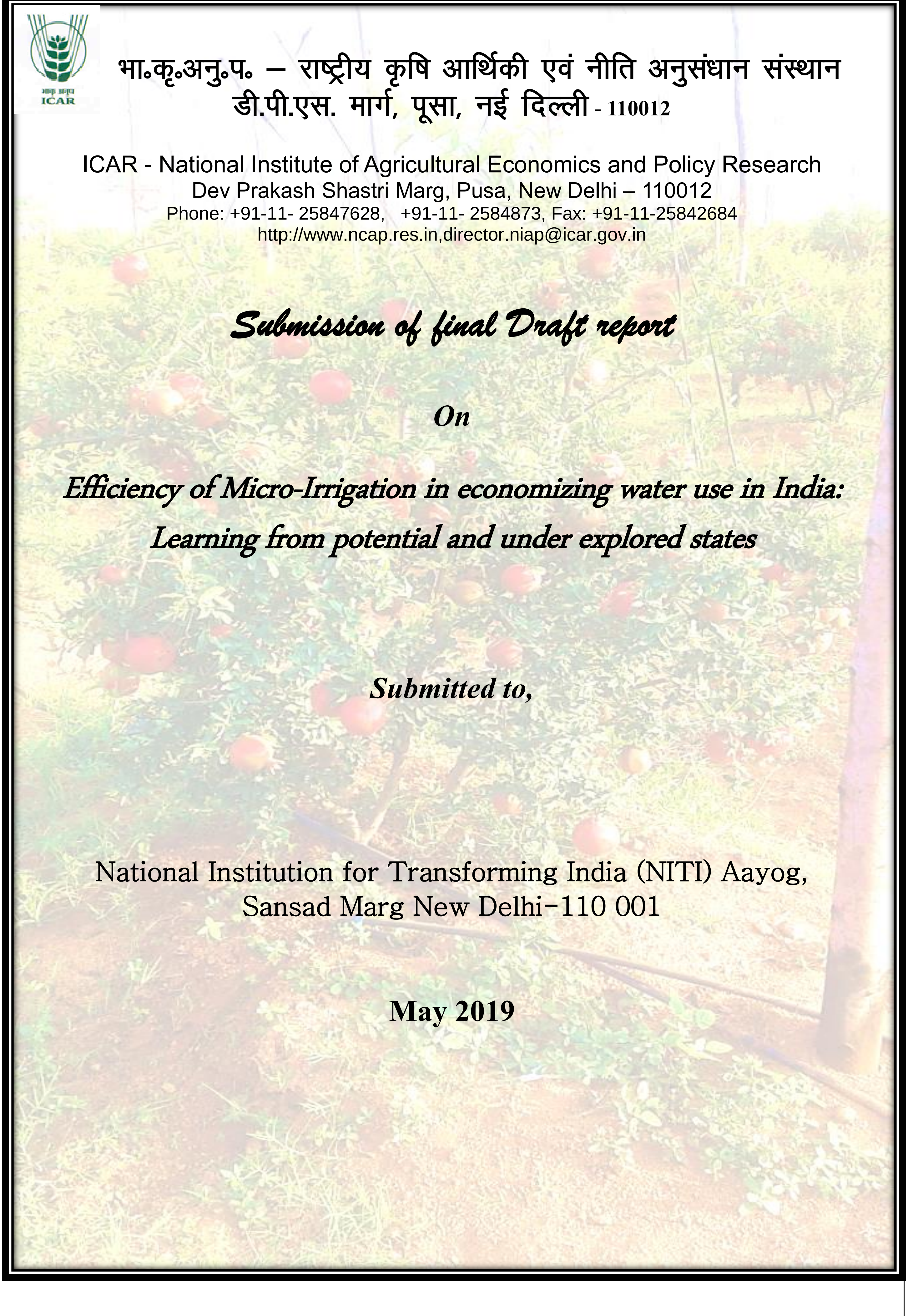

भा॰कृ॰अनु॰प॰ – राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान
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Submission of final Draft report

On

Efficiency of Micro-Irrigation in economizing water use in India: Learning from potential and under explored states

Submitted to,

National Institution for Transforming India (NITI) Aayog,
Sansad Marg New Delhi-110 001

May 2019

(For official use only)

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Efficiency of Micro-Irrigation in economising water use in India: Learning from potential and under explored states

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Address: Dev Prakash Shastri Marg, -110012, India, Phone: 011-25847628,
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Date of establishment: 2nd March 1991

Title of study: ***Efficiency of Micro-Irrigation in economising water use in India: Learning from potential and under explored states***

Objectives:

1. To study the administration processes practices adopted by the state and effectiveness of state implementing agencies.
2. Effect of water/ energy pricing on adoption of micro irrigation.
3. To find out the effectiveness of various MI technologies for water economy, energy and input economy, savings, employment and income.
4. To estimate the total area covered under MI in selected states and to assess the extent of the use of marginal and otherwise uncultivable lands.
5. To estimate the amount of private investment and area covered by them and developing database.
6. To assess the reliability and durability of the system for sustainable development.
7. To develop an alternate eco system for promotion of micro irrigation in under exploited but potential states/ regions.
8. To identify the major constraints, if any and suggest remedial measure.

Period of study: August 2018 to May 2019

Project Team

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Authors thank to the NITI Aayog, Govt. of India for funding and trusting on us while sanctioning this important study to ICAR- NIAP, Delhi. Their constant support and administrative backup helped us to complete the study in a comprehensive manner, which will be useful to take up policy decisions for scaling up the micro irrigation in the country.

Special thanks are due to the advisors, NITI, Aayog who had discussed time to time the intricacies of the study at field and administration level. Their constant support and guidance helped us to complete the study in time and comprehensive manner.

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(Subhash Chand)

Foreword

ICAR-NIAP regularly undertakes research studies on policy and institutional issues related to the development. The study on impact of micro irrigation sponsored by NITI Aayog, is of special interest for the water policy and research point of view. This study examines the spread and adoption of micro irrigation in four states, namely, Punjab (Unexploited region), Maharashtra, Gujarat and Andhra Pradesh.

This study combines and compares the observations across four states of India with varied cropping pattern. The study shows that farmers are motivated to adopt drip irrigation primarily to cope with the scarcity in at least one of three factors of production, namely water, power and labour. Micro irrigation appears to give very good results on each of these counts, and therefore the farmers see it as very useful technology. The survey results show that farmers use the saved water for variety of purposes including cultivation of new crops, giving more irrigation to other existing crops. Though rare, some farmers also share and sell water informally. The study clearly establishes the benefit of the technology for conservation of water and extending its use.

The study explores the adoption process beyond technology use to master the management of micro-irrigation in agriculture and roles of stakeholders. The different phases including purchase of the equipment, installation, getting subsidy approval and disbursements are very important. This post adoption phase is important in getting the maximum benefits from the system. While the initial phases are substantially influenced by friends, family and local networks, the subsequent phase is dominated by the action of drip dealer, company sales persons and the final phase is determined by others such as the drip after sales service staff. The results indicate the positive impact of micro irrigation on improving the productivity of agriculture and to cope with power, labour and water scarcity. The report makes recommendations for redesigning the benefit of micro irrigation by farmers and higher water productivity in sustainable manner. I hope research finding will be useful for the researchers and other readers.

Director

Glimpse of activities under micro irrigation study

Micro irrigation system lateral wrapped with tractor in Banaskantha, Gujarat

Micro irrigation system controlling unit In Fazlika, Punjab

Micro irrigation system in green shed net Sabarkantha

Different fertilizer tanks fitter with micro irrigation system unit Abohar Punjab

Micro irrigation system with fertigation unit Abohar Punjab

Plate 1: showing the micro irrigation device with fertigation unit attached


Discussion with farmers in Hoshiarpur solar micro irrigation system Punjab


Discussion with farmers in on micro irrigation system in Vishakhapatnam, AP


Discussion with farmers in Hoshiarpur on micro irrigation system Punjab


Discussion with farmers on micro irrigation system Banaskantha, Gujarat

Discussion with farmers on micro irrigation system Visakhapatnam, AP

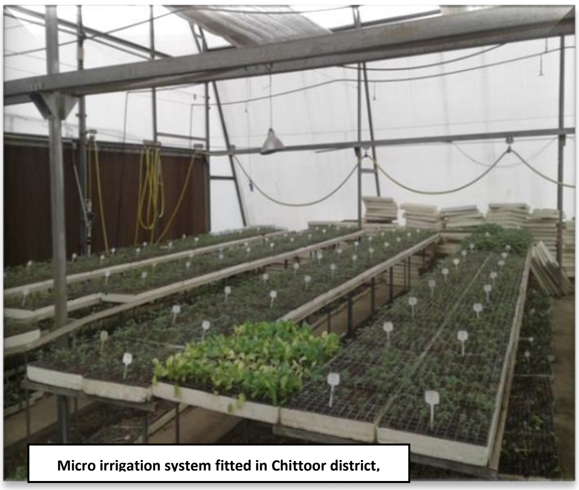

Discussion with farmers on micro irrigation system Visakhapatnam, AP

Plate 2: Research team conducting primary survey

Micro irrigation system fitted with opens well in Visakhapatnam, AP

Solar operated micro irrigation system in Abohar, Punjab

Micro irrigation system filter and distribution unit in Visakhapatnam, AP



Micro irrigation system fitted in Chittoor district,

Micro irrigation system fitted in Chittoor district, AP

Micro irrigation system fitted for plantation crop Chittoor district,

Plate 3: Showing the micro irrigation system with attachment of various devices

Discussion with farmers on micro irrigation system for Banana crop in Banaskantha,

Micro irrigation system fitted in polyhouse for nursery rising in Punjab

Micro irrigation system used for Kinnow crop in Abohar Punjab

Micro irrigation system fitted for Nursery rising in Abohar, Punjab

Discussion by the research team with farmers in Visakhapatnam, AP

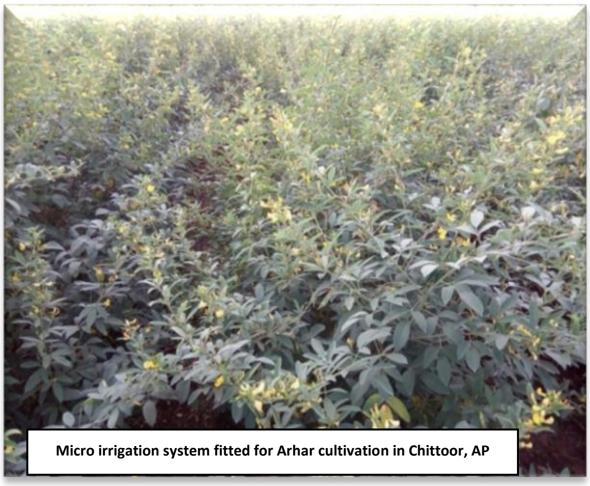
Micro irrigation system fitted for Nursery rising in Punjab

Plates 4: Showing the micro irrigation installed in the poly houses

Micro irrigation system fitted in mandin orange in Abohar, Punjab

Micro irrigation system fitted for Papaya cultivation in Chittoor, AP

Micro irrigation system fitted for Guava cultivation in Banaskantha, Gujarat



Micro irrigation system fitted for Arhar cultivation in Chittoor, AP

Micro irrigation system underground in Banaskantha, Gujarat

Discussion with farmers in Visakhapatnam , Andhra Pradesh

Plate 5: Showing the micro irrigation system intalled in farmers field visited by the research team

Micro irrigation system fitted in sugarcane cultivation in Chittoor, AP

Water storage tank for feeding to micro irrigation system in Abohar Punjabam , Andhra Pradesh

Farm pond constructed for storing water for Micro irrigation system in Abohar , Punjab

Micro irrigation system fitted in cotton cultivation in Sabarkantha, Gujarat

Farmer showing the water level in open well Gujarat

Fodder cultivation using underground micro irrigation system in Chittoor, AP

Plate 6: Showing the water resouces and fitings of MIS devices in the farmers fields

Micro irrigation system installed after sowing the crop in Punjab

Research team discussing the constraints on MIS with farmers in Banaskantha

Micro irrigation system installed in sugarcane in Chittoor district, AP

Micro irrigation system installed in cotton crop Banaskantha, Gujarat

Micro irrigation system installed in new crop (beans), Gujarat

Beans harvested from the irrigation through MIS, Gujarat

Plate 7: Showing the drip system fitted in sugarcane, beans and cotton

Micro irrigation system installed in maize crop in Chittoor district of AP

Micro irrigation system installed in cucurbit crop in Chittoor district of AP

Micro irrigation system installed in Brinjal crop in Chittoor district of AP

Micro irrigation system installed in Banana crop in Chittoor district of AP

Micro irrigation system installed in horticulture crop in Chittoor district of AP

Micro irrigation system installed in maize crop in Chittoor district of AP

Plates 8: Showing the drip irrigation system installed at farmers field under different crops

Executive summary

The water is one of the important and basic inputs for agriculture production. India is having about 139.5 mha. total irrigation potential and some of the states have already harvested the existing irrigation potential. Recognizing the importance of micro-irrigation, first time Central Government specifically mentioned it in Eighth Five-Year Plan in 1992. The first real thrust however came in 2006, when the government launched a Centrally Sponsored Scheme (CSS) for micro-irrigation. This was later upgraded to the National Mission on Micro- irrigation (NMMI) in 2010 and was implemented till year 2013-14. In the year 2014-15, NMMI was subsumed under the National Mission for Sustainable Agriculture (NMSA) and was implemented under the On Farm Water Management (OFWM) component of the scheme. Subsuming all the schemes of irrigation, *Pradhan Mantri Krishi Sinchayee Yojna* (PMKSY) was launched in 2015 by integrating micro irrigation in the flagship scheme as an integral component. This study examines the experiences in spread and adoption of micro- irrigation in selected four states, namely, Punjab (Unexploited region), Maharashtra, Gujarat and Andhra Pradesh. This study departs from the usual supply side perspective and provides a demand side perspective. It combines and compares the observations across four states of India with varied cropping pattern.

The specific objectives of the study are; to study the administration processes adopted by the states and effectiveness of state implementing agencies; effect of water/ energy pricing on adoption of micro irrigation; effectiveness of various MI technologies for water economy, energy and inputs use and income; estimate the total area covered under MI in selected states and to assess the extent of the use of marginal and otherwise uncultivable lands; estimate the amount of private investment and area covered ; assess the reliability and durability of the system for sustainable development: develop an alternate ecosystem for promotion of micro-irrigation in under exploited but potential states/ regions and identify the major constraints, if any, and suggest remedial measures.

The administrative process of Micro-Irrigation System (MIS) implementation adopted by different states is not uniform. However, the subsidy norms and selection of beneficiaries are practiced following the common guidelines. The MIS implementation model adopted by Andhra Pradesh, Gujarat and Maharashtra states is found to be better in terms of simplification of operational procedure, fairness in subsidy allotment, transparency, farmers' satisfaction and clarity in subsidy disbursement process. Punjab state needs to adopt and refine their implementation process of MIS on lines of Andhra Pradesh Micro Irrigation Project (APMIP) or Gujarat Green Revolution Company (GGRC).However, MIS under solar irrigation project is performing, well in the state. Operational process using ICT is very well utilized by AP, MAH and Gujarat states. Other states can replicate some of these approaches.

The micro irrigation has created the opportunity of employment generation, income improvement, attraction of youths towards agriculture (Chittoor, AP), reduction of out migration of farmers (Hoshiarpur, Punjab).

The teams implementing the micro-irrigation schemes in various states (with an exception of few) drew from different line departments. The frequent transfer of the staffs has hampered the progress of the project especially in Punjab and Maharashtra. Hence, a focused approach by providing separate department needs to be adopted by other states. Andhra Pradesh and Gujarat have opened dedicated separate department/unit exclusively for micro- irrigation implementation. This has resulted in scaling up of area under micro-irrigation in these states. Farmers face major challenges in finding financing for micro-irrigation products and there are high collateral demands. Adequate credit facilities to the farmers, trained human resources and infrastructure for training of farmers were lacking in Punjab. Peoples participation in the micro-irrigation programme was low to medium (PPI=68%). This needs to be improved by involving the stakeholder right from the planning to implementation stage of the scheme.

Micro irrigation is generally perceived as technology intensive; hence, its acceptance by farmers needs much persuasion. There is a lack of information on temporal and spatial variation in soil moisture, the optimal fraction of soil to be wetted, location specific and crop-specific irrigation and fertigation scheduling and lack of availability of low cost water-soluble fertilizers and other agro chemicals even in AP, Maharashtra and Gujarat, where MIS has progressed well. Farmers in Punjab and AP states are allowed to run their water pumps on free and subsidized energy, i.e. electricity and solar sources resulting in over exploitation of ground water due to the fact that method of irrigation mostly used flood. They don't feel the necessity of water saving technologies like MIS.

More than 75% farmers among adopters arewell aware about MIS and its benefits. Though non- adopters are also aware about MIS but the extent of awareness is less than 40%. Most of the adopters were familiar with the process of application filling and approaching the Programme Implementing Agency (PIA). Still efforts from the PIA are needed to create more awareness about the benefits of the MIS, particularly in the state like Punjab. The total coverage of area under MIS for the country as whole is about 10.25 mha which is about 7.6% to net sown area. The coverage of area under drip irrigation was higher in Andhra Pradesh (25.3%) fallowed by Maharashtra (23.6%), Gujarat (13.6%) and Punjab (< 1.17%). On the other hand, option in the case of sprinkler, Gujarat, Maharashtra and Andhra Pradesh have covered more area then in Punjab and other states.

The proportion of farmers who witnessed water scarcity was higher among the adopter category. This implies that depleting water resources is an important driving force behind adoption of MI technology. It is to be noted that in Punjab, nearly 36 per cent of the farmers strongly disagreed for existing water scarcity as they were facing water logging condition in their fields. The water logging existsin South-West part of Punjab. However, in the other selected states, majority of the farmers, particularly adopters feel shortage of water a big problem. The inputs used, number of irrigation, sources of irrigation, cost and net returns of the adopters were higher compared with the non-adopters. The evidence revealed a significant increase in yield and saving of water, energy and fertilizer as compared to the non-adopters. The fertilizer saving varies from 12.89% to 37.51% and similarly chemical used for pest and disease management saved varies from 17.71% to 48.23% (Punjab). However, increase in yield and saving in inputs does not vary uniformly across the crop and states. It was observed that the fund allocation and utilization was encouraging by different states during 2013-2016. Andhra Pradesh contributed nearly 20 per cent of total expenditure under India's micro irrigation total expenditure. However, for other states it was not much, except Gujarat, Maharashtra, and Karnataka. For successful and widespread diversification of agriculture in the state (Punjab, Maharashtra), the installation of Micro irrigation systems should be made an integral part of the programme by providing special assistance in the form of subsidies and interest-free loans.

There is a tendency amongst farmers to get the Micro-irrigation system installed from the unapproved firms without intimating the department. When there are problem with system, farmers blame the department. To avoid such hardship to the farmers, there should be a blanket ban on the unapproved firms in the state. However, AP, Maharashtra and Gujarat states have already taken into account these aspects seriously. The components like water storage tanks, electric motors and pump sets should also be part of the micro irrigation system. Electric connection priority and assured continuous power supply for at least 8 hours a day should be made available. To realize long-term impact of micro-irrigation, there should be a continuous process of monitoring and impact assessment studies.

Chapter 1.0

1.0 Introduction

Agriculture is one of the major contributors of Indian economy and a predominant source of livelihood. The small and marginal farmers (0-2 ha) comprised 86.21% of total farmer in 2015-16 against 84.97% in 2010-11 while their share in the operated area stood 47.34% in the current census as against 44.31% in 2010-11 (Agriculture census, 2015-16). The smaller land holding is accompanied by unequal distribution of water resources endowment and its access. Despite possessing world’s largest irrigated area, irrigation coverage in the country is only 48.2 per cent and thus a significant portion of agriculture land depends on rainfall. The average annual rainfall is about 117 cm, but it has wide spatial variations from 1100 cm in Cherrapunji to 10 cm in western Rajasthan. Further, over 80% of the annual rainfall is received only during four month of the year (June to September) (Rainfall Statistics of India, 2016). Due to rising population and increasing demand by various sectors, per capita water availability has declined from 5,177 m^3 in 1951 to 1,545 m^3. With an annual groundwater draft of 245 BCM, irrigation alone consumes nearly 91 per cent of total draft irrigating 62 % of total irrigated area of the country (CGWB, 2014). So, agriculture bears responsibility of using these scarce natural resources judiciously and efficiently.

Since independence, the Government of India has made huge investments in development of water resources. However, the performance of public funded irrigation projects has been continually declining over the years due to system maintenance issues, inefficient delivery systems, as well as inefficient management at field level. Further, the expansion of irrigated area does not commensurate with the amount of capital invested. Rising cost of cultivation and soil salinity is adversely affecting sustainability of agriculture. Irrigation, which was one of the key factors behind green revolution in India, led to large scale adoption of pumping technology at farmer field (T. Saha, 2009, 2011). The number of bore wells increased from less than one million in the 1960s to 20 million by 2009 (Dewandel *et al.*, 2010). Further government intervention to support farming community as free or subsidized power supply for irrigation has accelerated groundwater extraction, resulted in its over-exploitation in few parts of country. At same time, groundwater irrigation has emerged as a dominant source of irrigation due to its higher efficiency and reliability as compared to canal irrigation. At present, groundwater development of India is 62 % but states like Punjab, Haryana and Rajasthan it went up to 150 % (CGWB, 2016). The latest reports from the GRACE Mission of NASA (Rodell *et al.*, 2009, Samir Yacoubi; 2012) showed continuous groundwater decline 17.7645 BCM/year over the Indian states of Rajasthan, Punjab, Haryana and Delhi. Such high rates of groundwater exploitation have increased the percentage of 'unsafe' districts from 9 % to 30 % in a span of nine years between 1995 and 2004 (Shankar et.al, 2011). At present, almost all the easily possible ways for viable irrigation potential have already been tapped. However, the water demand for different sectors has been growing continuously (Saleth 1996; Vaidyanathan 1999) and demand management becomes the overall key strategy for managing scarce water resources (Molden et al 2001, Kumar 2008). In this context, water saving technologies like micro irrigation has emerged as a suitable demand management measure to address the water scarcity issues. Therefore, up-scaling water use efficiency in agriculture has become key issue for policy makers.

1.1 Government initiatives for micro irrigation system development

Recognizing the importance of micro irrigation, first time central government specifically mentioned it in eighth five-year plan in 1992. The first real thrust however came in 2006, when the government launched a Centrally Sponsored Scheme (CSS) for micro irrigation. This was later upgraded to the National Mission on Micro Irrigation (NMMI) in 2010 and was implemented until year 2013-14. In the year 2014-15, NMMI was subsumed under the National Mission for Sustainable Agriculture (NMSA) and was implemented under the On Farm Water Management (OFWM) component of the scheme. Subsuming all the schemes of irrigation, *Pradhan Mantri Krishi Sinchayee Yojna* (PMKSY) was launched in 2015, integrating micro irrigation as an integral component. PMKSY main focus is to achieve convergence of investments in irrigation sector at field level in order to provide end-to-end solutions in irrigation supply chain, viz. water sources, distribution network and farm level applications. This programme includes creating infrastructure to bring water to farms and watershed development. Therefore, the micro irrigation presents a quick-win opportunity for all the stakeholders where the implementation can be seen on ground within short period. The timeline of intervention to accelerate micro irrigation is presented in figure 1. All these programmes and schemes have been initiated by the government with specific objectives to improve the water use efficiency and water productivity by raising more crop per drop of water.

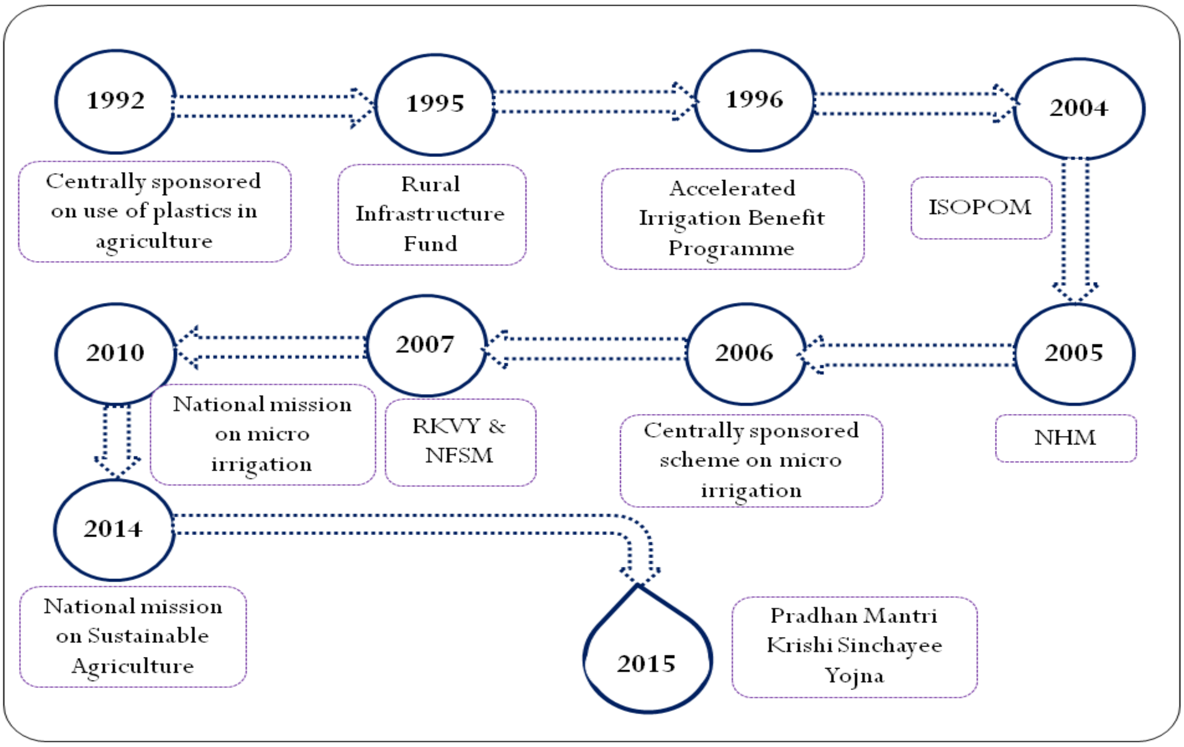


Figure 1: Journey of micro irrigation development in India

The guidelines issued for implementation of MIS, emphasizes on need to bring maximum area under micro irrigation. To accomplish the intended objectives of the government on MIS, different states follow different policies while implementing it. However, central guidelines are common. There is wide variation in the approach adopted by different states for implementation of the MIS. At present, total area under micro irrigation is 10. 3 million ha contributed by 4.8 million ha under drip and 5.5 million ha under sprinkler irrigation (Agri. Stat, 2018, DACNET).

With this prelude, this study has been taken up with following Objectives:

1.2 Terms of reference/ Objectives

1. To study the administration processes practices adopted by the state and effectiveness of state implementing agencies.
2. Effect of water/ energy pricing on adoption of micro irrigation.
3. To find out the effectiveness of various MI technologies for water economy, energy and input economy, savings, employment and income.
4. To estimate the total area covered under MI in selected states and to assess the extent of the use of marginal and otherwise uncultivable lands.
5. To estimate the amount of private investment and area covered by them and developing database.

6. To assess the reliability and durability of the system for sustainable development.
7. To develop an alternate eco system for promotion of micro irrigation in under exploited but potential states/ regions.
8. To identify the major constraints, if any and suggest remedial measure.

1.3 Rationale of the study on micro irrigation: The answer to emergence of groundwater scarcity and continuous groundwater depletion across states is twofold- supply and demand management of water. Since agriculture sector alone consume nearly 80% the total water in India, it would be central to reducing the aggregate demand for water to match with the available future supplies, thereby reducing the extent of water stress that the country is likely to face (Kumar, 2003). Measures to increase water supply such as completion of storage dams, interlinking of rivers, desalination of seawater and artificial recharge of groundwater and rainwater harvesting are costly and long-term steps. A number of demand management strategies like water pricing, water users association; turnover system, etc. have been introduced since the late-1970s to increase the water-use efficiency. Demand management becomes the key to the overall strategy for managing scarce water resources (Molden *et al.* 2001). Drip Irrigation is one of the most efficient methods of irrigation (Keller and Blisner, 1990). There are two lines of thought regarding the water-saving potential of micro irrigation technologies. The first line of argument is that the adoption of micro irrigation technologies results in net water savings, thereby easing the prevailing water-scarcity problems. The water saving is attained through substantial reduction in losses due to evaporation and inefficient field conveyance and distribution systems. This is the declared motive for the state governments of India to embark on the massive popularization of these technologies. However, the farmers' rationale for adopting these technologies may be different from the policy objectives of the state governments. Farmers may give more weight to the other attributes of micro irrigation technologies such as improvements in yield, reduction in labor requirement, improvement in output quality, etc. in their adoption decisions. The second line of thought is that even though micro irrigation technologies can result in water savings at the plot or field level, it may not translate into net water savings at a higher level of aggregation such as the watershed or the basin (Molden *et al*. 2001, Naryanmoorti *et al*. 1997). According to this line of thought, the net water savings could be only modest if the phenomenon of return flows, much of which goes to recharge the underground water source, is considered as useful. Thus the adoption of micro irrigation technologies may not automatically lead to water savings at the basin level unless enabling institutional and economic policy instruments are put in place that allow the equitable distribution or allocation of the saved water. Thus, to understand that micro irrigation system really save water, energy, enhanced income and employment opportunities are still debatable issue and put strains of risks on the farming community. To address the issues like administrative process adoptee, institutions involved benefits of micro irrigation and constraints in adoption micro irrigation, this study was planned and findings are reported in subsequent section of this report.

