No. of irrigations	3	6	3	3	10	11	4	5
Hours of pumping	22	35	27	42	59	150	34	65
Farm power & Equipment cost	3407	4607	3533	3606	7582	7730	4418	4657
Total man-days	102	118	51	59	193	199	88	96
Labour cost	20403	22503	11119	12552	49246	59821	30623	23962
Marketing cost	4774	2596	589	505	21274	18425	5650	4720
Other costs	36	14	36	44.52	12	12	294	309
1.								
2.								
Total Cost	74314	87106	25630	27594	127566	139819	53692	59145
Net Profit/Income	227446	123090	18328	8436	195566	137861	80949	49937

Note: Total Sales Revenue and Costs are in Rs.

Table-7.1(a)

Percentage Change in with MI value over that of without MI Value

Item	Percentage Change (%)			
	Tomato	Wheat	Sugarcane	All crops / Total
Area	19.28	(-)10.57	2.44	(-)5.88
Production	34.53	22.18	16.57	14.45
Yield	12.79	36.63	13.60	21.60
Price	6.71	(-)0.17	0.00	2.73
Total Sales Revenue	43.96	22.00	16.37	29.43
Seeds/Plants cost	(-)12.81	(-)6.78	(-)5.42	68.53
Fertilizer cost	(-)22.68	(-)9.33	(-)7.43	(-)14.13
Farm Yard Manure/Organic cost	(-)18.44	5.54	(-)1.23	(-)2.02
Pesticides cost	(-)20.99	(-)24.82	(-)13.41	(-)18.37
Electricity cost	(-)4.58	0.31	(-)11.07	(-)6.39
Diesel cost	(-)28.67	2.25	(-)27.77	(-)22.84
No. of irrigations	(-)50.00	0.00	(-)9.09	(-)20.00
Hours of pumping	(-)37.14	(-)35.71	(-)60.67	(-)47.69
Farm power & Equipment cost	(-)26.05	(-)10.34	(-)1.91	(-)5.13
Total man-days	(-)13.56	(-)13.56	(-)3.01	(-)8.33
Labour cost	(-)9.32	(-)11.42	(-)17.68	27.80
Marketing cost	83.90	16.63	15.46	19.70
Total Cost	(-)14.69	(-)7.12	(-)8.76	(-)9.29
Net Profit/ Income	84.78	117.26	46.86	62.10

Note: other costs are very nominal and meager (negligible) so not considered in this table

Figure- 7.1
Crop wise with MI and without MI per farmer productions

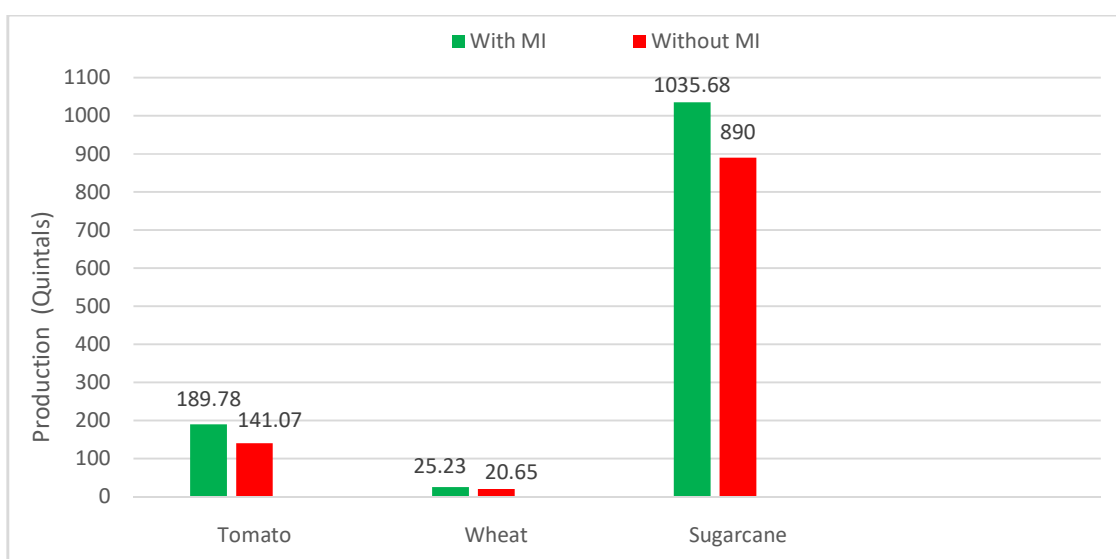


Figure-7.2
Crop wise with MI and without MI Yield in Ql/ha

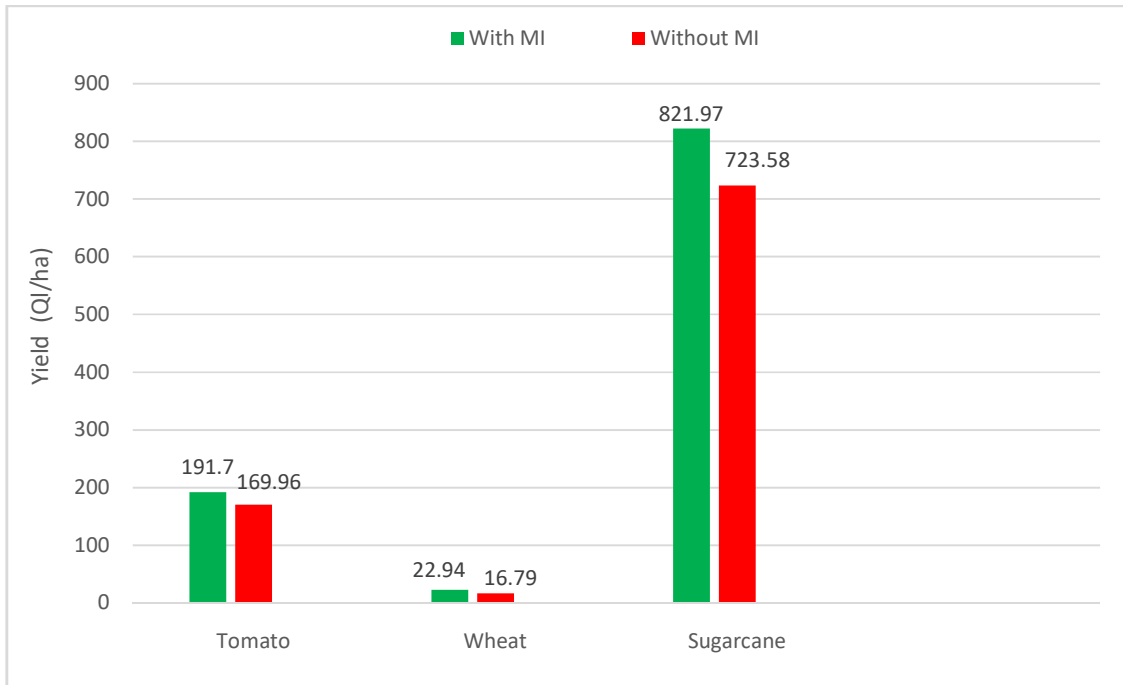


Figure-7.3
Crop wise with MI and Without MI per Farmer Total Sales Revenue

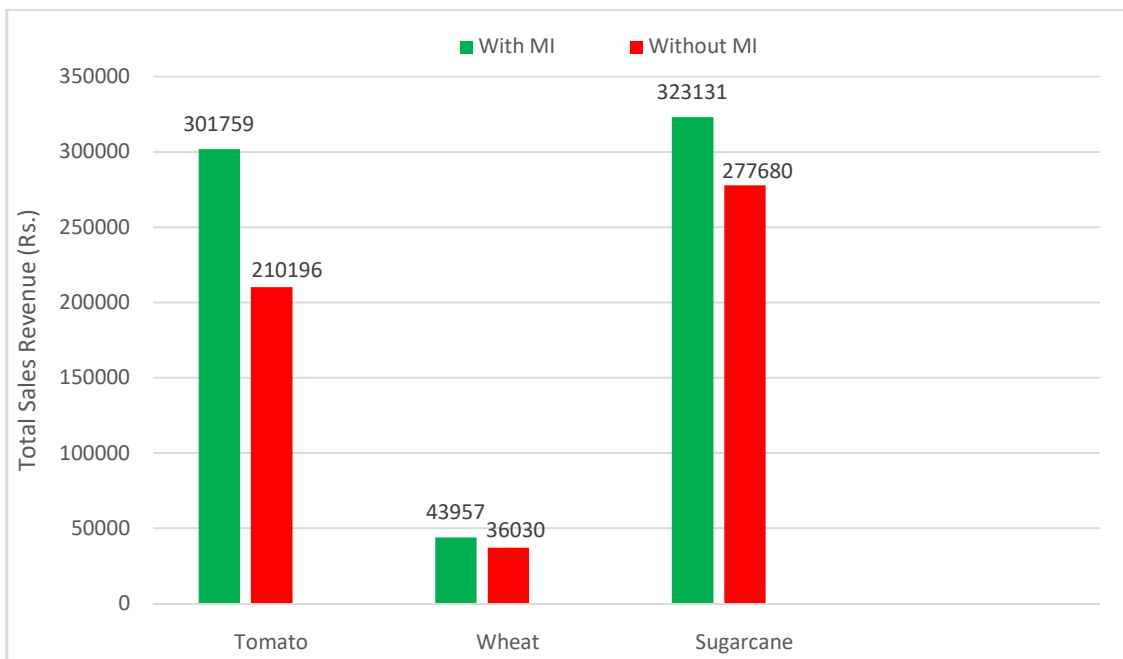


Figure- 7.4
Crop wise with MI and without MI per Farmer Hours of Pumping

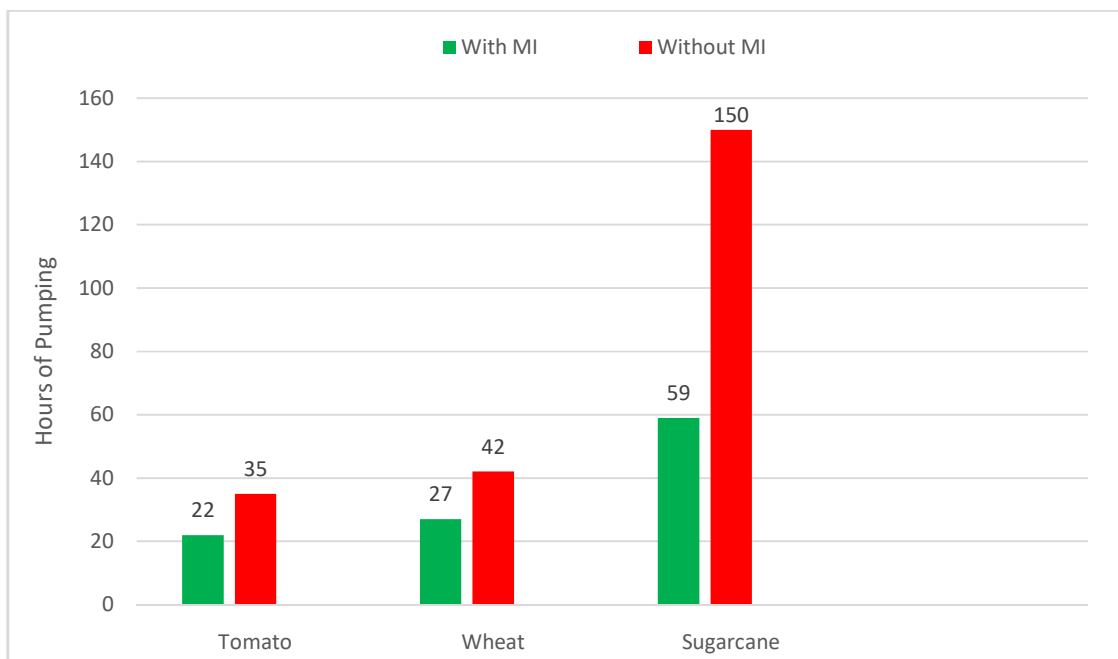


Figure- 7.5
Crop wise with MI and without MI per Farmer Total Cost

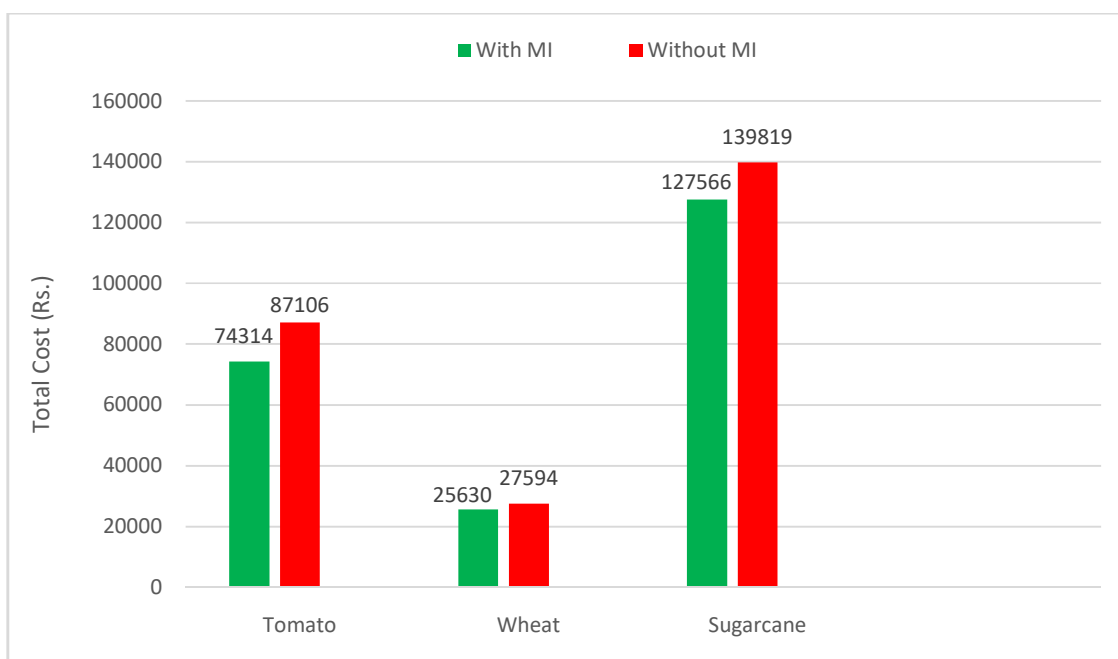
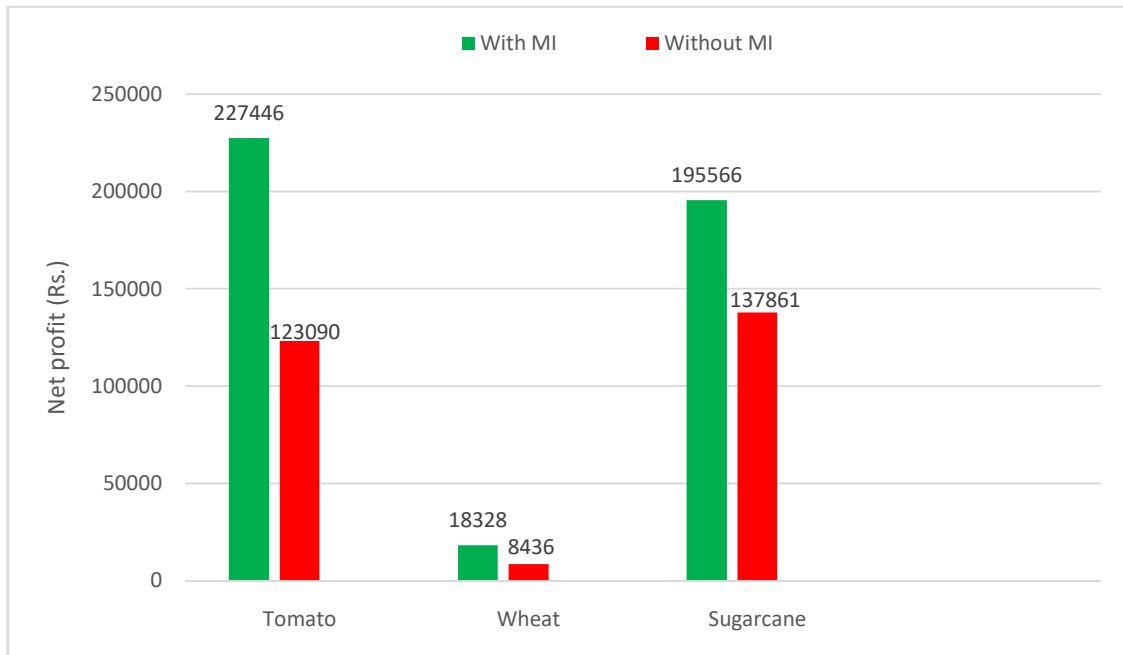


Figure-7.6
Crop wise with MI and without MI per Farmer Net Profit



Thus in general; it may be very emphatically said that the adoption of micro-irrigation has benefitted MI adopters substantially, not only in one but in number of ways through:

- (a) Enhancing (i) crop production (ii) crop price (iii) total sales revenue (iv) net profit/income.
- (b) Reducing expenses (costs) on items like (i) seeds/plants (ii) fertilizers (iii) pesticides (iv) diesel (v) hour of pumping (vi) farm power and equipment etc.

