ASSESSING SKILL GAP IN MICRO IRRIGATION ACROSS INDIA

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MINISTRY OF AGRICULTURE AND FARMERS WELFARE
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Table of Contents

List of Abbreviations

ATMA	Agricultural Technology Management Agency
APMIP	Andhra Pradesh Micro Irrigation Project
CIPET	Central Institute of Petrochemicals Engineering & Technology
DDP	Desert Development Programme
DPAP	Drought Prone Area Programme
B2C	Business to Consumer
GGRC	Gujarat Green Revolution Company
MI	Micro Irrigation
NABARD	National Bank for Agriculture and Rural Development
NCPAH	National Committee on Plasticulture Applications in Horticulture
NMMI	National Mission on Micro Irrigation
NMSA	National Mission on Sustainable Agriculture
OFWM	On Farm Water Management
PDMC	Per Drop More Crop
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
SPV	Special Purpose Vehicle
TANHODA	Tamil Nadu Horticulture Agency

List of Tables

List of Figures

Executive Summary

Globally, the attainment of 'water security' has been identified as a key development goal in the context of achieving environmental sustainability and human well-being. Intensive overextraction of groundwater, increasing temperature induced surface loss, and increasing global freshwater use have led to a rapid decline in water storage and freshwater availability Estimates from the United Nations (2021) suggest that 69 per cent of global water withdrawals are from the agriculture sector (encompassing crops, livestock, fisheries, aquaculture and forestry). Thus, over the last three decades, the need to identify strategies to manage scarce water resources in agriculture has been recognised. In this context, micro irrigation has been identified as an innovative demand management strategy, with empirical evidence to suggest that it leads to a reduced energy footprint, increased yields and income, savings in terms of water, labour, fertilizer and input usage.

In India, the Economic Survey 2020-21 has summarised the benefits accrued from micro-irrigation; saving of water from 20 per cent to 48 per cent, saving of energy from 10 to 17 per cent, saving of labour cost from 30 to 40 per cent, saving in fertilizer usage from 11 to 19 per cent and increase in crop production from 20 to 38 per cent, and commented on the scope of using this technology in closely spaced crops like rice, wheat, onion, potato, etc. Several policy incentives have been introduced in recent years to enable the rapid diffusion of micro irrigation technologies in India. The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched in the financial year 2015-16, under which one of its components specifically seeks to maximise water use efficiency at the field level, thereby ensuring "*Per Drop-More Crop (PDMC)*". The Per drop component focuses on enhancing water use efficiency at farm level through micro irrigation; drip and sprinkler irrigation systems and create employment opportunities for skilled and unskilled youth for installation and maintenance of micro irrigation systems.

Study Objectives

This study seeks to undertake the following:

- Catalogue the status of micro-irrigation coverage for improving water use efficiency in different states of India.
- Assess the impact/sustenance of micro-irrigation use by the farmers after two years of its coverage in different States.
- Identify reasons for disuse of micro-irrigation (if any) including reasons related to shortage of spare parts and skilled manpower locally.
- Study the nature and extent of skill-gap in the area of micro-irrigation and suggest measures to bridge the skill gap, including training, wages etc.
- Formulate the strategies and programmes that may be required for filling up the gap of skilled manpower in view of rapid expansion of micro-irrigation coverage.

The study is based on comprehensive primary surveys complemented by key informant interviews of stakeholders across the micro irrigation supply chain, government departments and beneficiaries across six states; including Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Tamil Nadu. Within these states, two high coverage districts were selected taking into account heterogeneity in agro-economic zones as well as cropping pattern. In each district, two taluks were

selected; there was oversampling of the high coverage taluk wherein 15 villages were randomly selected, while 5 villages were selected from the low coverage taluk. 10 beneficiaries were selected within each village through random selection. Additionally, we interviewed government stakeholders at the state, district, taluk and village level across each survey state, as well as micro irrigation equipment manufacturers, dealers and agents to attain a comprehensive idea of the nature of micro irrigation adoption and uptake in the selected states.

Coverage of Micro-Irrigation in India, with Specific Emphasis on Study States

As per the latest data available, the total physical achievement up until February, 2023 is 476711.310 hectares, in comparison of a physical target of 324951.44 hectares. The area covered under drip irrigation is 256048.750 hectares and area covered under sprinkler irrigation is 256048.750 hectares. In 2017, the top six states in terms of area covered under micro irrigation included Gujarat, Andhra Pradesh, Karnataka, Maharashtra, Telangana, and Madhya Pradesh, constituting almost 80 percent of India's total area under micro irrigation. In 2021, the top six states in terms of area covered under micro irrigation were Karnataka, Tamil Nadu, Gujarat, Andhra Pradesh, Maharashtra, and Rajasthan, constituting 86.2 percent of India's total area under micro irrigation. States such as Sikkim, Punjab, Nagaland, Mizoram, Kerala, Jammu and Kashmir, and Goa have very poor physical coverage and constitute less than 0.5 percent of the total physical achievement. The top 6 states in terms of financial achievement include Karnataka, Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and Telangana; thus, it has been observed that in the period 2017-21, the cumulative financial achievement has been highest for states which are characterised by the highest physical achievement as well.

Implementation of Micro Irrigation in Study States

Each state is characterized by a different institutional model of implementation of the PMKSY scheme; Andhra Pradesh, Tamil Nadu and Gujarat have a special purpose vehicle (SPV) which streamlines all institutions responsible for implementation of the micro irrigation scheme in the state. In the other states: Rajasthan, Karnataka and Maharashtra the Agriculture departments engage in implementation. Table 1 provides a comparison of different state models, the pattern of assistance provided, and monitoring and grievance redressal.

Table 1: Institutional Model of Implementation of PMKSY-PDMC Across Study States

Parameter	% of Assistance	Autonomy	Organizational Structure	Free of Cost After Sales Service	Monitoring Mechanism	Grievance Redressal
Gujarat	70-90% of unit cost	SPV-Semi-autonomous	Centralized; single window operations	5 years	Third party verification to check that system is operational by conducting trial run, and conduct impartial assessment	Complaint redressal by farmers within 15 days of receipt of complaint, otherwise penalty

Parameter	% of Assistance	Autonomy	Organizational Structure	Free of Cost After Sales Service	Monitoring Mechanism	Grievance Redressal
Andhra Pradesh	90-100% of subsidy for small/ marginal farmers, 70-90 for medium farmers, 50% for big farmers	SPV Under the Horticulture Department	Decentralized: district officers carry out key functions	7 years	IT enabled mechanism supported by TCS to monitor, third party assessments periodically conducted	Online to either company or the project office; it is streamlined to head office and Commissioner if unresolved at lower levels
Tamil Nadu	75-100% subsidy	SPV-Drip irrigation under the Horticulture Department, sprinkler under Agriculture Department	Decentralized: district officers carry out key functions	13 compulsory in 3 years	Inspection carried out by block officer to check equipment supply, and agri-engineer to verify working	Complaints registered through MMIS, complaints also routed through companies
Rajasthan	50-60 % for sprinkler, 50-70% for drip	None; under Commissionerate of Horticulture	Follows structure of relevant Departments (no specific mandate for micro irrigation)	3 years	District Mission Committee to track and review progress, village and block level officers for supervision. Mandated third party field inspections.	Unclear; manual escalation of complaints to company
Karnataka	45-90%	None; 4 Departments work in conjunction- Agriculture, Horticulture, Sericulture, Watershed Management	Multicentric and decentralized	3 years	Monitoring of quality of MIS equipment	Mandatory for companies to have technicians at the village level to resolve concerns
Maharashtra	45-55%	None; Agriculture and Horticulture department	Follows structure of relevant Departments (no specific mandate for micro irrigation)	3 years	Spot verification on field for proposal of MIS installation, no other monitoring	Helpline number on Mahadbt portal

Impediments to Adoption and Non-Adoption of Micro-Irrigation

Table 3 summarises the key factors that influence adoption in the study states, while Table 4 summarises the key factors that influence non-adoption in the study states.

Table 2: Reasons for Adoption

	Decline in Groundwater levels	Suitability of Crop for Micro Irrigation	Learning of Benefits from Peers, Government, Etc	Interacted with a dealer/distributor
Gujarat	✓	✓	✓	×
Rajasthan	✓	✓	✓	×
Maharashtra	✓	×	✓	×
Andhra Pradesh	✓	×	✓	×
Karnataka	✓	✓	×	×

Table 3: Reasons for Non-Adoption

	High Level of Initial Investment	Insufficient Subsidy Amount	Fragmented Land	Unavailability of Spare Parts	Production for Self-Consumption	Benefits not Being Believable	High Operation and Maintenance Costs
Gujarat	✓	×	✓	✓	✓	×	×
Rajasthan	✓	✓	✓	✓	×	✓	✓
Maharashtra	✓	×	×	×	✓	×	✓
Karnataka	✓	×	✓	×	×	×	✓

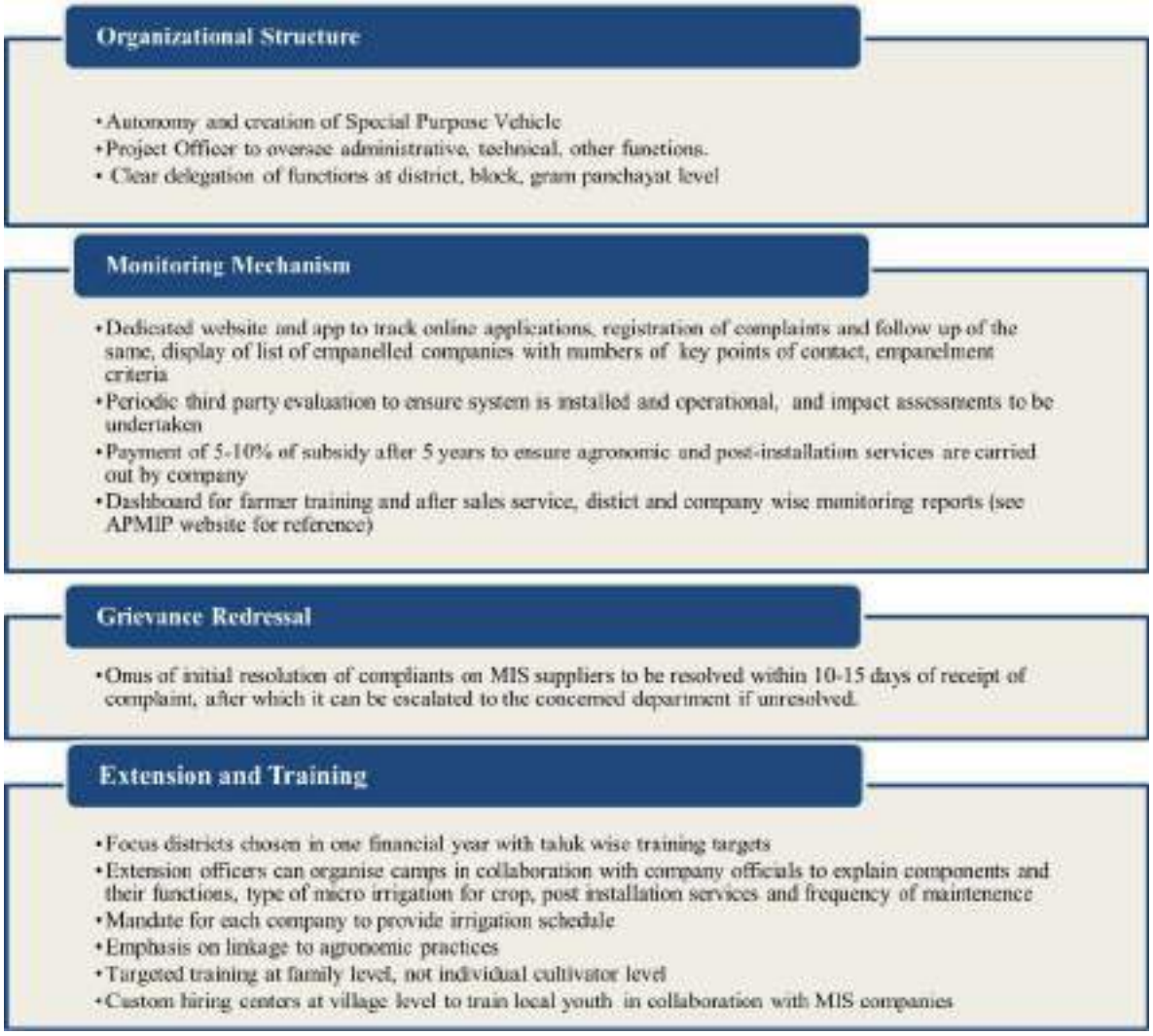
Based on these, a 5-point strategy is outlined to enhance uptake of the scheme, and ensure sustenance:

- **Awareness Generation with a Focus on 'Income Enhancement & Cultivation Cost-Saving' as Opposed to 'Water Saving', especially in States without a SPV:** Respondents across states such as Andhra Pradesh and Gujarat were seen to have a greater awareness of types of drip and sprinkler irrigation both in terms of identification of components, and basic functions. In states like Rajasthan, awareness was the first criteria which needed to be worked upon. Across states, functionality and maintenance related information, for instance, technical awareness of fertigation and acid treatment, etc remained as an information gap. This needs to be bridged, *and a monitoring mechanism put in place that can actually oversee whether the farmer has actually understood the process and is able to regularly undertake recommended maintenance practices in the frequency required*. In addition, farmers need to be made aware of the benefits of micro irrigation in plantation crops. In the case of vegetables and fruits, farmers are already practicing fertigation, and thus they are aware of the amount of water required for the crops. However, in the case of plantation crops, the amount of water does not affect the yield of the crop, but there is a tendency to flood the crop. Thus, in this case, the farmers need to be informed about the field capacity, water holding capacity, etc and be encouraged to undertake micro irrigation.
- **Accessibility of Spare Parts:** Across states, the availability of spare parts remained a concern, particularly in more interior regions. There were no shops at the village level (unless it was a gram panchayat level village), and delays in access did serve to be hinderance in sustenance. *Across states, a supplier map can be drawn out to identify empanelled suppliers, their distributors and retailer presence, in order to determine density.* In high coverage taluks, companies can be encouraged to mandatorily have a minimum number of suppliers to route to beneficiary farmers to ensure supply side ease.

- **Need for Reliable Dedicated Trained Technicians and Service Centers at Block & Village Level, as well as Certificate Based Courses in Collaboration with MIS Companies**: The primary survey indicated that a a number of technical issues such as blockages, accumulation of contaminants, clogging, pressure building served as an impediment to adoption etc, which was accompanied by understaffing of technicians to address these issues. The semi-temporary nature of employees of dealers and distributors was problematic in terms of effective after sales service, complaint resolution and quality of equipment supplied. *Thus, performance assessment needs to ensure that companies are reporting their actual number of employees, and training is being conducted for dealers/ distributors in the network to upskill them.* For every 100 ha, or depending on the density of coverage it is recommended that a company have a service center. These service centers can employ rural youth and train them as technicians. *Thus, it is suggested that unemployed youth/ school dropouts in villages can be trained, and a custom hiring center be developed at the village level to facilitate entrepreneurship and employment. A similar exercise was undertaken in the state of Andhra Pradesh in 2019, wherein 500 youth were trained in collaboration in Jain Irrigation.* This can serve the twin purpose of employment provision as well as easy access to trained personnel to resolve grievances in a speedy manner and prevent dis-use, as well as longer term usage. *The service center can have mobile vans which can bring the service to the farmer's doorstep rather than having the farmer go to those service centers.* Companies should additionally be encouraged to launch certificate-based courses to technicians, who can be recruited by micro irrigation companies. This will enable skill building and better imparting of knowledge to the beneficiary as well.
- **Streamlined Process of Subsidy Disbursement and Revised Unit Costs to Incentivise Uptake Among Small and Marginal Farmers:** It has been observed that the prices of raw materials for manufacturing micro irrigation equipment have been fluctuating, which has resulted in an increase in production costs. Farmers also listed high operation and maintenance costs as a key reason for non-adoption. *There is a need for state level and central level price revision committees that reflect market conditions.* This needs to be combined with easier access to credit to make adoption feasible for farmers.
- **Best Practices Demonstrations**: Modules can be created on several aspects; fertigation schedule, acid treatment, *linkage to agronomic practices*, selection of the right system etc. Companies must be mandated to conduct a target level of trainings at the district and taluk level; best practices demonstrations can take place by the government officers and site visits to encourage peer learning can be arranged.

Furthermore, an optimal institutional structure, based on 'best of all worlds' from states with a special purpose vehicle has been indicated to streamline implementation, ensure end mile ease of access, monitoring and effective grievance redressal, and have a clear line of authority in terms of administrative procedures.

Figure 1: A Suggested Institutional Framework for Reform



CHAPTER 1:

Introduction, Background and Study Objectives

Globally, the attainment of 'water security'[1] has been identified as a key development goal in the context of achieving environmental sustainability and human well-being. Furthermore, the need to mitigate the currently prevailing water scarcity has been emphasised by governments, the private sector and academia around the world. Globally, the pressure on water resources continues to increase; the 2030 Water Resources Group (2009) had forecasted that the world would face a 40 per cent water deficit by 2030 under a business-as-usual scenario. Several of the world's main aquifers are under increasing stress with water shortage risks in many parts of Australia, northern China, Spain, the western United States (US) and India. There has been a rapid decline in water storage and freshwater availability due to intensive overextraction of groundwater, increasing temperature induced surface loss, and increasing global freshwater use (which has been witnessing a growth rate of roughly 1 per cent per year) due to population growth and economic development (United Nations (UN), 2021; Liu, Feng and Fu, 2019). It is expected that water scarcity will further be accentuated by climate change and bioenergy demands.

The agriculture sector has assumed critical relevance in the context of water scarcity; estimates from the United Nations (2021) suggest that 69 per cent of global water withdrawals are used by the agriculture sector (encompassing crops, livestock, fisheries, aquaculture and forestry), mainly for irrigation and also including water used for livestock and aquaculture. Irrigated agriculture has a global water footprint of 2230 km per year (Mekonnen and Hoekstra, 2011), and water withdrawals for irrigation (surface and groundwater resources) amount to 2797 cubic km per year as per latest available estimates. In some developing countries, agriculture can account for upto 95 per cent of water withdrawals (Food and Agriculture Organization (FAO), 2011). The Food and Agriculture Organization (2017) has also forecasted that the world would require 60 per cent more food by 2050, and irrigated food production would increase by 40 per cent in the same period. Thus, over the last three decades, the need to identify strategies to manage scarce water resources in agriculture has been recognised through (a) supply side management practices such as watershed development and water resource development through major, medium and minor irrigation projects, and (b) demand management practices such as improved and more efficient water management technologies/ practices such as micro irrigation technologies on a global level.

Micro irrigation has been identified as an innovative demand management strategy which offers an efficient alternative to traditional systems of irrigation and water use, which demonstrate low water productivity and cannot ensure long term sustainable food security (Sidhu, Kumar, Rana and Jat, 2021). Micro irrigation supplies the water at the required interval and in the desired quantity at a place where water is required through a pipe network, emitters, and nozzles, resulting in low conveyance and distribution losses and higher water use efficiency. The conventional methods of

[1] United Nations Water had proposed the following definition for water security in 2013: "*The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability*". For more details see https://www.unwater.org/publications/water-security-infographic/ (last accessed December 18, 2021)

micro irrigation include drip and sprinkler irrigation. While micro irrigation technologies were originally associated with capital intensive large commercial farms in developed countries such as Israel and the United States (US) and were not suitable for smallholders in terms of design and affordability, these technologies have gradually undergone technical transformations and have a far wider potential for coverage across the world (Verma et al., 2004; Shah and Keller, 2002). As per latest data estimates, 46 million hectares (comprising 36 million hectares sprinkler irrigation and 10 million hectares of micro irrigation) are covered under micro irrigation technologies around the world.[2] The percentage of irrigated area under micro irrigation technologies varies across countries; while in developed countries such as the United Kingdom, it is 74 per cent (as of 2017), in developing countries like India it is 19 per cent (as of 2020-21).

India has the largest irrigated area in the world, accounting for a fifth of the global irrigated area. The total irrigated area in India has increased from about 30.2 million hectares (Mha) in 1970-71 to about 68.3 Mha in 2018-19, with around 39.17 per cent of the total agricultural land being dependent on irrigation in 2017 (Ministry of Agriculture and Farmers Welfare, 2019). Irrigation currently consumes about 84 per cent of the total available water in the country. However, the water use efficiency is estimated to only be around 30-40 percent (Suresh, 2012). Several factors have contributed to the inefficient utilisation of water in irrigation as well as to the rapid depletion of aquifers; these include the conventional practice of flood irrigation across India, intensive groundwater pumping for irrigation (65 per cent of the irrigated land is dependent on underground water) and the cultivation of water intensive crops, amongst others.

Given this, there has been a considerable emphasis by policymakers on shifting the focus from increasing agricultural productivity per unit of land to per unit of water in India in the last two decades and expand the scope for improving water use efficiency. In this context, the adoption of micro-irrigation in lieu of the conventional mode of irrigation has gained considerable policy traction, particularly in arid and semi-arid regions. Box 1.1 looks at the different types of micro irrigation technologies that are prevalent across India.

Box 1.1: Types of Micro Irrigation Technologies

Micro irrigation technologies have been categorised into two types based on their technical and socioeconomic attributes (International Water Management Institute, 2006)

- **Low-Cost Micro Irrigation Technologies**: These include systems such as bucket and drum kits, micro sprinklers, micro tube drip systems, Pepsee easy drip technology (with light plastic pipes). These are low-cost technologies that are based on local skills and materials, require low initial capital, and limited skill and capital to design, service and maintain. They are compatible with smallholder farming systems, and are largely promoted to poor farmers.
- **State-of-the-Art Micro Irrigation Technologies:** These include conventional drip and sprinkler systems. These require high initial capital, require relatively sophisticated facilities that need technical expertise and special skills. These are commercialized and are available through companies such as Jain Irrigation, Netafim etc.

Source: *Compiled from http://www.iwmi.cgiar.org/Publications/Water_Policy_Briefs/PDF/WPB23.pdf?galog=no%26iwmi=1; https://www.iima.ac.in/c/document_library/PMKSY-PDMC-Final-Report-IIMA%20-%20May%2024,%202021.pdf (last accessed November 5, 2021)*

Various studies have noted that the promotion of micro irrigation is an effective demand management strategy to reduce water demand in agriculture and has several other benefits such as reducing the energy footprint, increased yields and income, high return on investment, amongst others (Gandhi, Johnson & Singh, 2021; Bahinipati & Viswanath, 2019; Palanisami, 2015). The estimated water savings range between 40-80 percent as per different studies, with estimated yield increase to be around 100 percent (Sivanappan, 1994). *The Economic Survey 2020-21 has*

[2] Source: https://www.icid.org/wg_onfarm_new.html (last accessed December 22, 2021)

summarised the benefits accrued from micro-irrigation; saving of water from 20 per cent to 48 per cent, saving of energy from 10 to 17 per cent, saving of labour cost from 30 to 40 per cent, saving in fertilizer usage from 11 to 19 per cent and increase in crop production from 20 to 38 per cent, and commented on the scope of using this technology in closely spaced crops like rice, wheat, onion, potato, etc.