Chapter 2.0

2.1 Evidences from the literature: The survey of literature on the impacts of micro irrigation technologies indicate that they are usually promoted primarily for one or more of the following objectives (1) as a means of saving water in irrigated agriculture and averting the impending water crises (Narayanamoorthy, 2003 & Verma, 2004), (2) as a strategy to increase income and reduce poverty among the rural poor, (3) to enhance the food and nutritional security of rural households (Upadhyay, 2003 & 2004) and (4) as a means to extend the limited available water over a larger cropped area, especially during drought years or during the period before a monsoon season. Micro irrigation technologies lead to poverty reduction through substantial increases in farm income due to an increased area of cultivation, better crop yields, enhanced output quality, early crop maturity and hence higher unit prices, and reduced cultivation costs, particularly for operations like irrigation and weeding. Micro irrigation technologies enhance nutritional security by enabling the production and consumption of vegetables, particularly leafy vegetables, which are usually missing in the traditional staple diets of many cultures. Various studies in India have shown a considerable return to farmers' investments in micro irrigation technologies (Dhawan 2002).

Demand management mechanism such as micro irrigation (drip and sprinkler irrigation) shows superiority over other traditional irrigation methods in term of water use efficiency, energy saving, yield increase etc. (Kumar and Palanisami, 2010). The result of high crop yield and water use efficiency in sprinkler irrigation is partly because sprinkler irrigation can produce a favorable microclimate for crop growth (Yang et al, 2000).

Under drip irrigation, cost reduction is generally realized more in labour intensive operations like ploughing, weeding, irrigation, etc. (Narayanamoorthy, 2005). The environmental problems associated with surface method of irrigation like the one water logging and salinity are effectively solved under drip method of irrigation (Narayanamoorthy, 1997). Drip method helps in achieving saving in irrigation water, increased water-use efficiency, decreased tillage requirement, higher quality products, increased crop yields and higher fertilizer-use efficiency (Qureshi *et al.*, 2001; Namara *et al.*, 2005). Evidences show that the water-use efficiency increases up to 100 per cent in a properly designed and managed drip irrigation system (Sivanappan, 1994). Only a few states like Andhra Pradesh, Maharashtra and Tamil Nadu have adopted significant areas under micro-irrigation.

The poor adoption is attributed to a number of factors, such as, high cost, complexity of the technology and other socio-economic issues, such as, lack of credit access, fragmented land holdings, localized crop pattern, etc. Further, faulty design of irrigation system is another important factor forcing poor adoption of micro-irrigation, especially among the small and marginal farmers. The farmers adopted drip irrigation due to enhanced marginal productivity of water, savings in water use and the net returns per unit volume of groundwater (Chandrakanth et al., 2013). Failure of irrigation well in context of groundwater depletion, the probability of drilling additional well was as high as 0.87 due to high probability of well failure of 0.40 in Kolar and Bangalore district of Karnataka. This further exacerbated negative reciprocal externality, as farmers are involved in both causing and withstanding the worst of groundwater overdraft (Chandrakanth and Arun, 1997).

Bahinipati and Viswanathan (2016) examined the Role of Institutions and Policies in Diffusion of Micro-irrigation in Gujarat, Western India and results revealed that the promotion of micro irrigation in Gujarat corresponds with the national mission on micro irrigation, an unequivocal dynamism was observed in the expansion of this in the state as compared to the other states. This dynamism can be attributed to the specific policies and institutional innovations that the state had vigorously adopted and followed in terms of provision of differential subsidies targeted towards the farmers segregated by their socio-economic status as well as the physical and economic water scarcity of the agro-ecological regions.

A study conducted by Kiruthika (2014) has examined the determinants of adoption of drip irrigation in sugarcane cultivation in Tamil Nadu, the results showed that age and experience negatively and significantly influence the adoption of drip irrigation in sugarcane. Since younger farmers are more likely to be risk takers and hence perhaps more likely to be adopters than older farmers. Access to extension service positively and significantly influences the adoption of drip irrigation in sugarcane. Palanisami et al. (2011) studied the spread and economics of micro-irrigation in India: evidence from nine states and found that the poor adoption can be attributed to number of factors such as high cost, complexity of the technology and other socio-economic issues such as a lack of access to credit facilities, fragmented landholdings, localized crop pattern, etc. Reducing the capital cost and increasing technical expertise will help the spread of the micro irrigation in a bigger way. There is a need to redesign low cost drip and micro irrigation systems to suit the needs of the small and marginal farmers. There is a large time lag between the decision taken about the subsidy and actual implementation.

Reddy *et al.* (2017) examined the performance evaluation of drip irrigation systems in selected villages of Guntur district, Andhra Pradesh and study revealed that many of the farmers have been benefited by the use of water saving through drip irrigation and cultivation of land holdings was increased about 55-60%. The drip irrigation system has reduced the different operational costs by 25-40% such as (weeding, quantity of fertilizer application, manpower for irrigation and fertilizer application). A strategy paper on future prospects of micro irrigation in India (2016) revealed that in accelerating growth of Indian agriculture, micro irrigation an efficient solution with the need to increase productivity and suggested that while saving water, micro irrigation will play a key role for the future of Indian agriculture. Baranchuluun *et al.* 2015 examined the cost-benefit analysis of crop production with various irrigation systems in Mongolia and found that drip irrigation is water and labor saving alternative to conventional irrigation strategies. Further, cost benefit analysis of drip irrigation is the most efficient method not only reduce costs, but also to protect the environment as well. Benefit – Cost Ratio (BCR) clearly indicates that furrow irrigation has the lowest efficiency.

Bhaskar *et al.* (2005) examined the impact of micro irrigation on cotton crop in Maharashtra, India. Results revealed that yield improvement due to micro irrigation has been reported up to 35-50%, in cotton 5-10%, in castor 15-42%, in groundnut 20-66% and in potato 20-26%. The yield improvement in principal crops is to the tune of 30-105%. Biswas *et al*. (2015) studied the effect of drip irrigation and mulching on yield, water-use efficiency and economics of tomato in Gazipur, Bangladesh and the result revealed that yield of tomato increased with the increasing amount of irrigation water in un-mulched treatment. The trend was reversed when drip irrigation was coupled with mulches. The highest yield for each mulch (81.12 t/ha for polyethylene and 79.49 t/ha for straw) was obtained when 50% of water requirement was applied. The highest water use efficiency of 592 kg/ha/mm was obtained with 50% water application under polyethylene mulch. The highest net return (US$ 7098/ha), incremental net return (US$ 1556/ha), and incremental benefit-cost ratio (7.03) were found for 50% water application with straw mulch. Irfan *et al.* (2014) studied the impact of irrigation management practices and water quality on maize production and water use efficiency and results shows that for good quality water, the drip irrigation system produced 19% more crop production over raised-bed irrigation system. Similarly, for marginal and hazardous water crop yield was increased by 23, 25%, respectively. Hence, drip irrigation system was more efficient for saline water. It was recommended that drip irrigation could be adopted where groundwater quality is marginal to hazardous quality to get high crop production and water use efficiency.

Jha *et al* (2016) examined the impact of irrigation method on water use efficiency and productivity of fodder crops in Nepal. Results revealed that the controlled application of water through drip irrigation is able to produce acceptable yields of nutritionally dense fodder species during dry seasons, leading to more effective utilization and resource conservation of available land, fertilizer and water. The ability to grow fodder crops year-round in lowland and hill regions of Nepal with limited water storages using low-cost, water-efficient drip irrigation may greatly increase livestock productivity and, hence, the economic security of smallholder farmers. Qureshi *et al.* (2015) studied the effect of drip and furrow irrigation systems on sunflower yield and water use efficiency in dry area of Pakistan. Comparison of results under drip and furrow irrigation methods revealed that drip irrigation produced 26 percent more sunflower yield with 56 percent less water compared to furrow irrigation method. Water use efficiency of drip irrigation was about three times higher than furrow irrigation method. While water saving due to adoption of drip irrigation was found in the range of 12-84 percent in different crops, the same is found to be in the range of 8-60 percent in sprinkler irrigation method. Water saving is found to be relatively higher among the water-intensive crops like sugarcane, banana and vegetable crops.

Kumar *et al.* (2016) studied the effect of drip irrigation on yield and water use efficiency on brinjal in Moradabad (U.P.). Results showed that water use efficiency (yield per unit area per unit depth of water used) decreased with increase in irrigation levels for all the treatments of drip irrigation system. The increase in water use efficiency for drip irrigation system, Among the drip irrigation levels, the highest field water use efficiency (6148.31kg ha- 1 cm-1) was found at 65% irrigation level, indicating comparatively more efficient use of irrigation water with a possibility of water saving of 35% water by adopting brinjal plot (1.58 liter plant^{-1}day^{-1}). Namara *et al* (2005) studied the adoption and impacts of micro-irrigation technologies empirical results from selected localities of Maharashtra and Gujarat states of India. The study indicates that the use of micro irrigation technologies increases the marginal productivity of water. Study on potential for drip and sprinkler irrigation in India conducted by Narayanamoorthy in 2006 and found that micro-irrigation (MI) is proved an efficient method where water use efficiency is only about 35-40 percent. Paul *et al.* (2013) studied the effect of drip and surface irrigation on yield, water use- efficiency and economics of capsicum in Bhubaneswar. As a result, the use of drip irrigation system either alone or in combination with mulching, could increase the capsicum yield up to an extent of 57 % over surface irrigation method with the same quantity of water. The net profit could be increased by 54 % over the normal surface method by adopting drip irrigation system with mulch.

Wrachienb *et al.* (2014) studied the potential of micro-irrigation technology for poor-rural communities in Maharashtra, India and found that with refer to the existing traditional irrigation systems, the implemented MIS has shown a mean increasing in productivity for banana, grapes and sugarcane by 29%, 19% and 23%, respectively. Also, with respect to the flood method irrigation MIS has permitted to save the 37% of water and the lower energy expended and the reduced labor required by a MIS has a direct effect on the overall cost of production and therefore the profit level is found to be higher than that of non- MIS adopters.

Bhamoriya and Mathew (2014) analyzed the impact of micro irrigation technology in Gujarat state of India. Study revealed that farmers have managed to increase the yield of vegetables like tomatoes and bottle guards by up to 20 – 30% on the same land. In addition, the quality of produce with drip irrigation is much better than with flood irrigation there are no mud or water spots on the fruit as is usually the case with flood irrigation. Farmers are able to get up to 20% higher prices for their yield with drip irrigation. Chandrakanth *et al.* (2013) examine the economic benefits from micro irrigation for dry land crops in Karnataka. Results shows that by adopting drip irrigation the net returns per farm increased from 15,292 to 25,203 and the marginal productivity of water increased from 465 to 1960. Chandran & Surendran (2016) studied the factors influencing the adoption of drip irrigation by farmers in humid tropical Kerala, India and results indicated that socioeconomic characteristics such as age, education, experience, land holding size, etc. have a positive influence on drip irrigation adoption index on farmers. Farmers have realized yield improvement in the range of about 13% to 47% through drip irrigation, when compared to surface method of irrigation for arecanut, coconut and nutmeg.

Panigrahi *et al.* (2010) examined the water use and yield response of tomato as influenced by drip and furrow irrigation in Odisha state of India. The study reveals that drip irrigation at 100% ET, replenishment in tomato can increase the yield by 15.4%, besides saving 17.9% more costly irrigation water than the conventional furrow irrigation practiced by most of the farmers. Priyan and Panchal (2017) examined the benefits of micro-irrigation technology in India and found that due to adoption of micro-irrigation technology yield is increased, water use efficiency is improved, cost of water, fertilizers and manures and weed removal is reduced. All these added up in the increase in the overall economic benefits accrued due optimum utilization of water. Since the technology offers higher benefits like irrigation efficiency (50-90%), fertilizer (28.5%) and energy (30.5%), this technology is highly relevant and praise worthy.

Quevenco (2015) examined the effect of drip irrigation on yield of cauliflower, broccoli, sweet pepper and many other nutritious vegetables in Kenya, and found that the development of a low-cost, small-scale drip irrigation system that generated 2.8 times the yield of field grown tomatoes while using only 45% of the water traditionally applied by hand. The use of drip irrigation provided a tea yield four times higher than that of the rain-fed, non-irrigated tea. Tiwari *et al.* (2014) examined the influence of drip irrigation and plastic mulch on yield of Sapota and soil nutrients in Kharagpur India. The biometric observations of Sapota plants showed positive influence of the irrigation and plastic mulch treatments on growth of Sapota crop. Due to mulch alone, the increase in Sapota yield varied from 7.62% to 41% in different treatments. Yield of Sapota crop was increased by 21.05% due to drip in comparison to ring basin irrigation. Narayanamoorthy (2008) examined the Drip Irrigation and Rainfed Crop Cultivation Nexus in Maharashtra state of India. Results revealed that withdrawal of water under DIM also helps to reduce the consumption of electricity to the tune of about 140 Kwh/acre over the conventional irrigation method. Suresh Kumar & Palanisami (2010), The analysis of economics of crop cultivation under drip and conventional has revealed that the drip method of irrigation has a significant impact on resources saving, cost of cultivation, yield of crops and farm profitability.

2.2 Meta-analysis of previous studies: The effectiveness of various MI technologies for water economy, energy and input economy, employment and income has been studied through both literature review and analysis of primary survey. Table 1 provides a glimpse of benefits of micro-irrigation as reported by researchers in the past. Most of the studies reveal a significant saving in water, energy, fertilizer, increase of yield, crop area and overall reduction in cost of production due to adoption of micro irrigation. However, the extent of benefits varies depending upon underlying factors such as differences in methodology, farming system, climatic conditions, socio-economic settings, etc. The observations of the National Committee on Plasticulture Applications in Horticulture (NCPAH) observed based on their experiment studies that various crops reflect various input saving through micro irrigation i.e. drip and sprinkler. The following table shows the findings of different research studies conducted in India and abroad mostly at experimental research stations. There is limited study on field survey basis.

Table 1: Meta Analysis of micro irrigation studies reported by various researchers

Studies	**Study Area/ region**	**Water saving** (%)	**Energy saving** (%)	**Fertilizer saving** (%)	**Yield increased/ Income** (%)	**Additional area under irrigation** (%)	**Cost saving** (%)
Rahul Kapur *et al*. 2015	Maharashtra	50-90	30.5	28.5	42.4-52.7	31.9	30-45 & 30.4
National Mission on Micro MIS, Impact study for the Govt. of India, June 2014	India	22.96 - 42.73			19.37-73.48	32.6-68.02	
Raina *et al*, 2011		30-35					41.37
Narayanamoorthi, 2008, 2006	Maharashtra, India	12-84 & 8-60			114		50
Reddy *et al.*, 2017	Guntur District, AP					55-60	25-40
Wrachienb *et al*, 2014	Maharashtra	37			19-29		
Qureshi *et al*, 2015	Pakistan	56			26		
Paul *et al*, 2013	Bhubaneswar, Odisha				57	54	
Biswas *et al*, 2015	Gazipur, Bangladesh	50			25-27		
Kumar *et al*, 2016	Moradabad, Uttar Pradesh	35					
Bhaskar *et al*, 2005	Maharashtra	40-50			30-100		
Quevenco, 2015	Kenya	55			99		
Tiwari *et al*, 2014	Kharagpur, India				21.05		
Chandrakanth *et al*, 2013	Karnataka				65		
Priyan and Panchal, 2017	India	50-90	30.5	28.5			
Panigrahi *et al*, 2010	Odisha				15.4		17.9
Chandran and Surendran, 2016	Kerala				13-47		
Bhamoriya and Mathew, 2014	Gujarat			20	20-30		
Global Agri. System and their Impact Evaluation Study, 2014	India	20-40	25-35	40-50	20-25		
National committee on plasticulture application in horticulture,(https://www.ncpahindia.com)	India	25-40	30-40	20	30	30	40
Sharda R et.al, 2017	Punjab	40-42			9.13		
Govind, R etal. 2012 Vanitha and Mohandass,2014	Tamil Nadu	50		100	19.05		
Rao, KVR.,2017	MP		40		11.03		
AICRP-IWM 2016	MP	33			10		
Xinjang	China	60			10-12		
Westcott etal. 1986	USA	30-40			25		
Chand.S, 2019	India	17-50	6-36	25-40	12-43		11-36

Authors have collected from the literature

Chapter 3.0

DATA AND METHODOLOGY

3.1 Approach followed for this study: We have adopted the following steps to fulfill stated objectives for this study

1. Intensive review of previous research, government reports, documents, policies and programs for micro irrigation.
2. Collection of available secondary data.
3. Priming sampling framework to conduct study in four states.
4. Development of questionnaires and pretesting of questionnaires for primary data collection.
5. Training to the project staff for field survey.
6. Continuous contact and consultations with the various concern agencies and the stakeholder involved.
7. Field survey of adopter and non-adopter based on sampling framework in the selected areas.
8. Interaction, focus group discussion and interview with farmers, policy makers, planners, bureaucrats, development workers, and agencies involved for micro irrigation system.
9. Analysis of secondary and primary data using appropriate econometric tools.

3.2 Selection of study area and sampling design: Purposively four states namely Punjab, Andhra Pradesh, Gujarat, and Maharashtra have been selected for study. Stratified random sampling technique has been followed for selection of respondents. Based on the secondary data all districts of stated states were arranged in increasing order of area under micro irrigation system (MIS). From each state, one district with maximum and one district with minimum area under MIS was selected for primary survey. Further two blocks from each district were selected randomly. Selection of villages and respondent were done randomly. A sample was drawn consisting of equal number of micro irrigation adopter and non-adopter from each state have targeted for intensive survey using pre-tested schedule. Based on sampling design, intensive survey of 183, 204, 220 and 220 respondents was conducted in Punjab, Andhra Pradesh, Gujarat and Maharashtra respectively. Total sample of 827 respondents collected and it is comprised of almost equal number of adopter and non-adopter. Location of selected of districts in preselected states have been given in figure 2 and sampling framework have been given in table 2.

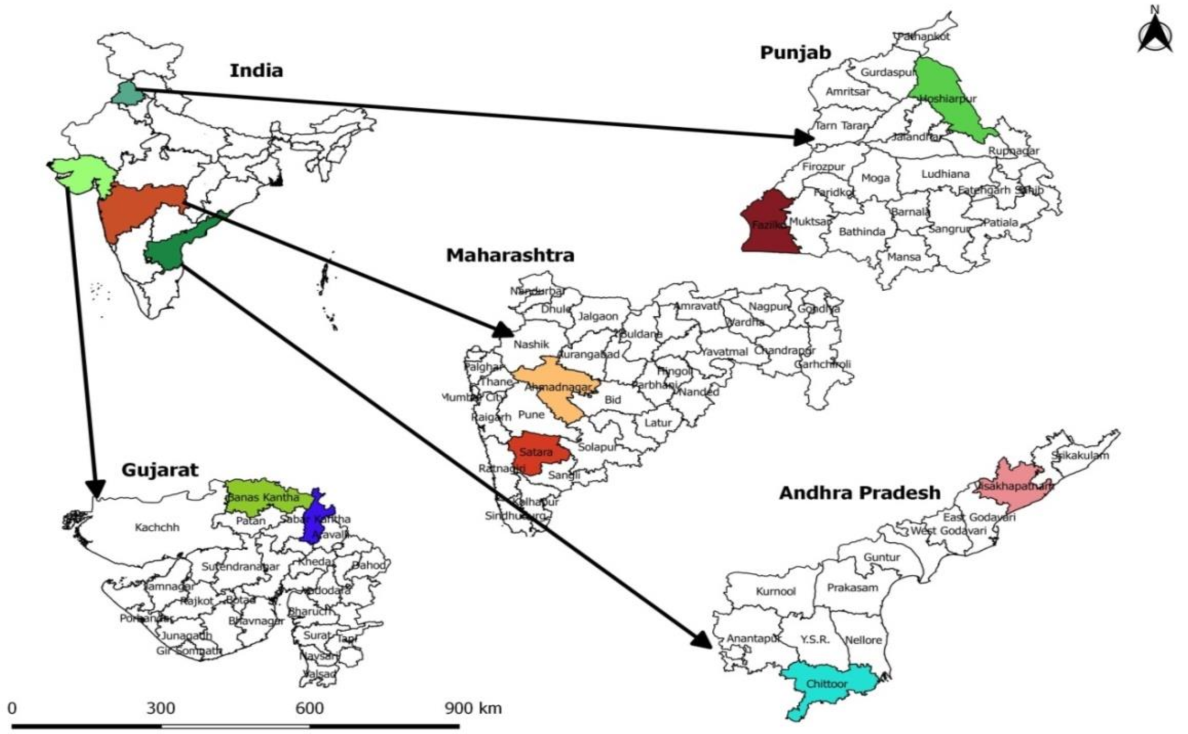


Figure 2: Showing the location of the study area

Table 2: Sampling design of states and respondents covered under the study

Name of state	District	Name of blocks	Adopter			Non adopter	Total
			Sprinkler	Drip	Total		
Punjab	Fazilka	Abohar, Khuian Sarvar	-	37	37	61	98
	Hoshiarpur	Talwara, Hajipur	20	34	54	31	85
	Total		20	71	91	92	183
Andhra Pradesh	Visakha-patnam	Atchutapuram, Rambilli	5	58	63	61	124
	Chittoor	Pileru, Punganur	10	30	40	40	80
	Total		15	88	103	101	204
Gujarat	Banaskantha	Deesa, Palanpur	21	34	55	55	110
	Sabarkantha	Idar, Khedbrahma	20	35	55	55	110
	Total		41	69	110	110	220
Maharashtra	Ahmednagar	Rahuri, Sangamner	30	25	55	55	110
	Satara	Karad, Phaltan	4	46	50	60	110
	Total		34	71	105	115	220
Grand total			148	261	409	418	827

3.3 Data and methodology: Primary and secondary data have been collected for the study. The primary information was collected through personal interview method on pre-tested questionnaire (Annexure IX). Primary data includes socio economic profile of adopter and non-adopters, crop grown, source of irrigation, year of MIS installation, cost structure, farmers perception on MIS use, operational procedure followed by the beneficiaries, cost of crop cultivation with and without MIS, source of information for micro irrigation etc.

The secondary information were collected from the line departments of selected states regarding the extent of area under MIS, operational procedure adopted by the concern department involved in its implementation, cost and subsidy norms, selected beneficiaries, irrigation source etc.

Based on data collected following method has been used for analysis.

1. Cost of cultivation concept
2. Logit model
3. Location coefficient
4. Peoples participation Index
5. Likert Scaling

3.4.1 Cost of cultivation and imputed value of inputs: The standard procedure on cost of cultivation was adopted to work out total cost, gross return and net return. The value of purchased input was taken into account as reported by the cultivators. Some of the inputs used in the production process come from family sources. The procedures adopted for deriving imputed value of these inputs are as under:

1. The value of family labor was worked out at the wage rate prevailing for different agricultural operations in the selected villages.
2. Owned bullock labor was valued at the prevailing market rate in that area. The cost of tractor charges was considered at the market rate.
3. The value of farm produced manure and seeds were computed as the rates prevailing in concerned villages.
4. The costs of irrigation and owned machinery charges were considered at the market rate custom service. In drip, the cost of irrigation was worked out considering total hours of irrigation run during the total period of crop.
5. The kind payments were evaluated at prices prevalent in the village at the time of that operation done.
6. Interest on working capital was charged at the rate of 12 per cent per annum, according to duration of the crops.

7. Depreciation of owned fixed capital was charged at the rate of 2 per cent for *pakka* and 5 per cent for *kachcha* buildings per annum for the period of crop. While it was worked out 10 per cent of drip installation cost.
8. Repair and maintenance cost of drip system was considered as opined by respondents.

3.4.2 Logit model: The logit model uses a logistic cumulative distribution function to estimate the linear determinants of the logit (Li) or the logged odds and has the following form:

$$Li(Y) = ln\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_k X \qquad \text{….. Eq.1}$$

Where, (Pi /1- Pi) is the odds expressing the conditional mean or probability of an occurrence of the event relative to the likelihood of a non-occurrence given X; β_0 is the constant term or intercept, β_k is a vector of regression coefficients to be estimated and X is a set of independent variables determining the probability of the event. The model in terms of Y would then be written as:

$$Y_i = \alpha + \sum_{k=1}^{K} \beta_k X_k + \varepsilon \qquad \text{…. Eq.2}$$

Where Yi is a binary dependent variable; and Yi equals 1 when a farm household adopted micro-irrigation system and 0 otherwise, α is the constant term and β_k are regression coefficients of k independent variables to be estimated and ε is the error term. The important thing is to find β that produces the logits and the conditional mean of Y given X values that have the greatest likelihood of producing the observed data.

Empirical model specification

The logit model of adoption of micro irrigation (Yi) has been specified as a function of all independent variables as follows:

$$Y_i = f(X_i) + u \qquad \text{… Eq.3}$$

Where, dependent variable is Adoption of micro irrigation and independent variables are age (years), family size (number), working labour (number), schooling (years), mobile use (years), caste (Gen+OBC=1 Otherwise=0), soil health card (Yes=1 No=0), income from food grain (Rs.), income from horticulture (Rs.), total expenditure per month (Rs.), crop insurance (Yes=1 No=0), water table depth (in feet), tube well owenership (Yes=1 No=0), Source of energy to extract water, irrigated area (ha), rain-fed area (ha).

3.4.3 Estimation of location coefficients for different states: Location coefficient has been calculated to see concentration of micro irrigation area in different states. This has been targeted to analyse the development pattern and regional disparity of micro irrigation as all states are growing at different rate. The location coefficient is calculated as:

$$L = \frac{\mathrm{Mj/M}}{\mathrm{Gj/G}} \qquad \text{… Eq.4}$$

Where,

Mj = area under Micro-irrigation in the jth state

M = area under Micro irrigation at the national level

Gj = area under groundwater-based minor irrigation in the jth state

G = area under groundwater-based minor irrigation at the national level.

The higher the value of coefficient depicts the higher concentration of micro-irrigation. The location coefficient was constructed using the area under MI and the area under minor irrigation.

3.4.4 People's Participation Index (PPI): The people's participation index was worked out for different stages of implementation of micro irrigation scheme. It is based on data collected from the MIS adopter on different aspects viz.; selection of site, selection of crop, selection of installing firm, selection of credit agency and contacts made to officials. The entire data set was compiled under planning, implementation and maintenance categories. The statistical tool i.e. mean score, standard deviation were computed and accordingly PPI values were arrived.

$$PPI = \sum_{ij}^{n}\left(\frac{x_{ij}}{X_{IJ}} * \frac{n}{N}\right)100 \qquad \text{…. Eq. 5}$$

Where,

x_{ij}= Score assigned by the ith farmer to the jth question at planning, implementation and maintenance of MIS

X_{IJ}= Maximum attainable score of Ith farmers to the Jth questions at planning, implementation and maintenance of MIS

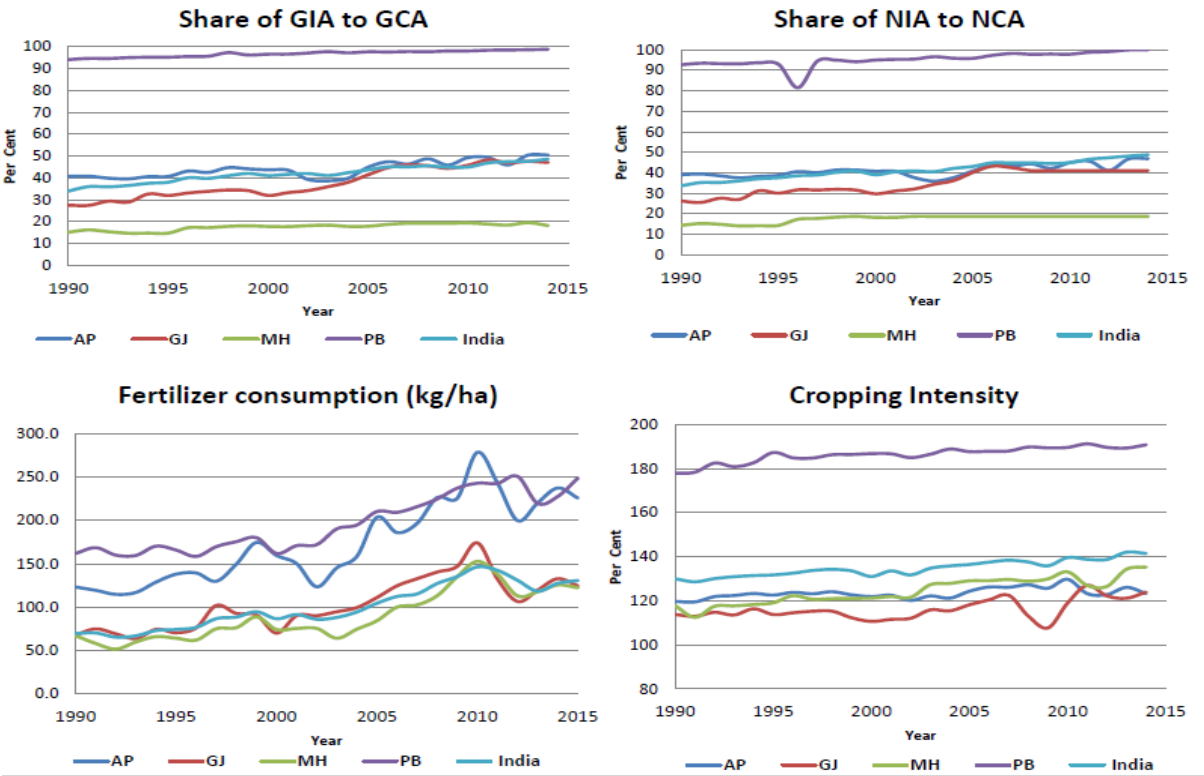
n= Number of question answered by ith farmer

N= Total number of respondents

3.4.5 Likert scale: The response of the farmers was analyzed using Likert scale to draw the logical conclusions regarding impact of micro-irrigation, constraint faced and reason for non-adoption. Data collected were on five point scale for impact of micro irrigation, constraints and reasons of non- adoption used as Not important =1, somewhat not important =2, neutral=3, somewhat important =4 and very important =5 likewise.

3.4 An overview of agriculture and water resources in selected states:

3.4.1 Trend in irrigated areas, fertilizer consumption and cropping intensity: The share of irrigated area (gross and net) in Punjab has been much higher since 1990s in comparison to other selected states. This may be due to the impact of green revolution in which irrigation was considered as one of the essential input and Punjab played significant role. Irrigation development in Maharashtra has been minimal covering just 20 per cent of its agricultural area. Trend of fertilizer consumption of all states have sown similar trend and leading states are Andhra Pradesh and Punjab with fertilizer application of nearly 250 kg/ ha. Analysis of cropping intensity revealed that in Punjab almost two crops is taken in a year. This is possible due to assured irrigation infrastructure irrigating almost total cropped area of the state. Overall agriculture situation of Punjab is much distinct than other selected states fig. 3.