Chapter-8

Capital and Maintenance Cost of Micro-Irrigation

The present chapter deals with details of capital and maintenance cost of micro irrigation, like initial capital cost/investments in micro irrigation; annual replacement/maintenance cost of micro-irrigation and details of companies as sources of equipment/parts/service.

8.1 Initial Capital Cost/Investment in Micro-Irrigation

The details of initial capital cost/investment in micro-irrigation are shown in the Table-8.1.

The data of the Table -8.1 shows that

- (i) Among 96 total MI adopters; 43 are reporting for drip irrigation set/ kit; 53 for sprinkler irrigation set/ kit; 30 for pumps and 30 for tube-well cost (only if additional for MI); while no one has reported for filters or pipes or any other costs
- (ii) On per farmer average basis (a) The total cost for drip irrigation kit works out to be Rs. 132384=00, out of which Rs. 19646=00 (14.84 percent) is paid by farmer while Rs. 112738=00 (85.16 percent) is the subsidy amount (b) For sprinkler irrigation kit, out of total cost of Rs. 22531=00, Rs. 15829=00 (70.25 percent) is paid by farmer while Rs. 6702=00 (29.75 percent) is covered as subsidy. (c) In case of pumps, the entire amount of cost, i.e.,Rs. 32933=00 is paid by the farmer on 100 percent basis and that there has been no subsidy on this item. (d) In case of tube- well as well, the entire cost of Rs. 9720=00 is met by the farmer and there being no subsidy on this as well. (e) On overall basis, the average per farmer total cost works out to be Rs. 52347=00 out of which Rs. 18995=00 (36.29 percent) is spent by farmer and the rest Rs. 33352=00 (63.71 percent) is shared as the subsidy amount. There have been 156 reporting in total towards initial capital cost/ investments, in micro irrigation.

The related data are shown in Table-8.1

Table-8.1
Initial Capital Cost/Investment in Micro Irrigation
(Figures in Rs. Per Farmer)

Item	No. reporting	Average for all reporting farmers			Percent reporting loan as source of funds	% Subsidy
		Amount Paid (Rs.)	Subsidy Amount	Total Cost		
1. Drip irrigation Set/Kit	43	19646	112738	132384	0	85.16
2. Sprinkler irrigation Set/Kit	53	15829	6702	22531	0	29.75
3. Filters (Cyclone, Disc, others)	0	0	0	0	0	0.00
4. Pipes (Micro, Distribution, Drip, PVC, PE, others)	0	0	0	0	0	0.00
5. Pumps	30	32933	0	32933	0	0.00
6. Tube well cost (only if addl. for MI)	30	9720	0	9720	0	0.00
7. Any others	0	0	0	0	0	0.00
Total	156	18995	33352	52347	0	0.00

8.2 Annual Replacement/Maintenance Cost of Micro-Irrigation

As there has been no reporting at all, by any of the MI adopter under study; towards Annual Replacement/Maintenance Cost of MI; the Table-8.2 entitled Annual Replacement/Maintenance Cost of Micro-irrigation has been removed. This is so, since from date of installation of MI system, no maintenance cost is paid by any farmer because of Annual Maintenance Contract (AMC) for three years, by the contractor.

8.3 Top Five Companies as Source of Equipment/Parts/Service

The Table-8.2 presents details of five top companies as source of equipment / parts/ service towards micro irrigation.

The Table -8.2 reports that (i) Towards micro-irrigation set/ kit / initial capital items; the top five companies in order are Captain, Vishakha irrigation, Shakti, Bharat Irrigation and Netafim Drip Irrigation, with respective percentages of their contribution as 36,19,17,14 and 14 and that (ii) There has been no reporting of any company in respect of micro-irrigation maintenance. The related data are shown in Table-8.2

Table-8.2
Top five 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
Captain	23	36	NA	0	0
Bharat Irrigation	9	14	NA	0	0
Visakha Irrigation	12	19	NA	0	0
Netafim drip Irrigation	9	14	NA	0	0
Sakti Irrigation Pvt.Ltd.	11	17	NA	0	0
TOTAL	64	100	NA	0	0

NA- No Reporting by Any Company

Chapter-9

Factors and Determinants Affecting Micro-Irrigation Adoption

The present chapter attempts to (i) Identify various determinants/ factors which affect the adoption of micro-irrigation at the farm level and (ii) Highlight the perceived advantages and disadvantages of micro irrigation, by adopting tabular analysis. This has been done by finding out responsiveness of selected MI adopters in the form of their opinion as (i) strongly agree, (ii) agree, (iii) partially agree/ disagree(neutral), (iv) disagree and (v) strongly disagree; with corresponding scores as 5,4,3,2 and 1; for each of the various factors, i.e., statements (which are all positive towards MI adoption) under various heads like agronomic potential, agro economic potential, effective demand, aggregate supply and the distribution.

9.1 Determinants/ Factors of MI adoption

The responsiveness of selected MI adopters, towards various determinants/ factors under various heads, in adoption of micro-irrigation techniques at the farm level, results as under:

(a) Agronomic Potential

Under agronomic potential (i) Above 95 to even 100 percent of MI adopters, agree or strongly agree (taken together) with the factors that micro-irrigation – increases yield/output; save water/ reduces water use; reduces labour use (ii) while 70 to 80 percent of MI adopters agree or strongly agree (combined basis) that micro-irrigation reduces – fertilizer use, pest problem/ pesticide use, weed problem. (iii) There is not even a single MI adopter who strongly disagrees with any of the factors, while just to the extent of zero to less than 4 percent disagreeing with the given factors (iv) However, in some cases there are also 3.13 to 30.21 percent adopters who are neutral,i.e., who partially agree/ disagree (v) Mean score wise, mean scores of all the factors, under the agronomic potential head are in the range of 3.77 to 4.38, i.e., above the neutral score of 3; indicating thereby that all the six stated factors in this head, are strongly supported by the selected MI adopters in adopting MI techniques. The related data are given in Table-9.1(a)

Table-9.1(a)
Determinants/factors affecting the adoption of micro irrigation
(Agronomic Potential)

Factors	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 4	Strongly Disagree (%) 1	Mean	No. reporting
Agronomic Potential							
Micro-irrigation increases yield/output	36 (37.50)	60 (62.50)	0 (0.00)	0 (0.00)	0 (0.00)	4.38	96 (100.00)
Micro-irrigation saves water/ reduces water use	35 (36.45)	61 (63.55)	0 (0.00)	0 (0.00)	0 (0.00)	4.36	96 (100.00)
Micro-irrigation reduces fertilizer use	33 (34.38)	38 (39.58)	22 (22.91)	3 (3.13)	0 (0.00)	4.05	96 (100.00)
Micro-irrigation reduces pest problems/ pesticide use	7 (7.19)	60 (62.50)	29 (30.21)	0 (0.00)	0 (0.00)	3.77	96 (100.00)
Micro-irrigation reduces weed problem	8 (8.33)	69 (71.87)	17 (17.72)	2 (2.08)	0 (0.00)	3.86	96 (100.00)
Micro-irrigation reduces labour use	18 (18.75)	74 (77.08)	3 (3.13)	1 (1.04)	0 (0.00)	4.14	96 (100.00)

Note: In Table-9.1(a) to 9.1(e), mean refers to weighted mean score and figures in parenthesis are percentages.

(b) Agro-economic Potential

In case of agro-economic potential as well (i) all the factors mentioned therein are supported and recommended by majority of MI adopters on strongly agree or agree basis (taken together), with highest percentage (95.83 percent) of MI adopters favoring that micro-irrigation increases profitability/ incomes, followed by micro-irrigation raises output quality/ profit (94.79 percent); subsidy on micro-irrigation is substantial important (90.63 percent), micro-irrigation reduces input use/ costs (84.38 percent) and capital cost of micro-irrigation is not high (79.17 percent) (ii) In this case as well, there is not even a single adopter who strongly disagrees with any of the above factors; while just 2.08 to 6.25 percent disagreeing with above statements (iii) A few MI adopters (3.12 to 18.75) percent being neutral in the sense of partially agreeing/ disagreeing and that (iv) mean score wise; mean scores of all the factors under agro economic potential as well are all above 4, i.e., higher than 3 (the neutral mean score). This again, shows that all the above mentioned factors related to agro economic aspects are strongly supported by the selected MI adopters towards MI's usefulness. The related data is presented in Table-9.1(b)

Table-9.1(b)
Determinants/factors affecting the adoption of micro irrigation
(Agro-Economic Potential)

Factors	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 4	Strongly Disagree (%) 1	Mean	No. reporting
Agro-Economic Potential							
Capital cost of micro-irrigation is not high	23 (23.96)	53 (55.21)	18 (18.75)	2 (2.08)	0 (0.00)	4.01	96 (100.00)
Micro-irrigation raises output quality/profit	30 (31.25)	61 (63.54)	5 (5.21)	0 (0.00)	0 (0.00)	4.26	96 (100.00)
Micro-irrigation reduces input use/costs	42 (43.75)	39 (40.63)	13 (13.54)	2 (2.08)	0 (0.00)	4.26	96 (100.00)
Micro-irrigation increases profitability/incomes	24 (25.00)	68 (70.83)	4 (4.17)	0 (0.00)	0 (0.00)	4.21	96 (100.00)
Subsidy on micro-irrigation is substantial /important	24 (25.00)	63 (65.63)	3 (3.12)	6 (6.25)	0 (0.00)	4.09	96 (100.00)

(c) Effective Demand

Under effective demand as well (i) there is not even a single MI adopter strongly disagreeing with any of the given factor while just 1.04 to 2.08 % disagreeing just with 2 out of 6 factors. (ii) In this case, as compared to agronomic and agro economic factors, relatively there are more micro-irrigation adopters(4.17% to 33.33 %) having no definite opinion i.e. partially agreeing/ disagreeing.(iii) On strongly agreeing or agreeing (combined basis) the different factors are supported by majority of MI adopters with highest percentage(95.83%) reporting that subsidy for micro-irrigation is easy to get; followed by information on micro-irrigation is easily available (92.71%); water supply for micro-irrigation is sufficient (90.62%); micro-irrigation technology is easy to understand and operate (88.54); finance for micro-irrigation is easy to get(77.09%); electric supply for micro-irrigation is available/ reliable(64.59%) and (iv) Mean score wise as well, all the factors under this head are above 4, except that of “electricity supply is available/reliable” with mean score 3.89 which too is above the mean neutral score of 3. This shows that under this head of effective demand as well, majority of adopters are in strong support of all the statements (factors). The corresponding data are shown in Table-9.1(c).

Table-9.1(c)
Determinants/factors affecting the adoption of micro irrigation
(Effective Demand)

Factors	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 4	Strongly Disagree (%) 1	Mean	No. reporting
Effective Demand							
Information on micro-irrigation is easily available	26 (27.08)	63 (65.63)	6 (6.25)	1 (1.04)	0 (0.00)	4.19	96 (100.00)
Micro-irrigation technology is easy to understand and operate	42 (43.75)	43 (44.79)	11 (11.46)	0 (0.00)	0 (0.00)	4.32	96 (100.00)
Subsidy for micro-irrigation is easy to get	26 (27.08)	66 (68.75)	4 (4.17)	0 (0.00)	0 (0.00)	4.23	96 (100.00)
Finance for micro-irrigation is easy to get	22 (22.92)	52 (54.17)	22 (22.91)	0 (0.00)	0 (0.00)	4.00	96 (100.00)
Electricity supply for micro-irrigation is available/reliable	25 (26.05)	37 (38.54)	32 (33.33)	2 (2.08)	0 (0.00)	3.89	96 (100.00)
Water supply for micro-irrigation is sufficient	20 (20.83)	67 (69.79)	9 (9.38)	0 (0.00)	0 (0.00)	4.11	96 (100.00)

(d) Aggregate Supply

With regard to aggregate supply (i) only 5.2% of MI adopters strongly agree with the factor that “there are large number of companies supplying micro-irrigation equipments” while 55.21% agree with it and 17.71% disagreeing with it and 21.88% remaining neutral (partially agree/ disagree).(ii) In respect of factor that “ the quality and reliability of micro-irrigation is good” 77.08% of MI adopters agree or strongly agree(both combined) while 22.92% remain as neutral. (iii) The mean scores of both the above factors are above 3 which shows that majority of respondents (MI adopters) are in support of these factors that “there are large numbers of micro-irrigation supplying companies and that quality and reliability of MI equipments are good” though certainly not up to that extent as reported under earlier mentioned heads like agronomic and agro-economic. The related data is shown in Table-9.1(d)

Table-9.1(d)
Determinants/factors affecting the adoption of micro irrigation
(Aggregate Supply)

Factors	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 4	Strongly Disagree (%) 1	Mean	No. reporting
Aggregate Supply							
There are a large number of companies supplying micro-irrigation equipment	5 (5.20)	53 (55.21)	21 (21.88)	17 (17.71)	0 (0.00)	3.48	96 (100.00)
The quality and reliability of the micro-irrigation equipment is good	21 (21.87)	53 (55.21)	22 (22.92)	0 (0.00)	0 (0.00)	3.99	96 (100.00)