Given this, several policy incentives have been introduced in recent years to enable the rapid diffusion of micro irrigation technologies in India. For example, the Government of India, in conjunction with state governments, has been providing capital cost subsidies (ranging from 30-90 per cent of purchase costs) for potential drip adopters. The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched in the financial year 2015-16, under which one of its components specifically seeks to maximise water use efficiency at the field level, thereby ensuring *"Per Drop-More Crop (PDMC)"*. More recently, the Micro Irrigation Fund was instituted with an initial corpus of INR 5000 crore in order to serve as a facilitative mechanism for states to mobilize additional resources for expanding micro irrigation coverage. Section 1.2 extensively provides an overview of the evolution of schemes and programmes pertaining to micro irrigation in India and provides the institutional architecture for the currently existing PMKSY-PDMC component.

1.1 Evolution of Policies Pertaining to Micro-Irrigation

Since independence, the Government of India has introduced several policy programmes in order to advance the development of micro irrigation. In 1981, the Ministry of Petroleum, Chemicals and Fertilizers of the Government of India constituted the 'National Committee on the Use of Plastics in Agriculture' in order to promote and develop the application of plastics in agriculture, including the popularisation of micro irrigation technology as a major step towards improving agricultural yields and efficiency[3]. Subsequently, 17 Plasticulture Development Centers were developed across the country, which played a key role in developing regionally differentiated technologies on micro irrigation and imparting training to both government personnel and farmers. The Government of India announced a subsidy scheme for drip irrigation in 1982-83 which continued until 1989-90, and drip irrigation companies were established in states such as Tamil Nadu, Maharashtra, Karnataka and Andhra Pradesh. While there was increased momentum in the advancement of micro irrigation on a commercial scale, the coverage was initially restricted to horticultural crops. In 1995, the Centrally Sponsored Scheme on promoting the Use of Plastics in Agriculture such as in mulching materials, poly-houses, etc was launched, which also included micro irrigation technologies in its ambit. The Accelerated Irrigation Benefits Programme, 1996, which was formulated in order to provide financial assistance to states to complete ongoing advance stage irrigation projects in the country and extend irrigation to more areas, also sought to promote the use of micro irrigation.[4] The Government of India emphasised on the need to further increase water use efficiency through appropriate policy interventions and requisite institutional support, and constituted a Task Force on Micro Irrigation for this purpose in 2004. The Task Force observed that micro irrigation had to be promoted in a holistic manner with an end-to-end approach involving cultivators, good agronomic practices, post-harvest handling, processing and marketing. The recommendations of the Task Force led to the launch of the Centrally Sponsored Scheme (CSS) for micro irrigation in January 2006, which promoted drip and sprinkler irrigation technologies. Along with this, micro irrigation technologies were also promoted within other schemes such as National Food Security Mission, Integrated Scheme of Oilseeds, Pulses, Oil

[3] For more details see https://www.ncpahindia.com/about-us (last accessed December 2, 2021)

[4] Note: The Accelerated Irrigation Benefits Programme was later co-opted into the Pradhan Mantri Krishi Sinchayee Yojana in 2015-16. For more details see https://dmeo.gov.in/sites/default/files/2019-10/Evaluation%20Study%20on%20Accelerated%20Irrigation%20Benefits%20Programme%20%28AIBP%29.pdf (last accessed December 1, 2021)

palm, and Maize and Technology Mission on Cotton. The Centrally Sponsored Scheme for micro irrigation was upgraded to the National Mission on Micro Irrigation (NMMI) in 2013-14 and implemented until June, 2013-14. The NMMI had the following objectives: (a) increasing the area under micro irrigation through improved technologies, (b) promote, develop and disseminate micro irrigation technologies through capacity building of farmers and beneficiaries and (c) increase the productivity of crops and farmers' income (Government of India, 2010).

The NMMI was subsumed under the National Mission on Sustainable Agriculture (NMSA) and was implemented under the component "On Farm Water Management" (OFWM) during the financial year 2014-15. In 2015, Pradhan Mantri Krishi Sinchayee Yojna (PMKSY) was launched to achieve convergence of investments in irrigation at the field level, with micro irrigation as one of the components under the title of 'Per drop more crop' (PDMC) (see Box 1.2 for details). In the recent decade, National Mission on Micro Irrigation (NMMI) witnessed the strongest growth of micro irrigation penetration. In 2018-2019, the Micro Irrigation Fund was created with NABARD with a corpus of Rs. 5000 Crore with objective of facilitating the states in mobilising the resources to provide additional incentives to farmers for incentivising micro irrigation beyond the provisions available under PMKSY-PDMC.

Box 1.2: Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)-Salient Features

The Pradhan Mantri Krishi Sinchayee Yojana has been launched with the objective of enhancing the physical access of water on the farm by providing "har khet ko paani", and provide end to end solutions across each aspect of the irrigation supply chain in order to expand cultivable area under assured irrigation. It comprises of four components; these include

- **Accelerated Irrigation Benefit Programme (AIBP)** – This component focuses on accelerating the completion of ongoing Major and Medium Irrigation that exceed the capacities of states, including National Projects. This component is being implemented by the Department of Water Resources, River Development and Ganga Rejuvenation.
- **PMKSY (Har Khet Ko Pani)-** This component focuses on expanding cultivable area under assured irrigation; source augmentation, ground water development, lift irrigation, supplementing rain water harvesting beyond the Integrated Watershed Management Programme, and working on the repair, restoration, renovation of traditional water bodies through MGNREGA. This component is being implemented by the Department of Water Resources, River Development and Ganga Rejuvenation.
- **PMKSY (Watershed Development):** This component focuses on watershed development through activities such as ridge area treatment, drainage line treatment, soil and moisture conservation, and other watershed works and livelihood support activities. This component is being implemented by the Department of Land Resources.
- **PMKSY (Per Drop More Crop):** This component focuses on enhancing water use efficiency at farm level through micro irrigation; drip and sprinkler irrigation systems. It also supports other interventions for micro level water storage, water conservation/management activities to supplement source creation for micro irrigation. It specifically seeks to promote micro irrigation technologies in water intensive/ consuming crops such as sugarcane, banana, cotton, etc, promote micro irrigation in water scarce and stressed blocks/ districts and create employment opportunities for skilled and unskilled youth for installation and maintenance of micro irrigation systems. This component is being implemented by the Department of Agriculture and Farmers Welfare.

Source: *Revised PDMC Guidelines, Department of Water Resources, RD & GR, 2021*

1.2 Review of Literature

The extant micro irrigation literature focuses on three strands: (i) determinants of adoption of MI, (ii) impact of micro irrigation and (iii) challenges that serve as impediments in effective implementation of micro irrigation technologies. These components are summarised in brief below.

1.2.1 Determinants of Adoption

A study conducted by Namara, Upadhyay and Nagar (2005) in Rajkot and Junagadh districts in Gujarat and Jalgaon district in Maharashtra found that micro irrigation adoption is dependent on (a) technical efficiency, (b) economic efficiency, (c) information and knowledge available to the target beneficiaries regarding the technical and economic superiorities of the technologies, and (d) access of technologies through institutional support systems. Further, their logit adoption model showed that socio-economic variables that increased the likelihood of micro irrigation adoption included (a) a higher level of education of the household head, (b) access to groundwater through ownership of dug/bore wells, additional sources of income (excluding wage labour income) and (c) a higher level of income. For example, in Maharashtra, the largest proportion of micro irrigation adopters were found to be rich farmers, while in Gujarat, adoption extended to middle and rich farmers both.

A study by Palanisami, Mohan, Kakumanu and Raman (2011), which looks at the economics of micro irrigation in different farm groups in 9 states in India finds a variance in this trend across states; while a majority of farmers adopting micro irrigation in Maharashtra and Tamil Nadu were observed to be large farmers it was observed that more than half (52 per cent) of farmers adopting micro irrigation in Kerala were marginal farmers, and a majority of farmers in Andhra Pradesh (70.67 per cent), Karnataka (66 per cent), Odisha (62.67 per cent) and Punjab (55.34 per cent) were small farmers. Kumar et al. (2008) found that high average land holdings and large sized individual plots created a conducive environment for adoption, supplemented by a cropping system which was dominated by widely spaced row crops.

A study conducted in 2 blocks of Coimbatore district, Tamil Nadu found that the adoption of drip irrigation is influenced by experience, farm size, proportion of wider spaced crops and participation in non-farm income activities (Kumar, 2012). Chandrakanth (2015) found that in Karnataka, variables such as cropping intensity, water used (acre-inches) and net returns per acre-inch influenced the adoption of drip irrigation vis a vis conventional irrigation systems. Viswanathan and Bahinipati (2019) assessed the impact of policy incentives on diffusion and adoption of micro-irrigation by farmers in the state of Gujarat and supported the continuation of present incentive policies such as making adoption of micro-irrigation mandatory for availing a new power connection, and entitlement of farmers in dark zones to avail an additional 10 per cent subsidy since 2012 by the state government. The study concluded that a pecuniary benefits and power connection together increased the likelihood of incremental adoption of micro irrigation from 1.6 per cent to 1.8 per cent.

1.2.2 Impact of Micro Irrigation

A number of studies indicate that the use of micro irrigation technologies has resulted in irrigation efficiency and productivity gains for all crops considered on average (Narayanamoorthy, 1997; Qureshi et al., 2001; Namara et al., 2005; Dhawan, 2002; Magar et al., 1988; Verma et al., 2004). These improvements include significant yield improvement, water and power savings, reduced labour costs, improved quality of produce, extended irritation time, increased efficiency in fertilizer and manure use, and reduced soil erosion and insect damage as opposed to traditional irrigation practices (Qureshi et al, 2001; Namara et al., 2005; Bahinipati and Viswanathan, 2016; and Bhamoriya and Mathew, 2014). An impact study on the National Mission on Micro Irrigation conducted by Global Agri System for the Government of India, June 2014 showed that the irrigation cost reduced by 20-50 per cent, and average electricity reduced by about 31 per cent, average productivity of fruits and vegetables increased by about 42.3 per cent to 52.8 per cent

after usage of the micro irrigation technology. It also noted that all the surveyed states reported an increase in the farmer's income in the range of 20 per cent to 68 per cent with an average increase of 48.5 per cent. For example, a farm survey conducted in Bundelkhand region, Uttar Pradesh in 2017-18 found that under the sprinkler system, the yield of wheat under the sprinkler system was 21.9 per cent more than the traditional method of irrigation. Furthermore, sprinkler irrigation adopters were observed to save 15 per cent of irrigation water, 8 per cent of diesel and 11 per cent of labour and perform better on efficiency and water productivity (Kishore, 2019). The micro irrigation system is seen to allow the cultivation of multiple crops, the intensification of cropping on the same field and the ability to cultivate crops in circumstances that were not possible earlier given the retreat of the monsoon.

Kumar (2012) observed that drip irrigation led to an increase in the net sown area from 13.27 hectares to 14.49 hectares, with an increase in gross cropped area from 13.71 hectares to 14.91 hectares. Sivappan (1994) demonstrated that drip irrigation enables a reduction in groundwater use, and Narayanamoorthy (1997) found that environmental problems associated with surface irrigation such as water logging and salinity were absent under drip irrigation. Additionally. Qureshi et al. (2001) also noted that drip irrigation contributed to higher quality products and a decreased tillage requirement.

Further, Namara, Upadhyay and Nagar (2005) noted that women of small cultivator households benefited most in terms of access to and control of income and household nutritional security.

However, studies in Gujarat have demonstrated that yield improvements are dependent on (a) the crops grown and (b) the type of irrigation system used. Conversely, studies across states have highlighted that the positive impacts of micro irrigation adoption on poverty, food security and sustainability of water use could be deflected by a diversification by farmers towards high-value water intensive crops. For instance, in Maharashtra studies (see Namara et al., 2005) have observed that there was a shift from groundnut and oil seeds to a water intensive crop such as banana, and in Gujarat, there was an increase in vegetable production.

1.3 Challenges in Adoption of the Micro Irrigation Scheme in India, with Specific Emphasis on Skill Gap

In the initial years, the advancing of the micro irrigation programme in India was constrained by several factors; these included non-competitive unit costs, an increase in custom and excise duty and taxes on raw materials, and implementational challenges such as inadequate allocation of subsidies and the inability of the state government to share their proportion of the subsidy under the centrally sponsored scheme (Sivanappan, 2016). Studies such as the Irrigation Association of India et al. (2016) and Priyan and Panchal (2017) indicate that the penetration of micro irrigation in India witnessed the strongest growth when the scheme operated in mission mode, i.e., the National Mission on Micro Irrigation. When the scheme was subsumed as a component under the National Mission on Sustainable Agriculture the focus on micro irrigation reduced.

Studies have indicated that high initial capital costs serve as a deterrent to the adoption of micro-irrigation; this is accentuated by the poor quality of rural infrastructure which heightens costs further. For instance, in states such as Bihar, eastern Uttar Pradesh and Odisha, the quality of power supply is a concern, which has contributed to farmers using diesel pump sets for irrigating their crops, which in turn increases the cost of extraction of well water. Furthermore, various farmers do not own wells, and are dependent on water purchased by other well-owners. Studies such as Namara et al., (2005) and Palanisami, et al., (2012) indicate that despite the presence of a subsidy,

relatively rich farmers are able to appropriate the subsidy. Chand et al. (2020) indicates that the lack of easy financing mechanisms and access to credit also serves as a constraint to uptake.

The subsidy disbursement process continues to serve as an impediment to the implementation of the scheme in terms of the unavailability of funds for installations already approved and delayed release and sanction of the funds. The variability in implementation of the subsidy across different states also remains a concern; while states such as Gujarat and Andhra Pradesh, wherein the implementation takes place through the Gujarat Green Revolution Company and the Andhra Pradesh Micro Irrigation Project respectively, are touted as models that have shown appreciable progress in recent years, other states wherein there are no dedicated teams for implementation of micro irrigation in a focused manner are observed to face governance concerns (Palanisami, 2015). For example, Malik et al. (2016) notes that in Madhya Pradesh, the application process for obtaining the subsidy is long drawn and leads to rent-seeking behavior by drip providers. Additionally, given that the subsidy scheme specifies configurations and quality checks for equipment, agents who act on behalf of the equipment manufacturers were observed to promote lower quality drip configurations and suppliers within the government approved lists. This was attributed to comparatively higher dealer margins on these products, which farmers often were seen to accept, partly due to information asymmetry, and partly due to faster processing of applications in these cases. Resultantly, the drip system may not suit the needs of the farmers, increasing investment costs and reducing benefits. Thus, the study noted that the primary beneficiaries of the programme seemed to be manufacturers/ dealers as opposed to the farmers. A study by the National Bank for Agriculture and Rural Development (NABARD) (2021) conducted in Haryana found that the farmers expressed dissatisfaction on the late arrival of the subsidy, and had concerns related to the fact that it sometimes not released in the same year. As in the case of Malik et al. (2016), the study found that the activities of dealers lack transparency which led to dissatisfaction in service delivery, and farmers do not have full information regarding quality of equipment supplied, as well as the application process and the financial details. Studies such as Namara et al. (2016) found that the multiplicity of government departments or agencies involved in the implementation of the subsidy also served as a deterrent. Furthermore, a differential subsidy pattern for different crops in different regions in the same state has been see impact both farmers and implementing agencies.

Some other farm level issues that have noted in the literature as contributing to dis-incentivising adoption include theft of the micro irrigation system, rat/pest menace which damages the pipes, absence of a reliable energy source/ presence of free energy sources due to which farmers do not have an incentive to adopt a water saving technology, localised cropping patterns and crop choices which make adoption of micro irrigation difficult for some farmers , unavailability of water or negative externalities in groundwater pumping(Chand et al, 2020; Namara et al., 2016; Palanisami, 2016).

A section of literature has pointed to the skill gap in micro irrigation and highlighted the need for technical support and capacity building of concerned stakeholders for effective adoption at the end mile. For instance, a study by the Centre for Budget and Policy Studies which assessed the situation of MI in Karnataka mentioned that large scale adoption is critically dependent on education and communication regarding the technology. In a study conducted by Bhamoriya (2016), he noted that a majority of the farmers believed that training is needed for better adoption of MI. Further, it has repeatedly been indicated that non-adopters find it difficult to adopt the technology due to lack of awareness of proper management practices. The hesitancy increases if proper equipment and spare parts are lacking along with high costs of maintenance. Moreover, a significant portion of adopters have also reported that mastering the use of MI systems is tedious.

Therefore, sharpening of skills of farmers as well as other stakeholders becomes a requisite in such a situation. In terms of the presence of the skill gap, extant studies have noted that there are issues associated with:

- Operational and maintenance related concerns.
- Lack of availability of post installation service and unresolved post-installation issues such as clogging and choking of laterals.
- Misconceptions regarding micro irrigation equipment functions and usage.
- Dependency on dealers due to lack of information regarding registration and technical specifications.
- Lack of staff to provide training in departments, low frequency/ absence of demonstrations conducted by extension departments.

1.4 Context and Objectives of the Study

The studies that focus on and document this skill gap extensively are scarce. Given that it is essential to learn about the challenges that adopters, non-adopters and other supply side stakeholders face in terms of the skill gap in order to harness the technology to its full potential, our study has the following objectives:

- To catalogue the status of micro-irrigation coverage for improving water use efficiency in different states of India.
- To assess the impact/sustenance of micro-irrigation use by the farmers after two years of its coverage in different states.
- To identify reasons for disuse of micro-irrigation (if any) including reasons related to shortage of spare parts and skilled manpower locally.
- To study the nature and extent of skill-gap in the area of micro-irrigation and suggest measures to bridge the skill gap, including training, wages etc.
- To formulate the strategies and programmes that may be required for filling up the gap of skilled manpower in view of rapid expansion of micro-irrigation coverage.

1.5 Methodology, Study Area and Data Collection

The study is based on comprehensive primary surveys complemented by key informant interviews of stakeholders across the micro irrigation supply chain, government departments and beneficiaries across six states that rank amongst the top in terms of area covered under micro irrigation as per the latest data; these include Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Tamil Nadu[5] . Within these states, two high coverage districts were selected taking into account heterogeneity in agro-economic zones as well as cropping pattern. In each district, two taluks were selected; there was oversampling of the high coverage taluk wherein 15 villages were randomly selected, while 5 villages were selected from the low coverage taluk. 10 beneficiaries were selected within each village through random selection. Table 1 provides the taluk and district wise details per state. Additionally, we interviewed government stakeholders at the state, district, taluk and village level across each survey state, as well as micro irrigation equipment manufacturers, dealers and agents to attain a comprehensive idea of the nature of micro irrigation adoption and uptake in the selected states.

[5] see Chapter 2 for state wise ranking as well as details on coverage

Table 1.1: Districts and Taluk Selected for the Study

State	High Coverage Districts	High Coverage Taluk	Low Coverage Taluk
Andhra Pradesh	Prakasam	Yerragondapalem	Thallur
	Chittoor	Ramakuppam	Irala
Karnataka	Hassan	Hassan	Arsikere
	Haveri	Savanur	Siggaon
Gujarat	Rajkot	Jamkandorana	Dhoraji
	Sabarkantha	Himmatnagar	Talod
Rajasthan	Jodhpur	Tiwri	Bhopalgarh
	Bhilwara	Mandalgarh	Mandal
Maharashtra	Ahmednagar	Kopargaon	Shevgaon
	Amravati	Warud	Chandurbazaar

Note: *In the case of Tamil Nadu, key informant interviews were conducted in three high coverage districts; Villupuram, Kancheepuram and Tiruvannamalai.*

This report has been divided into 10 chapters including the introduction. Chapter 2 catalogues the status of micro irrigation coverage in India as well as fund disbursement under the PMKSY-PDMC scheme, with specific emphasis on drip and sprinkler coverage in the study states. Chapter 3 examines the institutional implementation of the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More Drop in each state, drawing attention to the subsidy disbursement mechanism and the institutional actors and their roles and responsibilities. Chapter 4-9 presents the primary survey findings pertaining to each state, and Chapter 10 summarises the findings, identifies the state specific and common issues prevalent across each state to provide recommendations and the way forward.

CHAPTER 2:

Coverage of Micro Irrigation in India

2.1 Introduction

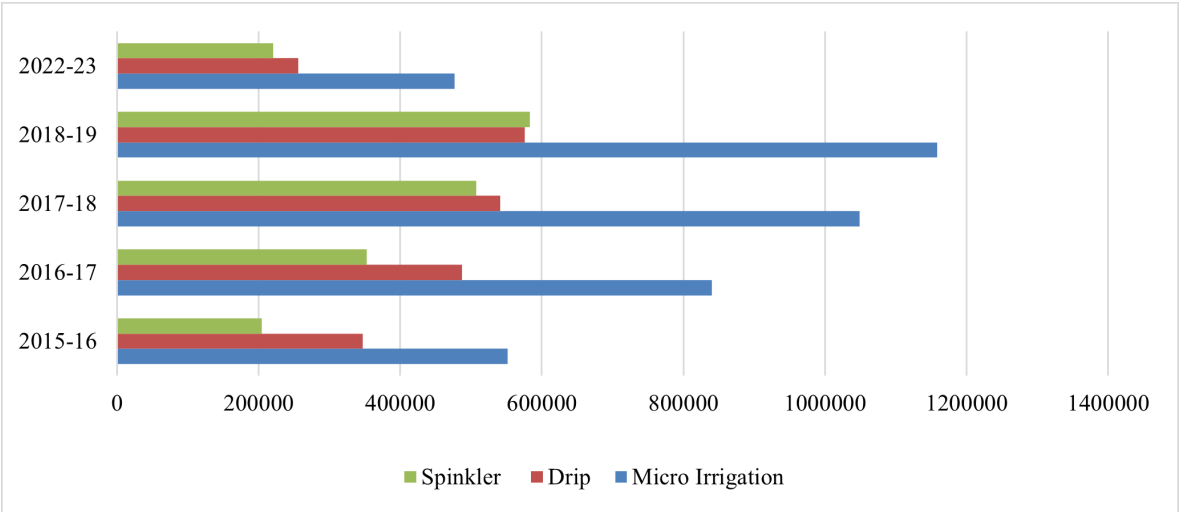
This chapter examines the current status of micro-irrigation coverage in India. By analyzing the data from the year 2017 to 2021, this chapter presents the state-wise and district-wise performance in micro-irrigation coverage over the last five years. The variables used for analysis are physical achievement and financial achievement of the scheme. Physical achievement explains the increase in farmland area (hectares) under micro-irrigation, whereas financial achievement denotes the overheads disbursed, and utilised by states for implementing the project.