Note: ***AP****- Andhra Pradesh,* ***GJ****-Gujarat,* ***MH****-Maharashtra,* ***PB****-Punjab,* ***GIA****-Gross Irrigated Area,* ***GCA****-Gross Cropped Area,* ***NIA****- Net Irrigated Area,* ***NCA****-Net Cropped Area,*

Fig. 3: Trend in irrigated area, fertilizer consumption and cropping intensity

3.4.2 Temporal changes in cropping pattern: The decadal percent change in area under different crops for the period of 2005-06 to 2015-16 was analyzed for the selected states and it is presented in table 3. Analysis indicates that there was significant difference in cropping pattern across states. Punjab state follow mostly Paddy-wheat cropping pattern and food grain occupy nearly 85 per cent of total gross sown area. In spite of groundwater over exploitation, area under paddy and wheat has increased by 4.09 and 0.52 per cent respectively during the last decade. This could be due to reduction in area under cotton. In Andhra Pradesh, area under oilseeds and maize has decreased significantly but area under fruits & vegetable and pulses have increased since 2005. In Gujarat, significant area has been brought under vegetables whereas area under total oilseed and bajra has significantly reduced. In Maharashtra, area under jowar and bajra has significantly declined in last 10 years but area under sugarcane, soybean and cotton has notable growth.

Table 3: Change in cropping pattern of selected states (2005-06 to 2015-16) (Per cent)

Crops	Punjab	Andhra Pradesh	Gujarat	Maharashtra
Paddy	4.09	-1.11	-0.07	-0.22
Jowar	-0.05	-1.01	-1.29	-7.23
Bajra	-0.05	-0.12	-5.27	-2.94
Maize	-0.28	-2.58	-1.01	2.56
Ragi	0.00	-0.08	-0.07	-0.21
Wheat	0.52	-0.08	-0.62	-0.21
Gram	-0.03	3.30	-0.26	1.72
Arhar (Tur)	-0.06	-0.78	-0.57	0.47
Others pulses	-0.07	3.38	-0.55	-0.46
Total Pulses	-0.16	5.91	-1.38	0.08
Sugarcane	0.08	-0.39	-0.18	2.07
Total Condiments &Spices	-0.02	0.68	1.08	0.00
Total Fruits	-0.17	3.01	-0.36	-0.15
Total Vegetables	0.46	0.61	2.59	1.22
Total Fruits and Vegetable	0.28	3.62	2.23	1.07
Groundnut	-0.02	-3.75	-5.52	-0.63
Sesamum	-0.04	-0.17	-1.89	-0.35
Rapeseed and Mustard	-0.21	-0.02	-1.16	0.00
Soybean	0.00	-0.71	0.50	5.65
Total Oilseeds	-0.43	-8.15	-5.35	1.91
Cotton	-2.83	1.12	4.44	5.48
Total cropped area (th. ha)				
2005-06	7867.52	13362.08	11494.70	22256.00
2015-16	7871.57	7531.59	12579.70	22863.20

Source: Directorate of Economics and Statistics, MoA&FW, GoI.

3.4.3 Status of water stress in selected states: The fig. 5: depicts trend in the ground water table in the selected states. It could be observed that Gujarat and Punjab had high depth of water table followed by Maharashtra and Andhra Pradesh. The data from Central Ground Water Board (CGWB) shows that nearly 70 to 80 per cent of block in Punjab are over exploited, which is much higher in comparison to other states. This may be due to over dependency on groundwater for agricultural production. This has put exploitation of groundwater in Punjab, just opposite to other states considered for study. Therefore, micro irrigation technology is very much essential for such states like Punjab and Andhra Pradesh so that further ground water depletion can be checked.

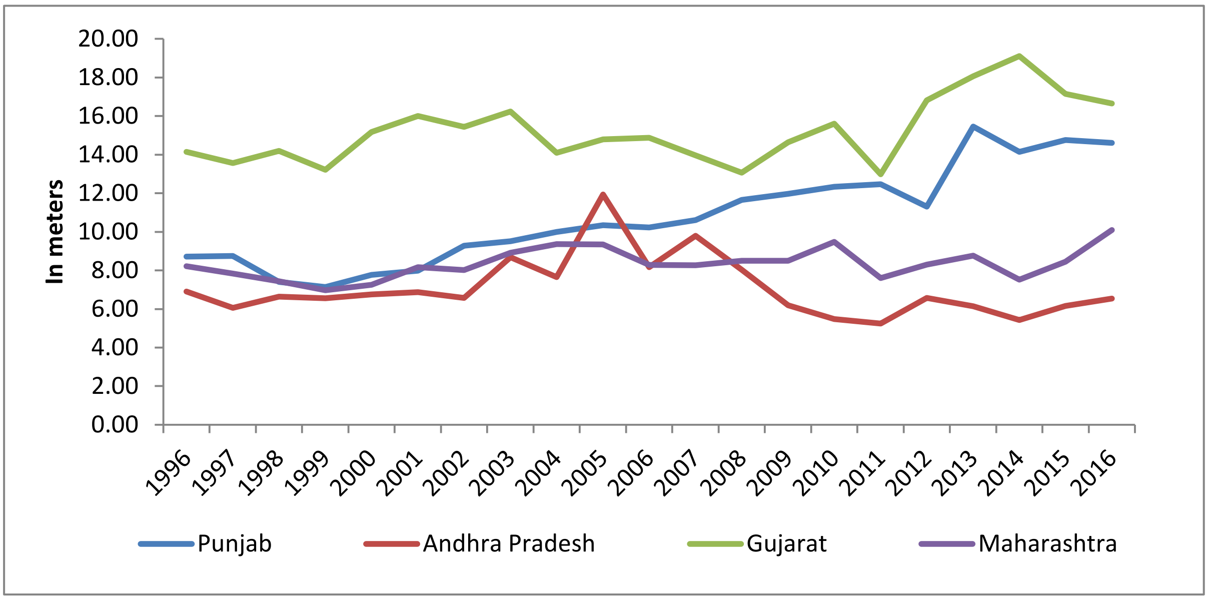


Fig 5: Trend in groundwater table in meters

3.5 Descriptive study of sample households

3.5.1 Socio economic characteristics

The table 4 shows differences in socio economic characteristics of adopters and non-adopters. The application of t test indicates that adopter and non-adopter of MIS had a significant difference in respect to various socio economic parameters. However, not all the parameters considered in analysis were significant but there was certainly a mean difference.

The age of family head does not varies much across the adopters and non-adopter in the selected states and on an average farmers were in the range of 46-54 years of age. The year of schooling was found to be higher with the adopter. This indicates that educated people get convinced faster for adoption of newer technology for the betterment of their farm and environment. The number of agriculture worker available in the family indicates a significant difference between adopter and non-adopter. There is no economic interpretation for this phenomenon but certainly higher availability of agriculture worker in the family help in completing the work in time and they may earn off farm income to support the family. The total income derived from various sources was higher for adopters.

Table 4: Socio economic characteristics of sample households

Particulars	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	A	NA	A	NA	A	NA	A	NA
Age of HH (Years)	51.96	50.57	52.10	54.28	46.40	47.71	47.49	48.14
Education of HH	7.67	7.02	8.64	5.94***	7.30	7.57	10.96	10.19*
Family size (No)	6.57	7.03	6.36	5.49***	5.96	5.08***	5.34	5.72
Agriculture worker in family (No)	2.51	2.19*	2.67	2.46*	3.55	3.24**	2.46	2.96***
Land holding Size (ha)	2.27	2.64	1.19	1.17	3.36	2.03***	1.70	2.17**
irrigated area (ha)	2.25	2.55	1.13	1.04	3.36	1.88***	1.67	2.17**
Income from food grain (Rs. Lakhs)	0.85	2.21***	0.49	0.79**	1.52	1.81**	1.50	1.32
Income from horticulture (Rs. Lakhs)	1.50	0.61**	0.94	0.36***	0.05	0.79***	0.51	0.23*
Income from livestock(Rs. Lakhs)	-	-	0.10	0.05**	0.17	0.47***	0.22	0.29
Income from labour (Rs. Lakhs)	-	-	0.01	0.02	0.22	3.16***	2.08	2.19
0ff-farm income (Rs. Lakhs)	0.83	0.58	0.28	0.35	-	-		-
Total income Lakhs	3.17	3.40	1.82	1.57	3.97	6.24***	4.31	4.03
Food expenditure (Rs.000)	3.69	4.29***	3.81	3.64	3.00	3.03	2.94	3.46**
Non -food expenditure (Rs.000)	3.38	3.86*	3.53	3.89	2.81	2.91	3.48	3.45
Total expenditure per month (Rs.000)	7.07	8.15***	7.33	7.53	5.81	5.94	6.42	6.91**
Loan taken for different purposes (Rs. Lakhs)	2.98	3.82	1.25	0.94**	3.81	2.85	2.98	1.67
Mobile use years	9.16	9.15	7.94	6.72**	11.39	7.45***	6.77	7.25
Member of social org (Yes=1 no=0)	12.23***	-	3.82**	-	18.39***	-	5.60**	-
Crop insurance (Yes=1 no=0)	17.86***		4.42**	-	18.52	-	16.74	-
Total number of observations	91.00	92.00	103.00	101.00	110.00	110.00	105.00	115.00

Note: A-Adopter, NA- Non adopter, HH- Household, **** is significant at 1%,** at 5% and * at 10%*

This may be due to the fact, higher production and reduced cost of cultivation due to MIS adoption. The result also indicated that those farmers who adopted micro irrigation are also member of any social organization in their area. This might have provided them better information and motivation for adoption.

3.5.2 Family size and work force available in sampled household: The collected data were post classified into two categories based on family size and work force (table 5). The findings indicate that on an average family size are nearly five to six people in the family. However, family size was found to be little higher in the case of Punjab for no adopter (7 persons) and for adopter (6.6 persons). The share of male workforce in the composition of family is about 57% to 72% across the different states in adopter family. While in non-adopter it varies from 49% to 78% for male. The remaining work force was available in the form of female. This indicates that male work force dominate in the selected states.

Table 5: Family size distribution of respondents

Particulars	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	A	NA	A	NA	A	NA	A	NA
Family size								
Male	2.45 (37.29)	2.52 (35.80)	2.05 (32.23)	1.95 (35.65)	2.28 (38.32)	1.68 (33.14)	1.83 (34.21)	2.04 (35.29)
Female	2.12 (32.27)	2.23 (31.68)	2.13 (33.49)	1.94 (35.47)	2.03 (34.12)	1.66 (32.74)	1.77 (33.08)	1.78 (30.80)
Children	2 (30.44)	2.29 (32.53)	2.18 (34.28)	1.58 (28.88)	1.64 (27.56)	1.73 (24.12)	1.75 (32.71)	1.96 (33.91)
Average	6.57 (100)	7.04 (100)	6.36 (100)	5.47 (100)	5.95 (100)	5.07 (100)	5.35 (100)	5.78 (100)
Work force available with households								
Male	1.79 (71.60)	1.71 (78.44)	1.60 (60.38)	1.61 (65.71)	2.00 (56.50)	1.58 (48.92)	1.40 (56.68)	1.59 (53.90)
Female	0.71 (28.40)	0.47 (21.56)	1.05 (39.62)	0.84 (34.29)	1.54 (43.50)	1.65 (51.08)	1.07 (43.32)	1.36 (46.10)
Average	2.50 (100)	2.18 (100)	2.65 (100)	2.45 (100)	3.54 (100)	3.23 (100)	2.47 (100)	2.95 (100)

Note: A-Adopter, NA- Non adopter, Figures in parenthesis indicate the percent to total

3.5.3 Classification of respondents based on the age groups: It is very important to know the age composition of the respondents. It is because mature respondents expected to reply correctly based on their rich experience. Therefore, we have analyzed the distribution of respondents based on age. It was observed that about 50% respondents were in age group of 35 to 50 years only about 5% were up to 35 years of age. The rest of the respondents were above 50 years. Thus, our sample comprising of mixed aged respondents and we have used their rich experiences, perception and self-motivating attitude towards adoption of water saving technology for this study (Table 6).

Table 6: Classification of the respondents based on age

Particulars	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	A	NA	A	NA	A	NA	A	NA
Up to 35	5 (5.49)	3 (3.26)	1 (0.97)	4 (3.96)	6 (5.45)	3 (2.73)	5 (4.76)	6 (5.22)
35-50	41 (45.05)	51 (55.43)	50 (48.54)	41 (40.59)	82 (74.55)	80 (72.73)	70 (66.67)	65 (56.52)
>50	45 (49.45)	38 (41.30)	52 (40.49)	56 (55.45)	22 (20.00)	27 (24.55)	30 (28.57)	44 (38.26)
Total	91 (100.00)	92 (100.00)	103 (100.00)	101 (100.00)	110 (100.00)	110 (100.00)	105 (100.00)	115 (100.00)

Note: A-Adopter, NA- Non adopter, Figures in parenthesis indicate the percent to total

3.5.4 Education status of the respondents: The education plays a significant role in adoption of improved, cost effective and modern technology. It was assumed that higher the education level, higher would be the adoption rate. Therefore, we have analyzed the data and classified it on education status of respondents (table 7). It was observed that the literacy status among adopter farmer ranges from 89-98 per cent were literate whereas for non-adopters, it ranges from 75-98 per cent. In case of Maharashtra sampled farmers among adopter and non-adopter categories, share of literate farmers is much higher as compared to other states. In Andhra Pradesh, share of illiterate among non-adopter is as high as 25 %.

Table 7: Classification of the respondents based on education

Particulars	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	A	NA	A	NA	A	NA	A	NA
Illiterate	8 (8.80)	14 (15.22)	11 (10.68)	25 (24.75)	11 (10)	9 (8.18)	2 (1.90)	2 (1.74)
Primary (up to 5th)	21 (23.07)	17 (18.49)	12 (11.65)	27 (26.73)	17 (15.45)	23 (20.91)	4 (3.81)	8 (6.96)
Secondary (5th to 10th)	51 (56.05)	53 (57.60)	47 (45.63)	39 (38.61)	69 (62.73)	59 (53.64)	42 (40.00)	58 (50.43)
College(>10th)	11 (12.08)	8 (8.69)	33 (32.0)	10 (9.90)	13 (11.82)	19 (17.27)	57 (54.29)	47 (40.87)
Total	91 (100)	92 (100)	103 (10)	101 (100)	110 (100)	110 (100)	105 (100)	115 (100)

Note: A-Adopter, NA- Non adopter, Figures in parenthesis indicate the percent to total

Chapter 4.0

RESULTS AND DISCUSSION

Objective 1: To study the administration and operational processes/ practices adopted by the selected states.

4.1 Guidelines at central government level: PMKSY, Mission Directorate has been established in Ministry of Water Resources, River Development and Ganga Rejuvenation for mission mode implementation of 99 major and medium irrigation projects (Table 8). The Mission is responsible for overall coordination and outcome focused monitoring of all components of PMKSY for achieving its target. Micro irrigation is an integral component of the PMKSY (Per Drop More Crop) to amplify water use efficiency at farm level. Micro irrigation is being implemented by Ministry of Agriculture, DAC& FW.

Table 8: Committee involved in Implementation of PMKSY

	Committee	Chairperson and Member	Work
National level	National Steering Committee (NSC)	PM as Chairperson and Union Ministers from concerned ministries and Vice chairman, NITI Aayog as members	To provide general policy strategic directions for programme implementation and overall supervision addressing national priorities etc.
	National Executive Committee (NEC)	Vice Chairman, Niti Aayog as Chairperson and Secretaries of concerned ministries/departments and Chief Secretaries of selected States as members	To oversee programme implementation, allocation of resources, Inter-ministerial coordination, monitoring & performance assessment, addressing administrative issues
State level	State Level Sanctioning Committee (SLSC)	Chief Secretary of the State as Chairperson	To sanction projects and activities as recommended by Inter Departmental Working Group
	Inter Departmental Working Group (IDWG)	Agriculture Production Commissioner/Development Commissioner as Chairperson and Secretaries of line departments as members.	Recommend project and activities to SLSC
District level	District Level Implementation Committee (DLIC)	the Chairmanship of Collector/District Magistrate / CEO of Zila Parishad/ PD DRDA as Chairperson, and JD/DD of line departments and progressive farmers, representative of MI industry, and leading NGO as members	To oversee PMKSY implementation and inter-departmental coordination.

Source: Operational Guidelines of Per Drop More Crop (Micro Irrigation) Component of PMKSY (2017)

District Irrigation Plans (DIP) present holistic irrigation development perspective of the district outlining medium to long term development plans integrating three components viz. water sources, distribution network and water use applications. DIP identifies gaps in available irrigation plan after assessing presently available resources and resources which could be added from ongoing schemes. So, DIP considered as foundation for planning and implementation of all components of PMKSY. All communication between Ministry of

Agriculture (MoA) and State Government would be with and through the nodal department. State Agriculture Department may be the Nodal Department for implementation of PMKSY (Per Drop More Crop) as outcome of PMKSY is to ensure efficient delivery and application of water at every farm enhancing agricultural production & productivity, However, State Govt. is free to identify the nodal department based on the established institutional set up and mandate of the department.

4.1.1 Assistance pattern for micro irrigation:

The unit cost of drip irrigation system varies with plant spacing and location of water resources. Government has provided cost structure for installing micro irrigation with different plant spacing in its guideline. On basis of this subsidy is given to farmers under various categories. Small and marginal beneficiary farmers under micro irrigation receive 55 per cent and other beneficiary farmers receive 45 per cent as subsidy to total cost. Subsidy amount shared by Centre and State Government in the ratio of 60:40 for all states except North Eastern and Himalayan states where ratio is 90:10. Central government grant total fund to the Union Territories (Table 8). Subsidy for installation of micro irrigation system is limited to five hectares per beneficiary in the present scheme.

Based on coverage of micro irrigation states have been classified into following categories:

Category "A" states: States with comparatively better penetration of micro irrigation system. In this category, states are Andhra Pradesh, Delhi, Gujarat, Goa, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu and Telangana. We feel that Punjab should have been put in C category of states since coverage area is very less.

Category B states: States with low penetration of micro irrigation system. States are Bihar, Chhattisgarh, Jharkhand, Odisha, Uttar Pradesh, West Bengal and Union Territories. Cost likely to be high as lesser availability of companies and after sale services. 15% higher unit costs for micro irrigation are considered for these states.

Category C states: states with much low penetration due to poor infrastructure and difficult terrain. These states include North Eastern and hilly region namely**,** Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand. The 25% higher unit costs for micro irrigation are considered for these states. Note: The unit cost for subsidy purpose would be exclusive of any taxes & fiscal levies.

Table 9: Assistance pattern in selected states

<table>
<tr><td colspan="3">**Andhra Pradesh**</td></tr>
<tr><td>Category/Caste</td><td>Subsidy (%) (centre state)</td><td>Subsidy limit (Rs.)</td></tr>
<tr><td>SC/ST farmers under Small and marginal farmers (landholding <2 ha)-drip irrigation</td><td>100(33+67)</td><td>2.00 lakh</td></tr>
<tr><td>Small and marginal farmers other than SC/ST (landholding <2 ha)-drip irrigation</td><td>90(33+57)</td><td>2.00 lakh</td></tr>
<tr><td>Medium farmers of Coastal district (2 ha to 4 ha)-drip irrigation</td><td>70(27+43)</td><td>2.80 lakh</td></tr>
<tr><td>Medium farmers of Rayalaseema & Prakasam districts (2 ha to 4 ha)-drip irrigation</td><td>90(27+63)</td><td>2.00 lakh</td></tr>
<tr><td>Other Farmers-drip irrigation</td><td>50(27+23)</td><td>4.00 lakh</td></tr>
<tr><td>Small and marginal farmers for all categories- sprinkler</td><td>50(33+17)</td><td>-</td></tr>
<tr><td>Others farmers-sprinkler</td><td>50(27+23)</td><td>-</td></tr>
<tr><td colspan="3">**Gujarat**</td></tr>
<tr><td>Category of Farmer</td><td>Non Dark Zone area</td><td>Dark Zone area for 57 talukas</td></tr>
<tr><td>Farmer: (land holding size ≥2 ha)</td><td colspan="2">Upto 70% (27+43) or Rs. 0.7 lakh/ha, whichever is less</td></tr>
<tr><td>Farmer: Small and Marginal farmer (land holding size <2 ha)</td><td>Upto 70% (33+37) or Rs. 0.8 lakh/ ha, whichever is less</td><td>Upto 80% (33+47) or Rs. 0.8 lakh/ ha, whichever is less</td></tr>
<tr><td>SC/ST Farmers</td><td>Upto 85% or Rs. 1 lakh/ha, whichever is less</td><td>Upto 90% or Rs. 1 lakh/ha, whichever is less</td></tr>
<tr><td colspan="3">**Punjab**</td></tr>
<tr><td>SC/ ST farmers</td><td colspan="2">90 per cent</td></tr>
<tr><td>Others farmer</td><td colspan="2">70 per cent</td></tr>
<tr><td colspan="3">**Maharashtra**</td></tr>
<tr><td>Small and marginal farmers</td><td colspan="2">60 per cent</td></tr>
<tr><td>Small and marginal farmers in Vidarbha region</td><td colspan="2">75 per cent</td></tr>
<tr><td>Other farmers</td><td colspan="2">50 per cent</td></tr>
</table>

Source: Different state government departments (APMIP, GGRC, SCMIP, SWC and Agriculture) report/documents 2017-18.

4.1.2 Pre-installation activities: The Implementing Agency identified by the state government advertises schemes at block and village level through its existing networks. At district level, it appoints a nodal officer who is responsible for coordination of the scheme implementation. It disseminates the suppliers list and unit price approved by SLSC to the farmers. At least one district level seminar or workshop is conducted. Implementing agency will compile the application submitted by the farmers and scrutinize and forward the same to the company's/Manufacturer's local offices as indicated by the farmer. The beneficiary share may be deposited with manufacturer/their representative or the state nodal agency as per the practices to be adopted by the state with the approval of SLSC. The beneficiary shall be free to purchase MI equipment from any MI manufacture out of the approved list of registered manufacturers. Manufacturer need to follow certain process indicated in table 10.

Table 10: Process need to be followed by the firms

Manufacturer	**Approval**
	Assessment of the crop water requirement and design the system accordingly.
	Prepare an estimate of cost and submit it to Implementing agency duly indicating the time frame for installation.
	The Implementing agency will approve the estimate, issue work order and ensure installation
	Installation
	Quality components having BIS marking are installed at farmer’s field.
	The installed system should match the water requirement of the crop earlier estimated
	Necessary orientation and training is given to the beneficiary farmers for system maintenance & irrigating the crop.
	Proper warranty and a user’s manual for running & maintenance of the system are provided to farmers.
	A certificate towards successful installation/commissioning of the system is obtained from the beneficiary

The entire data set collected from different line departments of respective state on micro irrigation on operational and administrative procedure was compiled and analyzed to draw the logical conclusions. The observations are presented in subsequent sections.

4.2 Guidelines on micro irrigation at state government level

4.2.1 Operational procedure adopted by Punjab: Drip and sprinkler irrigation system was introduced in the state in the year 1992-93 under centrally sponsored scheme. In the State of Punjab, Soil and Water Conservation Department is the nodal department for implementing the centrally sponsored scheme of micro irrigation system. The assistance for demonstration plots also can be given to state, Central Government farms, State Agriculture Universities, ICAR, progressive farmers and NGO’s. The maximum area for subsidy is 5.0 ha per beneficiary. Despite, having vast potential in the state, it is true that promotion of Micro Irrigation in the state of Punjab has not been up to the desired level (Annexure-IV). The State is facing very serious problem of depletion of ground water resources and conservation of irrigation water is of utmost importance. Only 48281 hectares area could be covered under micro irrigation system (DAC.Net, 2018) which is about 1.17 percent of the net sown area of the state. The operation procedure is presented in fig 6.

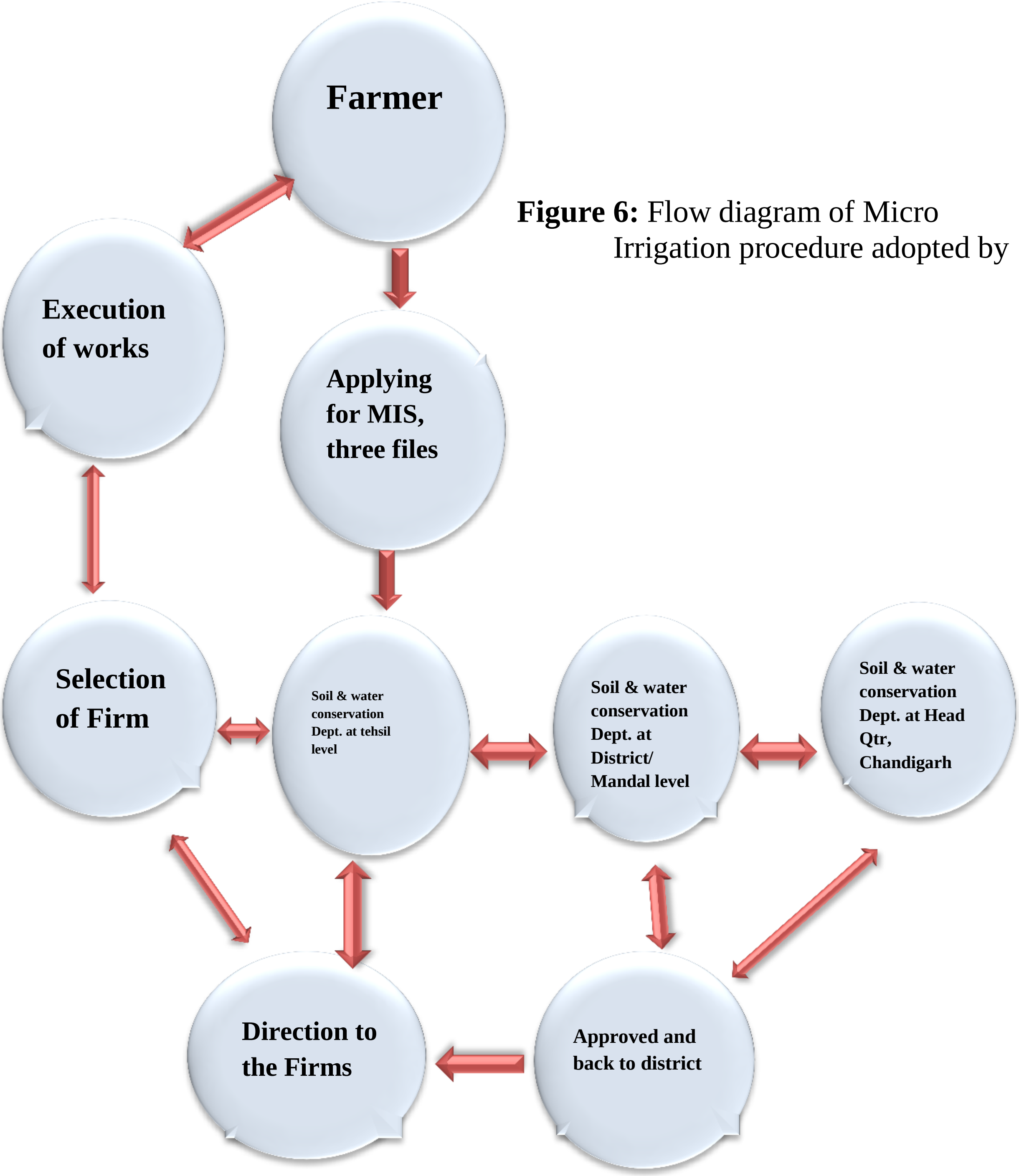


Figure 6: Flow diagram of Micro Irrigation procedure adopted by

4.2.2 Operational procedure adopted by Andhra Pradesh

Andhra Pradesh Micro Irrigation Project (APMIP) is the unique and first comprehensive project being implemented in a big way in Andhra Pradesh for the past 13 years. APMIP was launched in November, 2003.The Project aims at improving the economic conditions of the farmers by conserving water, bringing additional area into cultivation with the available water resources, enhancing the crop productivity and production, quality, facilitating judicious usage of ground water, saving in power consumption and cost of cultivation. APMIP is implemented with the assistance from government of India, state government and farmer contribution. In view of the deficit rainfall, rain shadow regions, unpredictable rains and considerable depletion of ground water, the farming community realized the need to adopt the technologies of Micro Irrigation to achieve the concept of “More crop per Drop”. Government of Andhra Pradesh has set a goal to cover the entire potential area available in all the 13 districts of Andhra Pradesh under Micro Irrigation, by 2022. On Farm Water Management (OFWM) is one of the four components of National mission for sustainable Agriculture, which focus primarily on enhancing water use efficiency by promoting efficient On Farm Water Management Technologies and equipment. The OFWM is implemented in the state through Andhra Pradesh Micro Irrigation Project (APMIP). The entire process of application filling and processing for micro irrigation is online and mobile app based. This help the farmers to access his information and can check the status of his application, subsidies without visiting the office. Operational procedure adopted in Andhra Pradesh is presented in figure 7& Annexure-I.