(e) Distribution

(i) The various factors under “ distribution” like, there are number of nearby located micro-irrigation dealers; the dealers- (a) provide good quality products one can trust (b) charge reasonable price (c) arrange for subsidy/credit (d) provide after sales service; are all supported as strongly agree or agree (both taken together) by a minimum of 70.83 percent to a maximum of 85.42 percent of the total 96 MI adopters (ii) Further, factor wise 5.20 percent to 17.71 percent of MI adopters are neutral (partially agree/ disagree); 1.04 to 23.36 percent disagree; while none (zero percent) strongly disagrees, except for just 3.12 percent disagreeing strongly in case of factor that, dealers charge reasonable price (iii) On overall factor analysis basis with regards to distribution, the mean scores of various factors (which are all above 3) clearly indicate the support of majority of MI adopters towards MI adoption. The related data are displayed in Table-9.1(e)

Table-9.1(e)
Determinants/factors affecting the adoption of micro irrigation
(Distribution)

Factors	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/D isagree (%) 3	Disagree (%) 4	Strongly Disagree (%) 1	Mean	No. reporting
Distribution							
There are a number of micro-irrigation dealers located nearby	20 (20.83)	48 (50.00)	5 (5.21)	23 (23.96)	0 (0.00)	3.68	96 (100.00)
The dealers provide good quality products you can trust	19 (19.79)	63 (65.63)	13 (13.54)	1 (1.04)	0 (0.00)	4.04	96 (100.00)
The dealers charge a reasonable price	11 (11.46)	62 (64.58)	16 (16.67)	4 (4.17)	3 (3.12)	3.77	96 (100.00)
The dealers arrange for subsidy/credit	30 (31.25)	42 (43.75)	14 (14.58)	10 (10.42)	0 (0.00)	3.96	96 (100.00)
The dealers provide after-sales service	30 (31.25)	45 (46.87)	17 (17.71)	4 (4.17)	0 (0.00)	4.05	96 (100.00)

9.2 Perceived Advantages and Disadvantages of Micro Irrigation

The detailed results in respect of perceived advantages and disadvantages of micro-irrigation show that:

There is not even a single item among all the 13 items which is opined as of disadvantage or of strongly disadvantage by any of MI adopter, except that 6.25 percent of total MI adopters disagreeing that MI is a source of employment for youth and 1.04 percent feeling against that MI gives high output price (b) Among 13 stated items, the prime four items of highest preference in

terms of MI adopters “agreeing or strongly agreeing (combined basis)” have been respectively as; MI results to higher yields (cent percent i.e. 100 percent); MI requires less water (95.83 percent); MI requires less labour (91.67 percent) and MI results to better quality products (91.67 percent).The respective mean values of these items as well have been as 4.69, 4.28, 4.15 and 4.19 i.e. all above 4. This gives strong footage to the fact that, “Apart from resulting to higher yields and better quality products, MI techniques require less water as well as less labour” to the benefit of MI adopter. (c) The item “easy marketing of output” is supported on strongly agree or agree basis by just 43.75 percent of MI adopters, while 56.25 percent disagrees with this, with mean score as well just as 3.54, the lowest among all (d) All the remaining items as well, in respect of micro-irrigation like- employment for youth, less risk/ uncertainty; higher profit; less fertilizers use; less pest problem; less weed problem ; less input cost; are all supported by majority of MI adopters to the extent of 56.25 percent to 88.54 percent on strongly agree or agree (combined basis); with mean scores as well in the range of 3.64 to 4.28 to result that these all are also supporting items (factors) towards adoption of micro-irrigation techniques not only in a single but in number of ways. The related data are shown in Table-9.2.

Table-9.2
Perceived Advantages and Disadvantages of Micro-Irrigation

Item	Strong Advantage (%) 5	Advantage (%) 4	No Difference (%) 3	Disadvantage (%) 2	Strong Disadvantage (%) 1	Mean	No. reporting
Higher Yields	50	50	0	0	0	4.69	100
Better Quality	27.08	64.59	8.33	0	0	4.19	100
High output price	35.42	38.54	25	0	1.04	4.07	100
Lower input cost	19.79	66.67	13.54	0	0	4.06	100
Less water need	32.29	63.54	4.17	0	0	4.28	100
Less labour need	22.92	68.75	8.33	0	0	4.15	100
Less weed problem	43.75	33.33	22.92	0	0	4.21	100
Less pest problem	29.17	52.08	18.75	0	0	4.10	100
Less fertilizers need	26.04	43.75	30.21	0	0	3.96	100
Easy marketing of output	10.42	33.33	56.25	0	0	3.54	100
Higher Profit	18.75	69.79	11.46	0	0	4.07	100
Less risk/ uncertainty	17.71	50	32.29	0	0	3.85	100
Employment for youth	13.54	42.71	37.5	6.25	0	3.64	100

Thus, it can be well stated that:

- (a) The factors (determinants) factors which are strongly supported, i.e., strongly agreed + agreed, by more than 90 percent of the MI adopters are in order as, Micro-Irrigation increases yield/output: 100 percent; Micro-irrigation saves water/reduces water use: 100 percent; Micro-irrigation Increases profitability/income: 95.83 percent; subsidy for MI is easy to get: 95.83 percent; MI raises output quality/profit: 94.79 percent; Information on MI is easily available: 92.71 percent; subsidy on MI is substantial important: 90.63 percent.
- (b) The factors which are not supported, i.e., strongly disagreed + disagreed, to the maximum extent of just 24 percent have been in order as; there are number of nearby micro-irrigation dealers: 23.76 percent; there are large number of companies supplying MI equipments: 17.71 percent; dealers arrange for subsidy/credit: 10.42 percent; followed by other with very meagre/ zero percentage.
- (c) In respect of perceived advantages/ disadvantages:
The prime four items in terms of highest preference of MI adopter (strongly agreeing+agreeing) have been in order, as; MI results to higher yields:100 percent; MI requires less water: 95.83 percent; MI requires less labour: 91.67 percent; MI result to better quality product: 91.67 percent.
- (d) Among disadvantage, the main four items with remarks as “no difference” due to MI, have been in order as easy marketing of output: 56.25 percent; employment for youth: 37.5 percent; less risk/ uncertainty: 32.29 percent; less fertilizer need: 30.21 percent.

Chapter-10

Larger Impacts and Problems of Micro-irrigation

The present chapter mainly deals with (i) larger impacts of micro-irrigation and (ii) the major problems faced by the farmers in relation to micro irrigation.

10.1 Larger impacts of micro irrigation

The larger impacts of micro-irrigation have been studied in terms of; substantially positive, positive, no impact, negative, substantially negative; on 11 groups/factors like- village as whole; water conservation/availability; women; upper caste; lower caste; labour/poor; tribal; young farmers/youths; upland farmers; lowland farmers and environment. The detailed observations in respect of these, record that:

- (i) Among eleven groups/factors; there is only one group (women) with substantially negative reporting; as also only one group (labour/poor) with negative reporting in respect of larger impact of micro-irrigation; but with very meagre or negligible percentage of just 1.04 percent in case of women's group and 4.16 percent in case of labour/poor group; respectively.
- (ii) There has been no reporting at all in tribal group.
- (iii) The extent of farmers reporting "no impact" of micro-irrigation; has been just 1.04 percent in two cases viz. 'village as a whole' and 'water conservation/availability'; while in rest of the cases this reporting has been varying to the extent of 13.54 percent to 34.38 percent.
- (iv) Most of the groups/factors have significant extent of favorable reporting by farmers (MI adopters) towards "larger impacts of micro-irrigation" on them. The order of various groups/factors as per positive reporting of farmers (substantially positive and positive; taken together) is listed as under:

1. Village as whole	98.96%	}
2. Water conservation/availability	98.96%	
3. Environment	86.46%	

4. Upper caste	82.29%
5. Labour/poor	73.96%
6. Lowland farmers	72.92%
7. Lower caste	68.75%
8. Women	68.75%
9. Upland farmers	67.71%
10. Young farmers/youth	65.62%
11. Tribals	no reporting

(v) The mean scores of all the above groups/factors (except tribal in which case there is no reporting at all) have been found to be in the range of 3.81 to 4.23; which are all above the 'no impact' mean score of 3. This, further advocates the importance of larger impacts of micro-irrigation on above mentioned groups/factors.

The related data are shown in Table-10.1

Table-10.1
Larger impacts of micro irrigation

Impact on	Substantially positive (%) 5	Positive (%) 4	No Impact (%) 3	Negative (%) 2	Substantially Negative (%) 1	Mean	No. reporting
1. Village as a whole	19 (19.79)	76 (79.17)	1 (1.04)	0.00 (0.00)	0.00 (0.00)	4.19	96 (100.00)
2. Water conservation/availability	23 (23.96)	72 (75.00)	1 (1.04)	0.00 (0.00)	0.00 (0.00)	4.23	96 (100.00)
3. Women	2 (2.08)	64 (66.67)	29 (30.21)	0.00 (0.00)	1 (1.04)	3.69	96 (100.00)
4. Upper Caste	12 (12.5)	67 (69.79)	17 (17.71)	0.00 (0.00)	0.00 (0.00)	3.95	96 (100.00)
5. Lower Caste	16 (16.67)	50 (52.08)	30 (31.25)	0.00 (0.00)	0.00 (0.00)	3.85	96 (100.00)
6. Labour/Poor	20 (20.83)	51 (53.13)	21 (21.88)	4 (4.16)	0.00 (0.00)	3.91	96 (100.00)
7. Tribals	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-	0.00 (0.00)
8. Young farmers/Youth	15 (15.62)	48 (50.00)	33 (34.38)	0.00 (0.00)	0.00 (0.00)	3.81	96 (100.00)
9. Upland farmers	13 (13.54)	52 (54.17)	31 (32.29)	0.00 (0.00)	0.00 (0.00)	3.81	96 (100.00)
10. Lowland farmers	15 (15.63)	55 (57.29)	26 (27.08)	0.00 (0.00)	0.00 (0.00)	3.89	96 (100.00)
11. Environment	17 (17.71)	66 (68.75)	13 (13.54)	0.00 (0.00)	0.00 (0.00)	4.04	96 (100.00)

10.2 Major problems faced by farmers in relation to micro irrigation

The major problems faced by farmers in relation to micro irrigation; have been studied by listing various farmer's related problems (20 in number) towards micro-irrigation and thereafter finding responsiveness of farmers to each of them, in terms of their strongly agreeing; agreeing; partially agreeing/disagreeing, i.e., being neutral; disagreeing and strongly disagreeing.

The problem listed for studying have been- poor quality of micro irrigation; high cost of maintenance of MI; inadequate water; poor water quality; difficulty in obtaining government subsidy and support; unreliable electricity supply; lack of credit; lack of own well/tube-well; high cost of wells/tube-wells; water table going down fast; lack of knowledge/ training for micro irrigation; lack of government support; difficulty in getting government support; lack of micro-irrigation dealers in area; poor after sales service; low output price/profitability; poor marketing arrangements; land fragmentation; damage by animals; lack of fencing.

The main findings in this regard are reported as under:

- (i) Among 20 stated problems; there are 11 problems corresponding to each of which there is not even a single farmer strongly agreeing with it; while 5 problems with just 1.04 percent to 2.08 percent and 4 problems with 11.46 percent to 30.21 percent farmers strongly agreeing with those.
- (ii) The major ten problems faced by farmers, as on the basis of their strongly' agreeing/agreeing (taken together); are in order as under:

1. Lack of fencing	69.79%	}
2. Damage by animals	69.79%	
3. Poor marketing arrangements	25.00%	
4. High cost of wells/tube-wells	20.83%	
5. Lack of knowledge/training for micro irrigation	19.79%	}
6. Land fragmentation	19.79%	

7. Water table going down fast	18.75%	}
8. Lack of own wells/tube-wells	18.75%	
9. Lack of credit	16.67%	
10. Unreliable electric supply	12.50%	

(iii) As different from other cases: in this case all the twenty problems are having neutral (partially agree/disagree) farmers; varying to the extent of 5.22 percent to 44.79 percent.

(iv) Among 20 problems:

Except three problems viz. lack of fencing; damage by animals and unreliable electric supply; which are respectively strongly disagreed/disagreed (combined basis) by 18.75 percent, 20.83 percent and 42.71 percent; all the remaining 17 problems are strongly disagreed/ disagreed by majority (more than 50 percent) farmers; the extent of which is varying from 51.04 percent (lack of credit) to 92.70 percent (poor water quality) of total responding farmers.

(v) The mean scores corresponding to 18 stated problems; except the two problems i.e. 'lack of fencing' and 'damage by animals'; are all being less than 3 (the mean neutral score); indicating that most of the stated problems are discarded by majority of farmers. The related data are displayed in Table-10.2.

Table-10.2
Major problems faced by farmers in relation to micro-irrigation

Problems	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/D isagree (%) 3	Disagree (%) 2	Strongly Disagree (%) 1	Mean	No. of reporting
1. Poor quality of micro-irrigation equipment	0 (0.00)	2 (2.08)	10 (10.42)	64 (66.67)	20 (20.83)	1.94	96 (100.00)
2. High need/cost of maintenance in micro irrigation	0 (0.00)	0 (0.00)	28 (29.17)	41 (42.71)	27 (28.12)	2.01	96 (100.00)
3. Inadequate water	0 (0.00)	7 (7.29)	12 (12.50)	38 (39.58)	39 (40.63)	1.86	96 (100.00)
4. Poor water quality	0 (0.00)	2 (2.08)	5 (5.22)	50 (52.08)	39 (40.62)	1.69	96 (100.00)
5. Difficulty in obtaining government subsidy & support	0 (0.00)	0 (0.00)	22 (22.92)	37 (38.54)	37 (38.54)	1.84	96 (100.00)
6. Unreliable electricity supply	1 (1.04)	11 (11.46)	43 (44.79)	31 (32.29)	10 (10.42)	2.60	96 (100.00)

Problems	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 2	Strongly Disagree (%) 1	Mean	No. of reporting
7. Lack of credit	0 (0.00)	16 (16.67)	31 (32.29)	38 (39.58)	11 (11.46)	2.54	96 (100.00)
8. Lack of own wells/tube wells	0 (0.00)	18 (18.75)	12 (12.5)	38 (39.58)	28 (29.17)	2.21	96 (100.00)
9. High cost of wells/tube-wells	1 (1.04)	19 (19.79)	14 (14.58)	45 (46.87)	17 (17.72)	2.40	96 (100.00)
10. Water table going down fast	11 (11.46)	7 (7.29)	20 (20.83)	39 (40.63)	19 (19.79)	2.50	96 (100.00)
11. Lack of knowledge/training for micro irrigation	11 (11.46)	8 (8.33)	19 (19.79)	29 (30.21)	29 (30.21)	2.5	96 (100.00)
12. Lack of government support	2 (2.08)	1 (1.04)	13 (13.54)	40 (41.67)	40 (41.67)	1.80	96 (100.00)
13. Difficulty in getting government support	0 (0.00)	0 (0.00)	25 (26.04)	30 (31.25)	41 (42.71)	1.83	96 (100.00)
14. Lack of micro-irrigation dealers in area	0 (0.00)	0 (0.00)	18 (18.75)	38 (39.58)	40 (41.67)	1.77	96 (100.00)
15. Poor after sales service	0 (0.00)	1 (1.04)	11 (11.46)	49 (51.04)	35 (36.46)	1.77	96 (100.00)
16. Low output price/profitability	0 (0.00)	4 (4.17)	8 (8.33)	46 (47.92)	38 (39.58)	1.77	96 (100.00)
17. Poor marketing arrangements	1 (1.04)	23 (23.96)	20 (20.83)	30 (31.25)	22 (22.92)	2.49	96 (100.00)
18. Land fragmentation	2 (2.08)	17 (17.71)	25 (26.04)	28 (29.17)	24 (25.00)	2.43	96 (100.00)
19. Damage by animals	29 (30.21)	38 (39.58)	9 (9.38)	9 (9.38)	11 (11.45)	3.68	96 (100.00)
20. Lack of fencing	16 (16.66)	51 (53.13)	11 (11.46)	12 (12.50)	6 (6.25)	3.61	96 (100.00)

The main points, emerging out of the findings of this chapter; are stated as under:

- The top five groups/factors as on the basis of “extent of” favorable responses by majority of farmers in respect of larger impacts of micro-irrigation have been: village as whole (98.96%); water conservation/availability (98.96%); environment (86.46%); upper caste (82.29%) and labour/poor (73.96%)
- The top two problems as reported by majority of farmers (69.79 percent in each case) are “lack of fencing” and “damage by animals.” As such these two problems must be tackled and taken due care of on top priority basis, towards enhancing micro irrigation, further more.