For this analysis, we use yearly data on physical coverage of micro-irrigation technology in terms of area and financial disbursement for the Pradhan Mantri Krishi Sinchai Yojana (PMKSY), the policy that facilitates the uptake of the technology. The secondary data used for the analysis are drawn from the Micro-Irrigation Progress Monitoring System maintained by the PMKSY. While there have been several schemes promoting the uptake of micro-irrigation technologies, the corresponding data to track real-time area coverage and financial disbursement have been scant. However, with the instating of the PMKSY scheme, such kind of data has been available. This has allowed us to understand the variations in adoption across the country.

As per the latest data available, the total area covered under micro irrigation up until February, 2023 is 476711.310 hectares, in comparison of a physical target of 324951.44 hectares. The area covered under drip irrigation is 256048.750 hectares and area covered under sprinkler irrigation is 256048.750. The trends in physical achievement in the period 2017-23 for years in which data is available have been presented in Figure 2.1.

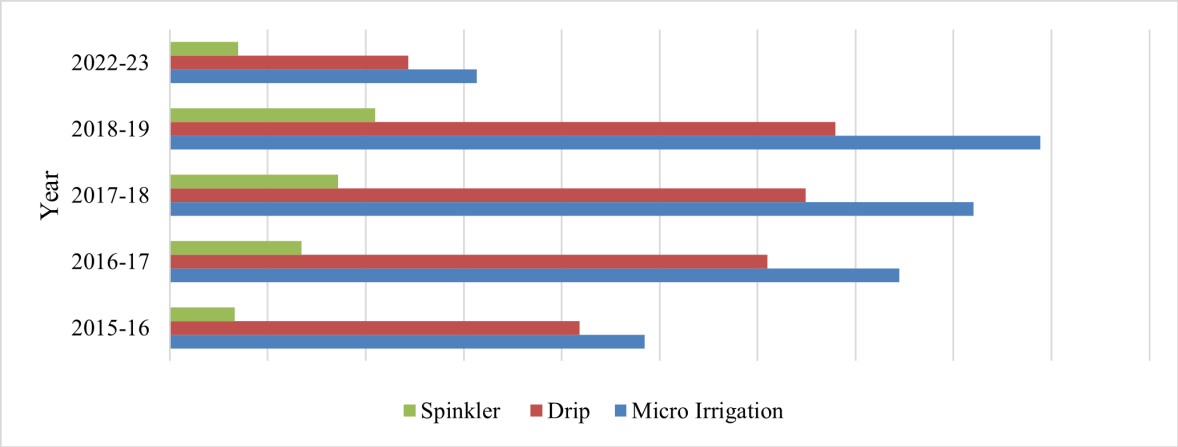
The total funds disbursed to states for micro irrigation up until February, 2023 is 62729.17 lakhs; out of this the financial achievement in drip irrigation is 48747.95 (77.71 %) and the financial achievement in sprinkler irrigation is 13981.22 lakhs (22.28%). Figure 2.2 presents the area covered under micro irrigation in the period 2015-16 to 2022-23.

Figure 2.1: Area Covered Under Micro Irrigation, 2015-16 to 2022-23



Source: *Compiled by authors from the PMKSY portal, Government of India*

Figure 2.2: Disbursement of Funds under PMKSY-PDMC, 2015-16 to 2022-23



Source: *Compiled by authors from the PMKSY portal, Government of India*

2.2 Trends in Indian States: Physical Achievement in the Period 2017-21

In 2017, the top six states in terms of area covered under micro irrigation included *Gujarat, Andhra Pradesh, Karnataka, Maharashtra, Telangana, and Madhya Pradesh*. These states constituted almost 80 percent of India's total area under micro irrigation. The rest of the states had a physical coverage (in terms of area) of less than 50,000 hectares. In 2021, the top six states in terms of area covered under micro irrigation included *Karnataka, Tamil Nadu, Gujarat, Andhra Pradesh, Maharashtra, and Rajasthan.* These states constituted 86.2 percent of India's total area under micro irrigation. States such as Tamil Nadu (ranking 8 in 2017) and Rajasthan (ranking 9 in 2017) made it into the top six states overtaking Telangana and Madhya Pradesh. They have shown a remarkable increase in area covered under micro irrigation by more than 1687 percent and 482 percent respectively, covering over 22.2 percent of India's total area under micro irrigation in 2021. Table 2.1 (a) presents the values for total physical achievement (in terms of area covered) of the top 6 states up to 2017, while Table 2.1(b) presents the values for total physical achievement (in terms of area covered) for the top 6 states in the period 2017-21.

Table 2.1 (a): Top Six States with Respect to Area under Micro Irrigation, 2017

Rank	State	Physical Achievement in 2017 (Ha)
1	Gujarat	165948.22
2	Andhra Pradesh	141098.08
3	Karnataka	139405.52
4	Maharashtra	106172.11
5	Telangana	61876.27
6	Madhya Pradesh	54323.89

Source: *Compiled by authors from the PMKSY portal, Government of India*

Table 2.1 (b): Top Six States with Respect to Area under Micro Irrigation, 2017-2021

State	Physical Achievement 2017-20 (Ha)
Karnataka	1182134.84
Tamil Nadu	800559.98
Gujarat	658833.22
Andhra Pradesh	649508.08
Maharashtra	619936.06
Rajasthan	277603.28

Source: *Compiled by authors from the PMKSY portal, Government of India*

Table 2.2 further presents the state wise ranking in the two years of comparison; 2017 and 2021, and highlights the change in ranks across states. It can be observed that states such as Sikkim, Punjab, Nagaland, Mizoram, Kerala, Jammu and Kashmir, and Goa have very low coverage of area under micro irrigation and constitute less than 0.5 percent of the total physical achievement. In the period 2017-2021, these states retained the lowest ranks in terms of area covered under micro irrigation and did not show much of an increment.

Table 2.2: Rank-Wise Comparison of Area Covered Under Micro Irrigation Across Indian States, 2017-2021

Rank (2017-2021)	State	Percent of Total Area Covered (2017-2021)	Rank in 2017	Change in ranks
1	Karnataka	24.35	3	+2
2	Tamil Nadu	16.49	8	+6
3	Gujarat	13.57	1	-2
4	Andhra Pradesh	13.38	2	-2
5	Maharashtra	12.77	4	-1
6	Rajasthan	5.72	7	+1
7	Telangana	4.27	5	-2
8	Madhya Pradesh	3.36	6	-2
9	Chhattisgarh	2.01	10	+1
10	Haryana	1.28	12	+2
11	Orissa	0.82	13	+2
12	Jharkhand	0.4	11	-1
13	Assam	0.38	**NA**	–
14	Bihar	0.28	14	0
15	Manipur	0.18	**NA**	–
16	Arunachal Pradesh	0.16	**NA**	–
17	Himachal Pradesh	0.15	17	0
18	Sikkim	0.11	**NA**	–

Rank (2017-2021)	State	Percent of Total Area Covered (2017-2021)	Rank in 2017	Change in ranks
19	Punjab	0.1	16	-3
20	Nagaland	0.09	**NA**	–
21	Mizoram	0.06	**NA**	–
22	Kerala	0.05	18	-4
23	Jammu and Kashmir	0.02	**NA**	–
24	Goa	0.02	19	-5

Source: *Prepared based on data available on the PMKSY portal, Government of India*

2.3 State Wise Trends: Disbursement of Funds under PMKSY-PDMC in the Period 2017-21

The data indicated that in 2017, the top six states with the largest physical coverage, i.e. Gujarat, Andhra Pradesh, Karnataka, Maharashtra, Telangana, and Madhya Pradesh also had the best financial accomplishment for the same year. Except for Andhra Pradesh, Gujarat, and Maharashtra, all other states had a fund disbursement (under PMKSY-PDMC) of less than INR 20,000 lakhs.

There has been a tremendous increase in financial accomplishment between 2017 and 2021. The top 6 states in terms of financial achievement include Karnataka, Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and Telangana; thus, it has been observed that in the period 2017-21, the cumulative financial achievement has been highest for states which are characterized by the highest physical achievement as well. Gujarat, Maharashtra, Karnataka, and Andhra Pradesh have particularly seen a significant increase, with financial achievement increasing from Rs. 400 crores in 2017 to more than INR 1000 crores in 2021. Similarly, states such as Sikkim, Punjab, Nagaland, Mizoram, Kerala, Jammu and Kashmir, and Goa which were characterized by low physical achievement are also seen to have meager financial achievement.

Table 2.3 (a) and 2.3 (b) present the financial achievement for the top 6 states for the year 2017, as well as the cumulative financial achievement for the period between 2017-21.

Table 2.3 (a): Top Six States with Respect to Fund Disbursement Under PMSKY-PDMC, 2017

Rank	State	Financial Achievement in 2017 (lakhs)	Physical Achievement-Rank in 2017
1	Andhra Pradesh	28850.87	2
2	Gujarat	21538.39	1
3	Maharashtra	20003.91	4
4	Karnataka	18501.54	3
5	Telangana	16479.19	5
6	Madhya Pradesh	13606.09	6

Source: *Compiled by the authors from the PMKSY portal, Government of India*

Table 2.3 (b): Top Six States with Respect to Fund Disbursement Under PMSKY-PDMC 2017-2021

Rank	State	Financial Achievement in 2017 (lakhs)	Physical Achievement-Rank in 2017
1	Karnataka	141497.3	1
2	Andhra Pradesh	125122.6	4
3	Gujarat	108661.7	3
4	Maharashtra	105117.8	5
5	Tamil Nadu	77178.2	2
6	Telangana	41157.31	8

***Source**: Compiled from the PMKSY portal, Government of India*

Table 2.4 provides the state wise ranking for financial achievement in 2 periods; 2017 and 2017-21 for comparison. The change in ranks is also noted.

Table 2.4: State-Wise Ranking of Financial Disbursement under PMKSY-PDMC, 2017-2021

Rank, 2017-2021	State	Total Financial Achievement, 2017-21 (lakhs)	Rank, 2017	Change in Rank
1	Karnataka	141497.26	4	+3
2	Andhra Pradesh	125122.58	1	-1
3	Gujarat	108661.7	2	-1
4	Maharashtra	105117.83	3	-1
5	Tamil Nadu	77178.2	8	+3
6	Telangana	41157.31	5	-1
7	Madhya Pradesh	37378.07	6	-1
8	Rajasthan	37142.11	7	-1
9	Kerala	28356.43	18	+9
10	Uttar Pradesh	24903.65	9	-1
11	Chhattisgarh	12920.32	10	-1
12	Haryana	9774.55	13	+1
13	Jharkhand	9178.01	11	-2
14	Orissa	8291.57	14	0
15	Uttarakhand	5931.74	12	-3
16	Bihar	5080.41	17	+1
17	Manipur	4779.52	NA	-
18	Sikkim	3420.99	NA	-

Rank, 2017-2021	State	Total Financial Achievement, 2017-21 (lakhs)	Rank, 2017	Change in Rank
19	Himachal Pradesh	2486.38	16	+3
20	Nagaland	1891.84	NA	-
21	West Bengal	1815.53	NA	-
22	Mizoram	1553.4	NA	-
23	Arunachal Pradesh	1521.92	NA	-
24	Punjab	668.5	15	-9
25	Jammu and Kashmir	379.97	NA	-
26	Assam	256.19	NA	-
27	Goa	142.78	19	-8

Note: *NA given that data is not available*

***Source**: Compiled from the PMKSY portal, Government of India*

The study states rank amongst the top 8 in terms of financial achievement in India; Tamil Nadu has progressed from the 8th rank to the 5th rank since 2017.

The financial coverage per hectare is obtained by dividing the financial disbursement by physical coverage. From 2017 to 2021, an analysis of the financial expenditure per hectare reveals that the states with the highest physical and financial achievement have low expenditure per hectare compared to other states. States such as Sikkim (INR 61925.99 lakh), Manipur (INR 55517.71 lakh), Mizoram (INR 54182.07 lakh), Jharkhand (INR 47728.85 lakh) and Nagaland (INR 43242.06 lakh) hold the top ranks in terms of high expenditure per hectare (see Table 2.5) but rank amongst the lowest in terms of physical and financial achievement. Table 2.5 provides the state wise ranking of financial coverage per hectare in 2021, in comparison to the financial coverage per hectare in 2017. In the case of the six study states, the expenditure per hectare lies between INR 9000 to INR 20000. Tamil Nadu had shown a remarkable decrease in financial coverage per hectare by around 51.8 percent (from rank 8 in 2017 to rank 24 in 2021) (see Table 2.5).

Apart from these six states, states like Assam and West Bengal also are characterised by low expenditure per hectare; however, the total coverage of land under micro irrigation are also poor in these states.

Table 2.5: State Wise Ranking of Financial Disbursement Per Hectare (Lakhs per hectare)

Rank in 2021	State	Rank in 2017
1	Sikkim	NA
2	Manipur	NA
3	Mizoram	NA
4	Jharkhand	1
5	Nagaland	NA
6	Bihar	19

Rank in 2021	State	Rank in 2017
7	Jammu and Kashmir	NA
8	Himachal Pradesh	2
9	Uttarakhand	5
10	Madhya Pradesh	4
11	Orissa	15
12	Arunachal Pradesh	NA
13	Telangana	3
14	Andhra Pradesh	7
15	Goa	14
16	Maharashtra	9
17	Gujarat	13
18	Haryana	11
19	Punjab	10
20	Rajasthan	6
21	Chhattisgarh	16
22	Karnataka	12
23	Uttar Pradesh	17
24	Tamil Nadu	8
25	West Bengal	NA
26	Assam	NA
27	Kerala	18

Note: *Study states have been highlighted*
NA- For those states, the data is unavailable.
Source*: Compiled from the PMKSY portal, Government of India*

Table 2.6: Financial Disbursement per Hectare in Study States

State	Expenditure Per Hectare (INR)
Andhra Pradesh	19264.21
Maharashtra	16956.24
Gujarat	16493.05
Rajasthan	13379.56
Karnataka	11969.64
Tamil Nadu	9640.527

Source*: Compiled and computed from the PMKSY portal, Government of India*

2.4 District Wise Trends for Study States-Physical and Financial Achievement

This section briefly tabulates down the top districts in terms of physical achievement in the period

2017-21. The state wise chapters further expound on the district level coverage of micro irrigation.

Table 2.7: District Wise Trends for Study States-Area Under Micro Irrigation, 2017 and 2021

State	Top 5 Districts in Drip (2017)	Area (Hectares)	Top 5 Districts in Sprinkler (2017)	Area (Hectares)	Top 5 Districts in Drip (2021)	Area (Hectares	Top 5 Districts in Sprinkler (2021)	Area (Hectares)
Andhra Pradesh	Chittoor	25733	Kurnool	7806.81	Anantapur	105147	Anantapur	20969
	Anantapur	25560	Y.S.R	6158	Y.S.R	88230.72	Kurnool	33658.81
	Y.S.R	19268.72	Guntur	2505	Chittoor	88230.72	Guntur	13889
	West Godavari	11792.7	Prakasam	2362.34	Prakasam	44877.49	Y.S.R	20796
	Prakasam	8506.49	West Godavari	1947	Kurnool	38678.54	West Godavari	9066
Gujarat	Banas Kantha	26358.47	Banas Kantha	11648.44	Banas Kantha	42107.91	Devbhumi Dwarka	96986.47
	Sabar Kantha	5765.15	Junagadh	11429.49	Sabar Kantha	40967.49	Junagadh	25995.15
	Kachchh	5167.14	Devbhumi Dwarka	8754.91	Kachchh	14124.45	Jamnagar	30645.14
	Surendranagar	3948.56	Surendranagar	5002.97	Botad	22205.44	Banas Kantha	25630.68
	Gir Somnath	3883.26	Amreli	4280.58	Bhavnagar	13872.5	Rajkot	21087.39
Karnataka	Bagalkot	4337.79	Ballari	9670	Belagavi	22647.01	Vijayapura	45911.44
	Ballari	3576.9	Belagavi	8056	Tumakuru	13948.17	Hassan	36277.06
	Belagavi	2750.55	Mysuru	7876	Vijayapura	14208.43	Haveri	41624.39
	Bengaluru	2699.57	Yadgir	7515	Chikballapur	13545.2	Mysuru	45628.69
	Bidar	2470.93	Chitradurga	6507	Davangere	16318.11	Chitradurga	29409.65
Maharashtra	Jalgaon	6942.43	Washim	2989.72	Jalgaon	58437.08	Buldhana	20671.65
	Amravati	5890.67	Osmanabad	2467.07	Aurangabad	29134.89	Yavatmal	15539.09
	Buldhana	5166.16	Ahmednagar	1903.72	Jalna	29507.07	Amravati	15193.09
	Yavatmal	4909.84	Beed	1746.74	Buldhana	24091.52	Beed	9785.39
	Solapur	4647.09	Wardha	1452.31	Solapur	24087.87	Osmanabad	10383.06
Rajasthan	Jaipur	2990.45	Bikaner	6099.9	Jalore	12737.37	Barmer	17905.3
	Sikar	1772.5	Hanumangarh	4133	Jaipur	18274.72	Bhilwara	11984.3
	Jalore	1531.76	Barmer	4036	Jhalawar	5809.01	Jodhpur	13588.4
	Chittorgarh	1286.19	Jodhpur	2451	Barmer	4672.16	Churu	11472
	Tonk	1044.98	Jaipur	2201.6	Sawai Madhopur	5810.49	Jalore	9290.4
Tamil Nadu	Salem	3933.91	The Nilgiris	2291.96	Dharmapuri	62115.92	The Nilgiris	36613.15
	Dharmapuri	3302.87	Madurai	1183.9	Krishnagiri	39461.93	Madurai	33791.75
	Villupuram	2988.71	Tiruvannamalai	1178.52	Erode	47085.2	Tiruvannamalai	15600.57
	Erode	2849.23	Ariyalur	1022.25	Salem	39248.83	Ariyalur	12536.24
	Krishnagiri	2838.31	Pudukkottai	930.8	Coimbatore	27346.63	Pudukkottai	9849.05

Source: *Compiled and computed from the PMKSY portal, Government of Ind*

CHAPTER 3:

Institutional Models for Implementation of Micro Irrigation in Study States

This chapter examines the programme architecture of the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More Crop (PMSKY-PDMC) to define the roles and responsibilities of each nodal department, and then moves on to examine the specific institutional models in each state of study, drawing out the eligibility criteria and pattern of subsidy, organisation and structure, operationalisation of the scheme and grievance redressal mechanism in place.

3.1 Programme Architecture for Implementation of the Scheme

The institutional architecture of the scheme has been presented in Figure 3.1. The scheme follows a two-tier structure at the central level with the National Steering Committee, under the chairmanship of the Honourable Prime Minister and the National Executive Committee, under the chairmanship of the Vice Chairman, NITI Aayog. At the state level, there is a three-tier structure; with a State Level Sanctioning Committee, Inter-Departmental Working Group and the District Level Implementation Committee.

Figure 3.1: Programme Architecture of PMKSY-PDMC at each Tier of Governance

Source: *Operational Guidelines of Per Drop More Crop component of Pradhan Mantri Krishi Sinchayee Yojana, Government of India, 2021*

The pattern of assistance provided to the beneficiary as defined by the Central government is 55 percent of subsidy of the unit costs for small and marginal farmers, and 45 percent for other farmers limited to an overall ceiling of 5 hectares per beneficiary. The exact percent of subsidy as well as eligibility criteria varies across states based on the state policies. This is met in a ratio of 60:40 for all states except the North-eastern and Himalayan states, wherein 60 percent is provided by the Centre and 40 percent by the state. In the case of North-eastern and Himalayan states, the ratio of sharing is 90:10, and additionally for Union territories the Central government provides a 100 percent grant.

The following sections expound on the implementation of PMKSY-PDMC in each study state; in states such as Andhra Pradesh, Gujarat and Tamil Nadu a special purpose vehicle (SPV) with a mandate to implement the scheme has been established; these include Andhra Pradesh Micro Irrigation Project (APMIP) in Andhra Pradesh, Tamil Nadu Horticultural Development Agency (TANHODA) in Tamil Nadu, and Gujarat Green Revolution Company (GGRC) in Gujarat. In the other states -Rajasthan, Karnataka and Maharashtra the Agriculture departments engage in implementation.

3.2 The Case of Andhra Pradesh: Andhra Pradesh Micro Irrigation Project (APMIP)

The Andhra Pradesh Micro Irrigation Project (APMIP) was launched in November, 2003 by the Andhra Pradesh Horticulture Department to promote the advancement of micro irrigation on a large scale, and "encourage crop productivity by improving water use efficiency" (Reddy and Reddy, 2015). It has been established as a Special Purpose Vehicle (SPV) to streamline all institutions responsible for implementation of the micro irrigation scheme in the state in order to aid in effective planning, implementation and monitoring through a dedicated team present until the mandal level.

APMIP has the following aims:

- Increasing crop productivity.
- Improving quality of agricultural produce.
- Facilitating judicious usage of ground water and aiding in the sustainable use and conservation of water.
- Ensuring higher energy efficiency in the agriculture sector.
- Ensuring higher fertilizer use efficiency and savings.
- Save on power consumption.
- Save in labour expenses.
- Improve the economic conditions of farmers.
- Being additional area into cultivation with the available water resources.

APMIP has estimated that the potential of micro irrigation is around 23.55 lakh hectares, and has been working towards enhancing coverage in all 13 districts of the state to realise this potential area by 2022.

3.2.1 Subsidy Provision: Pattern and Eligibility

At present, APMIP is implementing the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More

Crop, through provision of subsidies for all categories of farmers who adopt drip and sprinkler irrigation. The pattern of assistance and eligibility is provided in Table 3.1 (a) for drip irrigation and Table 3.1 (b) for sprinkler irrigation.