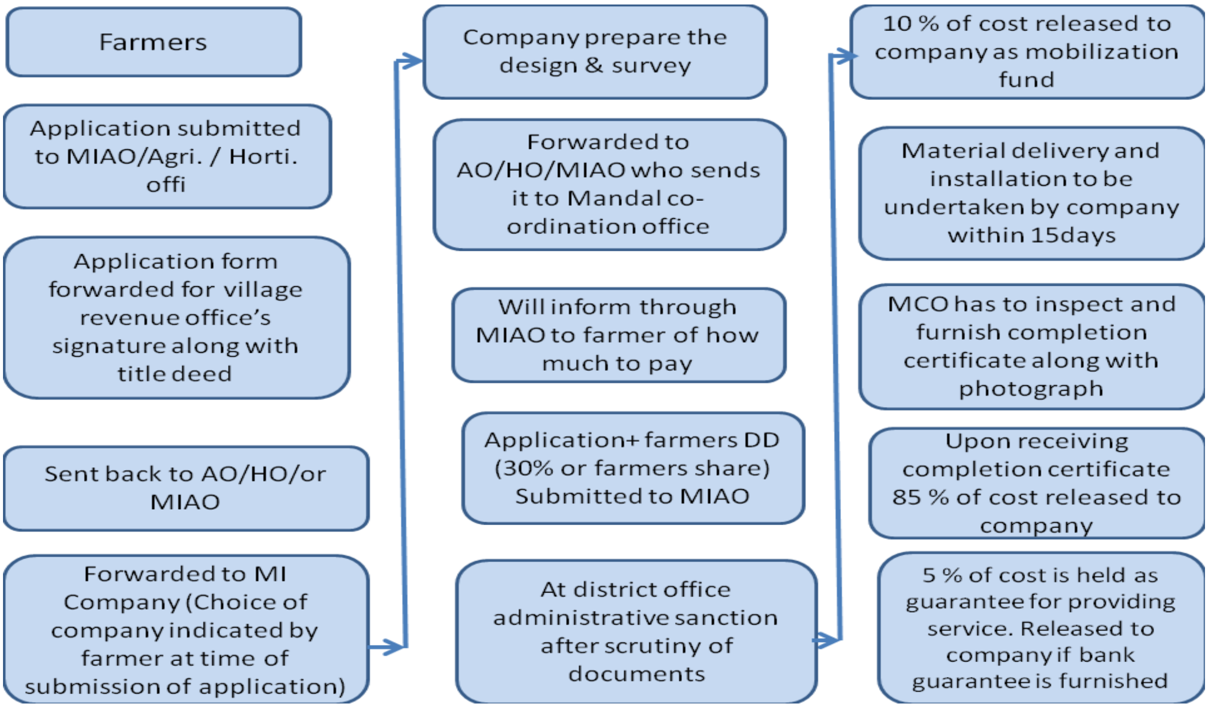


Figure 7: Operational process under APMIP Andhra Pradesh

4.2.2.1 Timelines of implementation of micro irrigation in AP: To achieve the targets in time, timeline setting is very important. AP government has framed the complete guidelines to increase the coverage of MIS in minimum period. Therefore, timelines was prepared and supplied to all the functionaries in the project area (Table 11).

Table 11: Timelines for implementation of the programme

Process flow	Timeline	Responsible Officer
Preliminary inspection, Bench Mark Survey, BOQ & Design	Within 30 days of after registration	MI company
Technical approval	Within 2 days from the date of submission of applications in full shaper	MIE and APD
Collection of farmer Contribution	Within 15 Days after issue of notice / SMS, alert for payment of non-subsidy amount.	Farmer, MIAO. To be monitored by APD
Processing of file for Collector approval for release of 10% mobilization advance	Within 7 Days	PD
Issue of 10% Mobilization Advance	Within 3 days after Collector's approval	PD
Trench Marking	Within 7 days after issue of Administrative sanction	MI company & APD
Trenching	Within 30 days after Trench marking	Farmer & APD
Installation of MI Systems	Within 21 days after Trenching by the Farmer	MI company
Uploading of photograph and Completion certificate and Generation of invoice in online	Within 7 days	MI Company
Release 50% subsidy	Within 10 days	PO Office
Submission of Invoice & other required documents for Final payment in PDs office	Within 7days in full shape after completion of Installation and uploading	MI company
Final Inspection	Within 21 days after receipt of hard copy of invoice by MI Company	MIAO/MIE/MIDC (70%+20%10%)
Release of final payment	Within 7 days after completion of final inspection	PD
Random Inspection	Within 30 days after release of final payment to MI Company	APD/PD

Source: APMIP, annual report, 2018

4.2.3 Operational procedure adopted by Gujarat:

During May 2005, the government of Gujarat (GOG) established a Government owned company namely Gujarat Green Revolution Company Ltd. (GGRC) and made it as the sole nodal agency to implement all types of micro irrigation projects in the state. Further, the government also introduced a unique scheme for micro irrigation adoption in the state. The farmers will get 50 % as subsidy and without any ceiling for the hectarage. This has been welcomed intervention by the farmers of Gujarat and the MI adoption has become comparatively faster. The Gujarat model of MI implementation is presented in fig 9. The Annexure_II present the physical progress of the MIS coverage in the state.

4.2.3.1 Operational procedure adopted in the Gujarat state: The entire operational procedure adopted to select the MI installation company by the Gujarat state in figure 8 as below. The system of allocating fund and payments is very transparent.

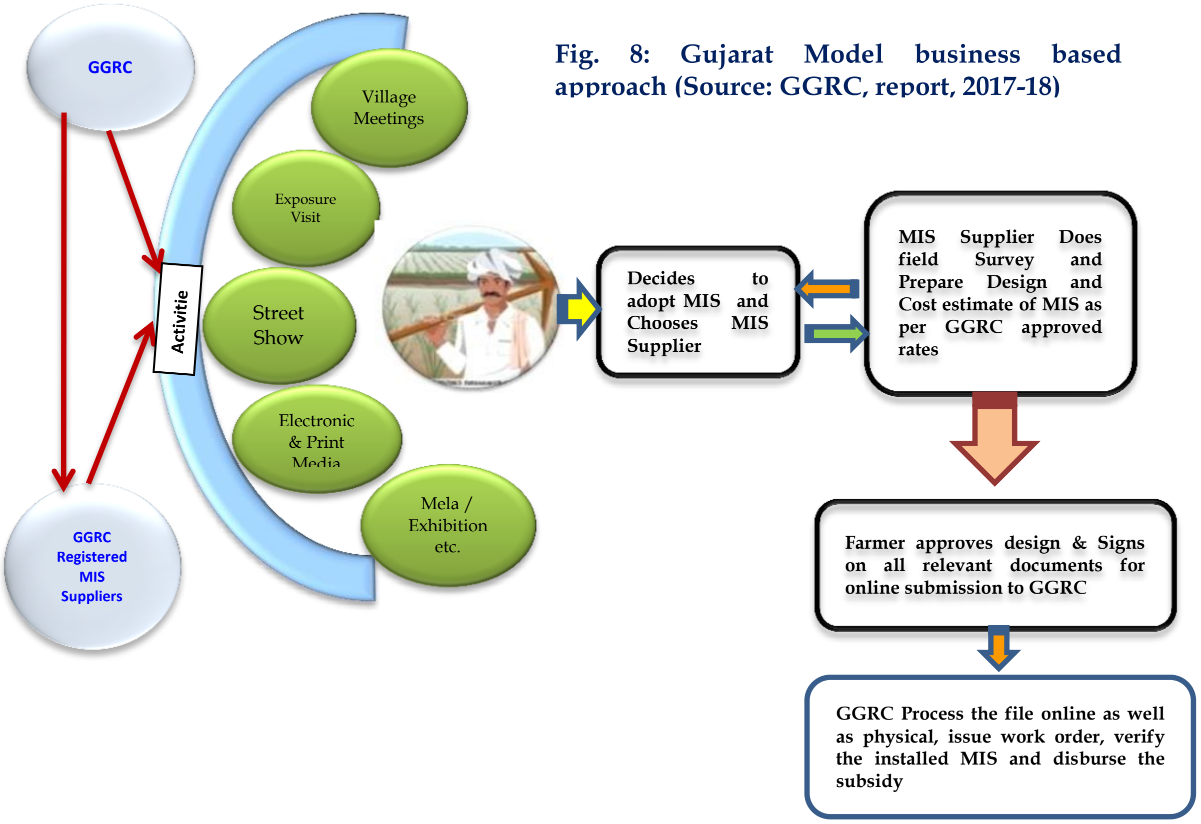


Fig. 8: Gujarat Model business based approach (Source: GGRC, report, 2017-18)

4.2.3.2 Operational process under Gujrat Green Revolution Company Ltd

Farmer’s action as depicted in the figure 9 to get the MIS in their field required in order of this sequence.

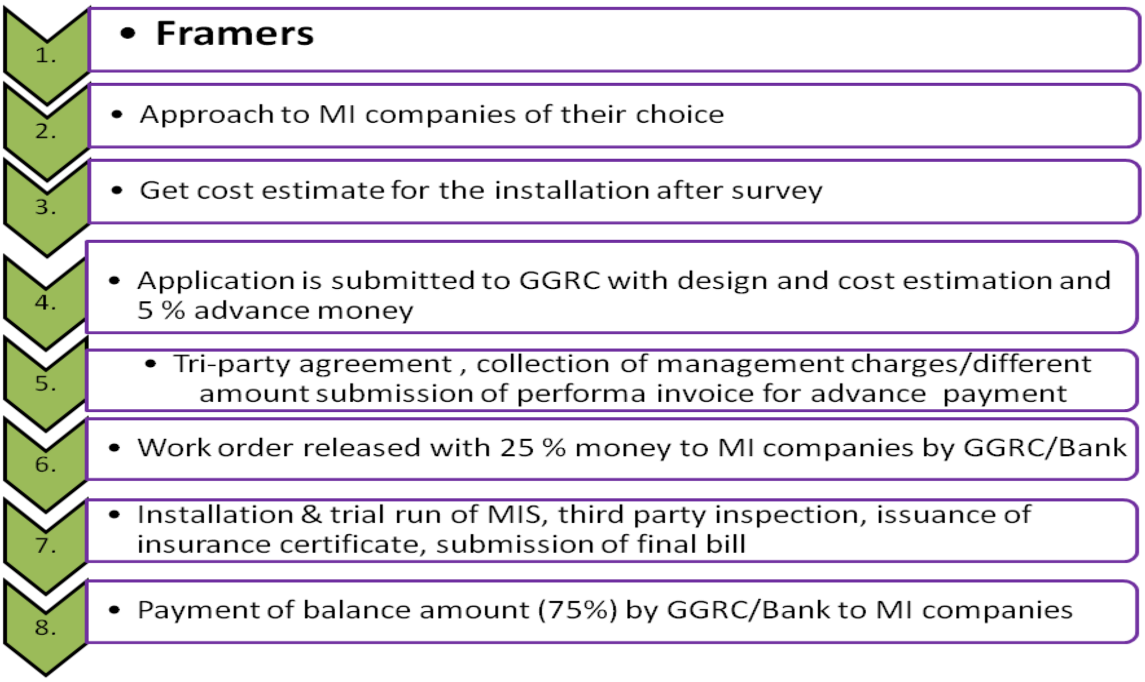


Figure 9: Operational process under Gujrat Green Revolution Company Ltd. (GGRC**)**

4.2.4 Operational procedure adopted by Maharashtra

Government of Maharashtra has actively implemented this scheme through Department of Agriculture to provide benefit to the farmers. The Government provides capital subsidy of 50% to 60% for installation of Drip and Sprinkler systems. Maharashtra has one of the highest rates of adoption of Micro-irrigation systems in the country. Main stakeholders are citizens as beneficiaries, Manufacturers and Dealers as System Suppliers, Government of Maharashtra and Government of India, officials as Implementing Agencies. A special programme called Vidarbha Intensive Irrigation Development Programme (VIIDP) has been initiated for the Vidarbha region of Maharashtra since 2012-13. Modified operational guidelines with revised cost norms for 8 districts of Vidarbha have been issued and accordingly assistance of 75% to small and marginal farmers is provisioned.

4.2.4.1 Documents requirement from farmers for filling application in Maharashtra: The documentary requirement and modalities for Maharashtra state farmer need to submit along with the application are given in the table 12.

Table 12: Documents required for filling MIS application Maharashtra farmer

Name of Document	**Nature of Document**	Ranking
Photo ID Proof (Driving license/PAN card/Election/adhar card/ passport/ card/ kisan credit card / Pensioner Card /Ration-PDS photo card/Arms license/kisan photo passbook or any ID.	Compulsory	I
Copy of form 8 A	Compulsory	II
Copy of form 7/12.	Compulsory	III
Consent letter of other Joint land holders	Optional / if joint land holding-Compulsory	IV
Form 16 /farmers self declaration	If mentioned in 7-12- optional if not it is Compulsory	V
Electric Bill / self certificate of farmer for declaring HP of electric motor or Diesel engine respectively	Compulsory	VI
Details of present passbook issued by any nationalized bank /schedule bank/co-operatives /post office (First two page & latest transaction page).	Optional	VII
Water sharing consent letter	If applicant farmer do not have own source in that case it is Compulsory. If own source optional	VIII
Schedule Caste / Tribe certificate (SC/ST)	In case of schedule cast or tribal farmer -compulsory	IX
Recommendation letter from respective PA's of Tribal Area Sub Plan (TASP)	Compulsory In case of tribal farmer from TASP area.	X
Bank loan Sanction Letter	Compulsory in case of loanee case	XI
GUVNL recommendation/approval letter in case of Tatkal / Dark Zone / PDC-RC	Compulsory in case of Tatkal-2013/ darkzone / PDC-RC (Reconnection cases)	XII

4.3 Comparative analysis of operational procedure adopted by selected state government: We have analyzed the strengths and weakness of the administrative procedure adopted by different states under the study and presented in the table 13. We observed that different states follow different norms while implementing the micro irrigation programme. The subsidy components allotted under central government scheme was provided in addition to state government fund to cover the maximum stakeholders. State like AP and Gujarat had dedicated separate department for implementation of MIS in the state. However, Maharashtra and Punjab is implementing the scheme with their own agriculture, horticulture, soil and water conservation departments. The online application submission, monitoring and app designing is helping the farmers and government functionaries to understand the progress and status of their work. However, manual application submission also practiced in the state like Punjab. The Punjab state is kept in A category of guidelines of government of India on micro irrigation as per the coverage of area. We observed that not much work has been done in the Punjab state on expansion of micro irrigation. Therefore, it should in the category of C. This state is having potential but still could not exploited its potential and area under micro irrigation is negligible. It may be due to subsidies electricity and high dependency on ground water. Therefore, under exploited parts of country can be brought under the ambit of water conservation technologies by taking policy decisions and promotional interventions. Furthermore, there should be dedicated separate department for promotion of micro irrigation. The model adopted by AP, Gujarat may be replicated in the country so that in faster manner water conservation technology may reach to the all farmers.

Table 13: Comparison of administrative procedure adopted in the selected states

Particulars	Selected states			
	Punjab	Andhra Pradesh	Gujarat	Maharashtra
Mode of application filling by farmers	Mostly manual	Online	Online	Online
Dedicated department or staff for MIS implementation	No	AP Micro Irrigation Project (APMIP)	Gujarat Green Revolution company (GGRC)	State Government Horticulture Dept.
Quantum of subsidy (%)	70-90	50-100	70-80 & 80-90	65-90
Land celling limit (ha)	5.0	5.0 after seven year farmer can retake the MIS	5.0	5.0
Selection of beneficiaries	Based on water resource availability with individual farmer	Own source and sharing basis with in the close blood relation	Own source	Own source
Financial help for creation of water resource	Yes	No	No	No
Selection of MI installing agency	Registered with department	Yes	yes	yes
Action against default firms	Debar from the list	Fine and debar from the list	Debar from the list	Debar from the list
MIS service provided (years)	3	3	5	3
Help in arranging the loans for margin money	No	Banks are linked with the farmer	Farmers have to arrange and contact with banks	Farmers responsibility
Disbursement of subsidy	Direct Bank Transfer (DBT)	DBT	DBT	DBT
Trainings for farmers	Limited	Yes & exposure visits, awareness camp, field day and on campus trainings given	Yes & awareness programme conducted	Limited extent awareness camps and staff trainings given.
Trainings for staff	Limited	Yes	Yes	Yes
Trainings for youths	No	Yes	No	Yes
Strength of the operational system	weak	strong	strong	strong
Efficiency in implementation of MIS	slow	Fast	Fast	Medium
Satisfaction level of beneficiaries	Neutral	Highly satisfied	Moderately satisfied	satisfied

4.4 Challenges in implementation of micro-irrigation schemes

Lack of focus on micro irrigation: In the beginning of National Mission on Micro Irrigation (NMMI-2010-2014) showed the strongest growth of micro irrigation penetration in some of the states. However, since the scheme was merged with the component under the National Mission for Sustainable Agriculture (NMSA), there has been slowed the pace on micro irrigation in India, which is a continuing issue with the Pradhan Mantri Krishi Sinchayee Yojna (PMKSY).

Lack of dedicated team and IT backed operations: Tracking the installation of a micro irrigation system, step by step, from initiation of work order to installation and payment is difficult and this is a major source of inefficiencies in the system. The programme Implementing Agency (PIA) staff that implementing the micro-irrigation schemes in various states is deputed from different line departments for time bound. The instability in the postings hampers the implementation of the projects.

Delay in release of guidelines/government orders: The lack of smoother/longer-term guidelines pose a major challenge as evidenced by the fact that operational period of the schemes, on an average, is only 5 months where the farmers miss the utilization of the micro irrigation system during the peak demand season (i.e., Punjab and Maharashtra state).

Subsidy disbursement process: Unavailability of funds for installations or delayed release of funds hampers the progress of MIS coverage in the country.

Lack of easy financing mechanisms for farmers: Farmers face major challenges in finding financing option for the micro irrigation products for depositing the margin money and in case they do find a financing source, there are high collateral demands. Adequate credit facilities to the farmers, trained human resources, and infrastructure for training of farmers are lacking.

Lack of promotional and information efforts: Micro irrigation is generally perceived as technology intensive; hence, its acceptance by farmers needed much persuasion. There was a lack of information on temporal and spatial variation in soil moisture, the optimal fraction of soil to be wetted, location specific and crop-specific irrigation and fertigation scheduling and lack of availability of low cost water-soluble fertilizers and other agro chemicals. Thus, there are several problems in implementation of micro irrigation system in terms of coverage at larger scale in the study area.

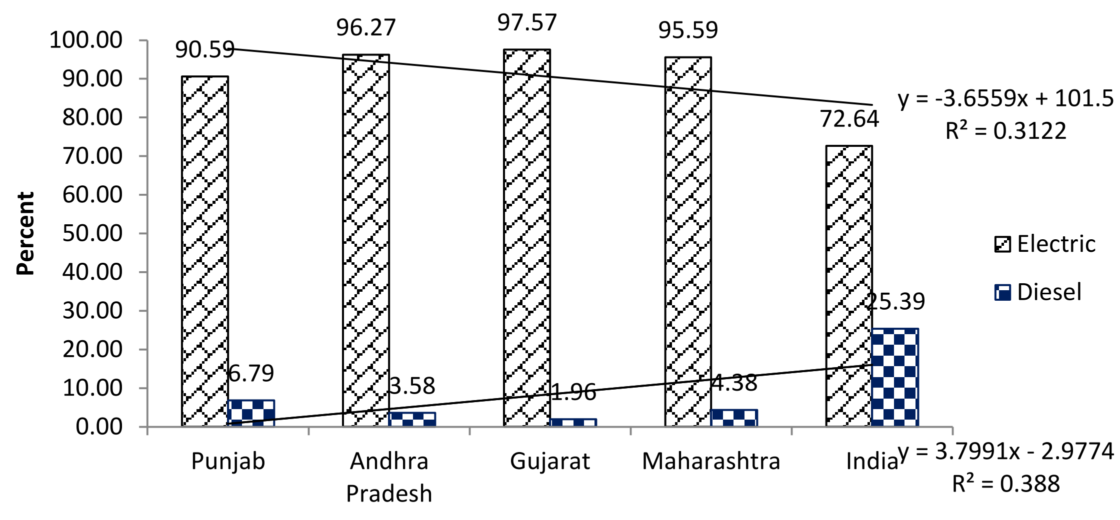
Lack of integration with farm irrigation system: Micro irrigation technology was not integrated with farm irrigation management systems, as they were generally viewed in isolation.

Free energy sources: Farmers are allowed to run their water pumps on free and subsidized energy i.e. electricity and solar sources resulting in over exploitation of ground water due to the fact that method of irrigation mostly used flood. Therefore, in such circumstances farmers are not realizing the importance of water saving technology and hesitant to invest in it.

Objective 2: Effect of water energy pricing on adoption of micro irrigation

4.5 Composition of electric and diesel pumps: Before study the water energy pricing on adoption of micro irrigation we need to understand the sources of energy and water resources in the study area. Therefore, secondary information from the 5th minor irrigation census, 2017, Ministry of Water Resources, River Development and Ganga Rejuvenation were collected and analyzed. Electricity is major source of ground water irrigation in the country including selected states. As compared to national average, the share of electric pumps was higher in the selected states. Higher dependency on electricity (free/ subsidized) is reason for higher dependency. Sometimes, it leads to inefficient use of groundwater. Price policy of electricity has significant role in sustainable and efficient ground water use. Among the selected states, Punjab diesel as source of energy was higher as compared to Andhra Pradesh followed by Maharashtra and Gujarat. Interestingly the electricity as a source of energy was higher for Gujarat followed by AP and Maharashtra >96%. However, in the case of Punjab it was about 91% (Fig. 10.). This could be observed that the dependency on electricity was higher for irrigation in the selected states. Though, the subsidized/ free electricity may be the reason of increasing use of more number of electric pumps for irrigation.

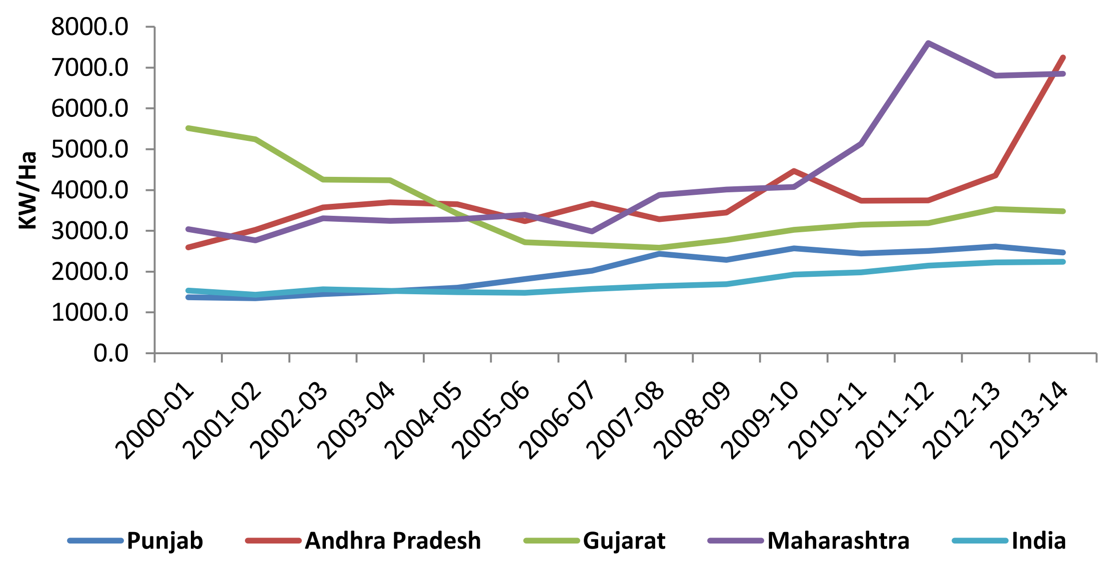
Fig. 10: Composition of electric and diesel pumps for irrigation



Source: 5th minor irrigation census, 2017, Ministry of Water Resources, River Development and Ganga Rejuvenation.

The per ha. Electricity consumption at all India basis indicates that it was increasing over the period of time (2000-01 to 2013-14). In the case of Maharashtra, the electricity consumption increased at faster rate as compared to Andhra Pradesh, Gujarat and Punjab. Though there was not a uniform trend in the electricity consumption for the selected states (Fig.11). However, over the period of time electricity consumption has been increased. Therefore, this is high time, in the scenario of demand pressure; energy conservation technology has to be placed in. Thus, micro irrigation technology needs to be transferred to make agriculture viable enterprise.

Fig. 11: Electricity consumption per hectare of net irrigated area (KW/Ha)



Source: Ministry of Agriculture and Farmers Welfare, Govt. of India

4.6 Extent of level of awareness about the micro irrigation system: The level of awareness about the micro irrigation indicates that farmers were highly aware or not. Therefore, we analyzed the extent of awareness and found that more than 75 % farmers among adopter were well aware about MIS and its benefits.

Table 14: level of awareness about micro irrigation system among respondents (%)

Attributes	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	Adopter	Non adopter	Adopter	Non adopter	Adopter	Non adopter	Adopter	Non adopter
Deep knowledge of MIS	70 (76.92)	41 (44.57)	89 (86.41)	45 (44.55)	94 (89.52)	47 (40.86)	77 (70.0)	32 (29.09)
About Agency PIA	62 (68.13)	35 (38.04)	73 (70.87)	28 (27.72)	87 (82.86)	35 (30.43)	95 (86.36)	38 (34.55)
About procedure of MIS	65 (71.43)	24 (26.09)	84 (81.55)	33 (32.67)	76 (72.38)	24 (20.87)	76 (69.09)	26 (23.64)
Cumbersome Procedure	54 (59.34)	15 (16.30)	63 (61.16)	12 (11.88)	78 (74.29)	45 (39.13)	65 (59.09)	58 (52.73)
Are you ready to expand area without subsidy	37 (40.66)	0	52 (50.49)	5 (4.95)	54 (51.43)	4 (3.48)	45 (40.91)	11 (10.0)
Total	91 (100)	92 (100)	103 (100)	101 (100)	105 (100)	115 (100)	110 (100)	110 (100)

Note: Figures in parenthesis percent to total

Though non- adopters were also aware about MIS but the extent of awareness was less only about 40%. Most of the adopters have found to be known the process of application filling and approaching to PIA. It could be observed that about 51% farmers in Gujarat and Andhra Pradesh have expressed that they will extend the area under micro irrigation even without government support (Table 14). However, in Punjab (40%) also farmers have stated the same. Therefore, we feel more awareness and exposure programmes needs to be executed for increasing more areas under MIS.

4.7 Farmer's perception on water energy pricing: The marginal effect of water/ energy pricing on adoption of micro irrigation is evaluated based on farmers response on the questions like, whether, water prices changed after introduction of MIS in your area. It was observed that In AP and Gujarat about 50% respondents felt that it reduces the water price due to surplus water available and water purchaser completion reduced for water demand. However, there was no uniform trend across the state.

Table 15: Perception on effect of MIS on water and energy price in the study area

Particular	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	Yes	No	Yes	No	Yes	No	Yes	No
MIS decrease the water price	45	46	73	31	55	50	47	63
Free electricity has any effect on water price (Decrease/increase)	13	78	54	50	97	48	102	8
Free electricity has any effect on MIS adoption(decrease/increase)	68	23	83	21	72	33	95	15
Effect of MIS on consumption of electricity (Less/High)	49	42	69	35	78	27	73	37
Effect of MIS water market (decrease/ increase)	37	54	43	61	39	66	68	42
Effect of MIS on diesel price (increase/decrease)	46	45	41	63	34	71	49	61

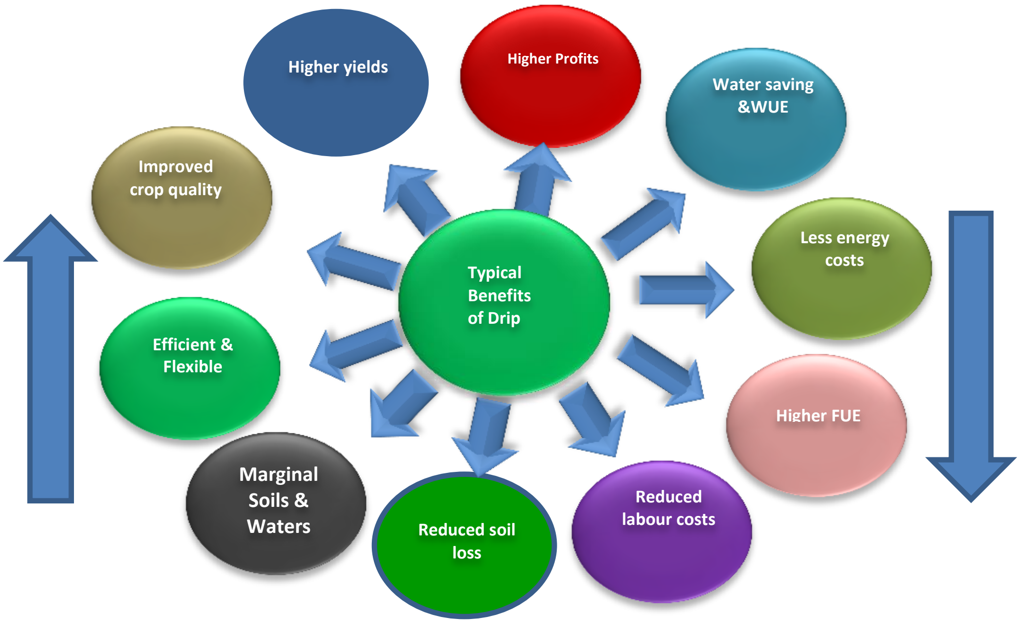
The free electricity fails to create scarcity of water resources and thus, it contributes negatively to the adoption of micro irrigation table 15. Majority of farmers feel that introduction of MIS decrease the electricity consumption. Further, MIS decrease the scope of water market. It may due to the fact that less number of farmers comes to purchase the water from water sellers. The majority of farmers feel that there was not much effect on water energy pricing. However, farmers said that MIS introduction decrease the peak demand of water in the pockets where MIS was adopted.

Objective 3: To find out the effectiveness of various MI technologies for water economy, energy and input economy, savings, employment and income.

4.8 To assess the effectiveness of micro irrigation we analyzed information on different inputs used, price paid for and received for inputs and output by adopters and non-adopters using the primary survey. Thus, data on cost of cultivation, farm gate price of output and quantity used in the cultivation of major crops in the respective states.

4.8.1 Impact of Micro Irrigation: We have identified ten important benefits of MIS as presented in fig.14 based on previous studies. In view of these benefits, we have analyzed the data and quantified the benefits. Few qualitative dimension of effects of micro irrigation were also analyzed based on farmers response and previous studies (Fig. 12).

Fig 12: Benefits of Micro irrigation



4.8.2 Estimation of savings in inputs cost, improvement in yield and income: We have collected the data on cost of Cultivation from adopter and no-adopter sample farmers. The four selected states are cultivating major crop as indicated in the table were selected in detail analysis.