Chapter-11

Overall Assessment of the Performance of Micro-Irrigation

This chapter is an evaluation, towards overall assessment of the performance of micro-irrigation in terms of (i) overall assessment of micro-irrigation (ii) continuance and expansion of MI by the farmers; followed by (iii) suggestions by the sample farmers for increasing the adoption of micro- irrigation.

11.1 Overall assessment of micro-irrigation by the farmers

The details of item wise responsiveness of the farmers, in terms of their opinion as excellent/ good/ satisfactory/ somewhat poor/ very poor; towards various items, related to performance as well as adoption/ expansion of micro irrigation, are presented as under:

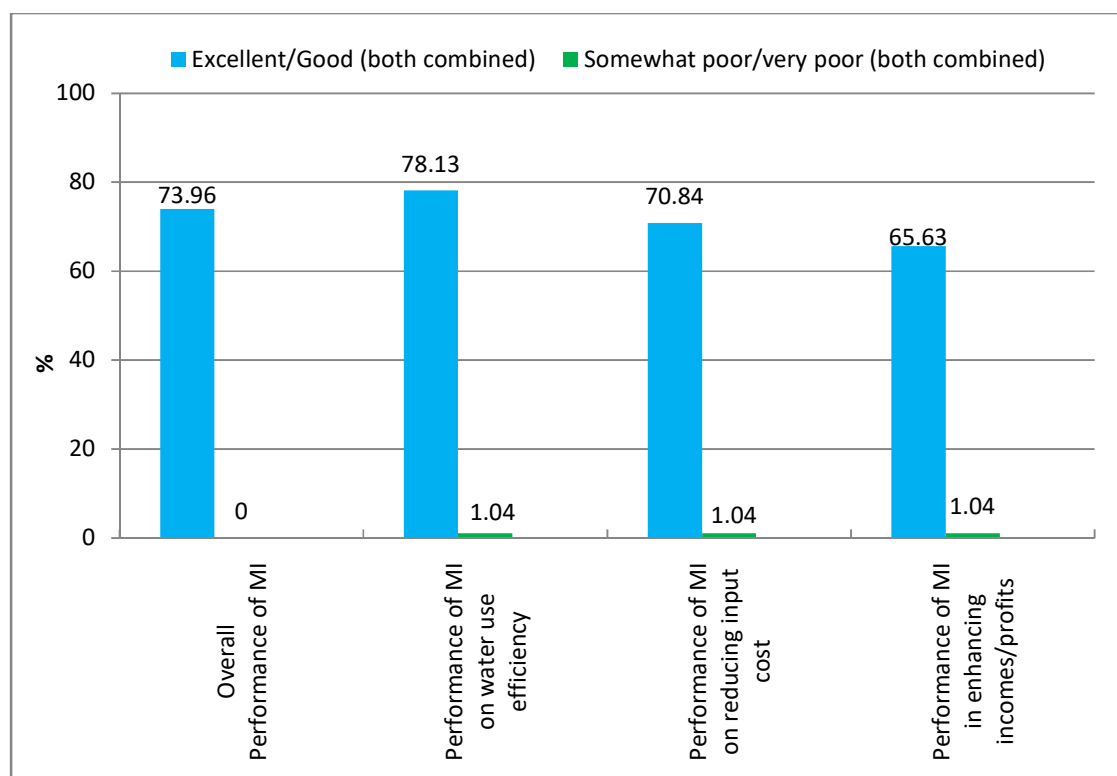
- (a) Taking responsive opinion of farmers as “excellent and good” (on combined basis); all the four items; viz. (i) overall performance of MI (ii) improving the water use efficiency (iii) MI reducing input cost in terms of pesticides, fertilizers, electricity and (iv) MI increasing incomes/profits; have all got favorable responses by the farmers, to the extent of 65.63 percent to 78.13 percent of total MI adopters.
- (b) The respective mean scores of the above four items are found as 4.13,4.06, 3.83 and 3.82; which are all above 3 (the mean satisfactory score).
- (c) Considering responsiveness of farmers on “somewhat poor and very poor” (combined); there is not even a single farmer reporting the overall performance of MI as very poor or even somewhat poor. In respect of remaining three items as well; just 1.04 percent farmers response as ‘somewhat poor + very poor’, on combined basis; in respect of every item.
- (d) The above reportings based on responsiveness of farmers towards performance of micro-irrigation, present quite encouraging results in respect of utility and application of micro-irrigation, towards farmers welfare, not only in one, but in a number of ways.

The relevant data are shown in Table-11.1.

Table-11.1
Overall assessment of micro-irrigation by the farmers

Item	Excellent (%) 5	Good (%) 4	Satisfactory (%) 3	Somewhat Poor (%) 2	Very Poor (%) 1	Mean	No. reporting
Overall performance of micro irrigation	37 (38.54)	34 (35.42)	25 (26.04)	0.00 (0.00)	0.00 (0.00)	4.13	96 (100.00)
Performance on Improving Water Use Efficiency	28 (29.17)	47 (48.96)	20 (20.83)	1 (1.04)	0.00 (0.00)	4.06	96 (100.00)
Performance on reducing input cost (such as Fertilizers, Pesticides, Labour, Electricity)	13 (13.55)	55 (57.29)	27 (28.12)	1 (1.04)	0.00 (0.00)	3.83	96 (100.00)
Performance on increasing incomes/Profits	17 (17.71)	46 (47.92)	32 (33.33)	1 (1.04)	0.00 (0.00)	3.82	96 (100.00)

Fig 11.1
Responsiveness of Sample Farmers (MI Adopters) towards Performance of Micro-Irrigation



11.2 Adoption/ Continuance and Expansions of MI: Farmers Responsiveness

The observed findings show that:

- (i) In relation to adoption or continuance of micro irrigation, as also expanding its use; of the two statements (items); not even a single item is disagreed or strongly disagreed by any of the farmer.
- (ii) Both the items under “adoption” are favoured (strongly agree+ agree) by majority of farmers.
- (iii) The two items in order of preference as per reporting of farmers are as:
 - Will you adopt/ continue to use micro-irrigation: strongly agree/agree: 94.79 percent.
 - Will you expand micro-irrigation use: strongly agree/agree: 87.50 percent
- (iv) The percentage of farmers being neutral (i.e. partially agree/ disagree) in respect of above two items, have respectively been reported as 5.21 percent and 12.50 percent.
- (v) The mean scores of these two items as well-being 4.13 and 4.02, i.e. above the neutral score of 3.

These findings are conclusive of fact, that majority of farmers are in favor of adopting/ continuing the use of micro irrigation; as well as further expanding its uses. The related data are presented in Table 11.1(a)

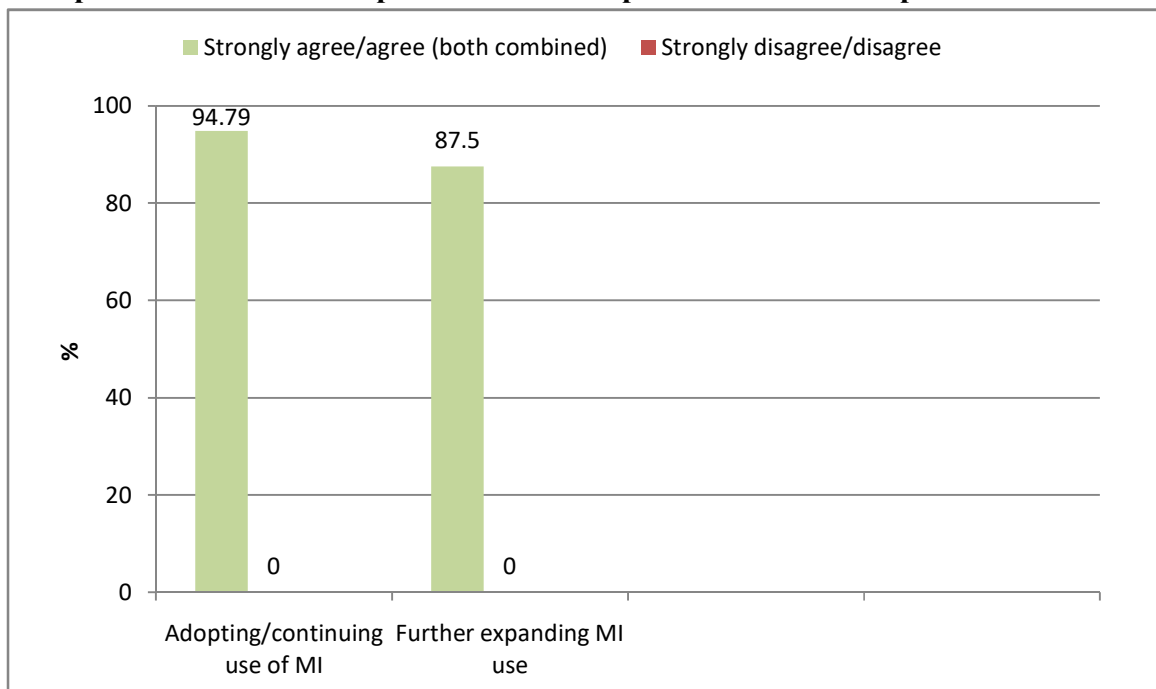
Table-11.1(a)
Assessment towards continuance and further expansion of MI

Item	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 2	Strongly Disagree (%) 1	Mean	No. reporting
Will you adopt/continue to use micro irrigation?	17 (17.71)	74 (77.08)	5 (5.21)	0.00 (0.00)	0.00 (0.00)	4.13	96 (100.00)
Will you expand micro-irrigation use?	14 (14.58)	70 (72.92)	12 (12.50)	0.00 (0.00)	0.00 (0.00)	4.02	96 (100.00)

Note: In Table-11.1 and 11.1(a) the figures in parenthesis are the respective percentages.

Fig 11.1(a)

Responsiveness of MI Adopters towards Adoption and Further expansion of MI use



11.3 Suggestions for increasing the adoption and impact of Micro-Irrigation

The details of responsiveness of farmers to various suggestions with regard to increasing the adoption and impact of micro-irrigation, result to that.

- (i) Out of total nine suggestions, there are seven suggestions, viz. more subsidy/govt. assistance, Easier process of getting subsidy, more loans / credit, Improve water availability, better training for MI, Provision of fencing and better marketing arrangement; corresponding to each of which there is not even a single farmer strongly disagreeing with it; while corresponding to each of the two remaining suggestion as well, just 1.04 percent strongly disagreeing with it.
- (ii) Item wise the various suggestions are disagreed by farmers to the extent of 1.04 percent to 11.47 percent.

(iii)The extent of farmers being neutral (partially agree/ disagree) to the given suggestions; has been of the order of 1.04 percent to 12.50 percent.

(iv)The specified nine suggestions “in order of priority” as per responsiveness of farmers; as strongly agree/agree (both taken together) are stated as under:

- | | |
|--|----------|
| 1. More subsidy/ government assistance | : 97.92% |
| 2. Provision/ support for farm fencing | : 94.79% |
| 3. Better micro-irrigation technology/ equipment | : 92.70% |
| 4. Better marketing arrangements | : 91.67% |
| 5. Improved water availability | : 88.55% |
| 6. Easier process for getting subsidy/ government assistance | :88.54% |
| 7. More loans/credit | : 87.51% |
| 8. Better training for micro-irrigation | : 86.46% |
| 9. Lower price of micro irrigation | : 85.41% |

(v) The respective mean scores of the above nine statements have been as 4.40, 4.54, 4.18, 4.36, 3.94, 4.03, 4.07, 4.29 and 3.98; which are all above the neutral mean score of 3, which indicate the favourable attitude of farmers towards all these nine suggestions. The detailed data is displayed in Table 11.2.

Table-11.2
Suggestions for increasing the adoption and impact of micro irrigation

Suggestion	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/ Disagree (%) 3	Disagree (%) 2	Strongly Disagree (%) 1	Mean	No. reporting
1. Better micro-irrigation technology/equipment	27 (28.12)	62 (64.58)	5 (5.22)	1 (1.04)	1 (1.04)	4.18	96 (100.00)
2. Lower price of micro irrigation	25 (26.04)	57 (59.37)	2 (2.08)	11 (11.47)	1 (1.04)	3.98	96 (100.00)
3. More subsidy/ government assistance	41 (42.72)	53 (55.20)	1 (1.04)	1 (1.04)	0.00 (0.00)	4.40	96 (100.00)
4. Easier process for getting subsidy/government assistance	18 (18.75)	67 (69.79)	7 (7.29)	4 (4.17)	0.00 (0.00)	4.03	96 (100.00)
5. More loans/ credit	20 (20.83)	64 (66.68)	11 (11.45)	1 (1.04)	0.00 (0.00)	4.07	96 (100.00)
6. Improve water availability	7 (7.29)	78 (81.26)	9 (9.37)	2 (2.08)	0.00 (0.00)	3.94	96 (100.00)

Suggestion	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 2	Strongly Disagree (%) 1	Mean	No. reporting
7. Better training for micro irrigation	42 (43.75)	41 (42.71)	12 (12.50)	1 (1.04)	0.00 (0.00)	4.29	96 (100.00)
8. Provision/support for farm fencing	58 (60.42)	33 (34.37)	4 (4.17)	1 (1.04)	0.00 (0.00)	4.54	96 (100.00)
9. Better marketing arrangements	45 (46.88)	43 (44.79)	6 (6.25)	2 (2.08)	0.00 (0.00)	4.36	96 (100.00)
10. Others	-	-	-	-	-	-	-

Note: Figures in parenthesis show respective percentages

The main points as noticed through tabular analysis show that:

- (i) 73.96 percent of total MI adopter farmers; support “overall performance of micro irrigation” as excellent/ good; while the extent of farmers supporting MIs performance as excellent/good, in-improving water use efficiency; reducing input cost and increasing net incomes/ profits, has respectively been as 78.13 percent, 70.84 percent and 65.63 percent.
- (ii) 94.79 percent of reporting farmers favour (strongly agree/agree) to adopt/continue use of micro-irrigation and 87.50 percent to further expand its use.
- (iii) All the nine suggestions in respect of enhancing adoption and performance of MI are favoured by more than 85 percent of the total reporting farmers; among which the “ top 5” are- more subsidy/ govt. assistance (97.92%); provision/ support for farm fencing (94.79%); better micro-irrigation technology/ equipment (92.70%); Better marketing arrangements (91.67%) and improved water availability (88.55%).