Table 3.1 (a): Drip Irrigation: Eligibility and Financial Assistance

S. No	Category of Farmers	Ceiling Limit Per Farmer		
		Subsidy (%) on Unit Cost of Drip	Area (Acres)	Subsidy Amount (Lakhs)
1.	Small and marginal farmers belonging to SC/ST category	100	5	2.0
2	Small and marginal farmers other than SC/ST	90	5	2.0
3.	Medium farmers of Rayalaseema and Prakasam Districts, and ST Farmers in Integrated Tribal Development Agency (ITDA) areas (above 5-10 acres)	90	10	2.80
4.	Medium farmers of coastal districts, except Prakasam	70	10	2.80
5.	Big Farmers	50	-	4

Note: *Small and marginal farmers include farmers with land holding up to.5 acres (irrespective of wet and dry), Medium farmers include farmers with land holdings of more than 5 acres and upto 10 acres (irrespective of wet or dry), big farmers include farmers with land holdings above 20 acres (irrespective of wet or dry) for the purpose of micro irrigation.*

Source*: G.O.MS. No 14 dated 14-02.2018, Agriculture and Cooperation (Horticulture) Department*

Table 3.1 (b): Sprinkler Irrigation: Eligibility and Financial Assistance

S. No	Category of Farmers	Subsidy (%) on Unit Cost of Sprinkler	Area Limit (Acres)
1	All farmers irrespective of category in all the districts	50	5.0

Note: *This includes portable sprinklers, semi-permanent sprinklers, and rain guns.*

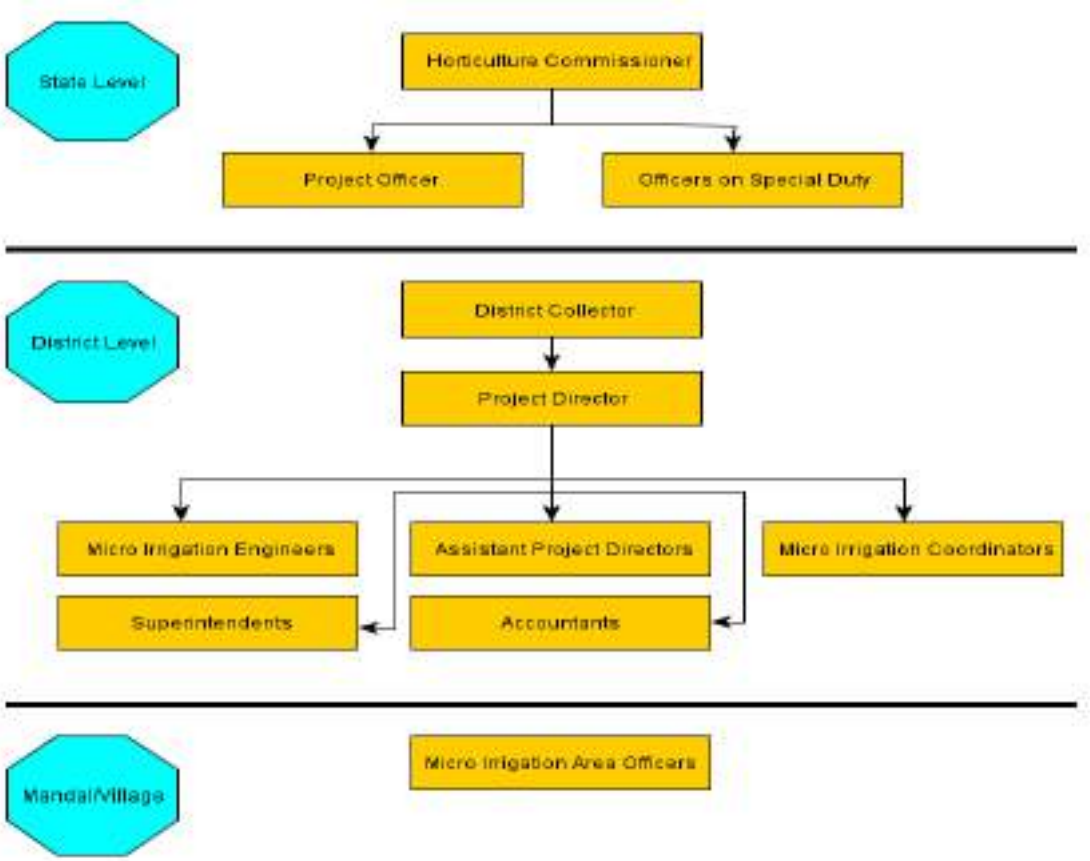
Source*: G.O.MS. No 14 dated 14-02.2018, Agriculture and Cooperation (Horticulture) Department*

3.2.2 Organizational Structure and Functions

With the Horticulture Commissioner, Department of Horticulture Project Officer at the helm, APMIP is led by a Project Officer and 5 Officers on Special Duty at the state level who work across several functions; administrative, technical, planning, online programmes, etc.

APMIP has an independent functioning in all 13 districts under the Chairmanship of the District Collector. The district team includes a Project Director for each district, Assistant Project Directors (depending on the need and potential), Area Officers, District Coordinators and Engineers. At the Mandal level, there is a Micro Irrigation Area Officer who is in charge of 2-3 mandals (see Figure 3.2)

Figure 3.2: Organogram: APMIP



Source: *Compiled from* https://krishna.ap.gov.in/apmip/ *and key informant interviews with APMIP officials*

3.2.3 Operationalisation of Scheme

APMIP has made the entire process of registration for the micro irrigation subsidy, subsequent processing and release of funds online and app based, so the beneficiary/ farmers can check their application status and view the subsidy amount online (Chand, Kishore, Kumar and Srivastava, 2020). The registration is biometric and Aadhaar enabled.

The farmer has the flexibility to choose a micro irrigation system company from a list of 37 empanelled companies provided by APMIP. The empanelment criteria are provided in Box 3.1. The selected company conducts a field survey and prepares a design and cost estimate, which is administratively sanctioned at the district level after an inspection to assess water availability, soil type and power supply. The farmer has to pay the subsidised cost to the company, and the company is reimbursed by the government. As per APMIP mandated norms, the company has to provide free after sales service for at least 5 years after installation of the system.

Box 1: APMIP's Empanelment Criteria of Companies

A firm will be empanelled if it satisfies the following criteria:

- Turnover of INR 1.5 crores in Andhra Pradesh and INR 5 crore outside the state
- Prior experience of at least 1 year purely in drip irrigation, and 3 years of experience outside the state
- Has its own manufacturing facility for lateral dippers and sprinklers, etc

Examples of Empanelled Companies: Jain Irrigation Limited, Netafim Irrigation India Private Limited, Akshaya Irrigation Products Private Limited, Kothari Agritech Private Limited

Source: *Survey inputs*

3.2.4 Monitoring and Grievance Redressal

APMIP has established an IT enabled monitoring mechanism, supported by Tata Consultancy Services, to monitor the progress in micro irrigation implementation on a real time basis. Furthermore third-party evaluation and impact assessments are conducted periodically. APMIP uses an IT enabled monitoring system, supported by TCS company, to monitor the progress of MI implementation. There is period checking of micro irrigation equipment by CIPET.

3.3 The Case of Gujarat: Gujarat Green Revolution Company

Gujarat Green Revolution Company is a special purpose vehicle established by the Government of Gujrat in 2005 in order to implement the micro irrigation scheme in the state, as well as work towards saving water and energy and enhancing agricultural production in the state. The objectives and mission have been elaborated below:

- To promote micro irrigation, protected cultivation, solar water pumping and the use of highly nutrient use efficient water-soluble fertilisers amongst the farmers of Gujarat as a tool for wise usage of resources resulting in higher agricultural productivity, thus, improving their livelihood and empowering them to participate meaningfully in the growth of the Agriculture Sector in the State.
- To promote the use of bio fertilisers, green and clean energy with the objective to protect the environment by conserving the agri-ecosystem in the state.

3.3.1 Subsidy Provision: Pattern and Eligibility

The pattern of assistance is determined by the social category (ie General, Scheduled Castes/ Scheduled Tribe, landholding size and the area in which the farmer resides (see Table 3.2 for details).

Table 3.2: Subsidy Norms with Effect From 01.04.2017 for the Micro Irrigation Scheme in Gujarat

Sr. No.	Category of farmer	Non-Dark Zone Area	Dark Zone Area
1.	General Farmer: (Landholding of 2 or more than 2 hectares)	Up to 70 percent of MIS Unit Cost or Rs.70,000/- per hectare, whichever is less	Up to 70 percent of MIS Unit Cost or Rs.70,000/- per hectare, whichever is less
2.	General Farmer: Small and marginal farmer (Landholding of less than 2 hectares)	Up to 70 percent of MIS Unit Cost or Rs.80,000/- per hectare, whichever is less.	Up to 80 percent of MIS Unit Cost or Rs.80,000/- per hectare, whichever is less
3.	Scheduled Caste (SC)/ Scheduled Tribes (ST) Farmers	Up to 80% of MIS Unit Cost or Rs.1,00,000/- per hectare, whichever is less.	Up to 90% of MIS Unit Cost or Rs.1,00,000-/ per hectare, whichever is less

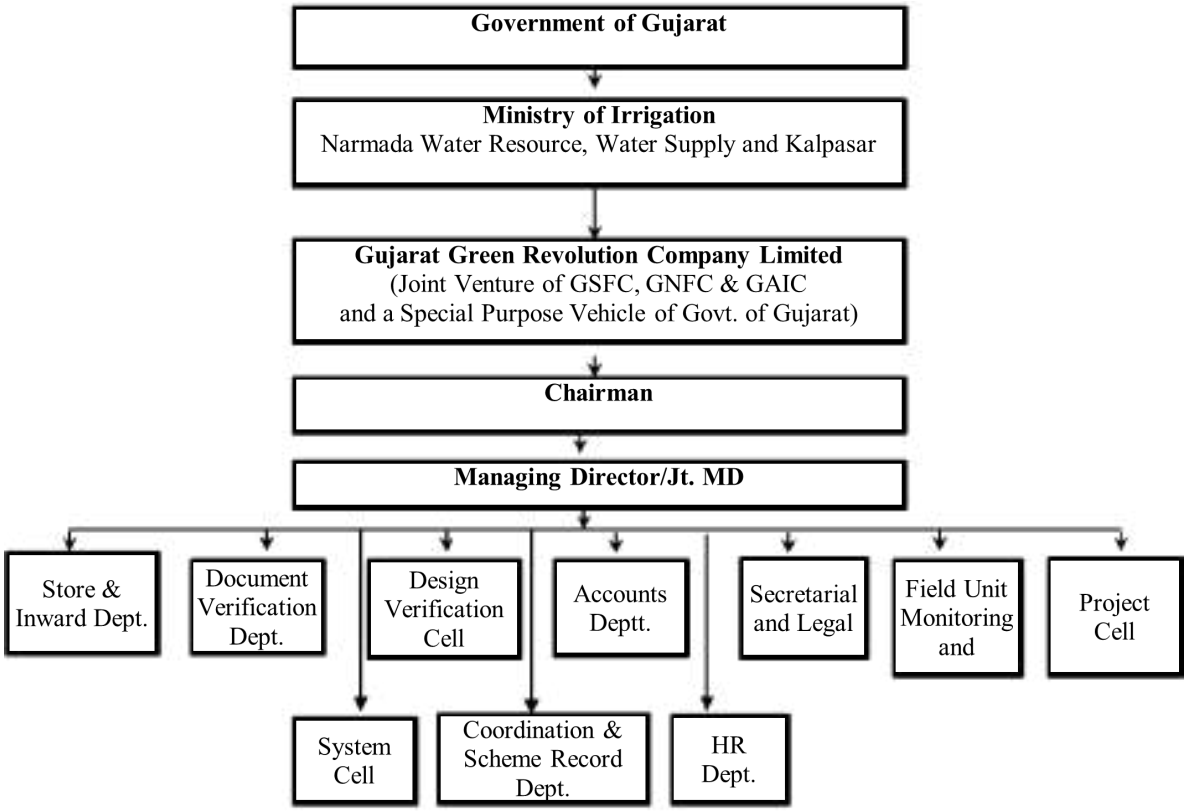
Note: *Dark zone areas are areas wherein there is over extraction of ground water with the extent of groundwater reaching critical levels*

Source: *Gujarat Green Revolution Company, 2020*

3.3.2 Organisational Structure and Functions

The organisation structure, starting from the state level and the subsequent dispersion of authority are illustrated in Figure 3.3 below. Apart from this, the MIS scheme has an established network of third-party inspection agencies, multi-stage monitoring and control through field and technical inspectors and an extensive list of MIS suppliers who work in sync with GGRC at the ground level.

Figure 3.3: GGRC: Institutional Structure



Source: *GGRC*

3.2.3 Operationalisation of Scheme

The MI scheme is a demand-oriented scheme in the sense that farmers have to approach a recognized MIS supplier/installation company rather than a GGRC representative approaching them first. The company then visits the farm where the drip has to be installed in order to conduct a survey, design and estimate the total cost of installation as per GGRC norms. The suppliers work in sync with the GGRC and become a part of MIS scheme by undertaking the administrative responsibility and also making the farmers aware about everything they need to know in order to work with the drip irrigation system. This reduces the transaction costs and makes the whole procedure faster and smoother for the applicants. The farmer then moves onto make an application with GGRC with the design plan, cost estimates and survey records along with the payment. The farmer only has to pay the net amount after deducting the subsidy. Once GGRC approves the application, it releases 15 percent of the total cost of installation to the MIS suppliers chosen by the farmer. A third-party verification is conducted to ensure that the system is installed and working, and after that 75 percent of the total cost is paid to the MIS supplier. The remaining 10 percent is paid after 5 years so that MIS suppliers have an incentive to provide the 5 system maintenance services and agronomical services for 1 year.

3.2.4 Monitoring and Grievance Redressal

GGRC leverages geo-tagging technology for monitoring the implementation of the scheme, and engages third party inspection agencies to ensure impartial and fair assessment. After the micro-irrigation is installed, third party inspection agencies come to ensure that the systems are functional by conducting a trial run of the MIS at farmer's field at each site. By using a system of QR (quick

response) code with geo locations, the monitoring is efficient and transparent in nature. There is an app available for farmers to keep a track of previous inspections and coming inspections as well.

The redressal system is also designed to ensure quick and efficient complaint redressal. GGRC has delegated the task of complaint redressal to MIS suppliers, and directed them to ensure that all complaints made by farmers are resolved within 15 days of the receipt of complaint (which can be made to GGRC or directly to the MIS supplier). If the complaints are not resolved within the above time period, the MIS supplying company might be penalised by the GGRC which they can do by delaying the final payment. The severity of the penalty is subject to severity of farmer's complaints. The possibility of delay in final payment provides a strong incentive for the MIS supplier to ensure that all complaints and issues are timely resolved.

3.3 The Case of Tamil Nadu: Tamil Nadu Horticulture Agency

Tamil Nadu Horticulture Agency (TANHODA) has been established as a society, and conceived as a special purpose vehicle to serve as a nodal agency to implement several centrally sponsored schemes; these include PMKSY-PDMC, the National Horticulture Mission, National Bamboo Mission, National Mission on Medicinal Plants, State Horticulture Farms and Irrigated Agriculture Modernisation and Water-Bodies Restoration and Management (World Bank Fund). Besides these, 63 state horticulture farms and 19 parks and gardens are under TANHODA. TANHODA is responsible for drip irrigation, while the Department of Agriculture is responsible for implementing sprinkler irrigation.

As per the latest data, the PMKSY PDMC scheme is being implemented to the extent of 2,50,000 acre for agriculture and horticulture crops at an outlay of INR 960 crore with the Union and State Government fund in 2022-23. TANHODA is currently working with 45 empanelled companies to implement the scheme.

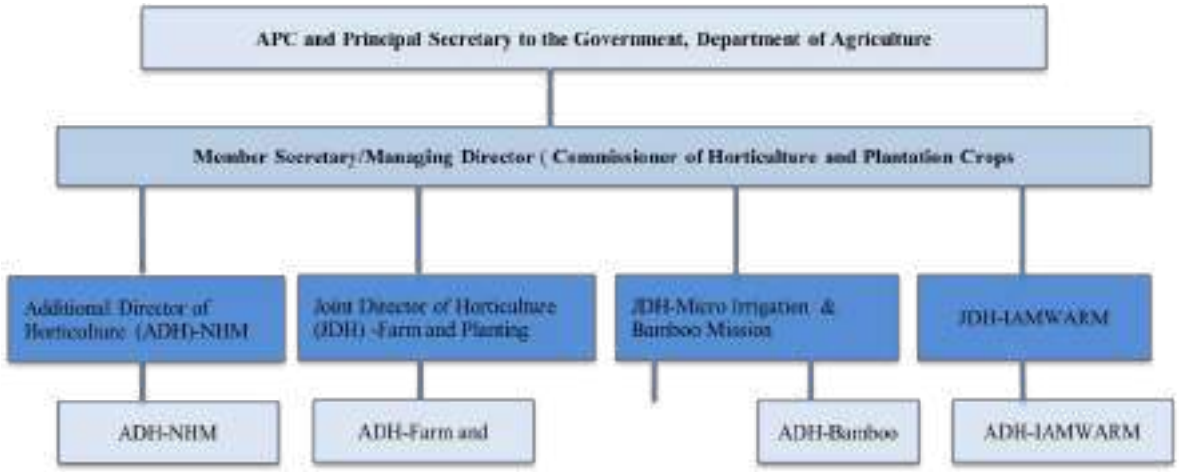
3.3.1 Subsidy Pattern: Provision and Eligibility

100 percent subsidy is being provided to small and marginal farmers, while 75 percent subsidy is being provided for other categories of farmers, with financial assistance provided upto 5 hectares. For small and marginal farmers, the cost coverage is inclusive of GST. A farmer can avail a subsidy on drip irrigation once in ever 7 years; within this period, if a beneficiary farmer wishes to increase his land coverage under micro irrigation, TANHODÅ will verify if the subsidy coverage by hectare has been exhausted and the commission the work order for extension. For PMKSY-PDMC, the central government: state government share is 50:50 for small and marginal farmers, while it is 40:35 for other farmers.

3.3.2 Organisational Structure

TANHODA is led by the Director of Horticulture and Plantation Crops, who serves as the Managing Director for the agency. The organisational structure is provided in Figure 3.4.

Figure 3.4: TANHODA: Organisational Structure



Source: *Department of Horticulture and Plantation Crops, Government of Tamil Nadu*

At the district level, the Deputy Director of Horticulture helms the department and is in charge of any horticulture related activity. At the block level, the Assistant Director of Horticulture officers are in charge of each horticulture related activity and engage in extension efforts.

3.3.3 Operationalisation of Scheme

The manner of disbursement of subsidy has been provided in Figure 3.5.

Figure 3.5: Subsidy Disbursement in Tamil Nadu

Source: *Key informant interviews*

3.3.4 Monitoring and Grievance Redressal

Members of the block office are present when farmers are given training by the company post the installation of the system. They ensure that the basic working of the system including checking pressure at valves, working of the filters and pressure gauge are understood by the farmer. They also ensure that farmers receive an operation manual along with instructions on acid treatment and maintenance of MI components. TANHODA has mandated companies to conduct 13 compulsory after sales services in 3 years for the farmers. After three years, the company has to respond as per the farmer's needs. TANHODA provides the farmers with a service card which must be filled out by the company for every visit they make within those 3 years which is also verified by the government officials. Furthermore, TANHODA has a toll-free number as well as provision for registering a complaint through MMIS. Apart from that, farmers can also route their complaints through the companies.

3.4 The Case of Rajasthan: Horticulture Department

The state level supervision of the micro irrigation is being carried out by the Horticulture Department of the state along with a separate State Level Committee (S.L.C.) constituted for the implementation of the scheme. The Director of Horticulture is the scheme in charge.

3.4.1 Subsidy Pattern: Provision and Eligibility

The subsidy on micro-irrigation equipment is provided for a minimum 0.2 ha of land and maximum 5 ha of land. If any farmer has availed the subsidy benefits for less than 5 hectares before and wishes to increase it, they have the option to do that as well (up to 5 ha.). The subsidy is also differentiated on the basis of whether the applicant is from a drought prone area i.e. DPAP (Drought Prone Area Programme) and Non DPAP or DDP (Desert Development Programme) or non DDP areas. (Lokesh Kumar Jain, 2021). It is also to be noted that sprinkler irrigation related subsidy is being provided to the beneficiaries only if drip irrigation is not sufficient for the particular applicant's fields and crops.

Farmers from all backgrounds, class and groups are eligible for the scheme. However, it has been mandated that 50 percent of the beneficiaries have to be marginal, small or women farmers. Out of this 50 percent, 30 percent beneficiaries have to be women farmers. 30 percent of the total budget allotted for the scheme is also reserved for women farmers. Out of the total sum of allotment, 16.2 percent is fixed for Scheduled Caste Plan and 8 percent is reserved under the Tribal Sub Plan (As per the 2021-22 guidelines). However, the district wise allotment of funds for scheduled caste and tribe beneficiaries is differential and calculated on the basis of their population in each district. For the purpose of categorization, farmers with not more than 1.0 hectare of land have been categorized as marginal, whereas farmers with 1.0 ha to 2.0 ha of land are considered small farmers. The details of the amount of subsidy disbursed per unit cost for different categories of farmers are mentioned in Table 3.3.

Table 3.3: Pattern of Subsidy Provided (Per Unit Cost)

Type of Equipment	Small and Marginal Farmers	Other Farmers
Drip and mini sprinkler	70 percent	50 percent
Sprinkler	60 percent	50 percent

Source: *Rajasthan Agriculture Department,2021*

The eligibility requirements are further expounded on in Box 3.2.

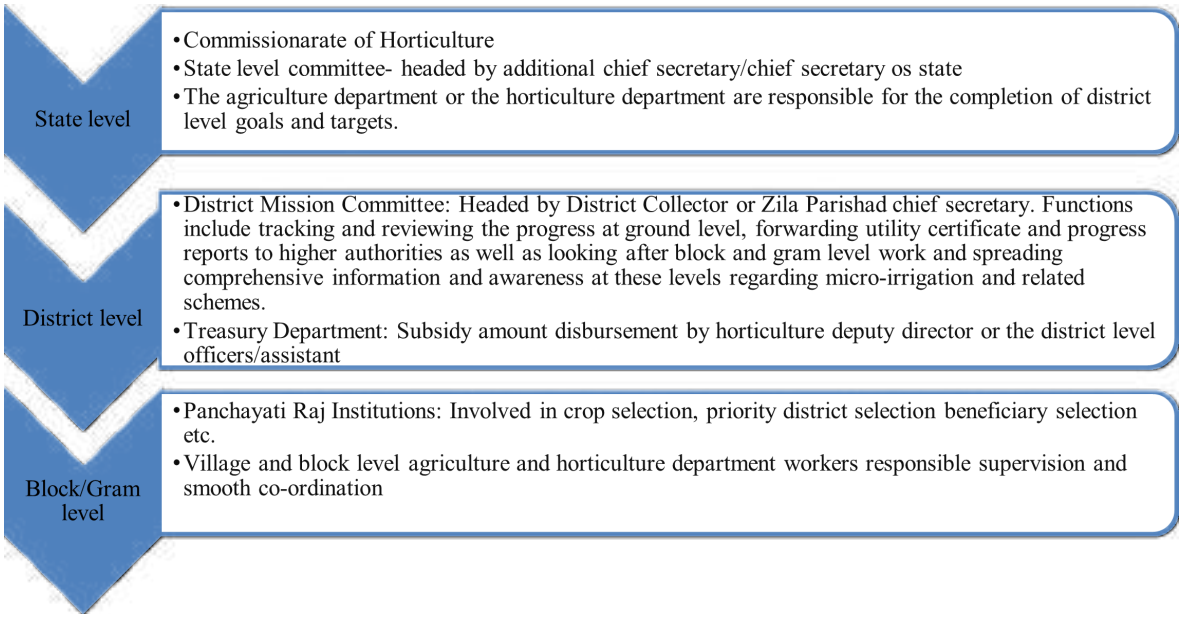
Box 3.2: Eligibility Criteria of Farmers

- Farmer should have land in their name.
- Farmers should have a well with an electricity/diesel/petrol pump.
- In case an own source of water is not available and the applicant is using someone else's water source, they have to have a no objection certificate signed by the owner of the water source.
- Farmers who have availed the benefits of the scheme once are not eligible to do so for the next seven years.
- Farmers or farmer organisations who have taken land on lease are also eligible for the subsidy if the lease agreement is of minimum 7 years.
- Along with individual farmers, farmer enterprises, councils, self-help groups, farmer producer organisations, co-operatives, agriculture colleges, panchayati raj institutions, limited companies etc. are also eligible for the scheme.