Punjab: We have taken four major crops grown in Punjab. These crops purposively selected since we got sufficient data for comparison with adopter and non adopters of MIS. The cost cultivation data for each crop input price and out-put price realized at farm gate was taken from the sample farmers for detailed analysis. Punjab indicates that seed and planting material varies from 2.25% to 46.87%, FYM cost saving over non-adopter varies from 3.17% to 9.78%. This saving of FYM for adopters might be due to the fact that less quantity required as compared to non-adopter. The fertilizer saving varies from 12.89% to 37.51% and similarly chemical used for pest and disease management, the saving varies from 17.71% to 48.23% (Table 16). This is the very important that MIS irrigation reduce the cost of cultivation over non-adopter was positive and tangible benefits to the adopter. It might be due to the fact that liquid fertilizer applied through MIS in right dose and right time with right quantity. While non-adopter had applied this input in traditional way and had resulted in higher dose application of fertilizer and chemicals leading to high cost of cultivation. The human labour and machine used, the cost saving varies form 5.14%, 9.83% to 31.72%, 17.79%, respectively. The total cost saving varies from 1.33% to 18.06% and net return increased in the range of 32.27% to 54.10% in the case of Punjab. The higher net return was noticed in the case of maize cultivation followed by Kinnow and wheat.

Andhra Pradesh: Similar, five crops grown by the selected respondents were considered for detailed analysis. It was observed that inputs savings in terms of cost of planting material for sugarcane crop was about 8.14%. However, other crops like coconut, Papaya and Tomato seed and planting material cost was higher as compared to non-adopter. This may due the fact that adopters have purchased high quality and costly seeds and planting material in micro irrigated areas. The application of Farm Yard Manure (FYM) saving in terms of cost saving varies from 7.42% to 30.40%. However, FYM cost was higher for Papaya crop for adopter as compared to non-adopter. This may be due to high quantity application in Papaya crop by adopters. The fertilizer saving varies from 12.6% to maximum 68.76% in different crops grown by AP adopter farmers. Similarly, chemicals and pesticides saving vary from 1% to 22.62% for the same crops in AP. The water is very much scare in the study area, therefore, we found that irrigation water saving varies from 16.07% to 51.19% across the crops cultivated by adopters. This is huge water cost saving due to adoption of micro irrigation. The manpower cost saving varies from 22.78% to 29.41% for four crops while there was higher cost of manpower in the case of tomato cultivation as compared to non adopters. The total cost saving was significantly high and varies from 4.59% to 24.60% for AP adopter farmers. The net returns vary from 12.28% to 43.02% for the same crops in AP and it clearly indicates the profitability of agriculture due to adoption of MIS in the state.

Table 16: Saving in inputs costs, increase in yield, income adoption of micro (Percent)

Particulars	Name of crops (Punjab)				Name of crops (Andhra Pradesh)				
	Cotton	Kinnow	Maize	Wheat	Brinjal	Coconut	Papaya	Tomato	Sugarcane
Seed/Planting material	-2.25	13.48	-29.76	-46.87	-89.40	4.43	34.87	3.90	-8.14
FYM	-5.46	-3.17	-9.78	3.67	-16.10	-7.42	6.53	-7.65	-30.40
Fertilizer	-12.89	-18.50	-20.73	-37.51	-68.76	-13.60	-38.12	-26.38	-21.66
Chemical	-48.23	-17.71	22.11	-45.30	-22.62	-6.25	-12.48	-8.89	-0.92
Irrigation	-14.77	-60.24	-35.21	-32.00	-34.63	-29.62	-51.19	-16.07	-43.59
Labour	-5.14	-12.35	-31.72	-13.77	-22.78	-26.16	-26.56	3.81	-29.41
Machine use	4.69	-17.29	-14.13	-9.83	9.08	-5.08	-5.35	1.40	-25.35
Total cost	-1.33	-8.14	-13.07	-18.06	-13.63	-8.52	-5.31	-4.59	-24.60
Yields	*11.62*	*10.76*	*8.17*	*12.96*	*10.54*	*20.17*	*10.51*	*22.27*	*6.82*
Net income	*32.27*	*34.40*	*54.10*	*35.14*	*32.40*	*42.03*	*12.28*	*43.02*	*21.32*

4.14 Gujarat: We have analyzed the data of five crops from the Gujarat. It was observed that seed and planting material cost saved by the adopter 4.32% to 59.76% as compared to non-adopters in Gujarat. The FYM cost saved by 13.73% to 57.94% where as fertilizer cost saving for adopter varies from 45.45% to 63.89% and this is a huge saving. It may be due to the fact that liquid fertigation approach is adopted by MIS adopter. This might be resulted in less quantity requirement. Hence, cost of fertilizer reduced drastically for the MIS adopter. Similar chemical and pesticide cost saving varies from 33.68% to 90.29% (Soybean), this again very important for adopter that they realized the big saving across the different crops. The water saving varies from 12.60% to 88.62%. There was saving in labour use and machine hours used by adopters and it varies form 8.31% to 48.65% across different crop selected for analysis in the state. The total cost saved in different crops in the states varies from 4.15% to 30.39% and net return was higher for adopters, which varies from 17.63% to 52.01% (Table 16). Thus, it is proved that MIS adoption enhance the net income and reduces the input costs. These finding are in conformity with the previous study on micro irrigation (Gandhi et.al, 2014).

Maharashtra: The six major crop grown by adopters and non adopters of MIS in Maharashtra were considered for the analysis. It was observed that seed and planting material cost saved by the adopter 4.91% to 36.31% as compared to non-adopters in Maharashtra. The FYM cost saved by 2.94% to 96.01% where as fertilizer cost saving for adopter varies from 12.98% to 52.09% and this is a huge saving. It may be due to the fact that liquid fertigation approach is adopted by MIS adopter. This might have resulted in less quantity requirement. Hence, cost of fertilizer reduced drastically for the MIS adopter. Similarly, chemical and pesticide cost saving varies from 5.08% to 50.0% (cotton), this again very important for adopter and resulted in they realized the big saving across the different crops. The water saving varies from 16.43 % to 85.81%. There was saving in labour use and machine hours used by adopters and it varies form 8.35% to 51.15% across different crop selected for analysis in the state. The total cost saved in different crops in the states varies from 7.76% to 35.15% and net return was higher for adopters, which varies from 20.95% to 58.69% across different crops (Table 17). Thus, it is proved that MIS adoption enhance the net income and reduces the input costs. The inputs saving and output enhancement due to micro irrigation was noticed in the case of Gujarat and Maharashtra.

Table 17: Saving in inputs costs, increase in yield, income adoption of micro (Percent)

Particulars	Name of crops (Gujarat)					Name of crops (Maharashtra)					
	Cotton	Groundnut	Potato	Soybean	Bajra	Cotton	Bajra	Maize	Onion	Soybean	Sugarcane
Seed/Plant-ing material	-6.67	8.76	-4.32	-21.28	-59.79	-32.27	-9.21	19.65	-36.31	-4.91	-11.59
FYM	-13.73	-57.94	-29.21	-22.53	-	-2.94	-20.45	-	-10.85	-8.33	-96.01
Fertilizer	-53.91	-49.76	-56.38	-63.89	-45.45	-15.04	-22.37	-16.41	-12.98	-36.10	-52.09
Chemical	-57.72	-34.54	-33.20	-90.29	-33.68	-50.00	-	-	-5.08	-38.84	-43.66
Irrigation	-12.60	-88.62	-37.21	-27.48	-39.46	-27.50	-42.14	-16.43	-85.81	-31.13	-28.33
Labour	-21.48	-36.03	-21.33	-48.65	-34.66	-51.15	-12.94	-19.92	-8.25	-25.88	-10.05
Machine use	-8.31	-20.84	-10.64	-20.25	-9.88	-35.81	-47.47	-12.67	-7.64	-35.61	-4.22
Total cost	-26.65	-30.39	-10.35	-29.59	-4.15	-35.15	-31.31	-7.76	-12.74	-24.08	-17.10
Yields	*21.72*	*10.00*	*18.49*	*13.09*	*4.82*	*18.64*	*17.37*	*15.56*	*12.54*	*8.69*	*10.01*
Net income	*42.80*	*17.63*	*37.86*	*52.01*	*41.64*	*35.26*	*58.69*	*39.35*	*20.95*	*25.88*	*25.74*

4.8.3 Impact of Micro irrigation system attract youth in agriculture: The information from the agriculture farmers were collected on the issues like youth interest in agriculture and their preference. It was observed in AP, that many youths having different educational qualification including professional degree, returned for farming in their village. The reason being that with introduction of micro irrigation, these youths were getting better returns from their agriculture farms. Therefor they left the job and started specialized agriculture (Table 18).

Table 18: Youth returning to agriculture due to availability of water saving technology

Level of youth education	Reasons of returning to agriculture (%)			
	Less remuneration with current job	Job is not as per the qualification	Distant place	Parental land remain fellow due to no caretaker
Engineering background	13.89	35.25	24.87	25.99
Science	28.60	31.52	25.24	14.64
Arts and Management	32.81	28.63	34.12	4.44
Others	27.70	32.45	25.45	14.40
Overall				

4.8.4 Micro irrigation enhances income and employment opportunity: The introduction of micro irrigation in an area, open the door of employment and income generations. We have observed that unemployed youth have undergone different trainings organized by programme implementing agency, NGO and MIS firms. After completion of training, they were getting local job with MIS firms, doing minor repairs in local areas. It was informed by farmers of AP that youth come for service of MIS at phone call at any time hence they are local. These youth also informed us that we are happy and getting decent work opportunity at our native areas. In table, 19 shows the possible opportunities created due to MIS in the study area. We have personally visited the Chittoor area and interacted with the youths and our field visit was covered by local newspapers (Annexure VII)

Table 19: Income and employment generation opportunities under micro irrigation

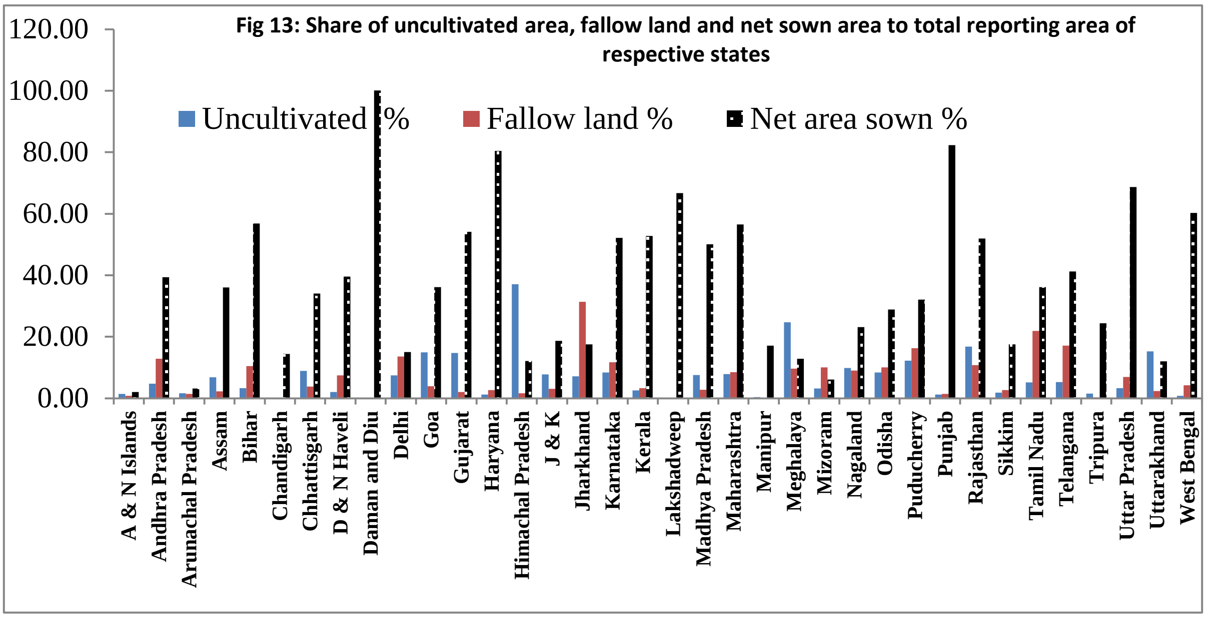
Type of activities	Extent of improvement				
	AP	Gujrat	Maharashtra	Punjab	Overall
Direct cultivation work	4.8 (1.53*)	4.1 (1.04*)	4.3 (1.12*)	3.8 (1.25*)	4.2 (1.16*)
Marketing of agril. produce	4.7 (1.09*)	4.7 (0.89)	4.7 (0.78)	4.7 (1.02)	4.7 (0.86)
Supply of seed and Planting material	4.6 (1.54*)	3.6 (1.04*)	3.8 (1.28*)	3.9 (1.34*)	3.7 (1.21*)
Supply of fertilizer and chemicals	4.7 (089)	4.1 (1.20*)	4.3 (1.04*)	3.8 (1.12*)	3.9 (1.22*)
Service works to MIS	4.9 (1.32*)	3.9 (0.89	3.7 (0.98)	3.9 (0.65)	3.6 (0.83)
Skill improvement	4.5 (1.14*)	3.5 (1.01*)	4.6 (1.12*)	3.7 (0.99)	3.9 (1.01*)
Self-esteem /respect in the society	3.5 (0.85)	4.3 (1.02*)	3.8 (0.87)	4.6 (0.92)	4.4 (0.45)

Note: Very high=5, High=4, Neutral=3, Less scope=2, No scope =1 and Figures in parenthesis in Standard Deviation (SD), * indicate the SD more than one.

4.8.4.1 Reduction in out migration: The out migration of small and marginal farmers has been reduced to the significant extent (Hoshiarpur Punjab) and created decent livelihood for the farmers and youth (AP, Gujarat and Maharashtra) as informed by the respondents.

Objective 4: To estimate the total area covered under MI in selected states and to assess the extent of the use of marginal and otherwise uncultivable lands.

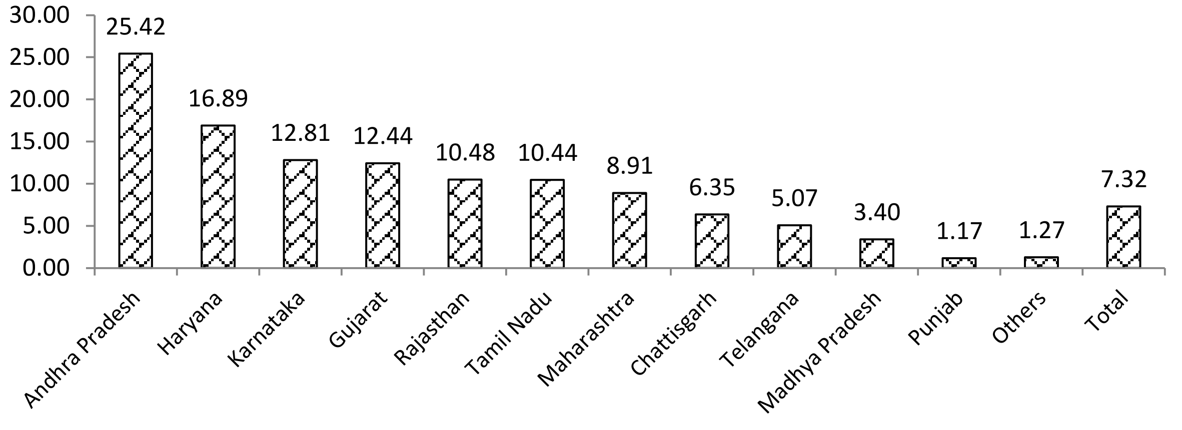
4.9 Extent of uncultivated and fellow land in the different states: Out of 307.7 million hectare reporting area in the country, 16.8 per cent is under uncultivated and fallow land categories. 45.6 per cent of reporting area is under crop cultivation. Their distributions across states have been depicted in fig 13. In the selected states, Punjab has highest area under cultivation and least area left as uncultivated and fallow land. In Andhra Pradesh, share of fallow land is nearly 13 per cent of total reported area whereas Gujarat has nearly 15 per cent area as uncultivated. Maharashtra also has nearly 16 per cent area categorized as uncultivated and fallow land. Every state have state specific issues for having nearly 1/6 of its reporting area under these categories but common and most dominant factor is unavailability of ensured irrigation. This is due to lower groundwater table since early or uncertainties of rain have discouraged to bring these areas under cultivation. In these states, some of this area can be brought under cultivation by introducing water conservation technologies in which MIS can play crucial role. The uncultivated and fallow land can be put under horticulture and forest plantation by installing of micro irrigation system. Therefore, these marginal lands can be productive. But Punjab, where already 85 per cent of its reporting area is under cultivation leaves minimal scope to bring more area under cultivation.



4.9.1 Estimation of the total area covered under micro irrigation: The data were collected from different published/ unpublished sources of central and state govt. we have collected some of the information from district statistical offices and estimated the total area under MIS in different states until 2017-18 and presented in subsequent section.

4.9.2 Penetration of MI in relative term: The extent of coverage of MI was estimated as the share of area under MI in net sown area. The figure 14 shows that only 7.32 per cent of the net sown area was covered with micro-irrigation technology. However, there exists wide spatial variation in adoption of MI technology in the country. Andhra Pradesh occupies the top position with 25.42 per cent MI irrigation coverage followed by Haryana, Gujarat, Rajasthan, and Karnataka. It is surprising to note that in the states like Punjab with acute groundwater scarcity, penetration of MI technology is only 1.17 per cent. The efforts must be extended to promote MI in such states.

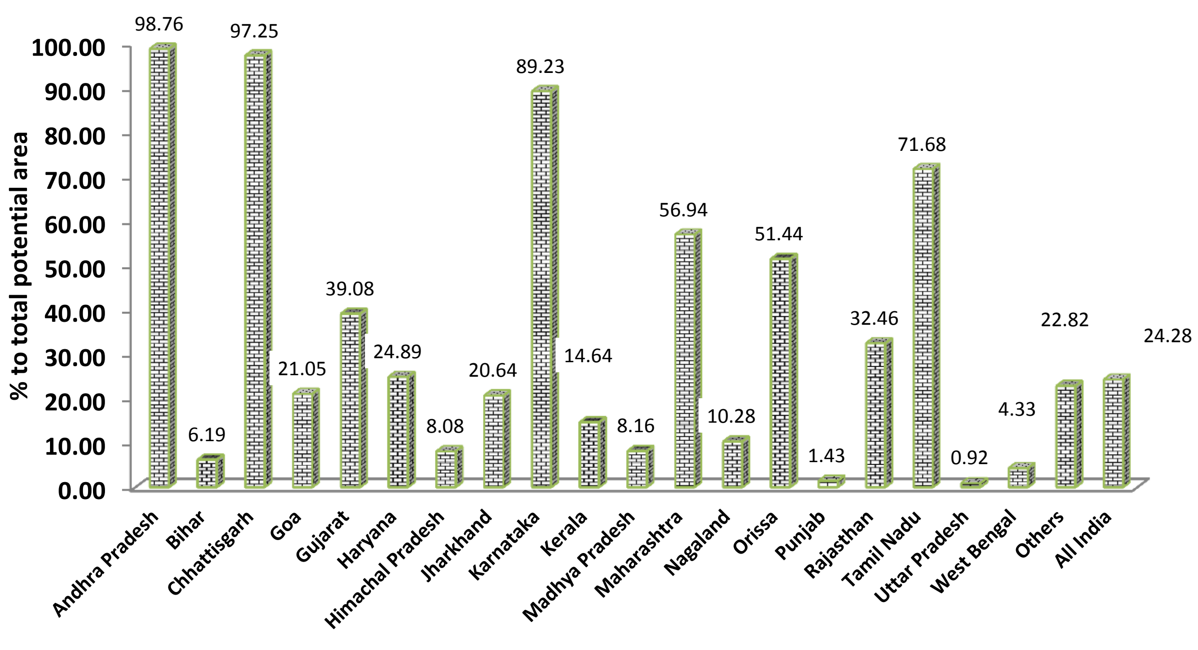
Fig. 14: Penetation of micro irrigation percent to net sown area



Source: Ministry of Agriculture and Farmers Welfare, 2018.

4.9.3 Estimation of Potential area and actual coverage under MIS: We used the methodology similar to Raman, 2010 and Palanisamy, 2011 and estimated MIS area in percent to the MIS potential across the states. Out of total 68 mha net irrigated area, 42.2 mha area had been estimated as potential area for micro irrigation (Raman, 2010). At present 8.6 mha area is under micro irrigation which is 20.37 % of potential area and 12.6% of irrigated area (Fig. 15). State wise calculation has indicated that AP (including Telangana) has covered area under micro irrigation more than its estimated potential area under drip as well as sprinkler irrigation. This may be due to government support, in form of subsidies to the farming communities. Other states like Maharashtra, Tamil Nadu and Karnataka have also achieved more than 50 percent of its potential area. Whereas other states are picking up but state like Punjab is in very decimal situations. Therefore, policy interventions need to formalize to scaling up the micro irrigation in such states, which has got potential but underutilized, Annexure –III and IV presents the physical progress of MIS in the respective state.

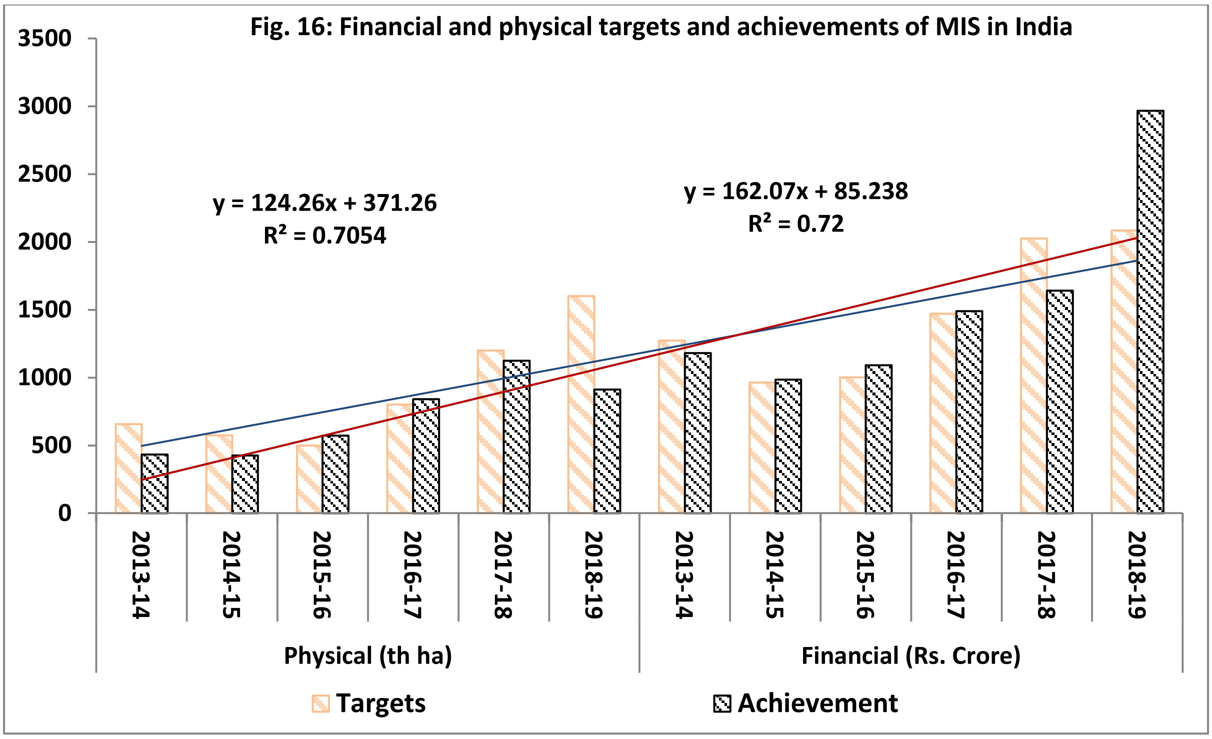
Fig 15: % area coverd to total potential area in MIS in selected states



Note: Authors own calculation based on Potential area given by Raman 2010

4.9.4 Physical and financial targets and achievements under micro irrigation

Year wise actual expenditure by different states has been worked out and presented in fig 16. The evidences indicate that Andhra Pradesh has spent highest expenditure under micro irrigation than any other states in the country in recent past. Punjab has spent the negligible expenditure on micro-irrigation. However, the trend of annual actual expenditure all over the country is declining. While seeing the balance sheet it could be observed that the fund allocation and utilization was encouraging by different states during 2013-2016. Andhra Pradesh contributed nearly 20 per cent of total expenditure under India’s micro irrigation total expenditure. Since last two year, share of Gujarat expenditure for micro irrigation in the country expenditure for micro irrigation also stood at nearly 20 per cent. This indicates these states were able to spread MIS in more area than they have targeted. The Annexures V to VI presents the financial and physical progress of different states.



4.9.5 Estimation of locational coefficient of micro irrigation in different states

The data from the successive minor irrigation census were collected and analyzed the location coefficients using statistical tool and presented the table 20. IT shows that the status of MI development from 2006-07 and 2017. The regional disparity is one of the key features in MI development. As of 2017, the states of Rajasthan, Maharashtra and Andhra Pradesh (undivided) have the largest area under MI. Close to half of the sprinkler irrigation is accounted for by only two states, Rajasthan (35%) and Haryana (12%). The spread of drip irrigation is concentrated mainly in states in the peninsular region. Maharashtra, Andhra Pradesh (undivided) and Karnataka together account for about a third of the national area under drip systems. Recently Gujarat has also performed commendably to increase drip-irrigated area. One could expect a close correspondence between MI and minor irrigation development. This aspect was quantified by using the location coefficient, which compares the share of a state in MI to its share in minor irrigation potential used. A value higher than one for a state would indicate a higher adoption of MI compared to minor irrigation. The value of location coefficient for AP was 5.37 during 2017 from 0.30 during 2006-07. Recently Gujarat 0.25 to 2.30 and for Maharashtra 0.65 to 1.74 indicating higher concentration of MIS respectively, in their state. Which reflect that these states like Punjab, Bihar, and UP etc. To get location coefficient value higher, these states need to put mac efforts for scaling up MIS.

Table 20: Estimation of locational coefficient of micro irrigation concentration in India

States	Location coefficient					
	2006-07		2014-15		2017	
	Ground Water	Micro Irrigation	Ground Water	Minor Irrigation	Ground Water	Minor Irrigation
Andhra Pradesh	***0.30***	***0.25***	***1.62***	***1.22***	***6.28***	***5.37***
Bihar	0.08	0.09	0.04	0.04	0.21	0.25
Chhattisgarh	0.73	0.58	1.38	1.26	2.46	2.56
Goa	4.85	3.73	3.67	2.71	4.16	2.17
Gujarat	***0.25***	***0.30***	***0.25***	***0.25***	***1.97***	***2.30***
Haryana	0.00	0.00	1.52	1.65	1.11	1.37
Himachal Pradesh	0.08	0.10	0.03	0.02	1.09	0.34
Jharkhand	0.02	0.03	0.04	0.03	1.14	0.79
Karnataka	1.85	1.85	1.51	1.57	2.70	2.73
Kerala	1.18	0.81	0.58	0.44	4.34	1.05
Madhya Pradesh	1.47	1.47	0.91	1.00	0.50	0.51
Maharashtra	***0.65***	***0.61***	***0.62***	***0.57***	***1.77***	***1.74***
Odisha	0.02	0.09	0.04	0.02	2.57	1.10
Punjab	***0.00***	***0.00***	***0.00***	***0.00***	***0.05***	***0.06***
Rajasthan	8.02	8.54	5.98	6.31	1.75	2.10
Sikkim	-	0.00	-	0.00	-	5.14
Tamil Nadu	0.26	0.21	0.68	0.66	0.76	0.82
Telangana	-	-	0.20	0.18	0.47	0.47
Uttar Pradesh	0.06	0.07	0.04	0.05	1.24	0.84
West Bengal	0.18	0.32	0.01	0.01	0.19	0.17
Total	1.00	1.00	1.00	1.00	1.00	1.00

Note: authors have adopted *Ramaswamyet.al., 2005,* methodology to work out the irrigation index

Objective 5: To estimate the amount of private investment and area covered by them and developing database

4.9.7 Estimation of the Public and private investment: The public investment was considered as the subsidy offered to different MIS systems (drip and Sprinkler). Since, the rate of subsidies varies with community, type of farmers and location of filed and location of farmer residing. The different state offers the different subsidy slabs for different stakeholders. Therefore, data from adopter households were collected, analyzed and presented in table 22. It was leant that for micro irrigation system investment worked out to be highest about Rs. 190.13 lakh was for Gujarat followed by Andhra Pradesh. The per ha highest cost of micro irrigation was about Rs.**0.79** lakh for AP followed by Punjab (Rs. 0.59lakh) and Maharashtra and Gujarat state. The private investment was considered the margin money deposited by the individual beneficiaries in different states. Thus, private investment was highest for Andhra Pradesh followed by Punjab and Maharashtra and it was lowest for Gujarat state. However, total private investment made by the different private agencies, farmers and other, the data was not available with the respective state government. Thus, this data need to be collected by the respective states to estimate the real private and public investments.