Chapter-12

Non Adopters of Micro-Irrigation: Profile and Issues

The profile details of non-adopters of micro-irrigation; like sample coverage, age, education, land profile, water sources and situation, cropping profile along with non-adopter v/s adopter comparison and various issues (reasons) for non-adoption of micro-irrigation have been highlighted in this chapter.

12.1 Sample Coverage of Non-Adopters

The sample coverage of non-adopters of MI as under.

(i) There are 12 villages covered in all with 6 villages in each of the two districts under study, viz. Sonbhadra and Saharanpur. (ii) In each district there are 12 non-adopter farmers to result in a total sample of 24 non adopter farmers and that (iii) All the 12 selected non-adopter farmers in each district have irrigation on cent percent basis; to show that there is not even a single non-adopter farmer without irrigation. The related data is given in Table-12.1.

Table-12.1
Sample coverage of non-adopters

Sr. No.	District Name	No. of Village	No. of Farmers surveyed	With irrigation	Without irrigation
1	Sonbhadra	6	12	12	0
2	Saharanpur	6	12	12	0
Total		12	24	24	0

12.2 Age profile of Non- Adopters and Adopters

The age profile of non-adopters and adopters show that:

In case of non-adopters (i) There are 6 farmers each in the age groups 30-40, 40-50 and above 60 years followed by 5 farmers in the age group 50-60, 1 farmer in the age group 20-30 and that there is not even a single farmer of age under 20 years(ii) on the whole of the total 24 non-adopters, 95.83% farmers are of age 30 years and more. In case of adopters (i), there are 18, 37 and 26 farmers in the age group 30-40, 40-50 and above 60 years followed by 14 in the age group 50-60, 1 farmer in the age group 20-30 years and that there is not even a single farmer of age under 20 years. (ii) On the whole, of the total 96 adopters, 98.96% farmers are of age 30 years and more. The related data are displayed in Table 12.2.

Table-12.2
Age profile of non-adopters& adopters

Age in Years	Number		Percent	
	Non-adopters	Adopters	Non-adopters	Adopters
Under 20	00	00	0.00	0.00
20-30	01	01	4.17	1.04
30-40	06	18	25.00	18.75
40-50	06	37	25.00	38.55
50-60	05	14	20.83	14.58
Above 60	06	26	25.00	27.08
All	24	96	100.00	100.00

12.3 Education profile of Non-adopters and Adopters

The education profile of non-adopters v/s adopters show that

Non-adopters(i) Out of total 24 non adopter farmers maximum, i.e., 13(54.18 percent) have education up to 10th standard while (ii) rest are evenly distributed over different groups with 3(12.50 percent) having post graduate education and 2(8.33 percent) each educated up to primary, middle, 12th standard and graduate level education respectively and that (iii) There is no non-adopter as technically educated or illiterate.The above data shows a sign of prosperity among non-adopter group, that, there is not even a single illiterate farmer.

Adopters: (i) Out of total 96 adopters, maximum, i.e., 28(29.17 percent) are educated upto 10th standard, followed by graduate20(20.83 percent), 12th standard 12(12.50 percent), illiterate 11(11.46 percent) and middle 10 (10.42 percent) (ii) Among the rest, 9(9.37) are primary educated, 5(5.21 percent) post graduates and 1(1.04 percent) technically educated. The related data are shown in Table 12.3.

Table-12.3
Education profile of non-adopters& adopters

Education Level	Number		Percent	
	Non-adopters	Adopters	Non-adopters	Adopters
Illiterate	00	11	0.00	11.46
Primary	02	09	8.33	9.37
Middle	02	10	8.33	10.42
10thStd	13	28	54.18	29.17
12thStd	02	12	8.33	12.50
Graduate	02	20	8.33	20.83
Post-Graduation	03	05	12.5	5.21
Technical	00	01	0.00	1.04
Total	24	96	100.00	100.00

12.4 Land profile of Non-adopters and Adopters

The land profile details of non-adopter and adopter farmers are displayed in the Table-12.4

Non-adopters(i) among 24 total non-adopters maximum, i.e., 11(45.83 percent) belongs to medium category, i.e., (2 to 10) ha group farmers; followed by 7 (29.17%) in the small, i.e., 1ha and more but less than 2 ha, farmers group and 6 (25.00 percent) in the marginal (less than 1ha) farmers group while there is no farmer at all in the land less/ tenant or large(more than 10 ha) group farmers.**(ii)** The average total per farmer area is recorded as 1.75 ha on the overall basis, with respective values in different groups as 0.59 ha in marginal, 1.29 ha in small and 2,67 ha in medium categories of non-adopter farmers and that **(iii)** In each i.e., marginal, small and medium group as well as on over all non-adopters sample group, the entire per farmer operated area is irrigated.

This again, is a sign of development that in the non-adopter group, entire area is irrigated and what in fact has to be done, is that these non-MI adopter farmers group have also to be

initiated that they must adopt MI technology to increase their respective crop productivity and other MI associated benefits.

Adopters (i) Among total 96 MI adopters; maximum, i.e., 57(59.38 percent) belongs to small (1-2) ha group farmers, followed by 33(34.37 percent) in medium (2-10) ha group and 6(6.25 percent) in marginal (<1ha) farmers group (ii) As compared to average per farm operated area of 1.75ha of adopters group, in case of non-adopters group it is recorded as 1.76ha. (iii) In respect of irrigated area; while in non-adopter group entire per farm operated area has been fully irrigated, in every category of farmer as well as on overall basis, in case of adopter group as well more than 96 percent perform operated area is irrigated category wise as also on overall basis. The related data are displayed in Table 12.4.

Table-12.4
Land Profile of non-adopters& adopters

Group	Number		Percent		Total Area Average		Area irrigated Average		Area un-irrigated Average	
	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters	Non-adopters	Adopters
Landless/Tenant	0	0	0	0.00	0	0.00	0	0.00	0.00	0.00
Marginal (<1)	6	6	25.00	6.25	0.59	0.68	0.59	0.68	0.00	0.00
Small (1-2)	7	57	29.17	59.38	1.29	1.22	1.29	1.21	0.00	0.01
Medium (2-10)	11	33	45.83	34.37	2.67	2.90	2.67	2.79	0.00	0.11
Large (>10)	0	00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	24	96	100.00	100.00	1.75	1.76	1.75	1.72	0.00	0.04

Note: Average refer to per farm figures

12.5 Water sources and situation

The details the water sources and water availability situation of non-MI and MI adopter farmers group show that:

Non-adopters(i) Among non-adopter group, tube-well is the main water source accounting for 16 (66.67 percent) of total 24 non adopters followed by just 2(8.33 percent) non MI farmers depending upon canal as water source and that **(ii)** 6 non adopters(25 percent) of total are dependent on other source of irrigation, which comprise of submersible water pump. (iii) As per water situation 19(79.17 percent) of total 24 non MI adopters have no scarcity of water while

3 (12.50 percent) have excess water and 2 (8.33 percent) are subject to occasional scarcity of water.

This again focuses, that prompting non MI adopter group to adopt MI installations based irrigation, can still very well enhance agricultural productivity and other related benefits to the farming community.

Adopters (i) Similar to non-adopter group of farmers, in case of MI adopters as well; Tube-well is the main water source, accounting for 92 (95.83 percent) of total 96 adopters; followed by others, i.e., submersible water pump, comprising of 4 (4.17 percent) farmers. (ii)As per water situation as well, 93(96.88 percent) of total 96 MI adopters, have no scarcity of water, while 2(2.08 percent) are subject to excess water situation and 1(1.04 percent) to occasional scarcity of water. Thus, in respect of water source and also water situation; the non-adopter as well as adopter group of farmers; both are running under similar conditions. The related data may be glanced in Table 12.5.

Table-12.5
Water sources and situation

Water source	Number		Percent	
	Non-adopters	Adopters	Non-adopters	Adopters
Canal	02	00	8.33	0.00
Canal-Lift	00	00	0.00	0.00
River-Lift	00	00	0.00	0.00
Tube well	16	92	66.67	95.83
Well	00	00	0.00	0.00
Tank	00	00	0.00	0.00
Pond	00	00	0.00	0.00
Farm Pond	00	00	0.00	0.00
Check dam	00	00	0.00	0.00
Percolation Tank	00	00	0.00	0.00
Others (submersible water pump)	06	04	25.00	4.17
Total	24	96	100.00	100.00
Water situation				
Excess water	03	02	12.50	2.08
No scarcity	19	93	79.17	96.88
Occasional scarcity	02	01	8.33	1.04
Scarcity	00	00	0.00	0.00
Acute scarcity	00	00	0.00	0.00
Total	24	96	100.00	100.00

12.6 Cropping profile of non-adopters and adopters

The cropping profile along with extent of irrigation for non-adopters and adopters of MI, record as under:

Non-adopters:The recorded observations reveal that (i) among kharif crops (a) Paddy is the major crop, grown by 20 farmers out of total 24 non adopter farmers, followed by Maize (6 farmers), Tomato (2 farmers) and Chili and Arhar (each 1 farmer) (b) the average per farmer total area under the respective crop is recorded as 2.00 ha for Arhar followed by 0.93 ha for paddy, 0.66 ha for maize, 0.50 ha for Chilli, 0.37 ha for tomato and 0.35 ha fodder (kharif/rabi). (ii)Among rabi crops (a) wheat is the most dominant crop grown by 22 out of total 24 non-adopters followed by Mustard (4 farmers), Gram (2 farmers) and Chilli (1 farmer) (b) the average per farmer total area under the respective crop is reported as 1.01 ha for wheat followed by 0.75 ha for Gram, 0.50 ha for Chilli, 0.22 ha for mustard. (iii) All the crops including fodder, are cent percent irrigated; except Arhar which totally un-irrigated and gram which is partially irrigated. (iv) Sugarcane as a perennial crop is grown by 11 farmers of the total 24 non-adopter farmers, while the per farmer total sugarcane area is recorded as 1.27 ha which is 100 percent irrigated. It may thus be said that apart from other crops grown by Non-MI adopters the most dominant are wheat, paddy and sugarcane.

Adopters: In case of MI adopters as well, (i) Paddy is the main kharif crop grown by 80 farmers out of 96 adopters, followed by Maize(20), Chilli (15), Tomato(14), and Arhar (3) ; with per farmer area recordings as Paddy (1.08ha), Tomato (0.99 ha), Arhar (0.83ha), Maize (0.82ha) and Chilli (0.41ha). (ii) The most dominant Rabi crop being Wheat (84 farmers) followed by Chilli (16 farmers), Mustard (12 farmers) and Gram (8 farmers); with respective per farm area as 1.10ha, 0.5ha, .49ha and 1.34ha. (iii) For MI adopters as well, all the crops are fully irrigated except for Arhar (fully unirrigated). (iv) The perennial crop sugarcane adopted by 28 farmers among 96 adopters; too is cent-percent irrigated.

It is clearly observed that for crops Paddy, Maize, Tomato, Wheat, Mustard and Gram MI adopters have higher per farmer crop area as compared to non-MI adopters; while for sugarcane, Chilli and Gram adopters per farm crop area is almost the same or lower than that of non-adopter. The relate data are showing in Table-12.6.

Table-12.6
Cropping profile of non-adopters

(Area in hectares)

Sr. No.	Crop name	Season	No. of farmers reporting		Average total area (ha)		Average irrigated area (ha) non-adopter	Average irrigated area (ha) adopter
			Non-adopters	Adopters	Non-adopters	Adopters		
1	Paddy	Kharif	20	80	0.93	1.08	0.93	1.08
2	Maize	Kharif	06	20	0.66	0.82	0.66	0.82
3	Tomato	Kharif	02	14	0.37	0.99	0.37	0.99
4	Chilli	Kharif	01	15	0.50	0.41	0.50	0.41
5	Arhar	Kharif	01	03	2.00	0.83	0.00	0.00
7	Sugarcane	Perennial Crop	11	28	1.27	1.26	1.27	1.26
8	Wheat	Rabi	22	84	1.01	1.10	1.01	1.10
9	Chilli	Rabi	01	16	0.50	0.50	0.50	0.50
10	Mustard	Rabi	04	12	0.22	0.49	0.22	0.49
11	Gram	Rabi	02	08	0.75	0.34	0.75	0.28
12	Fodder	Kharif/Rabi	17	14	0.35	0.24	0.35	0.24

- Average refers to per farmer figures.

12.7 Reasons for Non-Adoption

The analytical findings in respect of factors responsible for non-adoption of MI (micro irrigation) techniques on the basis of various statements (which are all non-mutually exclusive) and treated as negative statements for the simple reason of being against MI techniques show that:

- The three main factors responsible for non-adoption of MI have been in order as (i) High investment cost of micro-irrigation (ii) crop damage by animals and (iii) lack of fencing protection; as reported by 66.67 percent, 62.50 percent and 58.33 percent of total 24 non adopters, respectively on “strongly agree + agree” basis; with respective mean scores as 3.38, 3.50 and 3.42 which are relatively higher than those of other item statements, but not too much extent.
- Items like- non availability of subsidy, unprofitability of MI system, no market for micro-irrigation crops, unsuitability of MI to crops grown, traditional irrigation, inadequate water availability; are supported by a very meagre percentage(just by 5 to

20 percent of total non-adopters) on “strongly agree + agree” basis and that mean scores of these items as well have been just in the range of 2.17 to 2.42.

- (iii) Apart from above mentioned factors as causes of non-adoption of micro-irrigation by higher and lower extents of respondent percentages, there are other factors as well which are responsible for MI non-adoption, by 20 to 50 percent of respondents on (agree+ strongly agree) basis. These are unavailability of micro-irrigation equipment , high operating cost of micro irrigation, insufficient subsidy for micro irrigation, unavailability of credit for micro irrigation, lack of enough information for micro irrigation, unsuitability of micro-irrigation to farmer’s land and crops grown and fragmentation of land having respective mean scores between 2.42 to 3.08.
- (iv) It is to be mentioned that apart from these respondents there are 8.33 percent to 37.50 percent respondents as well among all non-MI adopters, who partially agree/ disagree, i.e., are neutral, to various item statements.
- (v) Among 16 statements, which are of course all negative statements with regards to MI adoption only 5 have mean score above neutral (partially agree/ disagree) score, i.e., 3 and that too just very slightly over 3 while the rest 11 are below 3. This clearly shows that non-adoption of MI system is supported only by a few among all non-adopters while majority of them do not approve at all negativity towards MI adoption.
- (vi) On overall basis, the related data shown in Table-12.7; recommend that;
 - (a) While, majority of non-MI adopters do not at all support negativity towards MI adoption in enhancing crop production and other benefits; there is an urgent need to take special care in respect of (a) high investment cost of micro irrigation (b) crop damage by animals and (c) lack of fencing protection.
 - (b) The following factors too need due care to make MI adoption still more effective and efficient in respect of its applicability and utility
 - Unavailability of micro-irrigation equipment.
 - High operating cost of MI system.
 - Insufficient subsidy for micro irrigation.
 - Unavailability of credit for MI.
 - Lack of enough information for MI.
 - Unsuitability of MI to farmers land and crops grown.