3.4.2 Organisational Structure

The Horticulture Deputy Director or the district level officers/assistant are in charge of executing scheme by forwarding the subsidy amount to beneficiaries through the medium of the treasury department. The detailed organisation structure is provided in Figure 3.6.

Figure 3.6: Organogram for Implementation of Micro Irrigation Scheme in Rajasthan

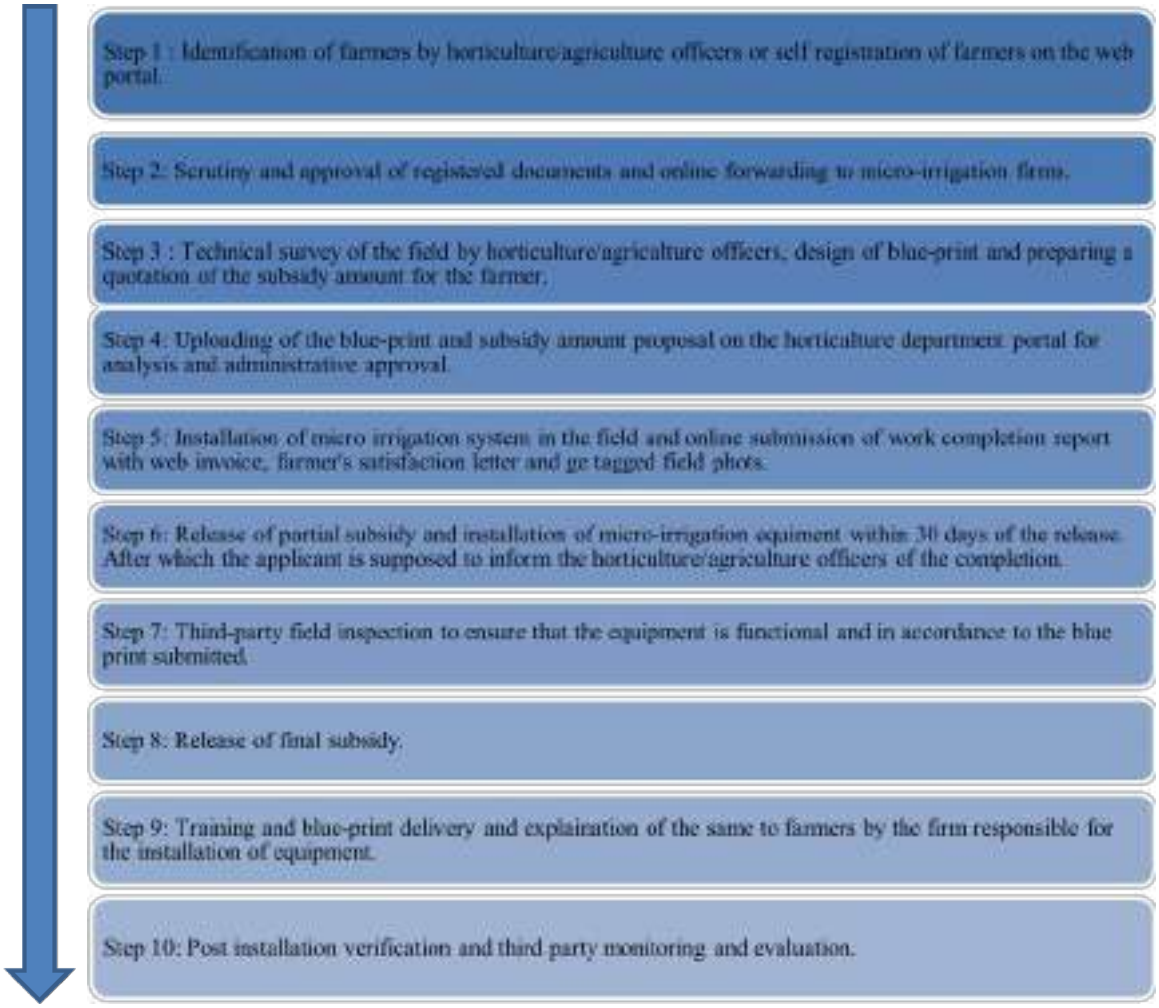


Source: *Rajasthan Agriculture Department,2021*

3.4.3 Operationalisation of the Scheme

For the purpose of reaching the farmers who need the subsidy and could benefit from it the most, field agriculture officers and drip manufacturers have been instructed to identify such farmers and make them aware about the scheme and it's benefits and help them with the online registration process. Farmers also have the option of registering themselves on their own in order to avail the subsidy benefits. The detailed procedure is depicted below in Figure 3.7.

Figure 3.7: Process for Disbursement of Subsidy



Source: *Rajasthan Agriculture Department,2021*

3.4.4 Monitoring and Grievance Redressal

The registered MI equipment manufacturers are mandated to provide free of cost after sale services for three years after the installation of the micro irrigation system and provide information and training to farmers regarding working of the equipment, it's maintenance, warranty and also how to farm with drip/sprinklers while they install it in their fields. In order to ensure quality control and that good quality equipment is delivered to the farmers, field surveys and inspections have been mandated which are carried out by inspection teams comprising of officers from NCPAH (National Committee on Plasticulture Applications in Horticulture), PFDC (Precision Farming Development Centres), CIPET (Central Institute of Petrochemicals Engineering & Technology), IAI (Irrigation Association of India), BIS (Bureau of Indian Standards) etc. The inspection team draws samples from fields randomly and tests them in order to assess whether the system is functional or not. If the test results show failure of equipment or poor quality of equipment within three years of installation, the registered companies get warnings (for the first offence) or get blacklisted altogether (on repeated offences) and become unable of participating under the MIS scheme anywhere in the country. They are also required to change the problematic component of the equipment within 15 days of the complaint and provide complete replacement in case of defects up to 1 year of installation.

3.5 The Case of Karnataka

In Karnataka, four government departments are responsible for the implementation of MI scheme in Karnataka: these include the Agriculture Department, Horticulture Department, Sericulture Department, and the Watershed Management Department. The Horticulture Department is mainly responsible for the drip/sprinkler irrigation demand and installation amongst horticulture crops, whereas the Agriculture Department focuses on sprinkler irrigation for farmers engaged in the cultivation of other agricultural crops. The Sericulture Department only focuses on provision of drip irrigation; for example, it provides drip for the mulberry crop.

3.5.1 Subsidy Provision: Pattern and Eligibility

The pattern of subsidy is on the basis of the size of the land of the farmer who is applying for the scheme. Small farmers are being prioritised and being given maximum amount of subsidy, i.e. 90 percent, whereas those with land-holdings of more than 5 hectares are not eligible for subsidy (see Table 3.4 for details). While the subsidy to the registered beneficiary can be repeated after a period of 7 years, the government of Karnataka has decided not to carry this forth in order to expand beneficiaries and area under micro irrigation coverage.

Table 3.4: Pattern of Assistance for Micro Irrigation Scheme in Karnataka

Sr. No.	Category	Subsidy
1	Farmers with a landholding size of up to two hectares	90% subsidy for micro irrigation systems
2	Farmers having land-holding of 2 to 5 hectares	45% subsidy for micro irrigation systems
3	Farmers having more than five hectares of land.	No subsidy

Source: *Key informant interviews conducted with the relevant departments*

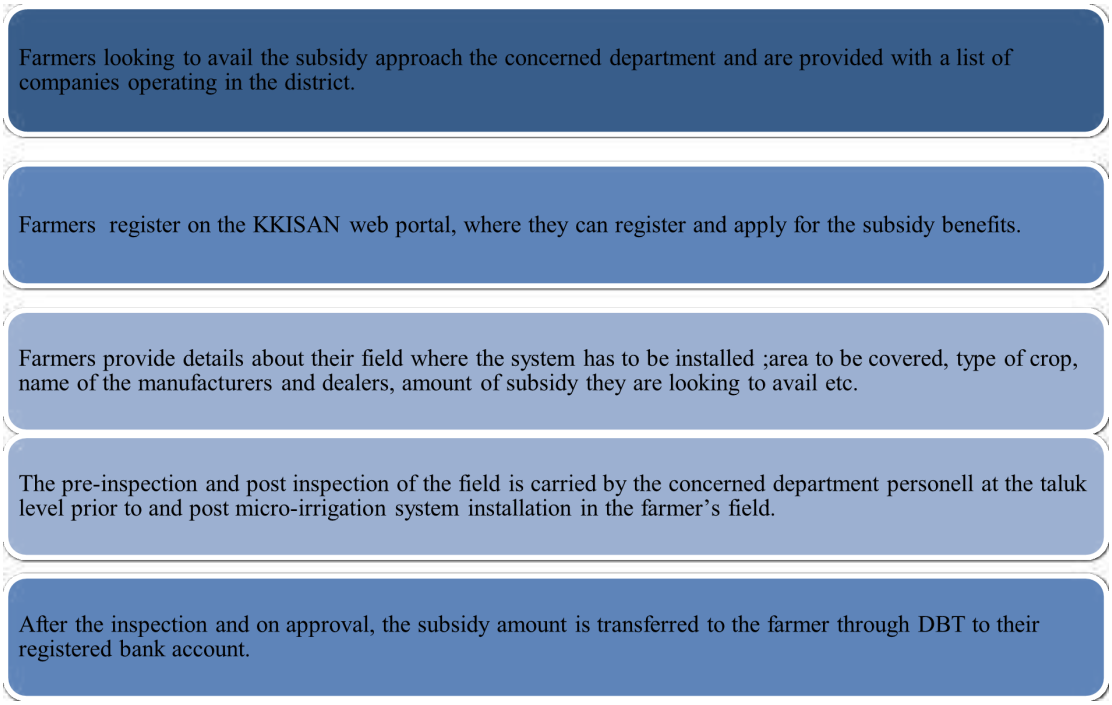
3.5.2 Organisational Structure

The Horticulture Department also acts as the nodal agency for the tender procedure of drip/sprinkler system suppliers. It comprises of the Director of Horticulture as the head, assisted by four Assistant Directors of Horticulture and nine Joint Directors of Horticulture at the state level, and four Joint Directors at the divisional level. The senior Assistant Director of Horticulture under State Sector looks after the development and maintenance of Horticultural farms and nurseries and monitoring of horticultural training centers. At the district level, the Deputy Director of Horticulture under the Zilla Panchayat is responsible for implementation of the scheme. At the taluk level, the Senior Assistant Director of Horticulture under the Zilla Panchayat is responsible for the implementation.

3.5.3 Operationalisation of Scheme

A farmer is provided with the list of MI drip/sprinkler companies when they approach the concerned department. While small farmers are able to make the MI system design or blueprint for their fields on their own, large farmers need to take help of supplying companies and firms. Figure 3.8 presents each step of the subsidy disbursement process in greater detail.

Figure 3.8: Step by Step Procedure for Disbursement of Subsidy



Source: *Key Informant Interviews*

3.5.4 Monitoring and Grievance Redressal

For the purpose of monitoring and ensuring the smooth working of the equipment once it is installed, farmers are provided with training on how to use the micro irrigation system by the company representatives/ dealers. It has made mandatory for suppliers and service providers to make technicians available at the village level and panchayat level to resolve problems of farmers as soon as possible. Companies are also required to provide a warranty of 3 years for the systems they are selling. The state government additionally provides some services to the farmers. For example, whenever clogging or salinity of water is witnessed, acid treatment is provided by the government. Furthermore, in case of a complaint made about the quality of MI systems by the farmers, the field staff has to go and collect samples from the pipes installed in the field and send them to CIPET for analysis. In case a problem is detected, the supplying company is blacklisted.

3.6 The Case of Maharashtra

The Department of Agriculture is the nodal department for the implementation of the PMKSY-PDMC scheme in the state of Maharashtra. The execution of the plan is undertaken by the Department of Horticulture, within the Commissionerate of Agriculture. Furthermore, the state has developed a software known as E-Thibak, through which farmers can apply for the micro irrigation subsidy online (see section on operationalisation for more details)

3.6.1 Subsidy Provision: Pattern and Eligibility

The pattern of assistance provided is 55 percent of the indicative unit cost for small farmers and 45 percent for other farmers, with a ceiling of 5 hectares on micro irrigation installation assistance. Farmers availing the subsidy can re-apply for the subsidy after a period of 7 years. Additionally, there is a separate and additional central assistance of 25 percent for chronically drought prone and farmer suicide prone areas and districts of Maharashtra such as Marathwada and Vidarbha.

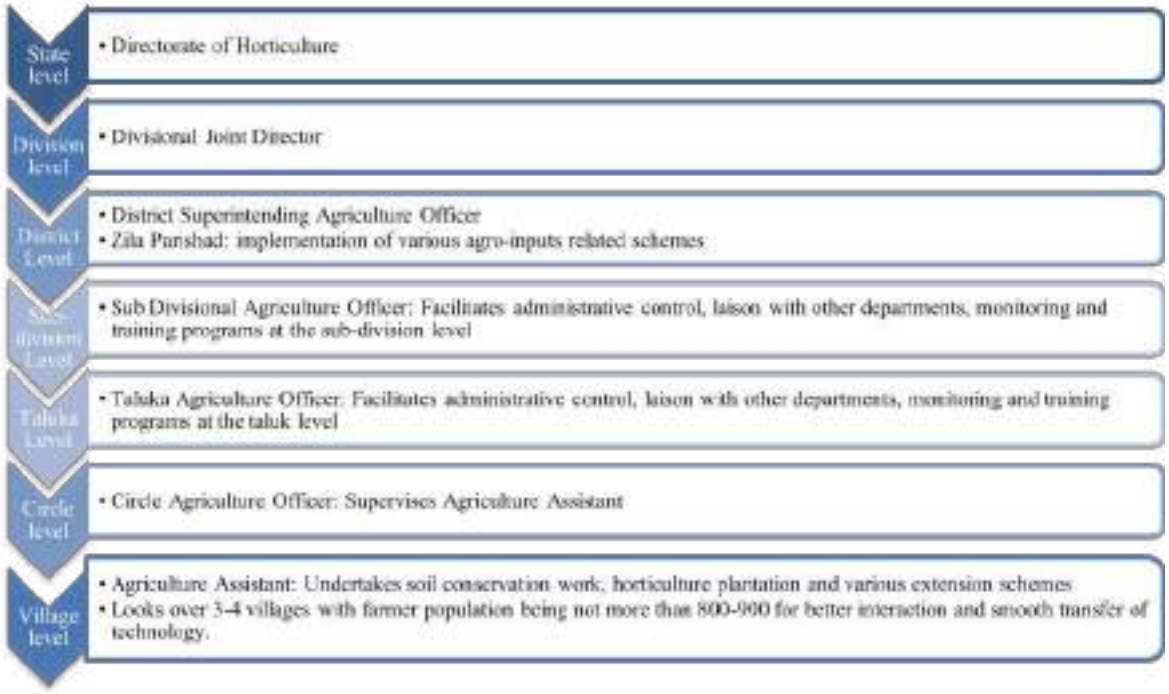
The eligibility criteria for farmers includes:

- Presence of irrigation source and facility (pump set, diesel engine etc.).
- A permanent electrical connection set for the electric water pump. Farmers have to submit a fresh copy of their electricity bill for the same.
- Own land in farmer's name.
- 7/12 certificate and 8-A certificate.
- Caste certificate, in case they belong to scheduled castes or tribes.

3.6.2 Organisational Structure

The PMKSY-PDMC scheme is being implemented in the state through a network of 90 sub-divisional agriculture officers, 351 taluka agriculture level officers and 897 board agriculture officers (E-thibak, 2016). The organizational structure is provided in Figure 3.9.

Figure 3.9: Organisational Structure of Micro Irrigation Implementation in Maharashtra

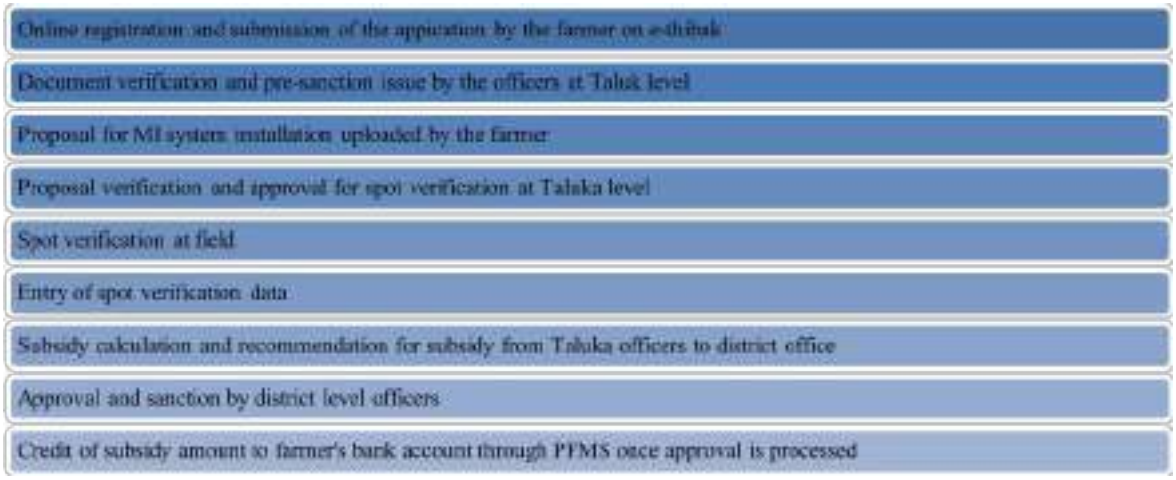


***Source**: Department of Agriculture, Maharashtra*

3.6.3 Operationalisation of Scheme

The selection of farmers for the subsidy is done through a lottery in order to ensure impartiality. The lottery system selects random farmers up to the point of meeting that particular year's financial target. The detailed procedure for disbursement of subsidy is provided in Figure 3.10. It is to be noted that unlike in other states, wherein the farmer has to pay the net amount minus the subsidy to the company, and the company received the subsidy amount from the government, here the subsidy is deposited in the beneficiary account and the farmer has to bear the entire amount of unit costs at the time of purchase.

Figure 3.10: Disbursement of Subsidy



Source: *Key informant interviews*

3.6.4 Monitoring and Grievance Redressal

To ensure transparency throughout the subsidy disbursement procedure, an SMS service has been brought in through which farmers are kept in the loop about the status of their application. They are intimated of their selection, pre-sanction approval, subsidy fund transfer to their account etc. through this SMS service.

Farmers are provided with a helpline number on the MahaDBT portal. Along with that a separate complaint section has been provided on the portal, wherein farmers can fill in their details and address specific types of complaints or difficulties they are facing in their application procedure. They can also provide suggestions to the government using the same form.

CHAPTER 4:

Gujarat

4.1 Introduction

As per the Census 2011, the state of Gujarat is spread over an area of 196024 square km, constituting around 6.4 percent of the total geographical area of the country. The total geographical area of the state is around 19.6 million hectares; the net cultivable area is around 53 percent of the geographical area (10.49 million hectares). The total gross cropped area was 13.81 million hectares in 2019-20, and the net area sown was 9.78 million hectares in the same year. The contribution of agriculture and allied activities in the overall gross state domestic product was 13.4 percent in 2018-19.

The population of the state was 50.8 million in 2011, marking an increase of 19.3 percent from 2001. Out of this, 49 percent of the workforce is engaged in agriculture (Labour Bureau, 2015-16). As per the latest available data, a majority (more than 68 percent) of cultivators are small and marginal farmers, operating on 34.19 percent of the state's operated area in 2015-16. The average size of landholdings was 1.88 hectares in the same year.

Gujarat is a water deficient state, with only 2 percent of the country's water resources. While the water situation differs across different parts of the state based on the terrain, Gujarat is a drought prone state with poor and erratic rainfall witnessed particularly in regions such as north Gujarat, Saurashtra and Kachchh, which constitute nearly 71 percent of the total geographical area of the state but account for less than 30 percent of the state's water resources. The average annual rainfall is 756 mm. The total water availability of the state is 55 BCM (billion cubic meters); out of this surface water constitutes 38.1 BCM while underground water constitutes 17.5 BCM. In terms of ground water availability, both the surveyed districts of Rajkot and Sabarkantha lie in the semi-critical zone; wherein groundwater utilization is between 70-90 percent.

Figure 4.1: Selected Districts in Gujarat

Source: *Prepared using paintmaps*

Given the drought prone nature of the state, irrigation plays a significant role in the agriculture development of the state. More than 80 percent of the surface water is utilised for irrigation. The gross irrigated area was 8.43 million hectares in 2019-20, while the net irrigated area was 5.23 million hectares in the same year. Table 4.1 presents the statistics pertaining to irrigation sources for the surveyed districts; Rajkot and Sabarkantha. Rajkot constitutes 6.2 percent of the gross irrigated area, in the state, while Sabarkantha constitutes 3.7 percent of the gross irrigated area in the state.

Table 4.1: Source Wise Irrigation, 2019-20 for Survey Districts (00 Hectares)

District	Net Area Irrigated						Gross Irrigated Area					
	Canal	Tank	Tube-wells	Other Wells	Other Sources	Total (%)	Canal	Tank	Tube-wells	Other Wells	Other Sources	Total (%)
Rajkot	334	73	1015	1554	291	3267 (6.2)	487	85	1649	2532	511	5264 (6.2)
Sabarkantha	179	136	597	923	3	1837 (3.5)	318	224	1018	1581	5	3145 (3.7)
Total	11642	2321	19004	15994	4422	52382	18941	3515	30766	24023	7069	84313

Source: *Compiled from Directorate of Agriculture, Gujarat*

Micro-irrigation has been implemented in the state in the pursuance of adopting scientific water management techniques in the presence of limited existent irrigation facilities. Since the implementation of the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More Crop scheme, a total area of 39465 hectares have been covered under micro irrigation[6], out of which drip irrigation constitutes 78.02 percent (30793 hectares) and sprinkler irrigation constitutes 21.9 percent (8672) of the total area covered under micro irrigation. Table 4.2 provides a brief picture of the status of micro irrigation in the selected districts for the study; the physical and financial achievements are highlighted. It can be seen that the financial achievement per hectare for the state is 0.24, while the financial achievement per hectare for both districts is higher in comparison to the state average. In terms of state wise ranking for physical achievement, Rajkot stood at rank 6 in 2022-23 (upto December 2022) with micro irrigation coverage in 2232 hectares, while Sabarkantha stands at rank 9 in the same period with micro irrigation coverage of 1491 hectares. Both Rajkot and Sabarkantha also lie in the top 7 districts in terms of coverage under micro irrigation.