Table 22: Public and private investment in micro irrigation (Rs. Lakh)

States	Area under MI	Public and private investment n micro irrigation			Per ha basis investment		
		Public	Private	Total	Public	Private	Total
Punjab	243.75	87.52	58.35	145.87	0.36	0.24	0.59
Andhra Pradesh	233.26	124.04	61.10	185.14	0.53	0.26	0.79
Gujarat	458.75	123.58	66.55	190.13	0.27	0.15	0.41
Maharashtra	337.89	110.57	64.94	175.50	0.33	0.19	0.52

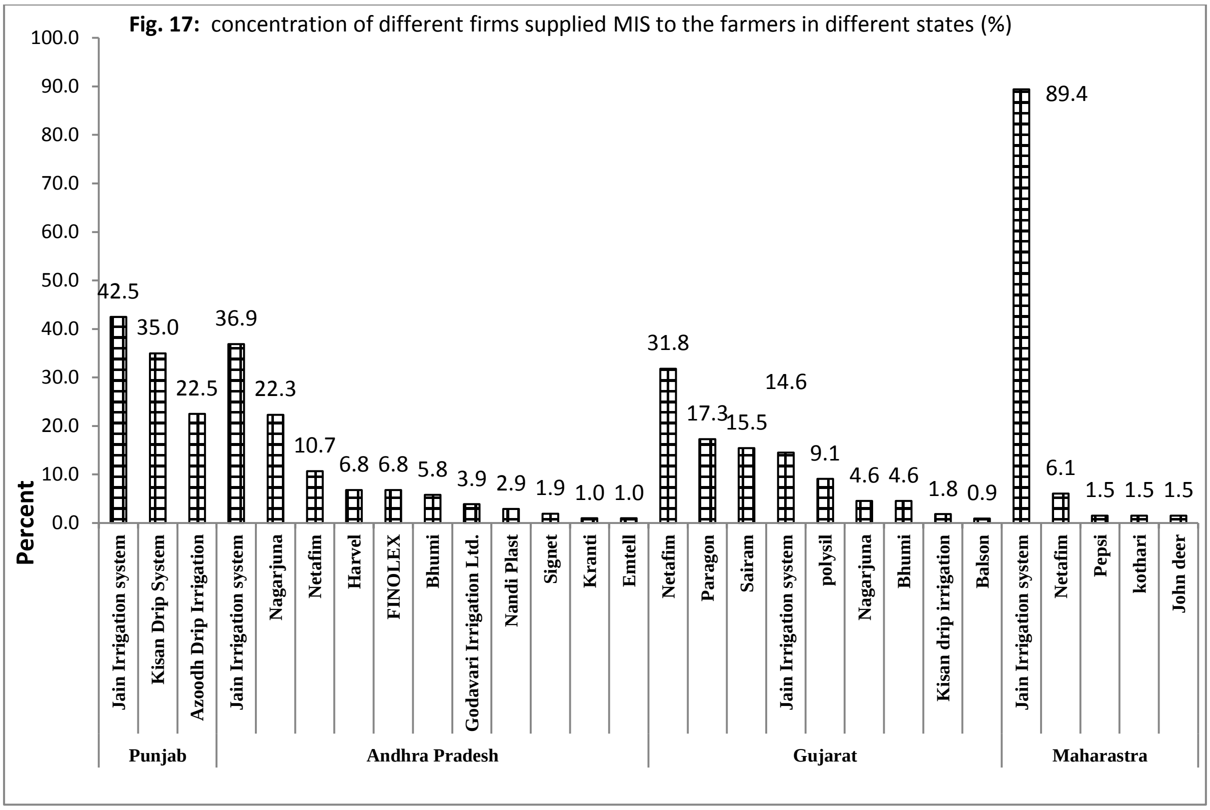
Note: Authors calculation based on sample households

4.9.6 Extent of use of marginal and uncultivated lands: We have collected the information from the sample farmers on how much and type of additional area brought under irrigation. It was observed that famers of Andhra Pradesh, Chittoor district have cultivated 50 to 200% additional land after introduction of MIS. The land use to be fellow or waste brought under cultivation of high value crops like tomato, beans, cucurbits, pomegranate, mangoes and others. It was informed by majority of farmers in AP, Maharashtra and Gujarat that we use to left part of our land as fellow before MIS due to non-availability of sufficient water (Table 21). Now we are able to cultivate complete land holding and taking two or more crops. Therefore, cropping intensity also has been improved.

Table 21: Perception of farmers on utilization of marginal lands after adoption of MIS

Particulars	Punjab	Andhra Pradesh	Gujarat	Maharashtra
Additional areas brought under cultivation	Very less (4.5%)	Very high (50% to 200%)	High (12%-45%)	High (13-47%)
Fellow land put under cultivation	Yes	Yes and in double crops	Yes	Yes
Increased cropping intensity	Yes but to limited extent	Yes more than 175%)	Yes more than 188%)	Yes more than 153%)
Received higher production	Yes and fetched good price for horticulture crops due to appropriate size and colour	Yes productivity improved for horticulture and other crops	Yes productivity of horticulture, pulses and oil seed crops increased	Yes productivity of sugarcane, grapes and other crops improved

4.9.8 Concentration of different firms supplying MIS materials in different states: The different micro irrigation system supplying firms registered with the different programme implementing agency are given in the fig.17 The different state have different procedure to select and register the firm for supplying the material. The guidelines were prepared by the concerned states department and conditions put before the material supplying firms. There is full security deposits and an agreement signed by the firm to maintain the quality material and services. In AP, it was observed that those firms, who could not provide reliable and timely services, were fined heavily. Some of the firms have banned for future involvement in the micro irrigation business in the respective district/state. The following figure indicates the percent of the farmers served by the respective firm. It could be observed that Jain irrigation is a dominate firm in all the states. While Kisan, Netafim were the IInd largest supplying MIS material in the state. However, other firms were also operating in the study areas but their coverage was less.



Objective 6: To assess the reliability and durability of the system for sustainable development.

4.9.9 People's participation in micro irrigation scheme: The various line departments have implemented the micro irrigation system in the respective states. We have collected the information on the involvement of the people at different stage of the micro irrigation system and findings are presented in the table 23. It was observed that Peoples Participation Index (PPI) was higher for Andhra Pradesh (86.9%) followed by Gujarat and Maharashtra. However, PPI was lower even at planning level for site selection for micro irrigation in Punjab. At overall basis PPI was about 68% indicating at planning stage more people were involved for stage as site selection. This trend was not the same at implementation and at maintenance stage as PPI was still lower 34%. This may be because of people at maintenance stage may not be happy with firm who has installed the system. Further, farmers might not be getting service in time. To select the suitable crop under MIS is very important. We observed that many farmers of AP and Gujarat were involved in the crop selection process. However, in the case of Maharashtra and Punjab PPI was low. The selection of MIS installing firm another important aspect to be considered. We found that at Overall basis AP, Gujarat and Maharashtra farmers were involved to the maximum extent of 56%. We have received the response on selection of credit institutions and observed higher PPI values for AP only

However, even in Gujarat and Maharashtra, the selection of credit institution, PPI was lover at all the stages of project. Contact made by farmers for getting information, submission of applications at planning, implementation and at post implementation stage. However, PPI was higher at implementation stage but decreased at maintenance and implementation stages.

Table 23: Level of Participation (Different stage of programme)

State	Criteria of people's participation in Micro irrigation in different states (%)														
	Selection of site			Selection of crop			Selection of installing firm			Selection of credit agency			Contacts made to officials		
	Pl.	Imp.	Mnt.	Pl.	Imp.	Mnt.	Pl.	Imp.	Mnt.	Pl.	Imp	Mnt	Pl.	Imp.	Mnt.
AP	86.9	56.7	45.8	87.7	57.1	54.3	85.2	62.5	51.2	78.6	57.1	41.2	70.9	51.2	41.3
GJ	75.6	52.3	31.8	69.8	53.2	50.7	71.2	55.2	48.7	28.2	36.5	14.8	51.1	33.7	30.4
MH	65.5	51.6	33.3	40.0	38.5	40.5	41.3	48.5	39.8	21.0	21.1	18.9	29.2	27.6	25.3
PB	35.7	39.6	28.9	30.4	33.2	12.1	31.8	34.2	5.7	No response			29.3	27.6	20.4
All	67.5	50.7	34.2	56.3	45.6	41.5	57.0	50.7	38.9		29.4	28.7	40.2	33.6	26.8

Note: Pl.: Planning, Imp.: Implementation, Mnt.: Maintenance, AP=Andhra Pradesh, GJ=Gujarat, MH= Maharashtra, PB=Punjab

Thus, PPI at planning was higher in all the cases and it decreased at implementation and maintenance stages respectively. The possible reason may be initially more farmers might have shown the interest of taking MIS and later on, they might have withdrawn their participation in the project. Another reason might be due to limited fund, time and man power with government and private functionaries, less farmers were included in the beneficiary list.

4.9.10 Determinants of micro irrigation adoption

The estimated coefficient of the parameters and marginal effect in the logit model are summarized in table 23. A series of logistic regression for pooled data (all states together) and for each state separately has been used to work out determinant of micro irrigation adoption. Independent variables have been common in each specified model. The coefficient presented determines whether a change in independent variable considered in model makes the event more likely or less likely.

Pooled data: Analysis of all respondents across all four states taken together, coefficient of family size came to be positive and significant at 10 per cent in adoption of micro irrigation. Its marginal effect indicates that the probability of adoption of micro irrigation increases by 2.1 per cent each additional member family. Years of mobile use, possession of soil health card, insurance of crop during survey and ownership of tube well came out to be positive.

Marginal effect of mobile use indicates that probability of micro irrigation adoption increases by 2.6 per cent for increase in each year of mobile use. Increase in probability of adoption if respondent have soil health card and crop insurance is 34.9 and 55.5 per cent (Table 24). These factor is as per expectation that if farmers are innovative then he will be going for adoption of newer technology available. Tube well ownership of respondent increases probability of micro irrigation adoption by 24.5 per cent in comparison to others. One of the essential criteria of taking benefit of micro irrigation is own source of irrigation. Result indicates that area under rainfed reduces probability to adoption by 51 per cent.

State specific findings

Punjab: Coefficient of soil health card, crop insurance and ownership of tube well are positive and significant at 1 per cent level of significance. Their marginal effect is 56.8, 30.6, 0.3 and 63 per cent respectively.

Andhra Pradesh: Coefficient of schooling years, mobile use years, cast of respondent, depth of water table and tube well ownership are positive and significant. Marginal effect of these variables is 3.8, 5.9, 25.6, 0.1 and 59.2 per cent respectively.

Gujarat: Coefficient of mobile use years, soil health card, crop insurance, tube well ownership and irrigated area came out to be significant. Marginal effect of these variables is 19.8, 80.9, 96.2, 52 and 15.3 per cent respectively.

Maharashtra: Coefficient of soil health card, crop insurance, tube well ownership and irrigated area came out to be significant. Marginal effect of these variables is 45.3, 89.2, 44.2 and 5.2 per cent respectively.

Table 24: Determinant of micro irrigation adoption

Variables	Pooled data		Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	Coef.	Marginal Effect	Coef.	Marginal Effect	Coef.	Marginal Effect	Coef.	Marginal Effect	Coef.	Marginal Effect
Family size (no)	0.090*	0.021*	-0.137	-0.034	0.205	0.051	-0.009	-0.002	-0.011	-0.002
Working labour (no)	-0.078	-0.016	0.133	0.033	-0.263	-0.065	-0.893	-0.211	-0.621	-0.142
Schooling (years)	0.010	0.003	0.067	0.017	0.155***	0.038***	-0.115	-0.027	0.001	0.001
Mobile use (years)	0.103***	0.026***	0.003	0.001	0.238***	0.059***	0.835***	0.198**	-0.065	-0.015
Caste (Gen+OBC=1 Otherwise=0)	0.246	0.062	-0.001	0.000	1.152*	0.256**	-2.907	-0.565	1.087	0.215
Soil health card (Yes=1 No=0)	1.515***	0.349***	3.502***	0.568***	0.297	0.074	7.095**	0.809***	1.961**	0.453**
Crop insurance (Yes=1 No=0)	2.485***	0.555***	1.265***	0.306***	0.643	0.158	8.049***	0.962***	6.03	0.892***
Water table depth (in feet)	0.001	0.001	0.010***	0.003***	0.005***	0.001***	-0.003	-0.001	0.01***	0.001
Tube well ownership (Yes=1 No=0)	1.137***	0.245***	3.366***	0.631***	3.073***	0.592***	3.373	0.520*	2.968***	0.442***
Irrigated area (ha)	-0.022	-0.005	0.031	0.008	0.073	0.018	0.646***	0.153**	0.229**	-0.052**
Rain-fed area (ha)	-0.510**	-0.125**	-0.627	-0.154	0.611	0.151	-3.6	-0.852	2.52	0.577
Energy (Diesel=1 otherwise=0)	0.253	0.06	1.671***	0.388***	-1.226*	-0.295**	-1.483	-0.353	-0.522	-0.125
Constant	-4.015***		-2.750**		-9.249***		-10.58		-3.730*	
Number of obs	827		183		204		220		220	
LR chi2(12)	399.41		103.9		151.79		279.59		229.97	
Prob > chi2	0.000		0.000		0.000		0		0	
Pseudo R2	0.348		0.4095		0.5368		0.9167		0.75	
Log likelihood	-373.48		-74.895		-65.497		-12.696		-37.279	

Note: *** significant at 1%, ** at 5% and * at 10%

Objective 7: To develop an alternate eco system for promotion of micro irrigation in under exploited but potential state/ region

4.9.11 The main source irrigation in Punjab state is ground water and canal, state has already tapped its irrigation potential and having almost 100% net irrigated area. In recent past irrigation through ground water sources is accelerating resulting in depleting ground water level. Metrological data shows, many blocks in the state were critical and under water stress due over exploitation of ground water. However, state is having potential of abandon water resources but still use of water saving technology is very poor. The uncultivable land (1%) and fellow land (1%) are not much in the state. Only the option remain that ground water irrigation system in traditional method may be replaced with micro irrigation system. Therefore, strong policy decision is required to restrict the ground water use through flood irrigation. In a phased manner, first horticulture crops and then annual crops need to be brought under micro irrigation. The Talwara project (SCIP) in Hoshiarpur district is already progressing well and farmers have adopted solar driven micro irrigation system. Similarly other states like Maharashtra, Gujarat need to take the policy decisions on whether to provide free electricity or not and how long. Thus, we feel about 20% groundwater irrigated area should be brought under MIS in phased manner. The figure 18 depicts the share of net irrigated area to net sown area and cropping intensity across the states. This could be observed that higher the cropping intensity with those states where percent net irrigated area is high. Further, cropping intensity can he enhanced with proper utilization of water resources including micro irrigation system.

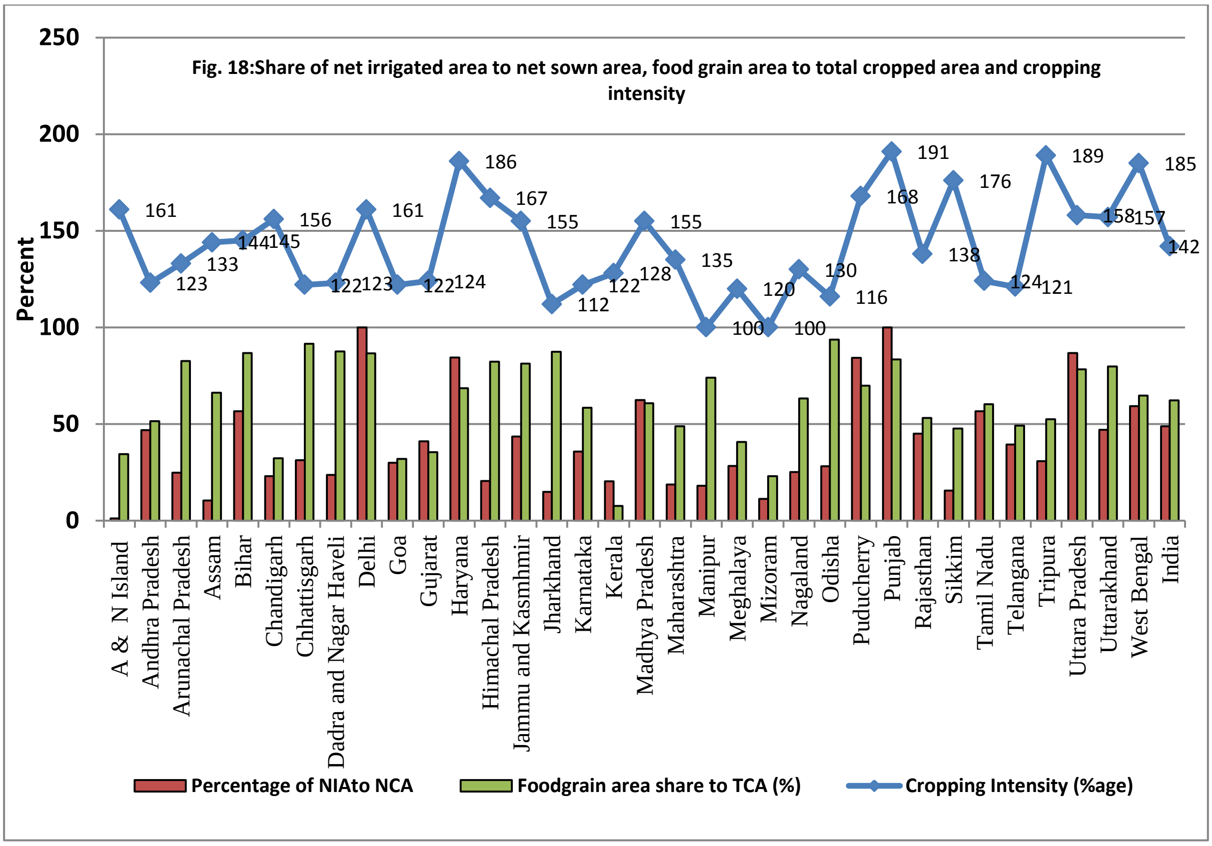


Fig. 18:Share of net irrigated area to net sown area, food grain area to total cropped area and cropping intensity

4.12 Groundwater depletion leads to demand of micro irrigation: The reports and data indicates that in the selected states the ground water level is being going down day by data. During field survey also farmers have expressed that water level is going low and low since many years. Therefore, we have asked the farmer how water table gone down during different period. In the primary survey, information regarding groundwater has been collected from the sampled farmer in the study area and presented in table 25.The highest depletion in absolute term was observed in the case of Andhra Pradesh, Gujarat, and Maharashtra. However, Punjab farmers have indicated about 20-30% depletion in water table from 2005-06 to 2017-18. Therefore, farmers of selected states were aware the declining ground water. They also said either some of the tube wells dried up or the farmers did re-deepening. They have informed that water conservation technology may avoid such reduction in water level since it required less water. Therefore, promotion of micro-irrigation technologies is very much essential for states like Punjab, AP and others where already water stress and scarcity is being pointed out by the hydrologists and researchers Srivastava etal. 2015. Since, MIS technology save water more than 30%, which can be used to save ground water resources.

Table 25: Perception on groundwater table depletion in the study area

Time period	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	Adopter	Non adopter	Adopter	Non adopter	Adopter	Non adopter	Adopter	Non adopter
Present (2017-18)	141.45	74.00	421.17	404.06	382.11	239.07	1066.91	905.01
Before 5 Years	126.87	66.99	332.23	297.30	303.50	198.44	996.91	835.01
Before 10 Years	100.07	58.47	247.74	198.76	268.81	178.74	551.61	509.87

4.9.13 Accessibility of information: In study area, almost all sampled farmers are aware about the micro irrigation system used in agriculture. In Punjab, nearly half of the adopter farmers got the information of micro irrigation from government official and Universities/Research institute/KVK still 38 per cent farmers depend of fellow farmers or relative for the information (table 26). In Punjab under non-adopter category, half of the framers have themselves aware for micro irrigation from fellow farmers or relatives. Penetration of government officials and Universities/Research station/ KVK in Andhra Pradesh is higher than in Punjab, as more number of farmers got the information from these sources. In Andhra Pradesh farmers, dependency for information on fellow farmers or relatives is lower in than the Punjab Farmers. The timely and accessibility of information helps in scaling the MIS in the country. We have observed most of the farmers who adopt MIS get information from fellow farmers, govt. departments, research institutes and print media. We strongly feel that agricultural university/KVK/research institutions need to increase their reach to the farmers.

Table 26: Source of information on micro irrigation

Particulars	Punjab		Andhra Pradesh		Gujarat		Maharashtra	
	Adopter	Non adopter	Adopter	Non adopter	Adopter	Non adopter	Adopter	Non adopter
Peers/fellow farmers	30 (38.46)	72 (78.26)	24 (23.30)	31 (31.69)	13 (11.82)	31 (28.18))	14 (13.33)	17 (14.78)
Govt. officials	32	14 (15.22)	54 (52.43)	47 (46.53)	31 (28.18)	2 (1.82)	43 (40.95)	24 (20.87)
Research institutions Universities/ KVK	22	0	11 (10.68)	13 (12.87)	39 (35.45)	13 (11.82)	20 (19.05)	40 (34.78)
Print media	2	0	10 (9.71)	6(5.94)	6 (5.45)	37 (33.64)	15 (14.29)	25 (21.74)
TV/Radio/Mobile	5	5 (5.44)	4 (3.88)	1(0.99)	21 (19.09)	27 (24.55)	11 (10.48)	7(6.09)
No response	0	1 (1.09)	0	3(2.97)	0	0	2 (1.94)	2 (1.74)
Total	91 (100)	92 (100)	103 (100)	101 (100)	110 (100)	110 (100)	105 (100)	115 (100)

Objective 8: To identify the major constraints, if any and suggest remedial measure

4.9.14 Challenges of micro irrigation system

There are several demerits associated with micro irrigation system, which hinder its adoption. Table 27 indicate demerits of MIS which have influence on adoption and corresponding values gives the per cent of sample farmers agreed for that category in respective state. In spite of government subsidies up to 90 per cent of cost, farmers perceived high initial capital requirement as dominant problem. This may be due to late or untimely disbursement of subsides and ineffective linkages with the stakeholders and other departments. Other demerits stated by respondent were related to technical issues like clogging, handling skills, procurement of MIS etc. Therefore, few issues, which are associated with micro irrigation, need to be addressed in order to increase the spread of micro irrigation in respective states.

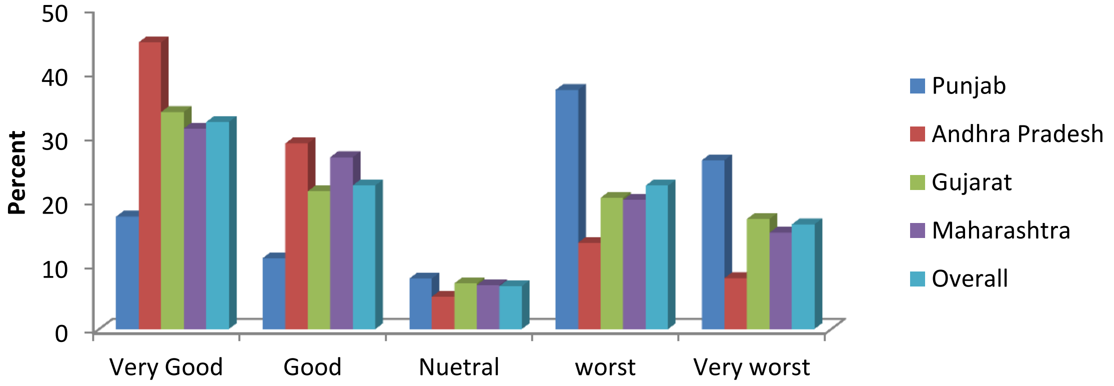
Table 27: Challenges of micro irrigation system (in Percent)

Particulars	Punjab	Andhra Pradesh	Gujarat	Maharashtra
High initial capital requirement	80	58	63	68
Clogging problems	75	75	73	69
Maintenance problems	76	65	68	58
Difficult to install	65	52	54	63
Requires know-how and skills	62	65	56	59
Crop specificity	56	37	48	68
Limits crop diversification	65	67	62	75
Interferes with harvesting	53	72	54	65
Interference with agronomic practices	54	65	58	47
Cumbersome procurement process	68	32	49	37

4.9.15 Experience of adopters on operational procedure and subsidy support:

The experiences and perceptions of the micro irrigation adopters were assessed through open-ended questions put before the respondents. Fig. 19 indicates the behavior of department staff and agencies involved in processing and granting the subsidies to the farmers. The behaviour of the staff as perceived very good varies from 18% for Punjab to 44.67% for Andhra Pradesh. However, combined behavior good and very good varies from 28% to about 72%. This means in AP, Gujarat and Maharashtra, agencies involved, their department staff behaved well the beneficiaries. This might be one of the reasons of better adoption rate in the respective state (Annexure-VII).

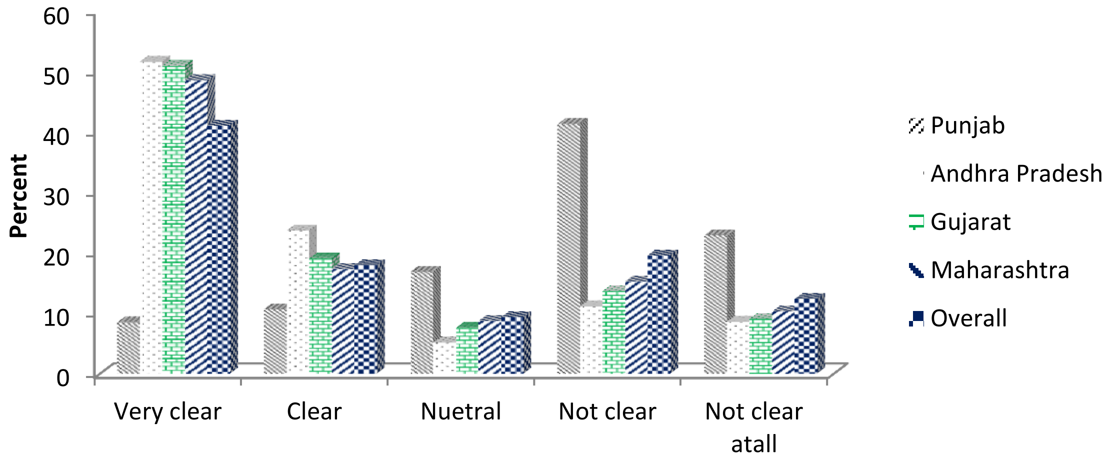
Fig. 19: Behavior of officials / agency involved in granting subsidy for MIS



Clarity in the subsidy and operational procedure was assessed and presented in the fig. 20. It could be observed from the table that the process of support to the beneficiaries was clear in the Andhra (52%), Gujarat (51%) and Maharashtra (49%) followed by Punjab 8.45% only.

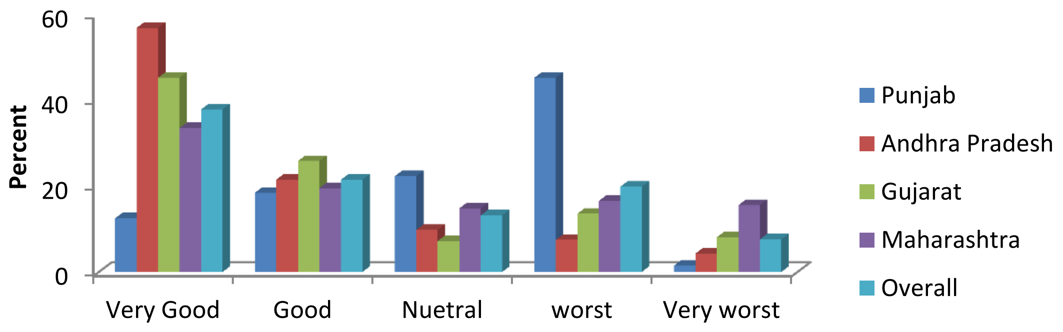
The range of clarity in procedure varied from 19% (Punjab) to 75% AP and followed by other states. There were beneficiaries who are not clear about the procedure and mechanisms of getting subsidy and they were maximum in the case of Punjab (64%).

Fig. 20: Clarity of procedure to avail subsidy for adopting Micro irrigation



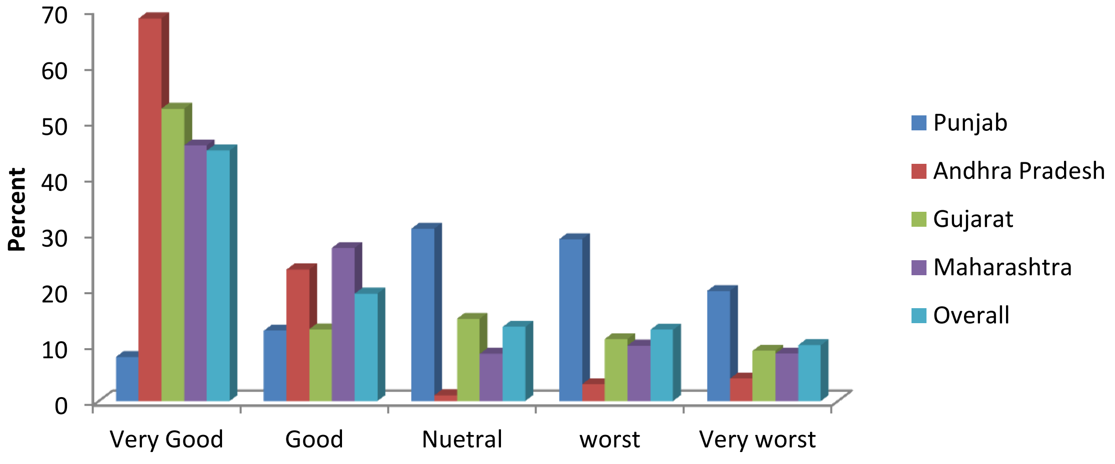
The fairness in availing subsidy and perception of beneficiaries were asked and presented in fig.21. It could be observed from the table that Farmers of AP, Gujarat and Maharashtra perceive it was very good to good. It means the subsidy distribution was fair in the states while about 41% adopters felt very good and good in the case of Punjab. However, there were adopter in all the states who could not say anything and they were neutral, maximum 22% in case of Punjab.