- Fragmentation of land.

(c) The top 5 factors as supported by MI Non-adopters on (Agree+ Strong agree) basis as causes of non-adoption of MI have been in order as High Investment cost of Micro-Irrigation: 66.67% crop damage by animals: 62.50%. Lack of fencing protection: 58.33%. Subsidy for micro-irrigation not sufficient: 50.00%,Not enough information available for MI: 41.67%. The related data are shown in Table-12.7.

Table-12.7
Reasons for Non-Adoption

Item	Strongly Agree (%) 5	Agree (%) 4	Partially Agree/Disagree (%) 3	Disagree (%) 2	Strongly Disagree (%) 1	Mean	No. reporting
1. Micro-irrigation equipment not available	0 (0.00)	7 (29.19)	7 (29.19)	6 (25.00)	4 (16.62)	2.71	24 (100)
2. High investment cost of micro irrigation	1 (4.17)	15 (62.5)	2 (8.33)	4 (16.67)	2 (8.33)	3.38	24 (100)
3. High operating cost of micro irrigation	1 (4.17)	5 (20.83)	7 (29.17)	8 (33.33)	3 (12.5)	2.71	24 (100)
4. Subsidy for micro-irrigation not available	2 (8.33)	2 (8.33)	5 (20.83)	10 (41.68)	5 (20.83)	2.42	24 (100)
5. Subsidy for micro-irrigation not sufficient	3 (12.50)	9 (37.50)	3 (12.50)	7 (29.17)	2 (8.33)	3.17	24 (100)
6. Credit for micro-irrigation not available	1 (4.17)	8 (33.33)	5 (20.83)	6 (25.00)	4 (16.67)	2.83	24 (100)
7. Not enough information about micro-irrigation not available	1 (4.17)	9 (37.5)	5 (20.83)	6 (25.00)	3 (12.5)	2.96	24 (100)
8. Micro-irrigation is not profitable	0 (0.00)	1 (4.17)	9 (37.5)	13 (54.16)	1 (4.17)	2.42	24 (100)
9. No market for micro-irrigation crops	0 (0.00)	2 (8.34)	5 (20.83)	12 (50.00)	5 (20.83)	2.17	24 (100)
10. Micro-irrigation is not suitable to crops grown	0 (0.00)	2 (8.33)	4 (16.67)	14 (58.33)	4 (16.67)	2.17	24 (100)
11. Micro-irrigation is not suitable for your land	1 (4.17)	5 (20.83)	3 (12.5)	13 (54.17)	2 (8.33)	2.58	24 (100)
12. You prefer traditional irrigation	0 (0.00)	4 (16.67)	4 (16.67)	13 (54.16)	3 (12.5)	2.38	24 (100)
13. Inadequate water availability	0 (0.00)	2 (8.33)	9 (37.5)	10 (41.67)	3 (12.5)	2.42	24 (100)
14. Fragmentation of land	5 (20.83)	3 (12.5)	7 (29.17)	7 (29.17)	2 (8.33)	3.08	24 (100)
15. Crop damage by animals	5 (20.83)	10 (41.67)	3 (12.5)	4 (16.67)	2 (8.33)	3.50	24 (100)
16. Lack of fencing protection	4 (16.67)	10 (41.66)	3 (12.5)	6 (25.00)	1 (4.17)	3.42	24 (100)

Note: Figures in parenthesis are the respective percentages.

Mean refers to per farmer mean values.

Chapter-13

Specific Major Problems, Needs, Innovation and Suggestions

The present chapter highlights the specific major problems, innovations, needs and suggestions with regard to Micro-Irrigation. These have been presented in the form of ‘Top 3’; under each of various heads like (i) Major overall problems faced (ii) Major problems in process of Government subsidy (iii) Major needs/requirements (iv) Recommendations and (v) Suggestion. It may also be very clearly mentioned that the “number reporting” corresponding to each of the Top 3 items under various heads refers to the “percentage” of number reporting to the Total Number of MI adopters, i.e., 96; in each case, on “Non” Mutually Exclusive Basis. The observed results are as under:

(i) Major Overall Problems:

The ‘top 3’ major overall problems faced by the farmers are reported as; Lack of fencing/ damage by animals, Poor marketing arrangements and high cost of wells/tube-wells; as respectively reported by 69.76%.25.00% and 20.83% farmers major problems in process of government subsidy:

(ii) Government Subsidy:

There is no problem at all, in the process of government subsidy; as reported by 95.83% farmers (MI adopters).

(iii) Major needs/ requirements

The major needs/requirements on ‘top3’ basis refer to better MI technology/equipment, Lower price of micro-irrigation and Better marketing arrangements; as respectively reported by 92.70%, 85.41% and 914.67% of farmers.

(iv) Recommendations

The top 3 recommendations, as respectively by 94.79%, 88.55% and 86.46%percent farmers have been as farm fencing, improved water availability and better training of micro irrigation.

(v) Suggestions

The three utmost suggestions recommended by the farmers, towards Micro-Irrigation are; more Subsidy/Govt. Assistance, Provision/Support for farm fencing and Better micro-irrigation technology /equipment; as per respective reportings by 97.92%, 94.79% and 92.70% of total MI adopter farmers; respectively. The related data are shown in Table 13.1.

**Table-13.1
Major problems, innovations, needs and suggestions on micro-irrigation**

Top 3	Major Overall Problems faced	Number Reporting
1	Lack of Fencing/Damage by Animals	69.76%
2	Poor Marketing Arrangements	25.00%
3	High Cost of Wells/Tube-wells	20.83%
Top 3	Major Problems in process of government subsidy	Number Reporting
1	“No Problems” in the process of obtaining government subsidy (As reported by MI adopters)	95.83%
Top 3	Major Needs/ Requirements	Number Reporting
1	Better MI Technology Equipment	92.70%
2	Lower Price of Micro Irrigation	85.41%
3	Better Marketing Arrangements	91.67%
Top 3	Recommendations	Number Reporting
1	Farm Fencing	94.79%
2	Improved Water Availability	88.55%
3	Better Training for Micro-irrigation	86.46%
Top 3	Suggestions	Number Reporting
1	More Subsidy/Govt. Assistance	97.92%
2	Provision/Support for Farm Fencing	94.79%
3	Better Micro-irrigation Technology Equipment	92.70%

Chapter-14

Conclusions and Policy Implications

The conclusions and the corresponding policy implications thereof, as derived on the basis of major findings of the present study, a study conducted in two districts of Uttar Pradesh, viz. Sonbhadra and Saharanpur (selected as per set norms of the study) with a sample of 120 farmers (96 adopters+ 24 non-adopters; of MI) by AERC Prayagraj; under overall guidance of the Coordinator Centre, the CMA, IIM Ahmedabad and sponsorship of Ministry of Agriculture and Farmers Welfare, Govt. of India, New Delhi; corresponding to the agricultural year 2018-19; are highlighted as under.

14.1 Conclusions:

To facilitate, towards drawing interpretation in respect of policy implications corresponding to the present study, the various conclusions have been presented under “sub-headings”, in the following paragraphs:

(a) PDMC in Uttar Pradesh

- (i) The Action Plan Area of PDMC component of PMKSY in U.P., consists of all of its 75 districts and that the MI programmes are equally applicable to Horticulture, Agriculture and Sugarcane crops while under other interventions of PDMC (Micro-Irrigation) component the priority areas by over exploited, critical, semi-critical and Minor Irrigation Department are developed tanks/water source clusters and Member of Parliament (M.P)’s Adopted Villages.
- (ii) In the State of Uttar Pradesh; “Agriculture Department” has been nominated as the Nodal Agency for PMKSY; while “Department of Horticulture and Food Processing” as Implementation agency for PDMC component of PMKSY.
- (iii) On overall basis for the state of Uttar Pradesh; Progressive M.I. coverage upto 2019-20 has been of the order of 277282, area under M.I. during 2019-20 as 56953 ha. and the

progressive M.I. as percentage of total irrigated area in 2019-20 has been 1.93%; while of the total adopted area under MI, i.e., 56953 ha, 59.80% has been under Horticulture crops like Potato, Tomato, Onion, Cauliflower and 40.20% under Agriculture crops like Wheat, Pulses, Sugarcane, Maize.

- (iv) It is also to be mentioned; that the crops like Mango, Guava, Banana, Citrus, Papaya, Garlic, Ginger, Linseed, and Groundnut have also been occupying MI adopted area in the state of Uttar Pradesh, but to a very meagre extent.

(b) Sample MI adopters and their profile

- (i) All MI adopters in the study area (96) started using MI technique w.e.f. 2018-19.
- (ii) Among total MI adopters, majority (59.38%) belonged to small (1-2) ha size, i.e., 1 ha and more but less than 2 ha, followed by Medium (2-10) ha (34.37%) and Marginal (<1 ha) size (6.25%); with no landless/tenant or Large (>10 ha) category farmers.
- (iii) “Tube-well” has been the main source of irrigation for 95.53% of MI adopters; while as per water situation, for 96.88% of farmers there has been no scarcity of water, with 3.12% being subject, to occasional scarcity or excess water situation.
- (iv) Category wise extent of irrigated area being more than 95% in each category; with overall sample average as 97.73% and that the breakup of irrigated area as Micro vs Non Micro has been as 66.86% and 33.14%.
- (v) In respect of rainfall, 82.29% of total MI adopters were subject to average rainfall, while 17.71% had heavy rainfall.
- (vi) With regard to type of soil, majority (62.50%) had Medium soil, 34.37% Heavy Soil and 3.13% Light Soil; while no adopter had Hilly terrain with majority (77.08%) having Flat terrain and 22.92% up & down terrain.

(c) Cropping profile and fertigation MI adopters

- (i) Among 96 MI adopters (a) The adoption of major kharif crops being as Paddy (80), Maize (20), Chilli (15), Tomato (14) while major rabi crops being Wheat (84), Berseem

(19), Chilli (16), Tomato (13) and Mustard (12); with Sugarcane as a perennial crop being grown by 28 farmers.

- (ii) For MI adopters, the average per farmer area under various crops have been as Sugarcane -1.26 ha; Wheat-1.10 ha; Paddy-1.05 ha; Tomato- (0.99 ha in Kharif+1.03 ha in Rabi); Arhar (Tur)-0.85 ha, Maize-0.82 ha; Chilli- (0.41 ha in Kharif+0.50 ha in Rabi); Onion- (0.25 ha in Kharif+ 0.31 ha in Rabi).
- (iii) (a) Under Kharif season; Paddy, Maize, Gourd, Cucumber, Fodder had entire crop area irrigated by Non-Micro sources; while Arhar, Til, Jowar had entire area as unirrigated.
- (iv) Under Rabi season, all crops have been fully irrigated by Micro or Non- Micro sources; except Gram having partially unirrigated area.
- (v) Crop wise; (a) Drip irrigation has been used for Tomato and Chilli (b) Sprinkler irrigation for Wheat, Pea, Mustard, Berseem and Sugarcane (c) (Drip+Sprinkler) both, for Onion.
- (vi) The extent of fertigation on per farmer area basis, has been highest in Sugarcane (96.00%); followed by Onion (75% in Rabi & 50% in Kharif); Chilli (62% in Rabi & 60% in Kharif); Wheat (58.33%) and Pea (50%).

(d) Impact of MI adoption on change in area, yield and other related factors for major crops.

- (i) It is noteworthy, that in case of all the three major MI adopting crops in the study area, viz. Tomato, Wheat and Sugarcane; the extent of farmers reporting for change (Higher Increase/Increase) has been relatively much higher in yield as compared to area.
- (ii) For (a) Tomato, out of 14 reporting farmers, 78.47% record change in yield against that of only 57.14% in area (b) In case of Wheat, out of 84 reporting farmers, 76.19% record change in yield against that of only 40.14% in area; while (c) Out of 28 farmers growing sugarcane, all of them report for change in yield on 100 percent basis, without even a single farmer reporting for change in area.

(iii) It is emphatically found that the “Adoption of Micro-Irrigation (MI)” has benefitted the farmers (MI-adopters) substantially; not only in one, but in a number of ways, through

(a) Enhancing (i) Crop production (ii) Crop price (iii) Total Sales Revenue and (iv) Net Profit/Income.

(b) Reducing expenses (costs) on items like (i) Seeds/Plants (ii) Fertilizers (iii) Pesticides (iv) Diesel (v) Hours of Pumping (Irrigation) (vi) Farm Power and Equipments (vii) Labour cost and (viii) The Total Cost.

(e) Drip/Sprinkler irrigation kit details

(i) Out of total 96 MI adopters; 43 reported for Drip Irrigation Kit/Set and 53 for sprinkler Irrigation Kit/Set; where as it may be clearly stated that a farmer (MI adopter) was allowed to avail only any one of these two, i.e., drip and sprinkler kits.

(ii) On average per farmer basis (a) Rs. 132384 has been the total cost for Drip kit, out of which 14.84% was paid by farmer and 85.16% being subsidy. (b) Rs.22531=00 as the cost of sprinkler kit, out of which 70.25% paid by farmer and 29.75% being the subsidy. (c) The total cost of pumps and tube well cost (only if additional for MI) being respectively as Rs.32933=00 and Rs.9720=00 and were totally paid by farmer as there being no subsidy on these.

(iii) No maintenance cost has been paid by any of the MI (adopter), due to privilege of three years AMC by the contractor/supplier.

(f) Impact of MI adoption on various factors like Agronomic, Agro-economic and others

(i) There is strong footage to the fact; that agronomically ; apart from resulting to higher yield/output; MI techniques also reduce water use, fertilizer use, pest problems/pesticide use, weed problems and the labour use; as per reportings by 67% to 96% of total MI users on strongly agree/agree basis.

(ii) Towards agro-economic potential and effective demand as well; all the stated factors like (a) MI- raises output quality/price; increases profitability; capital cost of MI is not

high and (b) Information on MI information is easily available; MI technology is easy to understand/operate; subsidy for MI is easy to get; are supported by 80.63% to 94.79% and 64.59% to 95.83%, of total MI adopters respectively.

- (iii) The responsiveness of farmers in respect of various “Aggregate Supply” and “Distribution” factors like- There are large number of MI equipment supplying companies; the quality and reliability of MI equipment is good; there are large number of dealers; the dealers arrange for subsidy/credit etc., has been found to be relatively a bit low and being to the order of 60.41% to 88.12%.
- (iv) In respect of perceived advantages and disadvantages of Micro-Irrigation, the item “MI results to Higher Yields” is taken as of strong advantage/advantage by all the 96 MI adopters on cent percent basis; while all the other items like Better Output Quality, High output price, Less water need, etc. by 67.71% to 95.83% of total MI adopters; except for items “Easy Marketing of output” and “Employment for Youth”, supported by just 43.75% and 56.25% of total MI adopter farmers.