Table 4.2: Area Covered Under Micro Irrigation (Hectares) and Financial Achievement (Lakhs)

District	Physical Achievement			Financial Achievement			Total Financial Achievement (Per hectare)
	Drip	Sprinkler	Total	Drip	Sprinkler	Total	
Rajkot	1991	225	2216	593.75	13.04	606.79	0.27
Sabarkantha	1484	7	1491	458.26	0.50	458.76	0.30
Total	30793	8672	39465	9250	506	9756	0.24

Source*: Ministry of Agriculture and Farmers Welfare, Government of India*

The major crops wherein micro irrigation is adopted (in terms of area) include groundnut, potato, green chillies, ladiesfinger, and maize; major crops under drip include potato, green

[6] Upto December 2022

chilli, groundnut, ladyfinger and maize, while the major crops under sprinkler irrigation include groundnut, maize, and guar (cluster bean).

Table 4.3 provides details of the district wise top five crops under micro irrigation.

Table 4.3: Major Crops Under Micro Irrigation in Gujarat, 2022-23

District	Major Crops Total (Area in Hectares)	Major Crops under Drip (Area in Hectares)	Major Crops under Sprinkler (Area in Hectares)
Rajkot	Cotton (1578), Groundnut (264), Green chillies (280)	Cotton (1578), Green chillies (280), Ladyfinger (62)	Guar (225)
Sabarkantha	Cotton (1135), Maize (149), Potato (87)	Cotton (1135), Maize (149), Potato (87)	Groundnut (7)
Total (Gujarat)	Groundnut (11851), Potato (4563), Green chillies (3731)	Potato (4563), Green Chillies (3731), Groundnut (3209)	Groundnut (8642), Maize (14), Cluster Bean (14)

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

4.2 Sample Profile: An Overview

The following sections expound on each district in greater detail; first the district wise profile is examined with specific emphasis on the chosen talukas. This is followed by the primary data analysis at the district and block level.

393 cultivators[7] were sampled across 2 high coverage districts; Rajkot and Sabarkantha. 13 percent of the respondents interviewed were small and marginal farmers, 69 percent of the sample were semi-medium and medium farmers, while 16 percent were large farmers. 2 respondents were landless. The district and taluk wise distribution of farmers as per land categories is presented in Table 4.4.

Table 4.4: District and Taluk Wise Distribution of Farmers as per Land Categories

Land Category / District		Marginal	Small	Semi-medium	Medium	Large	Total
Rajkot	Dhoraji	2	1	17	23	7	50
	Jam Kandorana	4	1	34	77	34	150
Sabarkantha	Himmatnagar	12	27	34	55	15	143
	Talod	2	6	14	21	7	50
Total		20	35	99	176	63	393

Source: *Compiled from survey*

Further, the land category distribution of adopters and non-adopters is presented in Table 4.5. A majority of adopters (75.32%) are either semi-medium or medium farmers, while 66.53 percent of non-adopters are either semi-medium or medium farmers, and 21.34 percent percent of non-adopters are small and marginal farmers, as opposed to 2.6 percent of adopters lying in the small and marginal category. This will be explored in a greater manner in the district wise analysis (see Section 4.3 onwards).

[7] While 400 farmers were sampled, we have discussed 393 farmers based on the data received after eliminating missing values.

Table 4.5: Distribution of Farmers as Per Land Categories: Adopters and Non-Adopters

Land Category (%) Adoption	Marginal	Small	Semi-medium	Medium	Large	Total
Adopters	1 (0.65)	3 (1.95)	30 (19.48)	86 (55.84)	34 (22.08)	154 (100)
Non-Adopters	19 (7.95)	32 (13.39)	69 (28.87)	90 (37.66)	29 (12.13)	239 (100)
Total	20	35	99	176	63	393

Source: *Compiled from survey*

The socio-economic profile is presented. The average household size was 5.11 members, and the average number of working members was more than 1.

Almost 40 percent of the sample was an adopter of micro irrigation (either drip or sprinkler or both) while the rest are either non-adopters or have discontinued adoption at present.

A majority of respondents (more than 97%) had a ration card. 71 percent of the total sample had an above poverty line card and more than 22 percent had a below poverty line ration card. Out of these, a higher proportion of adopters (91%) had an above poverty line (APL) card, in comparison to non-adopters.

96.18 percent of the sample had a mobile phone; out of these 69.62 percent had a smartphone. Almost 90 percent of the sample with a smartphone used their smart phone in order to avail information related to agriculture. 52 percent (143) of these were availing information associated with the weather forecast, 44.36 percent (122) availed information related to best cultivation practices, and 28 percent (78) availed information related to market information. Only 10 percent (28) availed information related to government schemes in agriculture and the allied sector, and only 7 percent (20) availed information related to insurance in the agriculture sector. 78 percent of adopters of micro irrigation had a smartphone; out of this, 90.9 percent were availing information related to agriculture. In comparison, 64.43 percent of non-adopters of micro irrigation had a smartphone; out of this, 87.66 percent were availing information related to agriculture.

In terms of any household member having membership in organisations, 34 percent of the sample households had members who were part of a farmer cooperative, 4 percent had a member in the Gram Panchayat and 3.31 percent were in self-help groups (SHGs) and Mandal Parishad Territorial Constituencies. 55 percent of the sample households did not have any member in any organisation. Table 4.6 further expounds on membership at the district level:

Table 4.6: Membership in Organisations (%)

District	SHGs	FPOs	Farmer Cooperative	Gram Panchayat	Mandal Parishad	Others (Water Users Association, Youth Associations)	Not a Member of any Organisation
Rajkot	7 (3.5)	6 (3)	77 (38.5)	12 (6)	7 (3.5)	2(1)	89 (44.5)
Sabarkantha	6 (3.1)	1 (0.51)	59 (30.56)	4 (2.07)	6 (3.1)	2 (1.03)	115 (59.58)
Total	13 (3.3)	7 (1.78)	136 (34.06)	16 (4.07)	13 (3.3)	4 (1.01)	204 (51.9)

Source: *Compiled from survey*

46.75 percent of adopters of micro irrigation do not have members as a part of any organization; 41.56 percent of adopters have household members who are part of a farmer cooperative. With respect to non-adopters, 55 percent of non-adopters were not members of any particular organization and more than 30 percent of non-adopters are members of farmer cooperatives. 81.17 percent of the sample had availed credit; this was true for 81.17 percent of adopters and 81 percent of non-adopters.

Table 4.7 provides the descriptive statistics for household and farm characteristics.

Table 4.7: Descriptive Statistics for Household and Farm Characteristics

Variables	Mean	Number of Observations
Household Size	5.114 (2.072)	393
Number of Working Members	1.620 (.860)	393
Presence of Ration Card	1.025 (.157)	393
Farm Size (Acres)	15.16 (17.76)	393
Farm Size for Adopters (Acres)	18.73 (22.01)	154
Farm Size for Non-Adopters (Acres)	12.86 (13.95)	239
Number of Plots Cultivated	1.87 (1.13)	393
Number of Plots Cultivated (Adopters)	2.12 (1.27)	154
Number of Plots Cultivated (Non-Adopters)	1.711 (1.006)	239
Access to Credit	1.188 (.391)	393
Annual Income from Agriculture	531306.488 (725437.97)	393
Income from Agriculture (Adopters)	677410.4 (951966.3)	154
Income from Agriculture (Non-Adopters)	438084.7 (512440.3)	239
Income from Farm Output	347618.3 (573881.7)	393
Income from Farm Output (Adopters)	467175.3 (783546.9)	154
Income from Farm Output (Non-Adopters)	270581.6 (364080.7)	239
Number of Agriculture Assets	11.949 (17.494)	393
Current Value of Agriculture Assets	2,61,211.3 (314817.4)	393

***Note**: Standard deviation is given in parentheses.*

4.3 Rajkot District - Profile

As per the Census 2011, the population of Rajkot district was 3.80 million, with the district lying among the top 5 populated districts in the state. The total geographical area is 768989 hectares; The net sown area is around 532582 hectares, while the gross irrigated area is around 648182 hectares, constituting 46.85 percent of the gross cropped area. In terms of water availability, the surface water availability is 1464.49 MCM while the ground water availability is 1123.77. The crop water demand is 2754 MCM; with potential to be created being 1209 MCM.

Two talukas were selected in Rajkot district; a micro irrigation low coverage district Dhoraji and a high coverage district-Jam Kandorana. Statistics pertaining to total geographical area, land under irrigation etc. have been presented in Table 4.8. It is important to note that Dhoraji has the

maximum command area under canal irrigation among all talukas; in contrast Jamkandorana lies amongst the talukas wherein the area covered by government canals are the least (2249 hectares); a larger amount of area is irrigated by private open wells (12515 hectares).

Table 4.8: Taluk Wise Land and Soil Characteristics

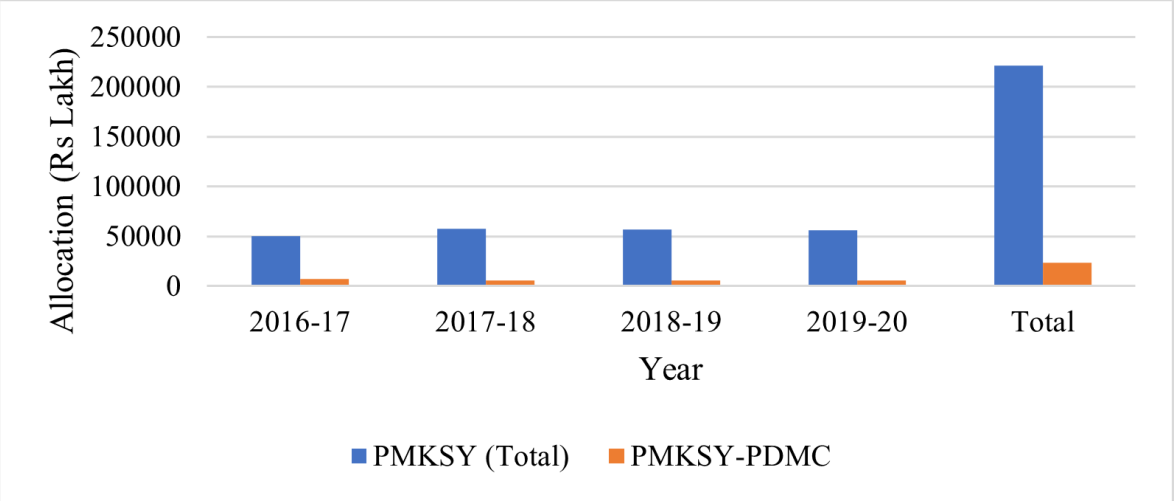
Taluk	Total Geographical Area	Net Sown Area	Gross Irrigated Area	Totally Rainfed/Un-Irrigated Area	Area Developed under Canal Command	Major Soil Cluster (Area)
Dhoraji	48495	40230	24625	22845	11681	Medium black soil (36065)
Jamkandorana	56734	40802	33057	21300	2070	Medium to shallow black (35200) Sandy soil (5800)

Source: *Compiled from Rajkot irrigation division*

4.3.1 PMKSY Allocation and Coverage under PMKSY-PDMC

As per the District Irrigation Plan prepared for Rajkot for 2016-17 to 2019-20, a total of Rs 221320.65 lakh was proposed for PMKSY, out of which 10.62 percent was allocated to PMKSY-PDMC. Furthermore, Rs 244.53 lakh was proposed for the purpose of extension and training, to be undertaken by ATMA (Agricultural Technology Management Agency).

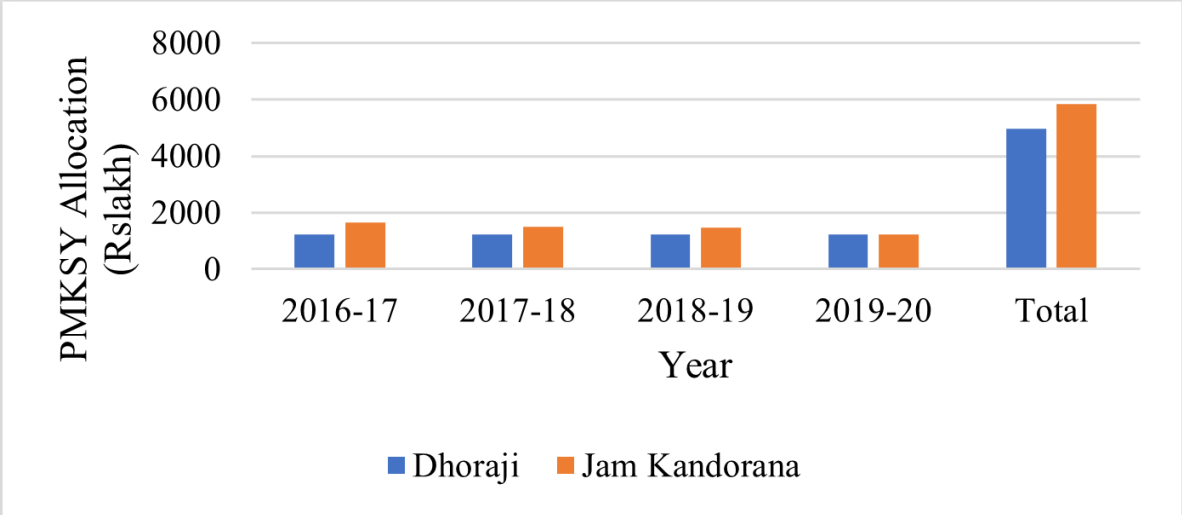
Figure 4.2: PMKSY and PMKSY-PDMC Allocation to Rajkot District (Rs Lakh)



Source: *Rajkot District Irrigation Plan, 2016-20*

In terms of taluk wise PMKSY allocation, the taluks with the maximum allocations include Gondal (28%), Jetpur (26%) and Jasdan (26%). Jamkandarona holds the fifth rank amongst 11 taluks, while Dhoraji holds the seventh rank. Both Jamkandorana and Dhoraji constitute 2 percent and 3 percent of the total PMKSY allocation respectively. Figure 4.3 presents the allocation under PMKSY for the selected taluks in the period 2016-17 to 2019-20.

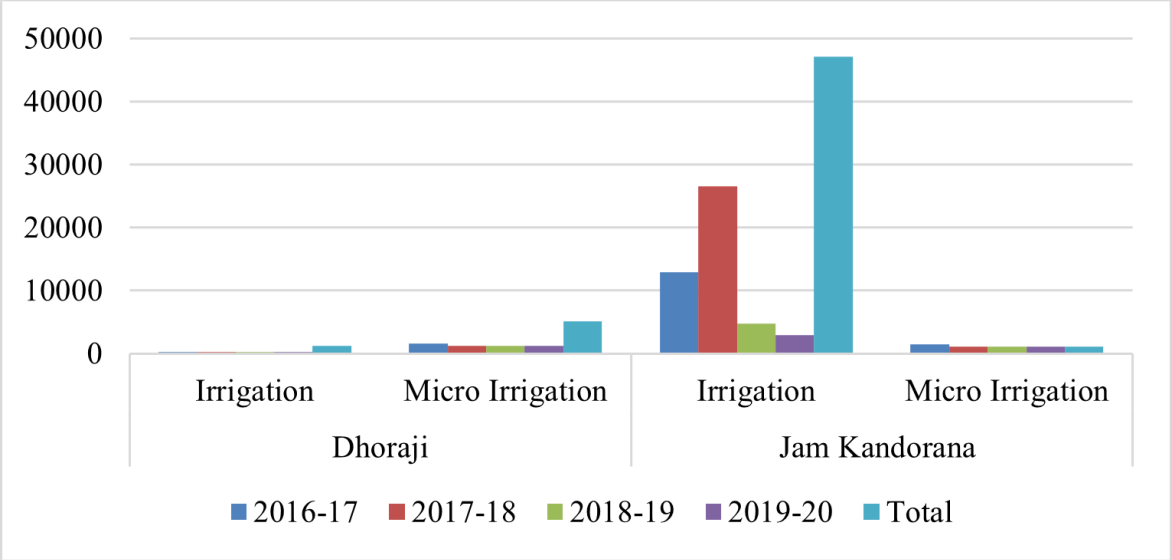
Figure 4.3: PMKSY Allocation to Dhoraji and Jamkandorana (Rs Lakh)



Source: *Rajkot District Irrigation Plan, 2016-20*

In terms of the block wise distribution of area planned to be brought under irrigation, Jamkandorana has the highest area planned to be brought under irrigation (Rs 47112.39 hectares). In terms of the block wise distribution of area planned to be brought under irrigation Figure 4.4 looks at the taluk wise year wise plan for bringing additional area under irrigation, and micro irrigation for the selected taluks.

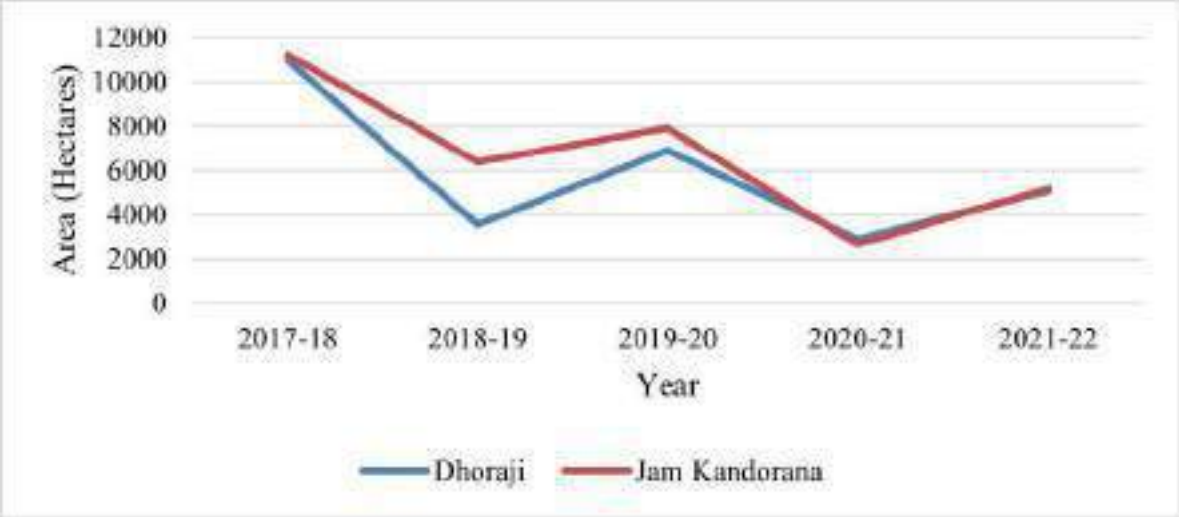
Figure 4.4: Proposed Additional Area Under Irrigation and Micro Irrigation



Source: *Rajkot District Irrigation Plan, 2016-20*

Figure 4.5 presents the area covered under micro irrigation in both the selected taluks in the period 2017-18 to 2021-22. There was a sharp decline in the area covered under micro irrigation in both the taluks in 2018-19 from 2017-18, and the area has been fluctuating since then; 2020-21 marks another period of decline.

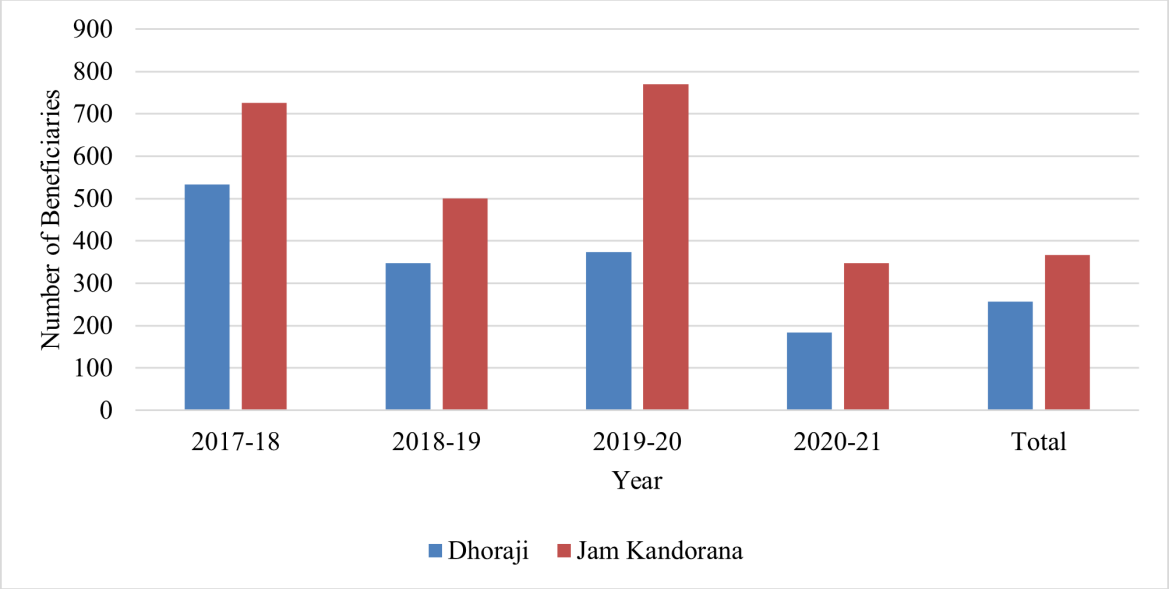
Figure 4.5: Area Under Micro Irrigation in Selected Taluks



Source: *Shared by GGRC*

Figure 4.6 further looks at the beneficiary-wise distribution under PDMC-PMKSY in the same period. Jamkandorana has a larger volume of beneficiaries in each period. In Jamkandorana and Dhoraji there has been a decline in beneficiaries from 2019-20 to 2020-21.

Figure 4.6: Taluk Wise Beneficiaries: PMKSY-PDMC, 2017-18 to 2020-21



Source: *Shared by GGRC*

4.3.2 Income and Cost of Cultivation

The average annual income for the respondents in Rajkot district was INR 5,58,086; the average income from farm output was INR 3,89,750. Table 4.9 presents the taluk wise average income from different sources for the district, including the income from sale of farm output. Table 4.10 looks at the average income as per land category in both the taluks.

Table 4.9: Taluk Wise Distribution of Average Annual Income from Various Sources

Taluk	Income from Livestock	Income From Self Employment	Income from Salary	Income from Agricultural Wages	Income from Agriculture Labour	Income from Other Sources	Income from sale of Farm Output (in Rs)	Income from sale of by-products	Total Income
Dhoraji	28326.67	35000	285772.7	33625		12000	390100	97275	574741
Jam Kandorana	27577.78	292666.7	421071.4	62500		6250	389633.3	82673.33	552534.7

Source: *Inputs from survey*

Table 4.10: Taluk Wise Distribution of Average Total Annual Income per Land Category

Taluk	Marginal	Small	Semi-Medium	Medium	Large
Dhoraji	81250	140000	298294.1	469858.7	1793829
Jam Kandorana	281250	87500	230402.9	446470.8	1160463

Source: *Inputs from survey*

Table 4.11: Taluk Wise Distribution of Average Income from Farm Output per Land Category

Taluk	Marginal	Small	Semi-Medium	Medium	Large
Dhoraji	65000	100000	188823.5	311521.7	1271429
Jam Kandorana	175000	70000	131911.8	319090.9	841764.7

The major crops cultivated by respondents in Rajkot district include *cotton, groundnut and wheat* in Dhoraji taluk and *cotton, groundnut and chilli* in Jamkandorana taluk. Table 4.12 (a) and Table 4.12 (b) presents the costs of cultivation for the three crops, with a comparison of adopters and non-adopters.