Fig.21: Fairness in availing subsidy for adoption of MIS



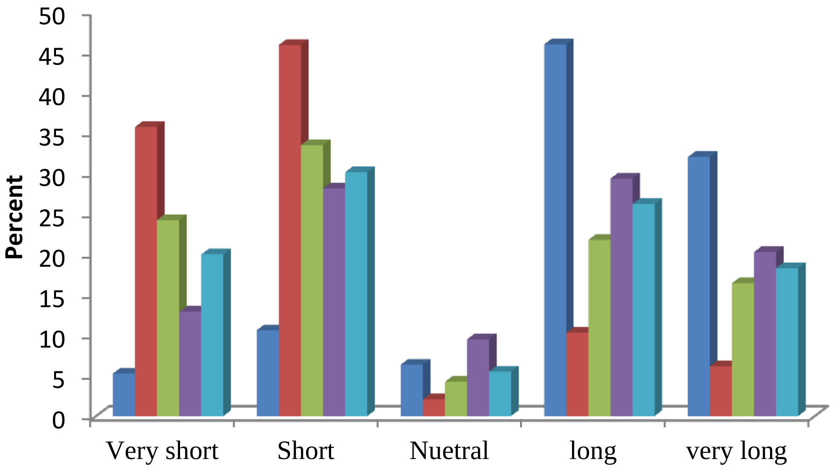
The transparency in the process of subsidy distribution is also an important issue, we have analyzed the perception of the farmers, and it is presented in the fig. 22. It could be noticed from the table that more than 68% adopter felt that subsidy support was transparent in the case of Andhra Pradesh flowed by Gujarat (52%), Maharashtra (46%) and for Punjab it was only 8%. Similarly about 19%,7%, 10% and 9% adopters felt that it was worst for Punjab, AP, Gujarat and Maharashtra, respectively. Thus, there is need to bring more transparency so that extent of beneficiaries can be increased.

Fig. 22: Transparency in the process of subsidy support



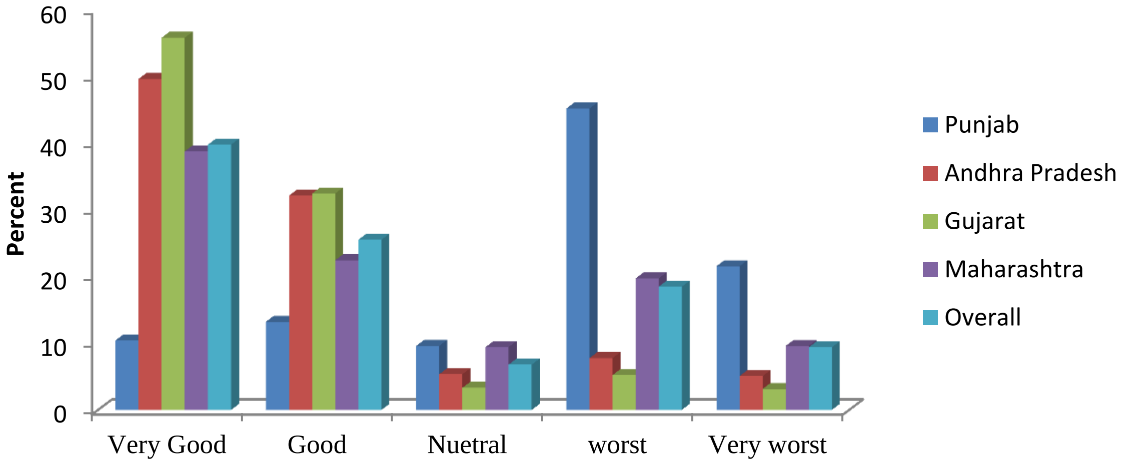
The disbursement of subsidy at soon as possible may enhance the efficiency of the PIA and has to be in speedy manner. We have analyzed the perception of adopters on this issue and observed that in AP, Gujarat and Maharashtra duration was very short to short for maximum number of beneficiaries while in the case of Punjab less number of beneficiaries (16%) have indicated the same (Fig. 23). In Punjab, maximum numbers of respondents have perceived that duration of availing subsidy was more. Thus, it is important that the disbursement of subsidy should be in speedy manner to attract more stakeholders.

Fig. 23:Time taken in availing subsidy



The adequacy of subsidy support for adoption of micro irrigation, farmers perception was analyzed and presented in the fig. 24. it could be observed from the figure that maximum adopters of Gujarat have perceived that subsidy support was adequate followed by Andhra Pradesh and Maharashtra. However, in the case of Punjab maximum adopters say support is not adequate.

Fig. 24: Adequacy of subsidy support for adopting micro irrigation system



4.9.16 Constraints in adoption of micro irrigation: we have collected the information from the adopters and same is summarized in the table 28. Farmers feel process of getting MI is lengthy. This can be settled through administrative setup of line departments involved in MIS prgramme in respective state However, responses for all the states were not uniform where farmers and line departments have better understanding and cooperation, process of

MIS access is simple. In Punjab, adopters have reported that favourism based on the caste, association with the political party and social status in the society is practiced in some of the areas. We feel that process of granting MI can be simplified.

Table 28: Constraints related to administrative process faced by adopter

Particulars	Punjab (n=91)	Andhra Pradesh (n=103)	Gujarat (n=105)	Maharashtra (n=110)
In process of getting MI				
Very lengthy	23	19	27	19
Lengthy	9	14	10	16
Neutral	5	1	3	2
Good	13	17	19	23
Very good	41	52	46	50
Favouritism /nepotism				
Very much prevalent	18	15	21	19
Prevalent	13	11	13	17
Neutral	9	18	7	4
No Favoritism	28	39	40	45
Not at all Favoritism	23	20	24	25
Post installation service is available				
Yes	49	94	86	78
No				
After installation problem Faced by farmers				
No problem	13	45	72	25
Clogging	49	63	43	86
Animal damage	37	45	27	67
Unreliable energy supply	48	78	66	47
Difficult in repair and maintenance	78	36	94	81
Problem of theft	23	12	17	24

The question of nepotism is also found to be prevailed in the study area as few farmers of each state have said, it is very much prevalent in village. The post installation of MIS, farmers face several constraints like clogging of laterals and pipes. Though state line departments involved in MIS implementation have supplied the acid and instructed to the installing firms to do the service time to time. Still farmers feel clogging and chocking of lateral is big problem. In AP, Gujarat and Maharashtra, PIA and firms on post maintenance organized series training progarmmes for farmers and field level staff. The state like Punjab training and awareness component was lacking. The damage to the MIS by own or wild animals was noticed in all the state. Farmers have reported that once laterals are damaged, it is very difficult to replace or to get serviced due remotely location of the fields. In the state of Maharashtra and Gujarat there were the cases of theft of MIS However, difficulties in maintenance and unreliable energy source were the other constraints. Therefore, scaling up the MIS in larger areas these constraints need to be minimized.

4.9.17 Reasons of non-adoption of micro irrigation: The information from the non-adopters was analyzed and is summarized in the fig. 25. The non-adopters of MIS were asked open-ended questions like whether MIS involved high initial cost or not? and perception gaged on Likert type scale. About 55% non-adopter s perceived that MIS required high initial investment. Only 19% farmers have indicated that it is not required high investment. About the time required for getting MIS, more than 71% farmers have said process is very lengthy. The question like the availability of free energy hamper the adoption rate of MIS or not? The free sources of energy discourage the adoption of MIS. It may be due to the fact that once water is available at nominal cost why farmers should adopt high cost irrigation system. Thus, they do not come forward to take up MIS on their fields. The perception on drudgery involved in the MIS operations and handling indicate that MIS involve some drudgery as more than 44% farmers were in this opinion. The question like whether skilled person needed for working with MIS or not? It was informed by the farmers that MIS need the skilled persons (47 responded for it). Difficulty in maintenance of MIS, about 85% farmers said this is the problem. Further farmers have pointed out that during farm operations, they face the problem of damage and break down during operation and delay in getting the service in time. Thus, it can be inferred from the above discussion that farmers were hesitant to install MIS due to several operational and maintenance associated problems. We feel that associated problems/constraints with MIS can be minimized through policy intervention, creating awareness conducting the exposure programmes for the farmers so that they may understand the benefits of micro irrigation. The annexure VIII present the typical questionnaire prepared for the collection of primary data.

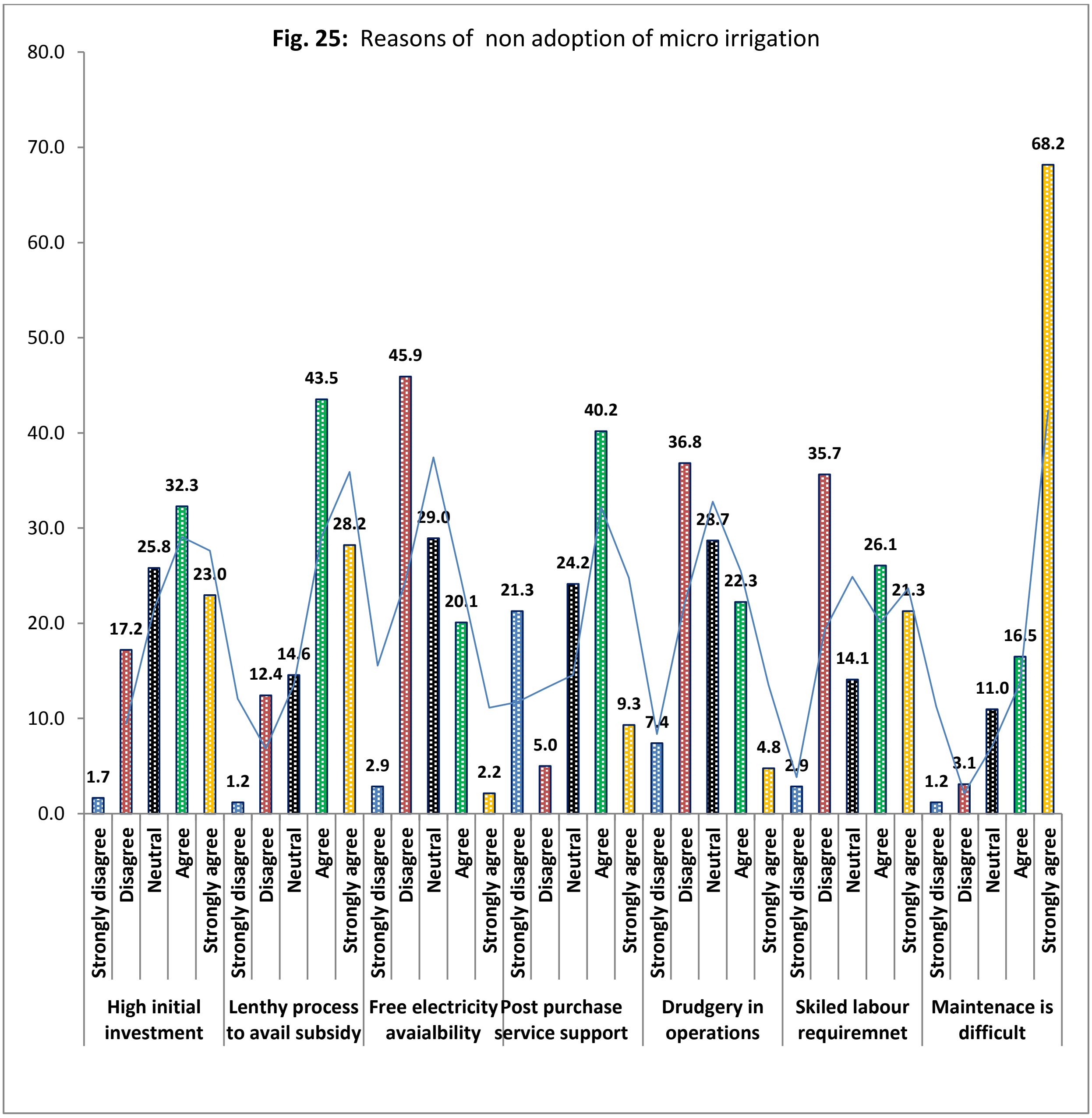


Fig. 25: Reasons of non adoption of micro irrigation

Chapter 5.0

Recommendation and lesson learnt

1. The administrative and operation process of APIMP, GGRC and Maharashtra states was found to be effective therefore; it should be replicated in other part of country.
2. The free electricity can be avoided so that ground water exploitation can be minimized.
3. The easy availability of Loan to the farmers is more beneficial. However, in case loan is not possible a lump sum grant by the department may be given for time bound and refundable manner.
4. For successful and widespread diversification of agriculture in the state, the installation of Micro irrigation systems should be made an integral part of the programme.
5. There is a tendency amongst farmers to get the Micro-irrigation system installed from the unapproved firms without intimating the Department. When the system fails due to substandard components, the farmers lay blame on the department officials. To avoid such difficulty to the farmers, a blanket ban on the unapproved firms in the state should be enforced.
6. The components like Water storage tanks, electric motors and pump sets should also be part of the micro irrigation system.
7. The data on private investment is not available with the programme implementing agencies. It is suggested that data may be collected and maintained at least district level so that exact private efforts can be quantified.
8. The constraints in MIS implementation and operational process need to be narrowed.
9. The rate of subsidy provided under NMMI through central government is fixed uniformly for different categories of farmer with a limit of 5.0 ha, this needs to be restructured as about 15% of the large and medium farmers' accounts for more than 55.42% of the land in India. Therefore, this limit of five hectares needs to be enhanced for extending the subsidy.
10. The maintenance of the system after installation and training to the farmers must also be assured so that the system works regularly without interruption. The firms supplying the system must be made responsible for the maintenance and supply of spares at least for fiver years.
11. Some R&D system may be developed at the central or the State research organization level to make recommendations regarding Drip/ Micro Sprinkler Irrigation System.
12. Region & climatic specific demonstration of the system may be developed for successful implementation of the Drip/ Micro Irrigation Systems.

Chapter 6.0

Limitations of the Study

1. Limited timeframe for the study since extensive survey is required from different locations of four states to meet the requirement of the study. Study should have been more than one year.

2. The survey was used to collect perception data and perception data has its own limitation of number and types of analysis methods available. The use of perception data makes it more difficult to establish causality as compared to research farm data.

3. The programme implementing agencies could not provide some of the data / information.

4. The impacts of micro irrigation are best studied through observation of actual ground water and surface water data. Monitoring of these data is time consuming, costly and the monitoring needs to be done on a larger duration across seasons, years to get authentic results. The time frame of *6 months* does not allow these advance econometric methods. Therefore, perception data based study methodology was decided used as the best option.

5. The sampling design based on the study design conducted the survey in selected pockets or clusters of high adoption of micro irrigation. These selection criteria can cause bias on the data collected variables such as awareness.

6. The survey instrument collected perceptions as responses on a five-point scale. This is theoretically a case of censoring a measurement and therefore induces some limitations on the measures and the analysis.

7. Another limitation was the survey questionnaire was prepared in one languages since our study area belong to different lingual states, field investigators have faced some problems. However, field staffs were also trained on the questionnaire filling prior to the survey. However, some error may have remained due to fieldwork across multiple language locations.

8. Administrative process of project has taken more time. It should be simplified to speed up the project works.

9. In spite of these limitations, efforts were made by the research team to complete the study in time.

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Annexures


Save
WATER
Preserve Life
I am participating in the Water Saving Campaign
at Los Amigos Beach Club!
DIAMOND RESORTS
INTERNATIONAL
Stay Vacationed.

Progress of micro irrigation coverage in Andhra Pradesh 2017-18

DISTRICT	**SPRINKLER**		**DRIP**		TOTAL	
	No.	**Area (ha)**	**No.**	**Area (ha)**	**No.**	**Area (ha)**
Ananthapuramu	11215	13997.63	81060	89936.55	92274	103933.4
Chittoor	***6946***	***6392.35***	***82727***	***78857.17***	***89673***	***85249.52***
East Godavari	5347	6949.74	5468	7181.87	10815	14131.61
Guntur	12729	13207.57	7368	5647.22	20097	18854.79
Krishna	6823	7306.86	10432	11480.09	17255	18786.95
Kurnool	21158	28174.03	28540	29415.73	49698	57589.76
Prakasam	13184	14614.69	29252	32256.44	42436	46871.13
SPS Nellore	10601	11187.81	11031	12812.06	21632	23999.87
Srikakulam	7183	6234.92	3476	3436.64	10659	9671.56
Visakhapatnam	***5507***	***5170.96***	***4645***	***4977.34***	***10152***	***10148.3***
Vizianagaram	4566	4743.08	3805	5424.95	8371	10168.03
West Godavari	5759	7602.62	30226	38706.85	35984	46308.68
YSR Kadapa	14309	20158.23	55497	64755.13	69806	84913.36
Total	**125327**	**145740.5**	**353527**	**384888**	**478852**	**530627**

Source: APMIP, progress report, Govt. of Andhra Pradesh, 2017-18

Annexure II

Progress of micro irrigation coverage in Gujarat up to 2017-18

DISTRICT	DRIP		SPRINKLER		TOTAL 2017		UP TO March 2018	
	No. of farmer	Area (Ha)	No. of farmer	Area (Ha)	No. of farmer	Area (Ha)	No. of farmer	Area (Ha)
Ahmedabad	1411	3165	7654	20203	9065	23368	10262	26592
Amreli	22344	33940	25710	39720	48054	73660	52510	81739
Anand	3477	4272	28	60	3505	4332	3672	4548
Arvalli	22711	45009	16630	18224	39341	63234	41829	67516
Banaskantha	***109810***	***181077***	***69115***	***127850***	***178925***	***308927***	***191536***	***328858***
Bharuch	9506	16931	3746	6512	13252	23442	14208	24957
Bhavnagar	22501	31138	21137	27299	43638	58437	48119	65239
Botad	21852	35678	1010	2503	22862	38181	26471	44843
Chhotaudepur	6528	9571	29098	38627	35626	48198	37569	50868
Dahod	935	1875	23120	32849	24055	34723	25242	36745
Dangs	207	132	5707	5796	5914	5928	6378	6479
D. Dwarka	4724	6444	14122	31758	18846	38202	23683	50065
Gandhinagar	5904	10061	3034	3771	8938	13832	9714	15029
Gir Somnath	9444	13909	26389	30799	35833	44708	39563	49109
Jamnagar	15429	23225	7644	14846	23073	38071	25896	43992
Junagadh	12459	17746	70645	99513	83104	117259	90447	127383
Kheda	5014	9349	7684	9392	12698	18740	13411	19804
Kutch	21202	50989	8808	18459	30010	69448	32999	76448
Mahisagar	1915	3532	5398	7446	7313	10978	8035	12208
Mehsana	7746	11014	11647	14358	19393	25372	20930	27108
Morbi	11716	18199	3436	6765	15152	24963	16703	27713
Narmada	8252	11889	7725	10218	15977	22107	17568	24640
Navsari	4170	5644	9750	13635	13920	19280	15093	20668
Panchmahal	1483	2249	5489	9180	6972	11429	7412	12106
Patan	3204	5607	9568	23951	12772	29558	13950	31898
Porbandar	1532	2152	16166	28125	17698	30276	19496	33434
Rajkot	34891	48242	16820	28822	51711	77064	57205	86499
Sabarkantha	***33163***	***55178***	***11349***	***12102***	***44512***	***67281***	***47721***	***72279***
Surat	6630	10571	8786	14975	15416	25546	16676	27680
Surendranagar	17060	31432	10078	27998	27138	59430	30980	68022
Tapi	4197	8420	19654	25220	23851	33640	26304	37518
Vadodara	7183	12652	1689	3895	8872	16547	9415	17485
Valsad	3346	5514	11010	13202	14356	18716	15160	19609
Gross total	441946	726804.6	489846	768073.1	931792	1494877.7	1016157	1639081

Source: GGRC, 2017-18 report

Annexure -III

Progress of micro irrigation coverage in in Maharashtra 2010-11 to 2016-17

District	Drip Irrigation			
	Number	Percent	Area in ha	Percent
Ahmednagar	***20470***	***61.36***	***13925.85***	***54.32***
Akola	5	0.01	7.67	0.03
Amaravati	8	0.02	10.75	0.04
Aurangabad	142	0.43	122.49	0.48
Beed	90	0.27	90.63	0.35
Bhandara	78	0.23	74.94	0.29
Buldhana	13	0.04	17.34	0.07
Chandarpur	253	0.76	369.05	1.44
Dhule	60	0.18	84.36	0.33
Gadchiroli	18	0.05	20.37	0.08
Gondia	42	0.13	41.05	0.16
Hingoli	2623	7.86	2120.59	8.27
Jalgaon	101	0.30	128.03	0.50
Jalna	24	0.07	18.34	0.07
Kolhapur	2800	8.39	1569.13	6.12
Latur	40	0.12	38.13	0.15
Nagpur	782	2.34	932.37	3.64
Nanded	3223	9.66	3357.51	13.10
Nandurbar	13	0.04	20.11	0.08
Nashik	52	0.16	30.03	0.12
Osmanabad	173	0.52	132.37	0.52
Palghar	76	0.23	103.36	0.40
Parbhani	4	0.01	5.09	0.02
Pune	56	0.17	42.39	0.17
Raigadh	1	0.00	2	0.01
Ratnagiri	6	0.02	3.34	0.01
Sangli	128	0.38	55.19	0.22
Satara	***81***	***0.24***	***54.14***	***0.21***
Sindhudurg	21	0.06	30	0.12
Solapur	68	0.20	62.36	0.24
Thane	246	0.74	218.54	0.85
Wardha	831	2.49	1054.45	4.11
Washim	824	2.47	884.16	3.45
Yavatmal	9	0.03	9.69	0.04
Total	33361	100	25635.82	100

Source: Directorate of Economics and statistics Govt. of Maharashtra 2016-18

Annexure IV

Progress of Micro Irrigation System coverage in Punjab state

S. No.	Name of scheme	**2013-14**		**2014-15**		**2017-18**
		Amount Utilized (lacs)	Area benefitted (ha)	Amount Utilized (lacs)	Area benefitted (ha)	Area benefitted (ha)
1.	Centrally Sponsored Scheme on Micro Irrigation (PMKSY)	604.89	2008	404.78	875	
	GOI 60%	591.15		145.36		
	State 40%	13.74		259.42		
	Sub-Total (A)	1209.78	2008	404.78	875	
B	STATE PLAN SCHEMES					
2.	Project for Promotion of Micro Irrigation in Punjab (RIDF-16)	216.16				
3.	Project for Promotion of Micro Irrigation in Punjab (RIDF-20)					
4.	Community Micro Irrigation Project in Kandi-belt of Talwara and Hajipur blocks of District Hoshiarpur (NABARD-RIDF-18)	631.58	134	1000	65	
	Grand Total	2057.52	2142	1404.78	940	48281

Source: *http://dswcpunjab.gov.in/contents/SCMIP and* (DAC.Net, 2018).

Annexure V

Actual expenditure by state and theirs share in expenditure under micro irrigation

States	Expenditure				
	2013-14	2014-15	2015-16	2016-17	2017-18*
Andhra Pradesh	265.6 (20.9)	351.1 (30.4)	197.8 (21.1)	177.5 (21.8)	425 (22.21)
Gujarat	203.1 (16.0)	137.1 (11.9)	208.4 (22.2)	181.5 (22.3)	275 (14.37)
Karnataka	186.2 (14.7)	117.4 (10.2)	110.5 (11.8)	60.6 (7.4)	300 (15.68)
Madhya Pradesh	96.8 (7.6)	67.1 (5.8)	92.7 (9.9)	70.7 (8.7)	150 (7.84)
Maharashtra	124.7 (9.8)	177.5 (15.5)	70.0 (7.5)	105.7 (13.0)	285 (14.90)
Tamil Nadu	167.9 (13.2)	87.6 (7.6)	59.9 (6.4)	64.7 (7.9)	171 (8.94)
Telangana	-	66.0 (5.7)	100.1 (10.7)	112.8 (13.8)	207 (10.82)
Punjab	5.9 (0.5)	0.9 (0.1)	2.4 (0.3)	3.9 (0.5)	-
Others	217.7 (17.2)	151.8 (13.1)	96.1 (10.2)	37.8 (4.6)	100.31 (5.24)
India	1267.9 (100)	1156.5 (100)	937.9 (100)	815.0 (100)	1913.31 (100)

Note: * released fund till 20.03.2018 in year 2017-18

Note: figure in parenthesis is percent expenditure to total expenditure made in that year under micro irrigation

Annexure –VI

Year-wise financial and physical targets and achievements for micro irrigation in India.

Year	Physical			Financial		
	Target (Ha)	Achievement (Ha)	Achievement %	Target (Rs.)	Achievement (Rs.)	Achievement %
2005-06	180223	11817	6.56	23284	1635	7.02
2006-07	397365	334301	84.13	44576	36590	82.09
2007-08	324049	421174	129.97	39896	47294	118.54
2008-09	423095	516338	122.04	41725	46784	112.13
2009-10	425764	554753	130.30	43536	56640	130.11
2010-11	667700	640069	95.86	90084	91737	101.83
2011-12	698197	557521	79.85	108290	108076	99.80
2012-13	714788	526485	73.66	109893	111888	101.82
2013-14	656000	423000	64.48	1273	1181	92.83
2014-15	574000	426000	74.22	964	986	102.28
2015-16	500000	573000	114.60	1001	1091	108.98
2016-17	800000	84000	10.50	1470	1489	101.26
2017-18	1200000	1049000	87.42	2025	1642	81.05
2018-19	1600000	1158000	72.38	2264	1751	77.32
Total	9161181	7275458		510277	508784	

Source: DAC.net, Ministry of agriculture and farmers welfare

Annexure-VII

Showing the media coverage of visits of reaeach team in Chittoor district of AP

పీలేరులో జామచెట్టును పరిశీలిస్తున్న శాస్త్రవేత్తలు - కేవీకే శాస్త్రవేత్తలతో చర్చిస్తున్న ఐసీఏఆర్ శాస్త్రవేత్తల బృందం

ఉద్యాన పంటలను ఆదుకుంటున్న
సూక్ష్మసాగు విధానం

- జాతీయ వ్యవసాయ విధాన నిర్ణాయక సంస్థ నిర్ధారణ

కలికిరి/పీలేరుటౌన్, జనవరి 19: రాష్ట్రంలో ప్రధానంగా రాయలసీమ జిల్లాల్లో ఉద్యాన పంటల విస్తీర్ణం అనూహ్యంగా పెరగడానికి సూక్ష్మసాగునీటి విధానాలే కారణమని నీతి ఆయోగ్ కమిటీకి సంబంధించిన జాతీయ వ్యవసాయ విధాన నిర్ణాయక సంస్థ (ఐసీఏఆర్) నిర్ధారణకొచ్చింది. బెంగళూరులోని ఐసీఏఆర్‌కు చెందిన ముగ్గురు శాస్త్రవేత్తలు శనివారం పీలేరు, కలికిరి మండలాల్లో సూక్ష్మ సాగునీటి (డ్రిప్ ఇరిగేషన్) పద్ధతులను వివిధ కోణాల్లో పరిశీలించారు. ఉద్యాన పంటలకు ఈ విధమైన సాగు విధానం మాత్రమే ప్రోత్సాహకరంగా వుందని దీనికి మించిన ఇతర సాగు పద్ధతులేవీ ప్రత్యామ్నాయం కావని ఈ సంస్థ ప్రధాన శాస్త్రవేత్త డా. సుభాష్ చంద్ అభిప్రాయపడ్డారు. క్షేత్రస్థాయిలో సూక్ష్మ సాగునీటి అమలు గురించి పలువురు రైతుల నుంచి అభిప్రాయాలు సేకరించారు. ఏపీఎంఐపీ అమలు చేస్తున్న డ్రిప్ ఇరిగేషన్‌లో రైతులకు అందజేస్తున్న సబ్సిడీ వివరాలు అడిగి తెలుసుకున్నారు. ఈ విధానంతో రైతులు సంతృప్తికరంగా వున్నట్లు ఈ అంశంపై అధ్యయనం చేసిన శాస్త్రవేత్తలు నిర్ధారణకొచ్చారు. సూక్ష్మ సాగు నీటి పరికరాల నాణ్యతను కూడా పరిశీలించారు. అనంతరం కలికిరి కృషి విజ్ఞాన శాస్త్రవేత్తలతో చర్చించారు. కేవీకే ద్వారా అమలు చేస్తున్న ప్రదర్శన క్షేత్రాలు, నిర్వహిస్తున్న శిక్షణ కార్యక్రమాలు, సాంకేతిక సమాచార పద్ధతుల గురించి వివరాలు సేకరించారు. ఐసీఏఆర్, కేవీకే ప్రధాన శాస్త్రవేత్తలు రెడ్డికుమార్, గణేశ్‌కుమార్, ఏపీఎంఐపీ ఏపీడీ కిరణ్‌కుమార్, ఎంఐఏ దొరబాబు తదితరులు ఈ అధ్యయనంలో పాల్గొన్నారు.

సూక్ష్మసాగు నీటి పారుదలలో దేశంలోనే ప్రథమం

ఇదిలా వుండగా సూక్ష్మ సాగునీటి పారుదల విషయంలో రెండేళ్ళ నుంచి రాష్ట్రం ప్రథమ స్థానంలో వుందని జిల్లా ఏపీఎంఐపీ సంచాలకులు విద్యాశంకర్ వివరించారు. ఇంత పెద్ద ఎత్తున రాష్ట్రంలో ఈ సాగు నీటి పద్ధతులు విస్తారంగా అమల్లోకి రావడానికి దోహదపడిన వ్యూహాల గురించి అధ్యయనం చేసేందుకు నీతి ఆయోగ్ సంస్థ ఐసీఏఆర్ ద్వారా రాష్ట్రంలో పరిశీలన జరుపుతున్నట్లు ఆయన చెప్పారు. విశాఖపట్నం, చిత్తూరు జిల్లాలను ఈ పరిశీలన కోసం ఎంపిక చేశారని తెలిపారు. డ్రిప్ ఇరిగేషన్‌లో రాష్ట్రంలో చిత్తూరు జిల్లా ప్రథమ స్థానంలో వుందని తెలిపారు. డ్రిప్ ఇరిగేషన్ రాష్ట్రంలో విజయవంతం కావడానికి కారణాలు, ప్రభుత్వం అవలంబిస్తున్న విధానాలు, రైతుల విజయగాథలపై ఐసీఏఆర్ శాస్త్రవేత్తల బృందం క్షేత్రస్థాయి పరిశీలనలు చేపట్టిందని విద్యాశంకర్ చెప్పారు. ఈ పరిశీలనలో వెల్లడయ్యే సానుకూల అంశాలను అన్ని రాష్ట్రాల్లో అమలు చేయడానికి అవకాశం వుందన్నారు. ● పీలేరు మండలంలో నీతి ఆయోగ్ కమిటీ నుంచి ఐసీఏఆర్ శాస్త్రవేత్తల బృందం పర్యటించింది. డ్రిప్ ఇరిగేషన్ ప్రాజెక్టు విధివిధానాలు, డ్రిప్ పథకం వల్ల రైతులకు కలిగే ప్రయోజనాలపై క్షేత్రస్థాయిలో పరిశీలించింది. రైతుల నుంచి డ్రిప్ పథకంపై ఆరా తీసి విధివిధానాలపై సంతృప్తి వ్యక్తం చేసింది. శాస్త్రవేత్తల వెంట ఏపీడీ కిరణ్‌కుమార్, ఎంఐఏవో దొరబాబు ఉన్నారు.