(g) Farmers (MI adopters) reportings towards larger impact of MI and its related benefits

- (i) Most of the groups/factors have significant extent of favourable reportings by the farmers towards “Larger Impact of Micro-Irrigation” on them. The order of top five, groups/factors as per positive reportings (substantially positive/positive, taken together) by the farmers has been as (i) Village as a whole-98.96% (ii) Water conservation/availability-98.96% (iii) Environment- 86.46% (iv) Upper caste -82.29% (v) Labour/Poor- 73.96%.
- (ii) The mean scores of all the above mentioned five groups/factors have been in the range of 3.81 to 4.23; i.e., above the No Impact mean score of 3.
- (iii)As per reportings of sample farmers (MI Adopters), 96 in number; the four items in order of preference are
 - a. Performance of MI on improving Water Use Efficiency is Excellent/Good: 78.13%
 - b. Overall performance of Micro-Irrigation (MI) is Excellent/Good/: 73.96%

- c. Performance of MI in reducing Input cost (such as fertilizers, pesticides, labour/electricity) is Excellent/Good/Satisfactory: 70.84%
 - d. Performance of MI on increasing farm income/profits is Excellent/Good: 65.63%
- (iv) The respective mean scores of above four items as 4.06, 4.13, 3.83, 3.82; are all above the mean satisfactory score of 3, to indicate utility and positive results of MI adoption.
- (v) Among all MI adopters, 94.79% strongly agree/agree to continue the use of MI; while 87.50% strongly agree/agree to further expand the use of MI, irrigation technique.

(h) Major problems faced by the MI adopter/non-adopter farmers and their suggestion thereof

- (i) The major problems faced by farmers, as on the basis of their strongly agreeing/agreeing (taken together) have been as (i) Lack of Fencing and Damage by Animals; each reported by 69.79% of the total MI adopter. (ii) Poor marketing arrangement-25.00% (iii) High cost of wells/tubewells-20.83% (iv) Lack of knowledge/training for Micro-Irrigation and Land Fragmentation, each corresponding to 19.79% and (v) Lack of own wells/tube-wells and water table going down fast, each reported by 18.75% of sample MI adopters.
- (ii) Among various suggestions by MI adopters, in respect of increasing the Adoption and Impact of Micro-Irrigation; the “top 5” on “Strongly Agree/Agree” basis are:

(a) More Subsidy/Government Assistance	: 97.92%
(b) Provision/ Support for Farm Fencing	: 94.79%
(c) Better Micro-Irrigation Technology/Equipment	: 92.70%
(d) Better Marketing Arrangements	: 91.67%
(e) Improved Water Availability	: 88.55%
- (iii) The three main factors responsible for Non-adoption of MI by “Non-Adopters of MI” have been (i) High Investment Cost of Micro-Irrigation (ii) Crop damage by animals and (iii) Lack of fencing; as reported respectively by 66.67%, 62.50% and

58.33% of total Non-Adopters of MI (24 in number) on “Strongly agree/Agree”; and “non mutually exclusive basis.”

- (iv) On overall basis; while majority of Non MI Adopters as well do not support Negativity towards MI-adoption, in enhancing crop productions and providing other MI related benefits; the following factors are taken as hindrances by them towards MI Adoption (i) the above mentioned three factors, i.e., High investment cost; lack of fencing; damage by animals followed by (ii) unavailability of MI equipment (ii) High operating cost of MI system (iv) Insufficient subsidy for Micro-Irrigation (v) Unavailability of credit for MI (vi) Lack of enough information for MI (vii) Fragmentation of land (viii) Unsuitability of MI to farmers land and crops grown; as reported by 20% to 50% of total Non-MI Adopters; on non-mutually exclusive basis.
- (v) As a sign of development and prosperity it may also be well mentioned in respect of “Non MI adopters group”; that (i) There is not even a single non-adopter farmer, who is illiterate and without irrigation facility (ii) Majority of them (66.27%) have Tube-well as major source of irrigation (iii) Among Kharif crops, the major, i.e., Paddy, followed by Maize, Tomato, Chilli, Arhar have cent percent irrigated area except Arhar (iv) Among Rabi crops the dominant one, viz. Wheat, followed by Fodder, Mustard, Gram and Chilli are fully irrigated (v) As a perennial crop Sugarcane, being adopted by 46.83% of total Non-MI adopters, is also 100 percent irrigated.

14.2 Policy Implications:

The major policy implications, as derived upon, on the basis of conclusion of the present study, are enlisted and highlighted as under:

1. There is wide scope for development of Agriculture, Horticulture and Sugarcane crops in Uttar Pradesh, subject to adoption of Advanced Irrigation techniques like Micro Irrigation; the use of which can increase and even double fold the farmers’ incomes, in a number of ways and thus contribute towards state’s as well as national economy.
2. As more than 85 percent of MI-adopters support (strongly agree/agree) to continue the use of MI as well as expand it further; it is erstwhile desirable and suggested that this

highly advanced Irrigation Technique must be continued and even extended even more, along with its specified subsidies.

3. In view of suggestion by 88.55 percent to 97.92 percent of MI adopters, the following points must be taken for due consideration and care thereof, towards further extension and applicability of MI system, in generation of more income from agriculture sector. (i) More subsidy (Govt. Assistance); (ii) Provision/Support for Farm Fencing, (iii) Better Marketing Arrangements and (iv) Improved Water Availability.
4. Considering (i) Lack of fencing (ii) Damage by animals (iii) Poor Marketing arrangements (iv) High cost of wells/tube-wells (v) Lack of knowledge/Training towards Micro-irrigation (vi) Lack of own well/tube-wells; as the major problems faced by MI adopter farmers; this is earnestly suggested and recommended that the above problems be tackled on priority basis, to make usefulness and applicability of Micro-Irrigation still more effective and beneficial to farming community in particular and the entire country in general; through (i) providing fencing to safeguard damage of crops by animals (ii) Improving Marketing arrangements for MI produced crops (iii) Arranging more demonstration and field trials to improve knowledge levels of farmers in respect of MI (iv) Providing “boring” facilities to farmers, mainly small & marginal, who form the bulk of farming community; to have their own source of water availability in support of crops irrigation, using MI techniques.
5. The study findings for “Non MI adopters group” that (i) On overall sample basis, as well as in each category of farmers, i.e., marginal, small and medium, the entire per farmer operated area is irrigated.(ii) Tubewell being the main water source of irrigation for 66.27% of all Non-MI adopters (iii) 79.17% of all Non-MI adopters have no scarcity of water; are all most prompting to suggest and recommend that, “ What in fact has to be done is that; The non-MI adopters group has also to be initiated, in the larger interest of the country to adapt MI-technology, to increase per farmer crop productions, as well as get benefitted by other MI associated benefits.
6. On overall basis, special attention has to be given by the concerned Department of Central/State governments and the national planners and policy makers; towards tackling down and solving the under mentioned problems as faced by MI adopters and Non adopters, including a few which are faced commonly by both, i.e., MI adopters and also

Non MI adopters; to safeguard the interest of farming community and the country as a whole, in enhancing crop productions and agriculture sector's contribution to National Economy. (i) Support to farmers for farm fencing, (ii) More subsidy/Govt. assistance, (iii) Better marketing arrangements for MI produced crops, (iv) "Boring facilities" to farmers towards assured irrigation, (v) Training camps/ Field Demonstration to farmers in respect of working and effective operation of MI system and (vi) to account for, in respect of problems, whatsoever, due to land fragmentation, water table going down fast and unpredictable electric supply.

7. Further more, as a way forward; PDMC (MI) component of PMKSY, also needs (i) special emphasis in view of its enhanced utility towards reducing conveyance & application losses as compared to conventional flow irrigation practices and (ii) due consideration towards employment for youth in the direction of enhancing MI's value added applicability.

Chapter-15

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Annexure-I

Central Assistance released under PMKSY-PDMC (2015-16 to 2018-19)
(Rs. in crore)

S.No.	Name of States	2015-16	2016-17	2017-18	2018-19
1	Andhra Pradesh	206.47	308.69	517.1	520.00
2	Bihar	28.6	21.6	12.5	27.91
3	Chhattisgarh	20.3	44.8	55	43.39
4	Goa	0.3	0.8	0	1.20
5	Gujarat	213.05	274	300	272.50
6	Haryana	34.97	27	14.01	27.41
7	Himachal Pradesh	7.6	8.5	19.25	26.00
8	Jharkhand	14.97	30.7	25	10.00
9	Jammu & Kashmir*	4.87	5.4	3	7.80
10	Karnataka	213.12	229	385	372.03
11	Kerala	8.53	0	25	4.00
12	Madhya Pradesh	161.74	121.1	150	132.56
13	Maharashtra	107.26	305.7	362.5	360.00
14	Odisha	28.7	39.7	48	58.00
15	Punjab	43	1.18	0	9.00
16	Rajasthan	142.84	129	107.5	168.48
17	Tamil Nadu	129.78	143.5	369.55	355.00
18	Telangana	111.32	189	257	122.00
19	Uttarakhand	9.6	15	27.2	43.00
20	Uttar Pradesh	37.51	41.4	55	87.88
21	West Bengal	4.8	19.9	31	40.00
22	Arunachal Pradesh	2.6	2	8.3	12.50
23	Assam	5.03	11	3	30.00
24	Manipur	2.76	3.6	7.5	40.00
25	Meghalaya	1.43	0	3.3	12.00
26	Mizoram	3.27	8.1	12.3	27.80
27	Nagaland	2.34	4.5	11.8	35.00
28	Sikkim	4.86	5.4	4	55.19
29	Tripura	1.55	0	3.75	15.00
30	UTs	2.23	0	0.5	0.00
	Grand Total	1555.4	1990.57	2818.06	2915.65

*- Jammu & Kashmir is UT now

Annexure-II**Rs in Crore**

State	Allocation (B.E)	Release
Release 2019-20 (Rs in crore)		
Andhra Pradesh		452.00
Bihar		
Chhattisgarh		32.15
Goa		0.50
Gujarat		280.00
Haryana		16.80
Himachal Pradesh		18.00
Jharkhand		22.97
Jammu & Kashmir		27.00
Karnataka		410.00
Kerala		0.00
Madhya Pradesh		102.00
Maharashtra		325.00
Odisha		30.00
Punjab		0.00
Rajasthan		75.00
Tamil Nadu		523.00
Telangana		
Uttarakhand		32.00
Uttar Pradesh		100.00
West Bengal		20.00
Arunachal Pradesh		18.00
Assam		42.00
Manipur		40.00
Meghalaya		0.00
Mizoram		28.00
Nagaland		53.00
Sikkim		31.80
Tripura		18.00
Andaman Nicobar		
Puducherry		
Laddakh		2.40
HQ		0.44
TOTAL		2700.06

Annexure-III

Area Covered under Micro-Irrigation under PMKSY-PDMC (2015-16 to 2019-2020)

(Area in ha)

S. No.	State	2015-16	2016-17	2017-18	2018-19	2019-20 (reported by 30.03.2020)	Total
1	Andhra Pradesh	94104	141098	186441	200269	95854	717766
2	Bihar	5155	4228	3143	924	1668	15118
3	Chhattisgarh	8056	19227	13087	18929	23931	83230
4	Goa	92	123	236	0	0	451
5	Gujarat	142681	165948	143134	140778	108322	700863
6	Haryana	3117	5701	10751	10469	5856	35894
7	Himachal Pra.	3306	937	1197	422	1071	6933
8	Jharkhand	4528	5810	1544	3978	5989	21849
10	Karnataka	64220	139405	236107	234853	141104	815689
11	Kerala	561	310	358	965	87	2281
12	Madhya Pradesh	75224	54323	39761	35195	9485	213988
13	Maharashtra	35242	106172	132829	159959	94214	528416
14	Odisha	2907	4611	3036	10081	8498	29133
15	Punjab	1799	1950	600	507	693	5549
16	Rajasthan	56346	47650	48205	53982	46732	252915
17	Tamil Nadu	32288	44778	105695	172445	218275	573481
18	Telangana	39864	61980	89474	40381	1588	233287
19	Uttarakhand	721	3199	2182	4256	6696	17054
20	Uttar Pradesh	1598	32511	28235	55086	40910	158340
21	West Bengal	0	0	2137	13370	408	15915
23	Assam	0	0	782	70	-	852
24	Manipur	0	0	0	1600	560	2160
26	Mizoram	398	0	0	0	2348	2746
28	Sikkim	773	0	0	0	-	773
	Grand Total	572980	839961	1048934	1158519	814289	4434683

**Comments on the Draft Report received from
Centre for Management in Agriculture, Indian Institute of Management Ahmedabad**

Review of the Report

(I) Title of the Draft Study Report Examined:

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

(II) Date of Receipt of the Draft Report: September 3, 2020

(III) Date of Dispatch of Comments: September 27, 2020

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

(IV) A. General Comments

1. Given its 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 Uttar Pradesh.
2. The study objectives are appropriate and sound. They include examining the 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 Uttar Pradesh, also touching upon the constraints faced by the non-adopters of micro irrigation.
3. The presentation of the study and its 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 Uttar Pradesh.

B. Comments on the Methodology and Analysis Presentation

1. Page 8: Kindly make and include a brief executive summary of the report in the beginning. This is necessary and will help the readers to get a quick picture.
2. Page 14- Please increase the length of the vertical axis in the figures to show the state levels better. Indicate the rank/ position of UP in the description. Please correct the state name spellings: Telangana in Figure 1.1 and Kerala in Figure 1.2.
3. Page 24 – Please move the references to the end of the manuscript.
4. Page 25- For Table 3.1, A line chart can be created to show the trends and changes over the years.
5. Page 26- To clarify, since you have given progressive in other columns, state “Area Added” instead of “Area” in column 4. Also bold the top 3 in progressive MI coverage. State were the selected 2 districts stand.
6. Page 32- : You may check the data shown in Table 4.1 and Figure 4.1 if it is ok and explain. Some farmers may be having both drip and sprinkler.
7. Page 39- : Table 5.2: Kindly explain “others” in a footnote, what it includes.
8. Page 43-46-: Table 6.1 and 6.2 on pages 43-46, please give results in terms of percentage of the row totals – with one decimal place – instead of average area. Generally description/ discussion should be above the Table
9. Page 43-46- Table 6.1 and Table 6.2: Please add comments on the changes in irrigated area and cropping pattern before and after micro-irrigation.
10. Page 49: Table 6.3 for tomato crop, there is some error in the mean response in “change in area”. Kindly check as it should be less than 5.
11. Page 51- Table 7.1: This is a very important and good Table. You can break it into 2 parts since it is very big. You can give some percentages/differences or change – to bring out the results better. Please also add a row of yield (prod/area). A figure can also be added for this.
12. Page 55-60: It is very good that for every cost/ item a separate paragraph on findings and discussion has been given in Page 55-60, and figures have been given for important items. Please add one for yield.