Table 4.12 (a): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Dhoraji

Category	Variable	Crops					
		Cotton		Groundnut		Wheat	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	12211.11 (13170.43)	9447.826 (14893.5)	25250 (13359.56)	19110 (11915.95)	12350 (9939.819)	4260 (2319.052)
	Chemical Fertilizer	14611.11 (10694.36)	14223.91 (11619.97)	11177.78 (10557.6)	12350 (14536.33)	12240 (9577.474)	3520 (2304.778)
	Bio Fertilizer	2450 (2027.313)	4440 (2343.715)	-	2400(-)	-	-
	Asset Rent	11977.78 (7714.277)	15445.65 (18024.94)	14138.89 (10189.28)	11900 (7062.42)	15200 (8983.318)	5600 (2924.038)
	Labour Cost (excluding supervision and irrigation)	36119.44 (30594.81)	30413.04 (31314.99)	26833.33 (16589.33)	32300 (25732.82)	13000 (11958.26)	8600 (4722.288)

Category	Variable	Crops					
		Cotton		Groundnut		Wheat	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	3890 (1516.905)	3688.889 (1839.082)	3212.5 (895.1257)	3270 (815.2028)	2375 (287.2281)	2800 (1036.822)
	Cost of Electricity	4180 (5344.53)	2143.75 (2333.5157)	3314.286 (3083.52)	1820 (1294.261)	2600 (270.8013)	4700 (3094.35)
Cost of micro-irrigation technology	Rental Charge	-	-	3 (-)	-	-	-
	LabourCost	2314.286 (2314.286)	2000(-)	1520 (944.0457)	-	-	-
	Cost of Electricity	4500 (816.4966)	4000(-)	1868.182 (1485.812)	-	-	-
Fertigation Equipment	Rental Charge	1250(-)	NA	4700 (6874.591)	NA	-	NA
	Labour Cost	750(191.4854)	NA	1030 (670.4476)	NA	-	NA
Farm Bunding	Labour Cost	3000(-)	1500(-)	-	-	2000(-)	-
	Cost of Electricity	4000 (-)	-	-	-	2000(-)	-

Note: *Standard deviation is given in parentheses*

The survey indicated that adopters are characterised by higher average input costs across all three crops (seed, chemical fertilizers and biofertilizers) in comparison to non-adopters. The average labour costs (excluding supervision and irrigation) are seen to be higher for adopters as opposed to non-adopters in the case of cotton and wheat; the average labour costs for groundnut is higher for non-adopters as opposed to non-adopters. It can be seen that in the case of wheat, the average electricity costs (overall) for non-adopters are higher as compared to adopters. In terms of irrigation related costs, the average labour costs were lower for adopters as compared to non-adopters in the case of groundnut and wheat. The average cost of electricity in irrigation was higher for adopters as compared to non-adopters across all three crops.

Table 4.12 (b): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Jamkandorana

Category	Variable	Crops					
		Chilli		Cotton		Groundnut	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	11846.15 (11171.74)	4392.857 (2732.839)	12246.2 (19889.54)	11556.33 (14583.39)	35862.27 (83758.22)	22098.57 (19694.08)
	Chemical Fertilizer	3746.154 (1265.316)	6557.143 (7187.566)	26884.31 (56510.21)	18679.62 (19511.23)	16840.91 (28820.97)	12247.36 (13061.47)
	Bio Fertilizer	-	-	4050 (3438.75)	3080 (1558.347)	1000(-)	1816.667 (1053.407)
	Asset Rent	7884.615 (3136.837)	5464.286 (2530.311)	22727.45 (38054.69)	19117.72 (24819.18)	18352.27 (27554.09)	14821.43 (13630.05)
	Labour Cost (excluding supervision and irrigation)	24230.77 (11584.14)	20500 (7429.153)	56545.1 (107750.4)	40312.03 (43566.97)	33022.73 (55902.53)	27172.86 (21876.34)

Category	Variable	Crops					
		Chilli		Cotton		Groundnut	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	2100 (424.2641)	857.1429 (350.1962)	3763.158 (1979.677)	4238.028 (2247.498)	3325 (844.0328)	3291.176 (977.4678)
	Cost of Electricity	1125 (530.3301)	1792.857 (789.8045)	3196.875 (4266.789)	2085.821 (1607.742)	4719.565 (3582.367)	2528.986 (1687.245)
Cost of micro-irrigation technology	Rental Charge	-	-	3 (-)	-	2500(-)	-
	LabourCost	1333.333 (248.0225)	500(-)	3356.818 (4177.258)	-	3900 (3122.622)	6000(-)
	Cost of Electricity	1483.333 (962.3204)	3000(-)	5543.182 (5435.773)	-	2982.143 (3769.35)	10000(-)
Fertigation Equipment	Rental Charge	1600(-)	-	3200 (1565.248)	-	1500(-)	-
	Labour Cost	625(324.3875)	-	1817.647 (1336.149)	-	1266.667 (1578.905)	-
Farm Bunding	Labour Cost	-	-	3000(-)	1000(-)	5500 (4330.127)	1000(-)
	Cost of Electricity	-	-	4000(-)	8000(-)	25000(-)	2320 (2375.879)

The survey findings indicated that the input costs are uniformly higher across chilli, groundnut and cotton for adopters as compared to non-adopters; only in the case of chilli, chemical fertilizer costs are higher for non-adopters as compared to adopters. The labour and asset rentals are also more for adopters in comparison for non-adopters across all three crops. In the case of chilli, the average electricity costs are lower for adopters as compared to non-adopters. The average electricity costs are higher for adopters in the case of cotton and groundnut in comparison to non-adopters.

4.3.3 Asset Ownership

The survey documented the ownership of major farm assets owned by the respondents included tractors (32.6 percent of the total sample surveyed in the district), harvester combiners (100 percent of the sample), drip and sprinkler irrigators (tube wells and bore wells, electric pumps, hand hoes, sprayers, pick axes, weed hooks etc). Table 4.13 looks at the number of respondents with ownership of select major assets, the average cost of the asset as well as the average current value of the asset. This is further analysed in terms of the ownership of assets for adopters and non-adopters, as well as the average number of units owned for each category.

Table 4.13: Taluk Wise Asset Ownership and Cost

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Dhoraji	19 (38)	19	0	347052.6	177578.9
	Jam Kandorana	79 (52.66)	77	2	342772.2	194050.6
Drip	Dhoraji	9 (18)	9	0	94222.22	46333.33
	Jam Kandorana	51 (34)	51	0	96450.98	92980.39

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Sprinkler	Dhoraji	13 (26)	4	9	37192.31	16692.31
	Jam Kandorana	9 (0.06)	2	7	24611.11	13888.89
Electric Pump	Dhoraji	33 (66)	26	7	42459.46	19756.76
	Jam Kandorana	71 (47.33)	51	20	35914.52	23717.34
Bore Well	Dhoraji	13 (26)	12	1	99000	81153.85
	Jam Kandorana	39 (78)	29	10	118461.5	110512.8
Tube Well	Dhoraji	8 (16)	7	1	106875	135000
	Jam Kandorana	31 (20.6)	22	9	129838.7	154838.7

Table 4.14: Asset Ownership Amongst Adopters and Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Tractor	Dhoraji	11 (47.82)	8 (29.62)	1	1
	Jam Kandorana	31 (56.36)	48 (50.52)	1.06	1
Drip	Dhoraji	9 (39.1)	NA	1	NA
	Jam Kandorana	51 (92.72)	NA	1	NA
Sprinkler	Dhoraji	12 (52.17)	NA	7	NA
	Jam Kandorana	9 (16.36)	NA	10.44444	NA
Electric Pump	Dhoraji	17 (39.1)	16 (59.25)	1.29	1.25
	Jam Kandorana	41 (74.5)	72 (75.78)	1.24	1.27
Bore Well	Dhoraji	9 (39.13)	5 (18.51)	1.125	1
	Jam Kandorana	21 (38.18)	18 (18.94)	1.285	1.22
Tube Well	Dhoraji	4 (17.39)	4 (14.81)	1.25	1
	Jam Kandorana	10 (43.47)	21 (22.10)	1.3	1.38

A greater percentage of adopters own a tractor as opposed to non-adopters in both the taluks. In addition, a higher percentage of adopters in both the taluks have a bore well (almost 40%); ie access to an assured source of irrigation, in comparison to under 20 percent of non-adopters owning the same.

4.3.4 Micro Irrigation Ownership

The data illustrates that in Dhoraji and Jamkandorana, a majority of drip irrigation adopters are *medium and large farmers*. The key informant interviews with Gujarat Green Revolution Company also highlight that micro-irrigation adopter farmers are ones who have the capability to invest in the technology, and tend to be medium-large farmers who can invest on their own, or even small and

marginal farmers if the subsidy is present. In Dhoraji, a majority (more than half) of medium and large farmers irrigation have taken sprinkler through the government subsidy. In Jamkandorana, none of the medium or large farmers have directly acquired sprinklers; they have received it as a gift or subsidy. A majority of adopter farmers have purchased drip irrigators through their own means as opposed to a subsidy.

Table 4.15 further elaborates on the supply network for micro irrigation in terms of its presence and accessibility as per the respondent response. In Dhoraji, the average number of dealer shops is 10; only 1 village had a dealer shop while the other 4 villages had dealer shops at the block or district level. For dealer shops outside the village, the average distance from the village was 14.77 km. None of the distributor shops were located within any of the surveyed villages; the average distributor shops were located at a distance of 21.2 km from the village.

In the case of Jamkandorana, the average number of dealer shops was 8; in 5 villages out of 15, these were located within the village. The average distance for dealer shops outside the village was almost 9 km. None of the distributor shops were located within the village; there were on average 6 distributor shops in the taluk, located at an average distance of 18.06 km outside the village. Box 4.1 further examines the organisational supply network and density of players at the state, district and block level for one major micro irrigation equipment supplier (constituting almost a 30 percent share in the Indian context) -Netafim as a case in point.

Box 4.1: Netafim-Organisational Structure

- The micro irrigation equipment supply ecosystem consists of manufacturer companies such as Netafim at the top of the supply chain, distributors who sell the equipment and dealers who fit the micro irrigation systems in the fields. Manufacturer companies engage in provision of equipment and parts; providing technical expertise and information and training. Dealers and distributors supply equipment from the company, and dealers hire field technicians on a contract basis to do the ground survey and fit the micro irrigation systems. The technicians help the farmers understand the maintenance and operation aspects of micro irrigation.
- Netafim employees include one regional manager at the state level, state coordinators and area managers, with one district manager for each district. At the taluk level, there are field officers; one field officer is allocated 3-4 taluks. Each district also has a micro irrigation engineer, and agronomists who work towards training and creating awareness among the farmers.

Source: *Key Informant Interviews with company officials*

4.3.5 Micro-Irrigation Service Providers: Access and Distance

Table 4.15 presents the data with respect to access to dealer and distributor shops.

Table 4.15: Micro Irrigation Service Providers: Access and Distance

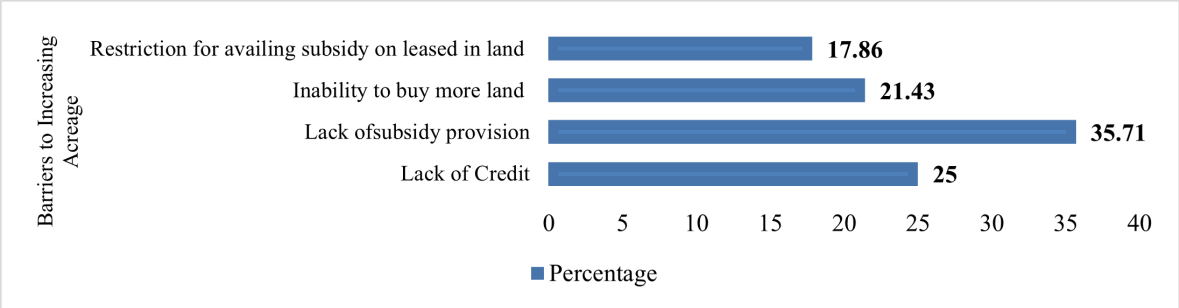
Taluk	Total Number of Drip Irrigation Units	Total No of Sprinkler Irrigation Units	Average Number of Dealer Shops (Km)	Average Distance from Dealer Shop	Average Number of Distributor Shops	Average Distance from Distributor Shop (km)
Dhoraji	9	13	10	14.775	5.2	21.2
Jam Kandorana	51	9	8	10.8	6.2	18.06

4.3.6 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

The survey revealed that out of the total respondents in Rajkot district, 80 percent (160 farmers) were aware of the subsidy in the state; 80 percent of farmers in both taluks were aware. 40 percent of the sample were adopters of micro irrigation in the district. For adopters, 33 percent of the sample had availed the subsidy prior to 2015, and 24 percent of the sample were availing the subsidy since the last two years. The average acreage under MI for Rajkot district was 17.61 acres (7.12 hectares); 12.82 acres (5.18 hectares) in low coverage Dhoraji and 19.61 acres (7.93 hectares) in

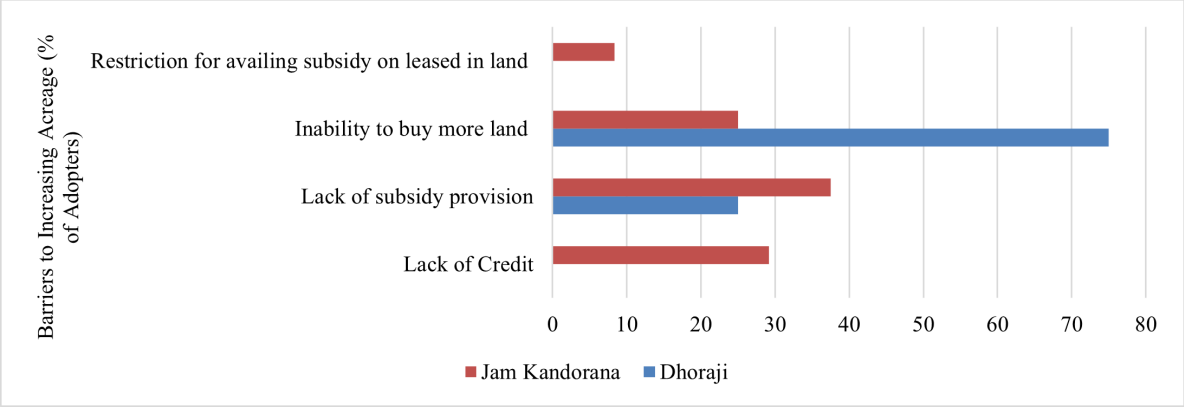
high coverage Jamkandorana. 36 percent of the adopter respondents wanted to increase acreage under micro irrigation in Rajkot. The major barriers to increasing acreage are provided in Figure 4.7.

Figure 4.7: Barriers to Increasing Acreage



The major barriers to increasing acreage at a taluk level included: restriction for availing subsidy on leased in land (75 % of adopters) in Dhoraji, and lack of subsidy provision (37.50%), lack of credit (29.17%) and inability to buy more land (25%) in Jamkandorana (see Figure 4.8).

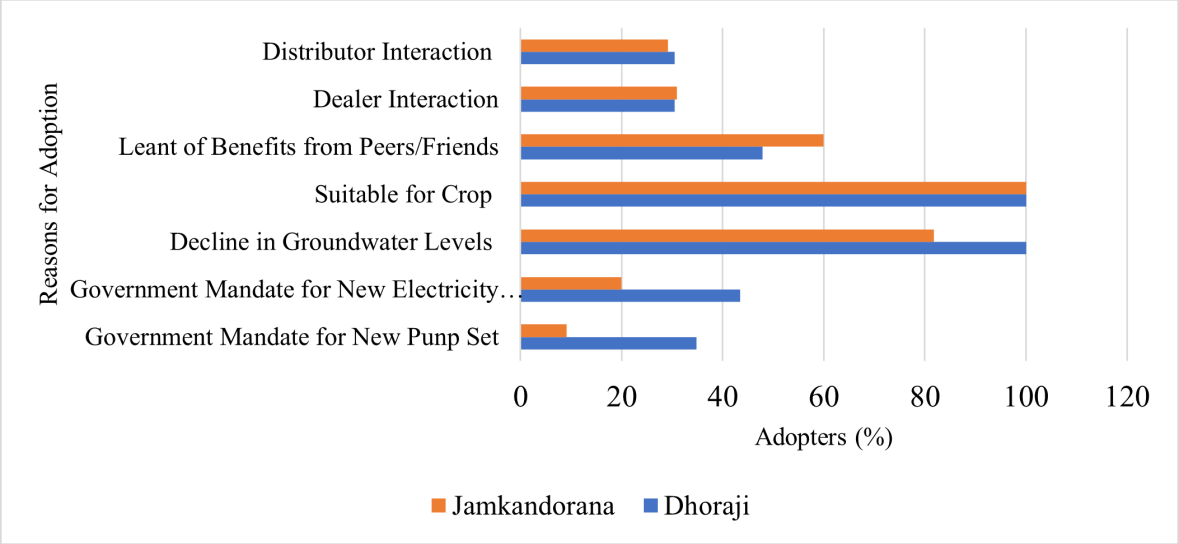
Figure 4.8: Barriers to increasing Acreage at Taluk Level



It has been observed that the major reasons for adoption in Rajkot district include (a) a decline in groundwater levels in both taluks, (b) suitability for the crop and (c) learning of its benefits from peers/ friends. In the low coverage taluk-Dhoraji, the government mandate for new pump set/ electricity connection played a greater role in impacting adoption, as compared to Jamkandorana.

Figure 4.9 presents the reasons for adoption.

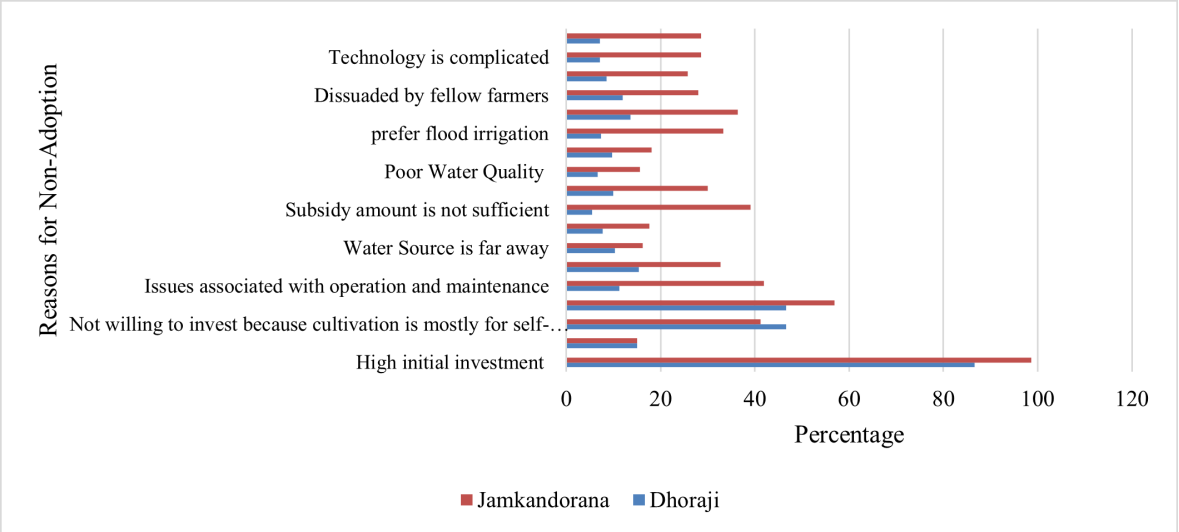
Figure 4.9: Reasons for Adoption



We further examine the reasons for non-adoption as well as disuse of micro irrigation at a district level. The survey on dis-adopters, i.e., beneficiaries who had availed micro irrigation but had disused the technology revealed that the major reasons are observed to be ***discontinuation of the subsidy*** **(43%),** ***high cost of spare parts*** **(faced by 37 percent of discontinuers) and** ***lack of spare parts*** **(31%).** 25 percent of respondents mentioned frequent replacement of parts as an issue, 18 percent of the respondents who discontinued did so due to a delayed subsidy/insufficient subsidy, 18 percent faced quality issues, 12 percent of the respondents had installation issues.

The non-adopters were observed to experience the following reasons for non-adoption; a high initial investment in both the taluks (mentioned by 86 percent of non-adopters in Dhoraji and 98.7 percent non-adopters in Jam Kandorana), high cost of operation and maintenance (mentioned by 46.6 percent of non-adopters in Dhoraji and 56.86 percent of non-adopters in Jam Kandorana) and unwillingness to invest because cultivation is mostly for self-consumption. In high-coverage Jam Kandorana, key reasons also included fragmented land (32.69%), issues associated with operation and maintenance (41.94%), and subsidy amount being insufficient (39.13%).

Figure 4.10: Reasons for Non-Adoption



Source: *Primary Survey*

4.4 Sabarkantha District - Profile

As per the Census 2011, the population of Sabarkantha district was 2.42 million, constituting 4 percent of the state's population. The total geographical area is 739000 hectares; The gross cropped area is around 427171 hectares, while the irrigated area is around 315188 hectare, constituting almost 74 percent of the gross cropped area. The net ground water availability is 1186.39 MCM; out of this almost 68 percent is accounted for irrigation. The crop water demand is 1179.25 MCM, constituting 94.13 percent of the total water demand. The main source of irrigation in the district is wells (76.88%), while 28.10 percent of the area has access to canal irrigation.

Two talukas were selected in Sabarkantha district; a micro irrigation low coverage district Talod and a high coverage district-Himmatnagar. Statistics pertaining to total geographical area, land under irrigation etc. have been presented in Table 4.16. It is important to note that Himmatnagar district has the highest water requirement in the state; 315.96 MCM and also holds the highest rank amongst all taluks in terms of net ground water availability. In terms of ground water development, Himmatnagar has been placed in the safe category while Talod has been placed in the 'semi-critical' category.