ఉద్యానపంటలకు ఆసరాగా బిందుసేద్యం

కలికిరి గ్రామీణ, న్యూస్‌టుడే : కరవు ప్రాంతాల్లో ఉద్యానపంటల సాగుకు సూక్ష్మనీటి సేద్యం ఎంతగానో దోహదపడుతోందని జాతీయ వ్యవసాయ పాలసీ సంస్థ ప్రధాన శాస్త్రవేత్త డాక్టర్ సుబాష్‌చంద్ తెలిపారు. శనివారం కలికిరి కృషివిజ్ఞాన కేంద్రాన్ని నీతిఅయోగ్ బృందం సభ్యులు పరిశీలించారు. ఈ సందర్భంగా కేవీకేలో అమలవుతున్న రైతులకు శిక్షణ కార్యక్రమాలు, సాంకేతిక సమాచారం, ప్రదర్శన క్షేత్రాలు, క్షేత్ర పరిశీలనలపై ఆరా తీశారు. అదేవిధంగా కేవీకేలో ఏర్పాటుచేసిన పలు ప్రదర్శన యూనిట్‌లను సందర్శించి రైతులకు అందుతున్న సేవల గురించి అడిగి తెలుసుకున్నారు. ప్రస్తుత వర్షాభావ పరిస్థితుల్లో రైతులకు సూక్ష్మనీటి సేద్యంపై మరింత అవగాహన కార్యక్రమాలు నిర్వహిస్తే రైతుల సామాజిక, ఆర్థిక పరిస్థితులు మెరుగవుతాయని వివరించారు. ఈ దిశగా శాస్త్రవేత్తలు చర్యలు చేపట్టాలన్నారు. అనంతరం మండలంలో బిందు సేద్యంతో సాగవుతున్న బొప్పాయి, దానిమ్మ, మామిడి తదితర పంటలను పరిశీలించారు. కార్యక్రమంలో కేవీకే కోఆర్డినేటర్ ఎం. రెడ్డికుమార్, శాస్త్రవేత్తలు గణేష్‌కుమార్, ఏపీఎంఐపీ ఏపీవో కిరణ్‌కుమార్, సిబ్బంది పాల్గొన్నారు.

బిందుసేద్యం అమలుపై కేవీకే కోఆర్డినేటర్‌తో చర్చిస్తున్న నీతిఅయోగ్ బృందం సభ్యులు

కసరత్తు

చిత్తూరు

చిక్కుడు సాగును పరిశీలిస్తున్న నీతి ఆయోగ్ శాస్త్రవేత్త సుభాష్ చంద్

వంగ సాగు పద్ధతులను వివరిస్తున్న ఏపీడీ కిరణ్‌కుమార్

బిందు సేద్యాన్ని పరిశీలించిన
నీతి ఆయోగ్ బృందం

సాగులో ప్రయోజనాలపై రైతులతో ఆరా

చిత్తూరు(వ్యవసాయం), న్యూస్‌టుడే: కేంద్ర ప్రభుత్వ పరిధిలోని నీతి ఆయోగ్(ప్రణాళిక సంఘం)ప్రధాన శాస్త్రవేత్త సుబాష్‌చంద్ సహా ఇద్దరు విద్యార్థుల బృందం జిల్లాలో పర్యటించింది. దేశవ్యాప్తంగా నీతి ఆయోగ్ ప్రత్యేక శాస్త్రవేత్తల బృందాలు వ్యవసాయం రంగంలో ఆర్థిక ఒడిదుడుకులు, స్థితిగతులపై అంచనా వేస్తున్నారు. దీనిలో భాగంగా వ్యవసాయంలో సూక్ష్మనీటిసాగు పథకం పాత్రపై అంచనాకు రాష్ట్రంలో సూక్ష్మసేద్యం ఎక్కువ విస్తీర్ణంలో ఉన్న చిత్తూరు, తక్కువ సాగు విస్తీర్ణం కలిగిన విశాఖపట్నం జిల్లాలను ఎంపిక చేసింది. ఈ తరుణంలో నీతి ఆయోగ్ ప్రధాన శాస్త్రవేత్త సుబాష్‌చంద్‌తో కూడిన ఇద్దరు విద్యార్థుల బృందం శుక్ర, శనివారాలు జిల్లాలోని కుప్పం, బైరెడ్డిపల్లి, పలమనేరు, వి.కోట తదితర మండలాల్లో సూక్ష్మసేద్యం పంటలను పరిశీలించారు. పంటల సాగులో బిందు, తుంపర్ల సేద్యం పాత్ర ఎంత..? పథకం అమలు ఎలా ఉంది..? సకాలంలో పరికరాలు, రాయితీలు అందుతున్నాయా..? తదితర అంశాలను రైతులను అడిగి తెలుసుకున్నారు. సూక్ష్మసేద్యం పద్ధతిలో సాగు చేస్తున్న పలు రకాల ఉద్యాన పంటలను క్షేత్రస్థాయి పరిశీలించారు. గతంలో ఎన్ని ఎకరాల్లో పంటల సాగు చేసేవారు..? సూక్ష్మసేద్యం విధానంలో ఎంత విస్తీర్ణంలో సాగు చేస్తున్నారు..? దిగుబడులు ఎలా ఉన్నాయి... సూక్ష్మసేద్యం రాయితీలతో ప్రయోజనాలు ఉన్నాయా..?, ఇంకా ప్రోత్సాహక రాయితీలు అవసరమా తదితర విషయాలను అడిగి తెలుసుకున్నారు. జిల్లాలో సూక్ష్మసేద్యం పథకం అమలు, పంటల సాగు విస్తీర్ణం, దిగుబడులు, మార్కెటింగ్ తదితర వివరాలను సూక్ష్మనీటి సాగు పథకం ఏపీడీ కిరణ్‌కుమార్ శాస్త్రవేత్త బృందానికి వివరించారు. సాగులో సూక్ష్మసేద్యం పాత్ర, ఆర్థిక స్థితిగతులపై సమగ్రంగా నివేదిక రూపంలో నీతి ఆయోగ్‌కు నివేదిస్తామని ప్రధాన శాస్త్రవేత్త సుబాష్ చంద్ పేర్కొన్నారు.

హెచ్చరి
ఇందుమూలముగా యావన్మందికి తెలియజే
ఆస్తి అనగా **వేలూరు రోడ్డులో ఆనందా** థి
నా కక్షిదారుడైన **శ్రీ పి.రమేష్ S/o నరసింహ**
చిత్తూరు అనువారు **శ్రీమాన్ 8** వ అదనపు

రాజంపేట మాజీ ఎంపీ పెద్దిరెడ్డి వెంకట మిథున్‌రెడ్డి, పీలేరు ఎమ్మెల్యే చింతల రామచంద్రారెడ్డి సహకారంతో నిర్వహించినట్లు నిర్వాహకులు తెలిపారు. స్థానిక వైఎస్సార్ కాంగ్రెస్ పార్టీ నాయకులు నజీర్, చింతల మల్లికార్జున, కార్జున, వెంకటప్పనాయుడు, సుధాకర్ మహబూబ్‌బాషా, చిగురుపాటి మల్లి నాయుడు తదితరులు పాల్గొన్నారు.

జగన్ కింగ్స్ జట్టు

సూక్ష్మనీటి వ్యవసాయంపై మరింత అవగాహన

కలికిరి: సూక్ష్మనీటి సాగు(బిందు సేద్యం)పై రైతులకు మరింత అవగాహన కల్పించాల్సిన అవసరముందని జాతీయ వ్యవసాయ పరిశోధన సంస్థ శాస్త్రవేత్తలు అభిప్రాయపడ్డారు. జాతీయ వ్యవసాయ విధాన నిర్ణాయక సంస్థ ఆధ్వర్యంలో జాతీయ వ్యవసాయ పరిశోధన సంస్థ ప్రధాన శాస్త్రవేత్త డాక్టర్ సుభాష్‌చంద్, సహాయ శాస్త్రవేత్తలు శనివారం పీలేరు, కలికిరి మండలాల్లో పర్యటించారు. రాయితీ, సూక్ష్మబిందు పరికరాల వినియోగం, ఉపయోగాలు, నీటి ఆదాపై రైతులను అడిగి తెలుసుకున్నారు. ఉద్యాన పంటల సాగుకు సూక్ష్మనీటి పద్ధతులు అనుకూలంగా ఉండటంతో రైతులు అటువైపు మొగ్గుచూపుతున్నట్లు వారు అభిప్రాయపడ్డారు. తీవ్ర వర్షాభావం దృష్ట్యా తక్కువ నీటితో ఎక్కువ విస్తీర్ణం సాగుచేసి లాభాలు గడించిన రైతులతో మాట్లాడి వివరాలు తెలుసుకున్నారు. అనంతరం కలికిరి కృషి విజ్ఞాన కేంద్రాన్ని సందర్శించారు.

మర్రికుంటపల్లె వద్ద సూక్ష్మనీటి సాగు పద్ధతిలో సాగు చేసిన కర్బూజా పంటను పరిశీలిస్తున్న శాస్త్రవేత్తలు

ఈ కార్యక్రమంలో కేవీకే శాస్త్రవేత్తలు రెడ్డికుమార్, గణేష్‌కుమార్ ఏపీఎంఐపీ ఏపీడీ కిరణ్‌కుమార్ పాల్గొన్నారు.

Annexure -VIII

(Survey Schedule)

ICAR - National Institute of Agricultural Economics and Policy Research
Dev Prakash Shastri Marg, Pusa, New Delhi – 110012

Efficiency of Micro-irrigation in economizing water use in India-learning from potential and unexplored area

1. Village profile

i) Name: __________________ ii) Block:____________ iii) District: __________
iv) No. of households------- SC---------, ST--------------, OBC----, General___________
iv) Pucca Road connectivity (Yes = 1 No=0): ____ if no then distance from village (km):
v) Telephone line (Yes=1, No=0):_______ vi) internet connection (Yes=1, No=0):____ Year:
vii) Rail connectivity (Yes =1 No=0):______ if no then distance from village (km):
vi) Distance from the nearest city/town (km): ____
vii) Availability of inputs in the village (Yes =1 No=0):______ if no then distance from village(km):
ix) Electricity connection year: ________
x) Banking facility (Yes = 1 No=0):______ xi) Primary health facilities (Yes =1 No=0):______
xii) School (Yes =1, No=0):__________ if yes then Primary, Middle, Secondary, senior secondary
xiii) Agricultural extension support (Yes =1 No=0):______ xiv) Soil type: sandy/loam/clay

2. General information

i) Name of household head: _________________________ ii) Aadhar card (Y/N): ___________
iii) Age: iv) Gender (Male=1 Female=0):_______
v) Education level (schooling Yrs.): _______ vi) Caste: Gen/OBC/MBC/SC/ST/Any____
vii) Family size: M __F__C__ viii) No of working members (agril): Male_____ Female______ ix) Mobile : ______ Since how many years using mobile: _____________
xii) Diversification of income:

Particular	Food grains	Horticulture	Livestock	Agri-labour	off farm	Total income
Annual Income (Rs.)						

xiii) Member of social organization/cooperatives (Yes=1 No=0):___ if yes then specify: __________
xiv) Food expenditure (month):___________ xv) Non-food expenditure (month):_______
xvi) Kisan Credit Card (Yes=1, No=0):__________ Year: ______ xvii) Total loan (Rs.):_________

xviii) Crop insurance (Yes=1, No=0):_______ if yes then premium rate:________
xix) Types of ration card (Yes=1, No=0):_____ If Yes then type: ________
xx) Soil health card (Yes=1, No=0):________ if no then why:________________________

3. Land (Acres):O____ Leased-in:________ Leased-out:_________ Fallow:________

Particulars	Sources of irrigation	Owned		Leased-in	
Irrigated		P1	P2	P1	P2
	Canal				
	Pond				
	Open Well				
	Tubewell				
Un-irrigated	Rainfed				

*P=Plot

4. Micro-irrigation (MI)

A. General

i. Do you feel water scarcity: Strongly agree: ☐ Agree: ☐ Neutral: ☐ Disagree: ☐ Strongly Disagree:☐
ii. Depth of water table (feet) (now): ________before 10 years: _________ before 5 years_____
iii. Reasons for deepening water table: Since early water table is low: ☐ Extraction rate is high: ☐ High temperature: ☐ low rainfall: ☐ Others specify: ________________
iv. Reason for high extraction rate:_________________
1.High dependence on groundwater 2. Water intensive cropping pattern 3. Subsidized energy source 4. Electricity supply during night hours 5. Any others_________________
v. Decline in water level will be problem for me in next 5-10 years: 1.Strongly agrees: ☐ 2. Agree: ☐ 3. Neutral: ☐ 4. Disagree: ☐ 5. Strongly Disagree:☐
vi. Are you aware of MI (Yes=1 No=0):
vii. Source of information: Peers/Government official/ Universities/ KVK/ news paper /TV/ radio/Mobile.
viii. Do you have micro-irrigation system (Yes=1 No=0):
ix. If yes then year of installation:____________
x. Name MI System and installation year: i) Sprinkler ☐year___ ii) Drip ☐ year____
xi. Is it under government scheme (Yes=1 No=0):______
xii. if yes then name of scheme
xiii. To whom you have approached

Particulars	No. of visits	Distance (Km)	Time in Man-days	Expenses incurred (Rs.)
Pradhan/Sarpanch and PRI members				
NGOs or others				
Local dealers/contractor				
Block level Dept.				
District level Dept.				
Other				

xiv. Average time taken for getting micro-irrigation and installation (days):
xv. How much total cost you incurred (Rs):__________ subsidy

amount(Rs):__________

xvi. Your contribution: Cash______ Kind______
xvii. How you got subsidy (Code A):______
xviii. How much time taken in getting subsidy credited (days):
xix. How you have managed rest money for MI installation (Code B): ________
xx. If installed then still continuing with MI (Yes=1 No=0):_________
xxi. If no then why (Code C):__________
xxii. If yes then Are you willing to continue MI if subsidy removed (Yes=1 No=0):_________
xxiii. Are you aware of fertigation (Yes=1 No=0):_________
xxiv. If yes then do you follow (Yes=1 No=0):_______

Code A: Account transfer (BDT) =1 Bank cheque=2 private company installed=3 other mode=4
Code B: paid himself=1, took loan from bank=2, loan from money lender=3, from relative/friends etc=4
Code C: post installation service/care was not given=1 quality of MI system was not good=2 consumed more labour in shifting pipes=3 other specify=4

B. People's participation in MI

Particulars	Level of participation (Different stage of programme)		
	Planning	Implementation	Maintenance
Selection of site			
Selection of crop			
Selection of installing firm			
Selection of credit agency			
Contacts made to officials			

1. Not at all 2. Less participation 3. Moderate 4. High participation 5. Very high participation

C. Problems faced by farmers:

a. Process of getting MI (Code D):
b. Favouritism/nepotism in getting MI (Code E):
c. Post installation service is available (Yes=1 No=0):
d. Main problem faced after installation (Code F):
e. Do you face problem of seed/planting material (Yes=1 No=0):

D. Reason for non-adoption

S no	**Particulars**	**strongly agree**	**agree**	**neutral**	**disagree**	**strongly disagree**
1	High initial investment					
2	Lengthy process for availing subsidy					
3	Free electricity getting so why sprinkler					
4	No proper support after purchase of MI from distributors					
5	Not aware of MI					
6	Small size of land holdings					
7	Drudgery in operation					
8	Lack of skilled manpower required					
9	Maintenance is difficult					

E. Area under different crops grown by farmers

	Kharif				**Rabi**				**Annual/plantation/orchards**			
10 years back												
Crop name												
Crop Area												
At present time												
Crop name												
Crop Area												
At time of MI installation												
Crop name												
Crop Area												
At present time crop and area under MI												
Crop name												
Crop Area												
Any new area brought under MI												
Crop name												
Crop Area												

Code D: Very lengthy=1 lengthy=2 Neutral=3 Good=4 Very good=5, **Code E:** Very much prevalent=1 Prevalent=2 Neutral=3 No=4 Not at all=5, **Code F:** Clogging=1 animal damage=3 Unreliable energy supply=4 Difficult in repair & maintenance=5 problem of MI system theft= 6 any others= 7 specify

5. Farmers experience for MI Technology

S no	Crops	Particulars	Improvement		Increase			Saving			
			Yield	Quality	Price	Net income	Gross income	Water	Energy	Labour	Fertilizer
1		Yes=1 No=0									
		If yes then by what %									
2		Yes=1 No=0									
		If yes then by what %									
3		Yes=1 No=0									
		If yes then by what %									
4		Yes=1 No=0									
		If yes then by what %									
5		Yes=1 No=0									
		If yes then by what %									

6. Irrigation details:

		Traditional irrigation								Micro-irrigation							
Name of Crops	Total area	Irrigated Area	No of irrig.	Source of irrig *	Irrig. Time (hr) / area	Energy source (E/D)#	Energy consume/ hr	Engine BHP	Engine (O/H)	Area	No of irrig.	Source of irrig *	Irrig. Time (hr)/area	Energy source (E/D)#	Energy consume/ hr	Engine BHP	Engine (O/H)

Note: ****:****1= Owned TW, 2= Hired TW, 3=Canal, 4= Pond or others,* ***#:*** *E= Electric D= Diesel O= Owned, H= Hired.*

Cost and return of crop production (Crop A)

Operations		Traditionally irrigated :----------						Sprinkler/Drip Irrigated:---------					
		Human Labour		Machine		Material used		Human Labour		Machine		Material used	
		Man Day	Wage	Hrs.	Rate	Qty	Rate	Man Day	Wage	Hrs	Rate	Qty	Rate
Land Prep.	Pre. Sowing irri.												
	Ploughing												
	Ridging												
	Sowing/ planting												
Manure &Fert.	FYM												
	Urea												
	NPK												
	DAP												
	Others												
Plant Prot.	Chemical												
	Human												
Irrigation													
Harvesting													
Threshing													
Transportation													
Other													
Yield		Production (q)		Sold (q)		Rate (Rs./q)		Production (q)		Sold (q)		Rate (Rs./q)	
Main product													
By product													

i **Production**:

i. Point of sale: Farm gate/Local Market or Mandi/ District market/ Home/Godown/Storage place/other, please specify:__________
ii. Distance to be covered for sale:
iii. Transportation mode:
iv. Storage facilities (Yes=1 No=0):
v. Any type of processing (Yes=1 No=0): if yes then specify: ____________________
vi. Packaging: traditional or modern

Cost and return of crop production (Crop B)

Operations		Traditionally irrigated :----------						Sprinkler/Drip Irrigated:---------					
		Human Labour		Machine		Material used		Human Labour		Machine		Material used	
		Man Day	Wage	Hrs.	Rate	Qty	Rate	Man Day	Wage	Hrs	Rate	Qty	Rate
Land Prep.	Pre. Sowing irri.												
	Ploughing												
	Ridging												
	Sowing/ planting												
Manure &Fert.	FYM												
	Urea												
	NPK												
	DAP												
	Others												
Plant Prot.	Chemical												
	Human												
Irrigation													
Harvesting													
Threshing													
Transportation													
Other													
Yield		Production (q)		Sold (q)		Rate (Rs./q)		Production (q)		Sold (q)		Rate (Rs./q)	
Main product													
By product													

i **Production**:

i. Point of sale: Farm gate/Local Market or Mandi/ District market/ Home/Godown/Storage place/other, please specify:__________
ii. Distance to be covered for sale:
iii. Transportation mode:
iv. Storage facilities (Yes=1 No=0):
v. Any type of processing (Yes=1 No=0): if yes then specify: ____________________
vi. Packaging: traditional or modern

10. Cost of installing MI

S. no.	Crops Name	Cost of MI (Rs.)	
		Drip company name	Sprinkler company name
1.			
2.			
3.			
4.			
5.			

11. Level of satisfaction for MI

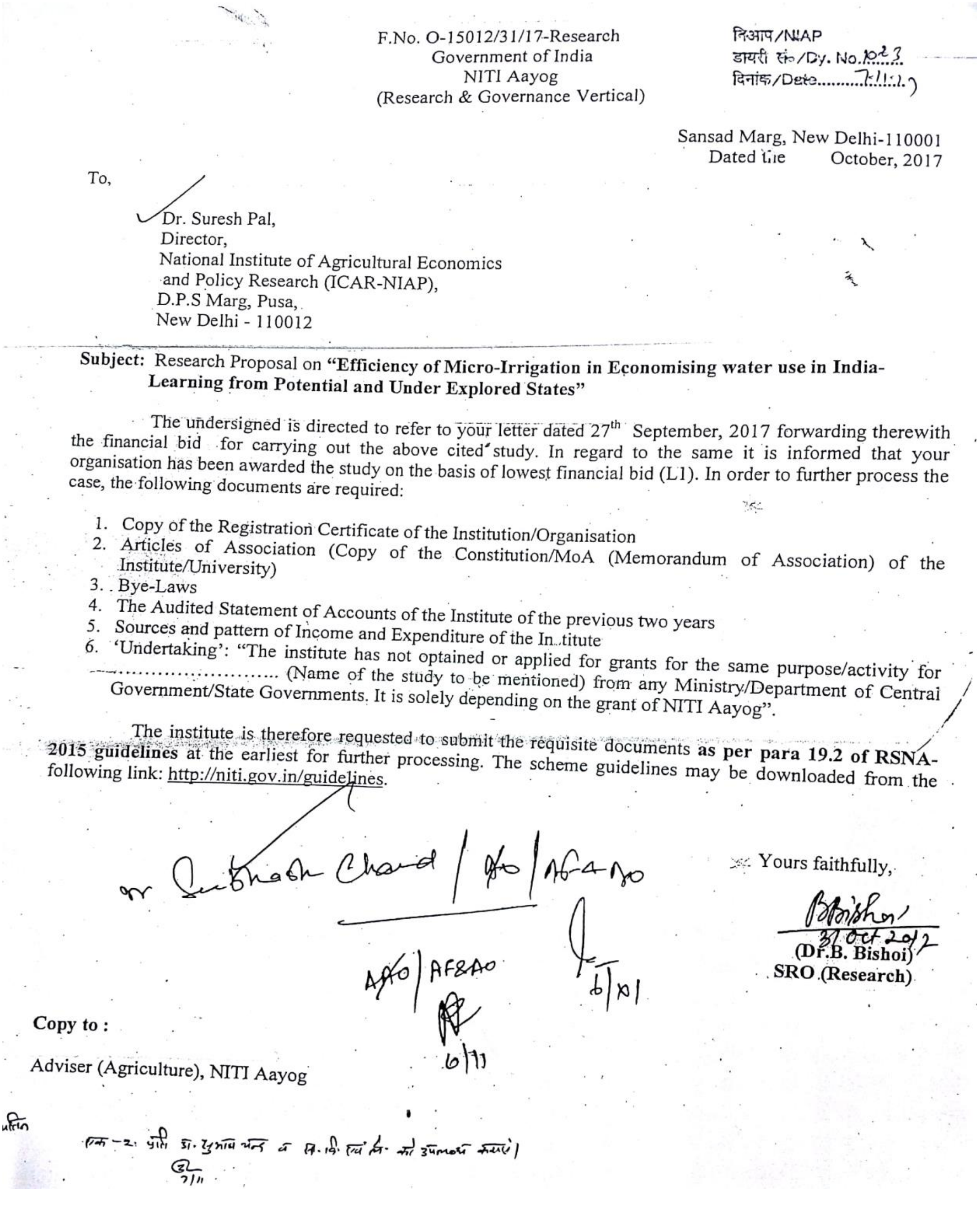
S. no	Particulars	Highly Satisfied	Satisfied	Neutral	Dissatisfied	Highly. Dissatisfied
	Govt. level drivers					
1.	Advice for MI					
2.	Awareness creation					
3.	Line dept. supports					
4.	Subsidies by Government					
	Dealer/ distributor					
1.	Technical support from agencies					
2.	Quality material supply					
3.	Quality installation					
4.	Clogging resistance					
5.	Compatibility with crops					
	Farmer level					
1.	User friendly					
2.	Water saving					
3.	Energy saving					
4.	Labour saving					
5.	Quality product					
6.	High production					
7.	High return					
8.	Production round the year					
9.	wasteland area can be put to use					

12. Assets of households

Assets	Yes= 1 No=0	Number	Assets	Yes =1 No=0	Number
Cattle shed			Cow		
Store & equipment’s			Buffalo		
Tractor			TV		
Harrow			Mobile		
Power tiller			Motorcycle		
Thresher			Car		
Any other specify					

Annexure-IX

Sanction order



F.No. O-15012/31/17-Research
Government of India
NITI Aayog
(Research & Governance Vertical)

नि.आप/NIAP
डायरी सं./Dy. No. 1023
दिनांक/Date 7/11/17

Sansad Marg, New Delhi-110001
Dated the October, 2017

To,

Dr. Suresh Pal,
Director,
National Institute of Agricultural Economics
and Policy Research (ICAR-NIAP),
D.P.S Marg, Pusa,
New Delhi - 110012

Subject: Research Proposal on **"Efficiency of Micro-Irrigation in Economising water use in India- Learning from Potential and Under Explored States"**

The undersigned is directed to refer to your letter dated 27th September, 2017 forwarding therewith the financial bid for carrying out the above cited study. In regard to the same it is informed that your organisation has been awarded the study on the basis of lowest financial bid (L1). In order to further process the case, the following documents are required:

1. Copy of the Registration Certificate of the Institution/Organisation
2. Articles of Association (Copy of the Constitution/MoA (Memorandum of Association) of the Institute/University)
3. Bye-Laws
4. The Audited Statement of Accounts of the Institute of the previous two years
5. Sources and pattern of Income and Expenditure of the Institute
6. 'Undertaking': "The institute has not optained or applied for grants for the same purpose/activity for ……………………… (Name of the study to be mentioned) from any Ministry/Department of Central Government/State Governments. It is solely depending on the grant of NITI Aayog".

The institute is therefore requested to submit the requisite documents **as per para 19.2 of RSNA-2015 guidelines** at the earliest for further processing. The scheme guidelines may be downloaded from the following link: http://niti.gov.in/guidelines.

Dr Subhash Chand / AFO / AF&AO

AFO / AF&AO
6/11

6/11

Yours faithfully,

B Bishoi
31 Oct 2017
(Dr.B. Bishoi)
SRO (Research)

Copy to :

Adviser (Agriculture), NITI Aayog

प्रति
एक-2 प्रति डा. सुभाष चन्द व वि.वि. एवं ले. को उपलब्ध करायें।
7/11

भा॰कृ॰अनु॰प॰ – राष्ट्रीय कृषि आर्थिकी एवं नीति अनुसंधान संस्थान
डी.पी.एस. मार्ग, पूसा, नई दिल्ली - 110012

ICAR - National Institute of Agricultural Economics and Policy Research
Dev Prakash Shastri Marg, Pusa, New Delhi – 110012

FORM GFR – 12– C

[See Rule 239]

Form of Utilization Certificate

Project: Efficiency of Micro-Irrigation in Economizing Water use in India- Learning from Potential and Under Explored States.

S.No	Letter No. & date	Amount
1.	F.No. O-15012/31/17-G&R dt. 03.07.2018	647595/-
	TOTAL	**647595/-**

Certified that out of **Rs. 7,71,226/-** (Rupees Seven Lakh Seventy One Thousand Two Hundred Twenty Six Only) of grants-in-aid sanctioned during the **year 2018-19** in favour of ICAR-NIAP under this Ministry/Department Letter.No. given in the margin and **Rs. NIL** on account of unspent balance of the previous year, a sum of **Rs. 771226/-** has been utilized for the purpose of Project Activity for which it was sanctioned and that the balance of **Rs. -123631/-** (Rupees Negative One Lakh Twenty Three Thousand Six Hundred Thirty One Only)..

1. Certified that I have satisfied myself that the conditions on which the grants-in-aid was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually utilized for the purpose for which it was sanctioned.

Kinds of checks exercised

1. Paid Vouchers
2. Sanction Order
3. Purchase Order
4. Relevant Register

Signature 30.4.2019

Designation

Date 30.4.2019

National Institute of Agricultural Economics and Policy Research D.P.S. Marg, Pusa, New Delhi-110012

Statement of Expenditure (SOE) in respect of project "Efficiency of Micro-Irrigation..........in India" for the year 2018-19

S.No.	Items of Expenditure	Opening Balance	Funds Received	Expenditure Incurred during the	Closing balance as on 31st March,
1	Salaries/Honorarium/Fellowhip etc.	0.00	647595.00	162000.00	-123631.00
2	Travelling Allowance	0.00		192846.00	
3	Recurring Contingencies	0.00		416380.00	
4	Chemicals and Consumables	0.00		0.00	
	Sub Total (A)	**0.00**	**647595.00**	**771226.00**	**-123631.00**

30/4/19

(Dr. Subhash Chand)

Principal Scientist & PI

30.4.2019

Assistant Finance & Accounts Officer

Breakup of closing balances in various Projects, Externally Funded Schemes,Contractual and Consultancy Research Programs

Coordinator: Dr. Subhash Chand

बाहय परियोजनाएं Externally Funded Schemes

411 Efficiency ofMicro-Irrigation in Economising Water use in India- Learning from potential and under Explored States

	Opening Balance	Budget	Remittances Received	Headwise Remittance Received	Payments Made	Refunds	Closing Balance
Salaries/Honm./Fellowships		0.00	0.00	0.00	162000.00	0.00	
Travelling Allowances		400000.00	0.00	0.00	192846.00	0.00	
Recurring Contingencies		1250000.00	0.00	0.00	416380.00	0.00	
Receipts		0.00	647595.00	0.00	0.00	0.00	
Chemicals and Consumables		748500.00	0.00	0.00	0.00	0.00	
Transactions Upto 22-Dec-18	0.00	2398500.00	647595.00	0.00	771226.00	0.00	-123631.00