13. Page 61- Chapter VII- Table 8.1: Please add a column on % subsidy.
14. Page 62- Chapter VIII: Table 8.2: please correct the name of the company Netafim. Also check other brands names.
15. Page 64- Chapter IX: Table 9.1: This is very important but may be broken up. Please list the factors at the beginning of the Chapter and then break the Chapter and the Table into sub-parts by factor: Agronomic Potential, Agro-economic Potential, Effective Demand, Aggregate Supply, and Distribution. You already have write-ups on each, and these can be given with each sub Table. You can give the reference for this model as: Gandhi, Vasant P. 2014, "Growth and Transformation of the Agribusiness Sector: Drivers, Models, and Challenges", *Indian Journal of Agricultural Economics*, Vol.69, No.1, Jan-Mar.
16. Page 64 Table 9.1: Please remove decimal places in frequency numbers i.e. 36 60...
17. Page 68- Table 9.2: This is very important.The description should be above the Table. Please remove the Others and Overall rows.
18. Page 71- Table 10.1: This is important.The description may be kept above the Table. Please remove decimal places in frequency numbers. Remove Others rows.
19. Page 73- Table 10.2: This is a very important Table.It can be broken into two parts with the explanations.Please remove decimal places in frequency numbers. Remove Others rows.
20. Page 78-79: The figure & description are not suitable and may be deleted. This section should be about overall performance/satisfaction of MI as seen by farmers. Please add description regarding the performance of MI reported – overall and on different aspects based on Table 11.1 – focusing on Excellent+Good. Please remove decimal places in frequency numbers. You could make figure based on 5+4 responses, separate figure for last two responses.
21. Page 80: The important/ frequent suggestions should be highlighted in the text.
22. Page 82-90 on Non-Adopters: Please compare the results of non-adopters vs adopters, such as on age, education, land holding, source of irrigation and crops.
23. Page 90- Highlight few important factors of non-adoption using the percentages (Strongly Agree + Agree).
24. Page 91- Table 13.1: Highlight the important factors/ responses in the text. Remove the empty row.
25. Page 92-99: You may remove the bullet point mode and make it paragraphs. You could have sub-headings. Please try and make sure that you give findings/ conclusions with respect to each of the objectives of the study.

Other Comments on the presentation of report

A. Table and Figure presentation:

- A list of acronyms may be added.
- A suggestion for figure 1.1 and 1.2: The data/names can be arranged in decreasing order - plot the highest bar first and smallest last. It will make the results easier to see.
- You can add some pictures/ field pictures on the cover.

B. Other issues:

1. Bold letters, underline and capitals can be avoided. For example in Chapter 1 first paragraph last sentence "...POSSIBLE EXTENT" should be written as "possible extent". Similarly in page number 12 "... PRESSURISED IRRIGATION MEANS of MICRO IRRIGATION, DRIP IRRIGATION, SPRINKLER IRRIGATION" should be written as "... pressurised irrigation means of micro irrigation...". You could use underline but not excessively.
2. You could avoid first letter bold inside paragraph such as "...Present Study ..." in chapter II.
3. In page 12 and page 22 footnotes have been added using a text box, which may move while editing. You can use the footnote option in MS Word. Go to Reference tab on top of MS-Word, look for option "Insert Footnote" and click to add footnote. Make sure your cursor is where you want to put footnote.
4. Please avoid text boxes in document as it changes its location while reading/ revision. There is one in the long Table 3.2 on pages 27-28. You can do as above or make it a part of the Table in a row below.
5. Try to begin every chapter from a new page.
6. Please recheck for grammar and spelling such as "..... short spam" in page 9 last paragraph. Check for errors in the word equipment as "equipments". Kindly do a spell check of the entire report to remove spelling and spacing issues.
7. Do not have repeat Header Rows in every multipage Table.

(V) Overall View on Acceptability of the Report

The report presents the study and its findings quite 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.

Action Taken on the Comments

Comment-wise action taken on the Draft Report entitled “Improving Water Use Efficiency in India’s Agriculture: The Impact, Benefits and Challenges of Micro-Irrigation under the Pradhan Mantri Krishi Sinchayee Yojna: Per Drop More Crop (PMKSY-PDMC) in Uttar Pradesh”.

Sl. No.	Review of the Report	Action Taken
I	Title of the Draft Report Examined Improving Water Use Efficiency in India’s Agriculture: The Benefits, Impact and Challenges of Micro-Irrigation under PMKSY-PDMC in Uttar Pradesh (Pradhan Mantri Krishi Sinchayee Yojna: Per Drop More Crop)	Title of Report edited slightly as per comment
II	Date of Receipt of the Draft Report	September 3, 2020
III	Date of Dispatch of Comments	September 27, 2020
A.	General Comments	
1.	Given its 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 Uttar Pradesh.	Action not required
2	The study objectives are appropriate and sound. They include examining the 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 Uttar Pradesh, also touching upon the constraints faced by the non-adopters of micro irrigation.	Action not required

3	The presentation of the study and its findings is in general very well done	Action not required
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 Uttar Pradesh.	As per comment, the title of the report has been edited slightly, as "Improving Water use Efficiency in India's agriculture: The Impact, Benefits and Challenges of Micro-Irrigation under the Pradhan Mantri Krishi Sinchayee Yojna: Per Drop More Crop(PMKSY-PDMS) in Uttar Pradesh"
B.	Comments on the Methodology and Analysis presentation	
1	Page 8: Kindly make and include a brief executive summary of the report in the beginning. This is necessary and will help the readers to get a quick picture.	As per comments, a brief executive summary of the report has been made and included in the beginning of the report.
2	Page 14- Please increase the length of the vertical axis in the figures to the show the state levels better. Indicate the rank/ position of UP in the description. Please correct the state name spellings: Telangana in Figure 1.1 and Kerala in Figure 1.2.	As suggested, the length of vertical axis has been increased accordingly in Fig 1.1 & Fig 1.2, along with respective spelling correction as Telangana and Kerala. The rank position of Uttar Pradesh has also been indicated in the description .
3	Page 24 – Please move the references to the end of the manuscript.	As per suggestion, references have been moved to the end of the manuscript.
4	Page 25- For Table 3.1, A line chart can be created to show the trends and changes over the years.	As per comment, for Table 3.1 a line chart has been created to show the trends and changes over the years.
5	Page 26- To clarify, since you have given progressive in other columns, state "Area Added" instead of "Area" in column 4. Also bold the top 3 in progressive MI coverage state where the selected 2 districts stand.	As per comment, "Area" has now been stated as "Area added" in col.4, and also "the top3" districts have been shown as "bold" in progressive MI coverage as well as the stand (rank) of two districts selected under study, have also been stated accordingly.
6	Page 32- : You may check the data shown in Table 4.1 and Figure 4.1 if it is ok and explain. Some farmers may be having both drip and sprinkler.	As per comment, the data shown in Table 4.1 and Fig. 4.1 has been checked. It is OK. There is no farmer in the sample having, drip and sprinkler, both.
7	Page 39- : Table 5.2: Kindly explain "others" in a footnote, what it includes.	As pointed out in Table-5.2, "others" in foot note, includes submersible water pump.

8	Page 43-46- : Table 6.1 and 6.2 on pages 43-46, please give results in terms of percentage of the row totals – with one decimal place – instead of average area. Generally description/ discussion should be above the Table	As per suggestion, description/ discussion has been presented above the Table.
9	Page 43-46- Table 6.1 and Table 6.2: Please add comments on the changes in irrigated area and cropping pattern before and after micro-irrigation.	As per suggestion, in Table-6.1 and Table-6.2, comments have been added on the changes in irrigated area and cropping pattern as, before and after micro irrigation.
10	Page 49: Table 6.3 for tomato crop, there is some error in the mean response in “change in area”. Kindly check as it should be less than 5.	As per comment, in Table-6.3, for tomato crop, the error in the mean response in “change in area” has been checked and corrected accordingly. The correlated value is 3.85.
11	Page 51- Table 7.1: This is a very important and good Table. You can break it into 2 parts since it is very big. You can give some percentages/differences or change – to bring out the results better. Please also add a row of yield (prod/area). A figure can also be added for this.	As per suggestion, Table-7.1 has been modified accordingly for better presentation. To bring out the results more distinct and clearer percentage differences have also been worked out and shown accordingly and that a row of yield (production/ area) has also been added along with corresponding figure.
12	Page 55-60: It is very good that for every cost/ item a separate paragraph on findings and discussion has been given in Page 55-60, and figures have been given for important items. Please add one for yield.	As per suggestion, a separate paragraph on findings for yield, has been added.
13	Page 61- Chapter VII- Table 8.1: Please add a column on % subsidy.	As per comment, a column on % subsidy has been added in Table 6.1.
14	Page 62- Chapter VIII: Table 8.2: please correct the name of the company Netafim. Also check other brands names.	As per comment, the name of the company Netafim and other brand names have been corrected accordingly.
15	Page 64- Chapter IX: Table 9.1: This is very important but may be broken up. Please list the factors at the beginning of the Chapter and then break the Chapter and the Table into sub-parts by factor: Agronomic Potential, Agro-economic Potential, Effective Demand, Aggregate Supply, and Distribution. You already have write-ups on each, and these can be given with each sub Table. You can give the reference for this model as: Gandhi, Vasant P. 2014, “Growth and Transformation of the Agribusiness Sector: Drivers, Models, and Challenges”, <i>Indian Journal of Agricultural Economics</i> , Vol.69, No.1, Jan-Mar.	As per suggestion, the different factors- Agronomic potential, Agro-economic potential, effective demand, Aggregate Supply and distribution, have been listed at the beginning of the chapter and thereafter , the chapter and the table has been expressed as factor wise in sub-parts and sub-tables, along with corresponding write-ups on each. The reference for this model has been given as Gandhi Vasant P. 2014, “Growth and transformation of the Agri-business Sector: Drivers, Models and Challenges”, <i>Indian Journal of Agricultural Economics</i> , vol. 69, No.1, Jan-March

16	Page 64 Table 9.1: Please remove decimal places in frequency numbers i.e. 36 60	As per comment, in Table-9.1 decimal places have been removed in frequency numbers.
17	Page 68- Table 9.2: This is very important. The description should be above the Table. Please remove the Others and Overall rows.	As suggested, in Table-9.2 the description has been given above the Table. The others and overall rows, have been removed.
18	Page 71- Table 10.1: This is important. The description may be kept above the Table. Please remove decimal places in frequency numbers. Remove Others rows.	As suggested, in Table-10.1 the description is kept above the Table. Decimal places in frequency numbers; and other rows have been removed.
19	Page 73- Table 10.2: This is a very important Table. It can be broken into two parts with the explanations. Please remove decimal places in frequency numbers. Remove Others rows.	As per comment, Table-10.2 is presented accordingly with explanations. The decimal places in frequency numbers, and 'others' row; has been removed.
20	Page 78-79: The figure & description are not suitable and may be deleted. This section should be about overall performance/satisfaction of MI as seen by farmers. Please add description regarding the performance of MI reported – overall and on different aspects based on Table 11.1 – focusing on Excellent+Good. Please remove decimal places in frequency numbers. You could make figure based on 5+4 responses, separate figure for last two responses.	As per suggestion, (i) the figure and description which were not suitable have been deleted. (ii) the reporting in respect of overall performance/satisfaction of MI is as seen (reported) by farmers (iii) the reporting on the performance of MI, overall and on different aspects as based on Table 11.1 have now been focused on 'Excellent+Good' criteria (iv) appropriate figures have been added on 5+4 responses and for last two response.
21	Page 80: The important/ frequent suggestions should be highlighted in the text.	As suggested, the important suggestions have been highlighted in the text.
22	Page 82-90 on Non-Adopters: Please compare the results of non-adopters vs adopters, such as on age, education, land holding, source of irrigation and crops.	As per suggestion, the result of non-adopters v/s adopters, such as on age, education, land holding, source of irrigation and crops, have been compared accordingly.
23	Page 90- Highlight few important factors of non-adoption using the percentages (Strongly Agree + Agree).	As per comment, important factors of non-adoption have been highlighted using the percentage on (strongly agree +agree) basis.
24	Page 91- Table 13.1: Highlight the important factors/ responses in the text. Remove the empty row.	As per suggestion, in Table-13.1, important factors/ responses have been highlighted in the text and the empty row has been accordingly removed.

25	Page 92-99: You may remove the bullet point mode and make it paragraphs. You could have sub-headings. Please try and make sure that you give findings/ conclusions with respect to each of the objectives of the study.	As suggested, the bullet point mode has been removed and the text has been presented as paragraphs with sub-headings. The findings/conclusions have been given with respect to each of the objectives of the study.
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Other Comments on the presentation of report

Sl. No.	Comment	Action Taken
A.	Table and Figure presentation	-
•	A list of acronyms may be added	As per comment, a list of acronyms has been added.
•	A suggestion for figure 1.1 and 1.2: The data/names can be arranged in decreasing order - plot the highest bar first and smallest last. It will make the results easier to see.	As suggested, in figure 1.1 and 1.2 the data/names have been arranged in decreasing order- highest to lowest; to have more clarity of result
•	You can add some pictures/ field pictures on the cover.	As per suggestion, the some pictures/field pictures on the cover, have been added.
B.	Other Issues	
1.	Bold letters, underline and capitals can be avoided. For example in Chapter 1 first paragraph last sentence "...POSSIBLE EXTENT" should be written as "possible extent". Similarly in page number 12 "... PRESSURISED IRRIGATION MEANS of MICRO IRRIGATION, DRIP IRRIGATION, SPRINKLER IRRIGATION" should be written as "... pressurised irrigation means of micro irrigation...". You could use underline but not excessively.	As per comment, bold letters, underline and capitals have been avoided all over, in the report.
2.	You could avoid first letter bold inside paragraph such as "...Present Study ..." in chapter II.	As suggested, first letter bold inside paragraph in chapter II and elsewhere, as well, has been avoided.

3.	In page 12 and page 22 footnotes have been added using a text box, which may move while editing. You can use the footnote option in MS Word. Go to Reference tab on top of MS-Word, look for option “Insert Footnote” and click to add footnote. Make sure your cursor is where you want to put footnote.	As per suggestion, in pages 12 & 22, foot note using a text box has been moved and replaced by foot note in MS word.
4.	Please avoid text boxes in document as it changes its location while reading/revision. There is one in the long Table 3.2 on pages 27-28. You can do as above or make it a part of the Table in a row below.	As suggested, text boxes in document, have been avoided.
5.	Try to begin every chapter from a new page.	As per suggestion, every chapter has been started from a new page.
6.	Please recheck for grammar and spelling such as “..... short spam” in page 9 last paragraph. Check for errors in the word equipment as “equipments”. Kindly do a spell check of the entire report to remove spelling and spacing issues.	As per comment, taking full cognizance of grammar/spelling errors and spacing issues; a spell check of the entire report has been made to remove such errors, to all possible minimum.
7.	Do have repeat Header Rows in every multipage Table.	As suggested, repeat header Rows have been provided in a multipage table.
	<p>Overall View on Acceptability of the Report.</p> <p>The report presents the study and its findings quite 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.</p>	All the valuable suggestions and comments by the peer reviewer Prof Vasant Gandhi, Project Coordinator, Centre for Management in Agriculture, Indian Institute of Management Ahmedabad, have been addressed (incorporated) in the final report, accordingly.