Table 4.16: Taluk Wise Land and Soil Characteristics

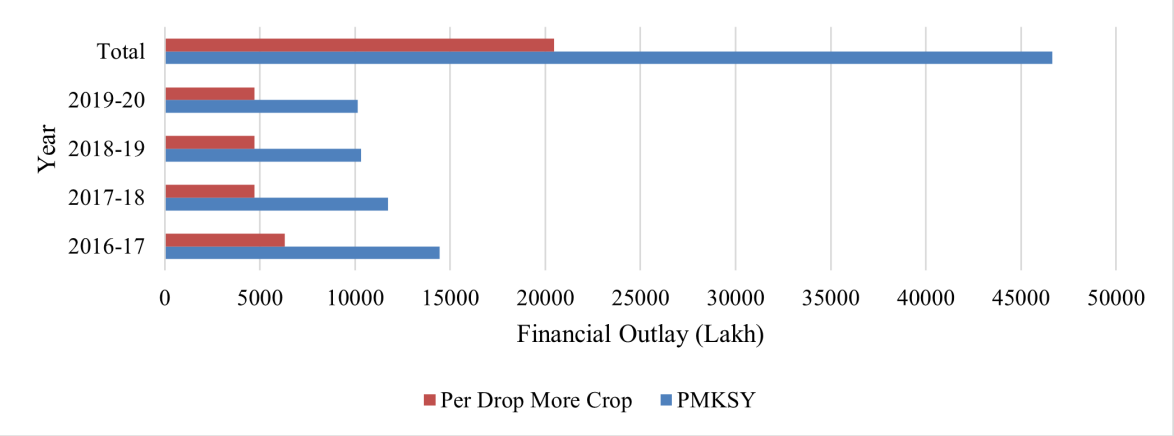
Taluk	Total Geographical Area	Net Sown Area	Gross Irrigated Area	Totally Rainfed/ Un-Irrigated Area	Area Developed under Canal Command	Major Soil Cluster (Area)
Himmatnagar	77391	54120	74765	19080	29756	Sandy loamy
Talod	44079	29866	37875	4710	2325	Sandy loamy

Source: *Compiled from Rajkot Irrigation Division*

4.4.1 PMKSY Allocation and Coverage under PMKSY-PDMC

As per the District Irrigation Plan prepared for Sabarkantha for 2016-17 to 2019-20, a total of Rs 46637.69 lakh was proposed for PMKSY, out of which *43.88* percent was allocated to PMKSY-PDMC. Furthermore, Rs 120.24 lakh was proposed for the purpose of extension and training, to be undertaken by ATMA (Agricultural Technology Management Agency). Figure 4.11 presents the financial outlay for PMKSY, with a specific emphasis on the per drop more crop component.

Figure 4.11: PMKSY and PMKSY-PDMC Allocation to Sabarkantha District (Rs Lakh)

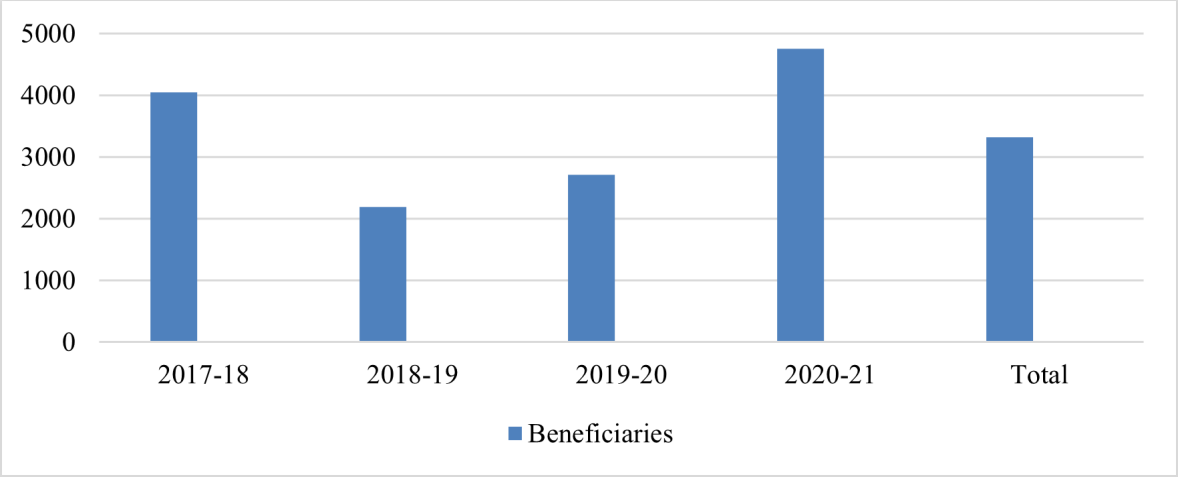


Source: *Sabarkantha District Irrigation Plan, 2016-20*

In terms of taluk wise PMKSY allocation, Himmatnagar has a total financial outlay of 6656.69 lakhs, and Talod has a total financial outlay of 5086.27. The maximum outlay has been estimated for Himmatnagar amongst all taluks by the irrigation department.

Figure 4.12 presents the beneficiaries under PMKSY-PDMC in Sabarkantha between the period 2017-18 to 2021-22. There was a sharp decline in the area covered under micro irrigation in 2018-19 from 2017-18, and the area has been fluctuating since then; 2021-22 marks another period of decline.

Figure 4.12: Beneficiaries under PMKSY-PDMC, 2017-20 to 2020-21



Source: *Shared by GGRC*

4.4.2 Income and Cost of Cultivation

The average annual income for the respondents in Sabarkantha district was INR 502434.7; the average income from farm output was INR 303958.5. Table 4.17 (a) presents the talk-wise average income from different sources for the district, including the income from sale of farm output. Table 4.17 (b) looks at the average income as per land category in both the taluks.

Table 4.17 (a): Taluk Wise Distribution of Average Annual Income from Various Sources

Taluk	Income from Livestock	Income From Self Employment	Income from Salary	Income from Agricultural Wages	Income from Other Sources	Income from sale of Farm Output (in Rs)	Income from sale of by-products	Total Income
Himmatnagar	73480	264363.6	559571.4	78000	78000	304405.6	71657.34	509114
Talod	81636.67	377333.3	226250	66000	235333.3	302680	74170	483332

Source: *Inputs from survey*

Table 4.17 (b): Taluk Wise Distribution of Average Total Annual Income per Land Category

Taluk	Marginal	Small	Semi-Medium	Medium	Large
Himmatnagar	236400	442203.7	492051.5	563436.4	687216.7
Talod	360250	216916.7	319200	598323.8	730142.9

Source: *Inputs from survey*

Table 4.17 (c): Taluk Wise Distribution of Average Income from Farm Output per Land Category

Taluk	Marginal	Small	Semi-Medium	Medium	Large
Himmatnagar	141666.7	284074.1	215588.2	374636.4	415000
Talod	257000	108333.3	212857.1	385238.1	414285.7

Source: *Inputs from survey*

4.4.3 Asset Ownership

The survey documented the ownership of major farm assets owned by the respondents.

Table 4.18: Taluk Wise Asset Ownership and Cost

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Himmatnagar	61 (42.6)	58	3	572606.6	321721.3
	Talod	26 (52)	25	1	566346.2	283000
Drip	Himmatnagar	52 (36.36)	51	1	138432.7	124903.8
	Talod	26 (52)	26	0	151192.3	150000
Sprinkler	Himmatnagar	29 (20.27)	16	13	84275.86	56758.62
	Talod	12 (24)	2	10	57916.67	49333.33
Electric Pump	Himmatnagar	71 (49.65)	51	20	43006.41	17535.9
	Talod	29 (58)	19	10	35914.52	13887.1
Bore Well	Himmatnagar	69 (48.25)	58	11	370808.8	138050.8
	Talod	39 (78)	29	10	135434.8	115176.5
Tube Well	Himmatnagar	15 (10.5)	13	2	119000	161666.7
	Talod	7 (14)	7	0	90000	220714.3

Table 4.19: Asset Ownership Amongst Adopters and Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Tractor	Himmatnagar (51) (92)	30 (58.82)	31 (33.69)	1.13	1
	Talod (25) (25)	19 (76)	7 (28)	1.05	1
Drip	Himmatnagar	51 (100)	NA	1.020833	NA
	Talod	25 (100)	NA	1	NA
Sprinkler	Himmatnagar	29 (56.86)	NA	17.41379	NA
	Talod	12 (48)	NA	14.75	NA
Electric Pump	Himmatnagar	32 (62.74)	16 (17.39)	1.59	1.35
	Talod	16(64)	13 (52)	2	1.27

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Bore Well	Himmatnagar	27 (52.94)	42 (45.65)	1.259	1.095
	Talod	14 (56)	9 (36)	1.142	1
Tube Well	Himmatnagar	8 (15.6)	7 (7.6)	1.75	1
	Talod	2 (3.9)	5 (20)	1	1

Source: *Inputs from survey*

The cost of cultivation has been mapped further in Table 4.20. It is seen that the seed costs and chemical fertilizer costs are higher for adopters across all three crops; groundnut, potato and wheat as opposed to non-adopters. The labour cost is higher for cultivators of groundnut and wheat for adopters, while it is higher for non-adopters in the case of potato.

Table 4.20: Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Sabarkantha District

Category	Variable	Crops					
		Groundnut		Potato		Wheat	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
	Seed Cost	43038.36 (31433.12)	22914.77 (34398.65)	251555.7 (329794.2)	172714.3 (108098.3)	8940.278 (7681.507)	7306.25 (6923.595)
	Chemical Fertilizer	48117.81 (42798.52)	17832.11 (28145.65	153818.2 (595518.8)	63571.43 (55880.4)	9146.111 (8147.131)	7620.833 (7397.907)
	Bio Fertilizer	3308.824 (2020.693)	3421.212 (1768.033)	-	-	-	-
	Asset Rent	24302.74 (18617.66)	11846.79 (13546.74)	17209.09 (14378.13)	18000 (13038.4)	11330.56 (8567.074)	8902.083 (7439.807)
	Labour Cost	45608.9 (42695.98	19802.75 (24889.11)	60788.64 (83587.89)	66642.86 (112622.8)	16244.44 (13576.96)	14397.92 (16459.69)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	3568.421 (1875.886)	3026.136 (2036.76)	2633.333 (776.7453)	1957.143 (687.6461)	2248 (528.4569)	2251.042 (627.4417)
	Cost of Electricity	1284.211 (357.8689)	1581.765 (1221.115)	2000 (866.0254)	2014.286 (552.0524)	3344 (3370.47)	2768.75 (1852.186)
Cost of micro-irrigation technology	Rental Charge	-	-	1 (-)	-	1200 (-)	-
	Labour Cost	2591.525 (2117.927)	1900 (1504.539)	1387.805 (802.9462)	1500 (-)	1622.727 (598.0651)	1500 (707.1068)
	Cost of Electricity	4338.136 (3663.277)	3569.231 (2442.125)	4228.571 (3842.289)	4000 (-)	1636.364 (1898.564)	2500 (2121.32)
Fertigation Equipment	Rental Charge	1909.091 (1091.288)	-	1250 (353.5534)	-	1500 (-)	-
	Labour Cost	1660.87 (1371.376)	3000 (2828.427)	920.5882 (344.4622)	-	816.6667 (256.2551)	-

4.4.4 Micro Irrigation Ownership

The data illustrates that in Himmatnagar and Talod, a majority of drip irrigation adopters are *medium and large farmers*. This is the case for sprinkler adopters as well which lie in the category of medium and large. In Himmatnagar and Talod, a majority of medium and large farmers have procured the sprinkler irrigators through their own means, as opposed to a subsidy. At least half

or more farmers have taken drip irrigators through the subsidy mode in Himmatnagar and Talod taluk.

Table 4.21: Drip and Sprinkler Adopters per Land Category

Land Category	Himmatnagar		Talod	
	Adopters with Drip	Adopters with Sprinkler	Adopters with Drip	Adopters with Sprinkler
Marginal	0	0	0	0
Small	2	1	0	0
Semi-medium	8	6	6	1
Medium	30	15	13	5
Large	12	7	7	6

Table 4.2 further elaborates on the supply network for micro irrigation in terms of its presence and accessibility as per the respondent response. The average number of dealer shops available in the taluk are 10 in both Himmatnagar and Talod taluk. In Himmatnagar, only two villages out of 15 had a dealer shop, while in Talod two villages out of five had a dealer shop. The average distance of dealer shops outside the village was 18 in the case of Himmatnagar and in the case of Talod it was 17. The average number of distributor shops in Himmatnagar was eight; all of them were located outside the village at the district or taluk level at an average distance of 14.4 km. In the case of Talod as well, all the distributor shops were either at the taluk or district level located at an average distance of 20 km from the respective villages.

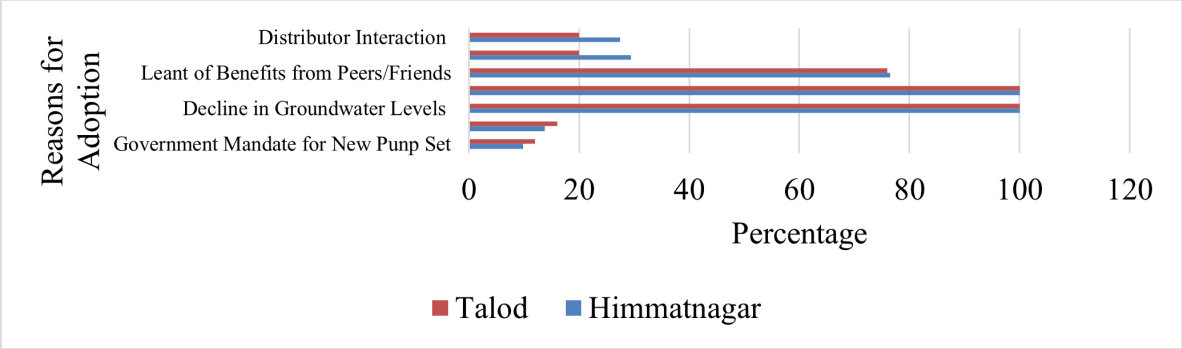
Table 4.22: Micro Irrigation Service Providers: Access and Distance

Taluk	Total Number of Drip Irrigation Units	Total No of Sprinkler Irrigation Units	Average Number of Dealer Shops	Average Distance from Dealer Shop	Average Number of Distributor Shops	Average Distance from Distributor Shop
Himmatnagar	52	29	10	18.4	8.13	14.4
Talod	26	12	10	17.4	6.6	20.2

4.4.5 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

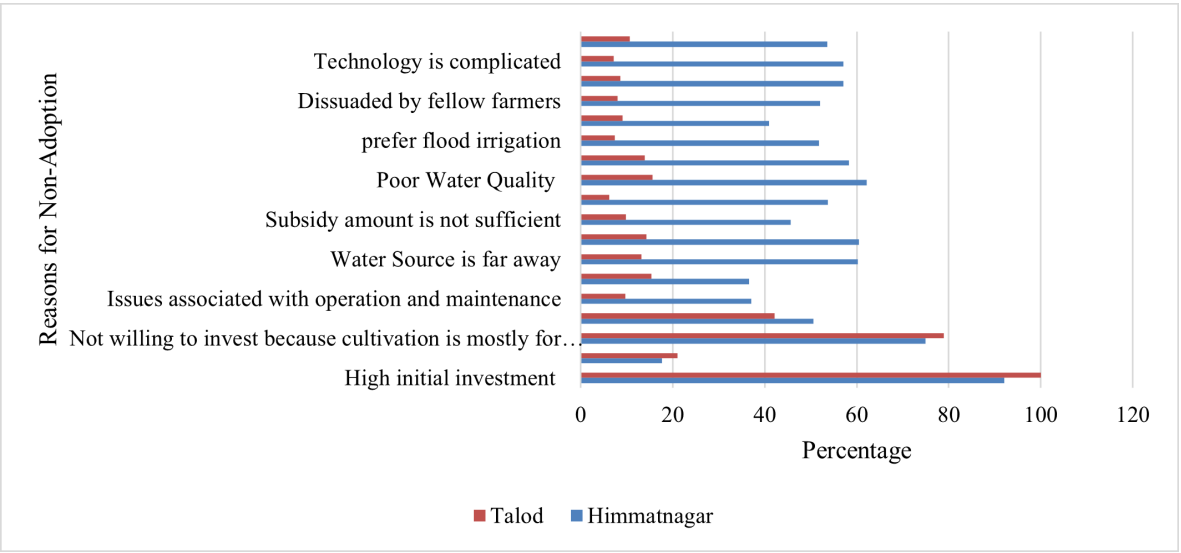
It has been observed that the major reasons for adoption in Sabarkantha district include (a) a decline in groundwater levels in both taluks, (b) suitability for the crop and (c) learning of its benefits from peers/ friends. In the low coverage taluk-Talod, the government mandate for new pump set/ electricity connection played a greater role in impacting adoption, as compared to Himmatnagar. Figure 4.13 presents the reasons for adoption.

Figure 4.13: Reasons for Adoption



The key reasons for lack of adoption include a high initial investment (mentioned by 92% of non-adopters in Himmatnagar and all non-adopers in Talod), unwillingness to invest because a large part of the produce was for self-consumption (75% in Himmatnagar and 78.9% in Talod). In Himmatnagar, more than 50 percent of the non-adopters agreed to most of the issues such as fragmented land, poor water quality, long subsidy availing process and complicated technology, amongst others (see Figure 4.14)

Figure 4.14: Reasons for Non-Adoption



4.5 Skill Gap in Micro Irrigation in Gujarat

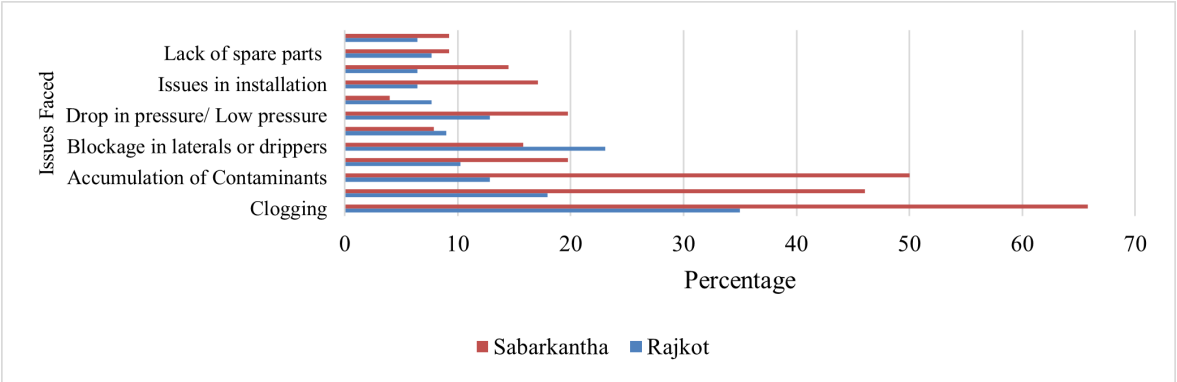
The key informant interviews as well as the primary survey identified several arenas of skill gap in the case of Gujarat. Awareness of micro irrigation components was not observed to be a key concern in the state of Gujarat, both amongst adopters and non-adopters; 98 percent of respondents could identify drip irrigation and 97 percent could identify sprinkler irrigation on being shown pictures by the survey team. However, issues were seen mostly in terms of functionality, maintenance and sustenance. These have been elucidated on below:

- **Lack of Integration with Agronomic Practices and Usage of Micro Irrigation in a Scientific Manner:** Farmers are not cognizant of the actual requirement on the ground; as per key informant interviews with the Gujarat Green Revolution Company, only around 5 percent of farmers implement micro irrigation in a systematic scientific manner. Earlier, Gujarat Green Revolution Company used to outsource the agronomic service provision to suppliers and pay

the company for the same. The agronomic service training included irrigation scheduling, fertigation, implementing the technology as per the soil type, climatic conditions and plant protection. Profitable crops to cultivate would also be suggested under this training. However, for the last four years, this service has been stopped, and no alternative service mechanism is in existence. Thus, the interviews with supply side intermediaries revealed that this has adversely impacted the training imparted to farmers in this context. The survey revealed that 81 percent of adopters did take into account the climate while opting for micro irrigation, and 87 percent suggested the type of micro irrigation technology suitable for the climate. 79 percent suggested the type of crops that would be suitable to cultivate under micro irrigation. However, only 64 percent said that the soil type mattered while adopting micro irrigation. In terms of irrigation water quality, 79 percent knew that irrigation water quality mattered for micro irrigation, and those respondents had also gotten a water test done. One gap highlighted was that only 44 percent of adopters had received an irrigation schedule by the concerned company. Furthermore, in regions wherein the TDS exceeds 1000, crops cannot be cultivated under micro irrigation. Furthermore, there is a requirement of acid treatment in regions wherein the TDS is more than 500.

- **Technical Issues:** 51 percent of adopters raised clogging as an issue faced, and 55 percent resolved this themselves. Clogging was a major concern in Sabarkantha (65.32 percent of adopters), and so was chemical precipitation (46.07 percent). Additionally, 50 percent of adopters in Sabarkantha faced the issue of accumulation of contaminants (see Figure 4.15).

Figure 4.15: Technical Issues Faced by Adopters



- **Information Gap in Terms of Farmer Education:** 31 percent of adopters were not aware how the distance between holes or emitters in drip irrigation could be determined, while only 44 percent of adopters knew it was to determine by the company due to the uniformity of equipment. Thus, this basic gap needs to be bridged.
- **Grievance Redressal Needs to be Strengthened:** In terms of issues such as pipe damages and leakages, there are good technicians available in the state of Gujarat. However, on acceleration of other concerns, the key informant interviews revealed that the state department had a paucity of personnel at the taluk level to address grievances; the in charge at the taluka level has to handle up to 60-70 cases, which leads to delays in resolution time.

CHAPTER 5:

Rajasthan

5.1 Introduction

Rajasthan is the largest state in the country in terms of area, spread over an area of around 340000 sq km. The total geographical area of the state is around 34.2 million hectares; the net cultivable area is 25.633 million hectares (constituting around 66.7% of the cultivable area). The total gross cropped area was 21.664 million hectares in 2019-20, and the net area sown was 5.239 million hectares in the same year.

According to the Census 2011, the population of Rajasthan is approximately 6.86 crore which constitutes 5.66 percent of the entire population of the country. The density of population per sq. km is about 200, which is below the national average. Additionally, 75 percent of the population lives in the rural areas and around 62 percent depend on agriculture and allied sectors for their livelihood. As per the latest available data, a majority (more than 60 percent) of cultivators are small and marginal farmers, operating on 18.55 percent of the state's operated area in 2015-16. The average size of landholdings was 2.73 hectares in the same year.

Rajasthan is the driest state of India, it has 13.88 percent of India's cultivable land and about 11 percent of the country's livestock. However, it only possesses 1.16 percent of the country's surface water and 1.70 percent of its groundwater. The average annual rainfall is 504 mm. The total water availability of the state is 45.09 BCM; out of this surface water constitutes 21.71 BCM while underground water constitutes 11.36 BCM. Based on the stage of ground water extraction, out of 295 blocks in Rajasthan 203 blocks fall in the over-exploited category. Both the surveyed districts of Jodhpur and Bhilwara lie in the over-exploited zone.

More than 60 percent of the land area of Rajasthan is covered by desert. Irrigation plays a significant role in the agriculture development of the state. The gross irrigated area was 7.68 million hectares in 2018-19, while the net irrigated area was 6.27 million hectares in the same year. Figure 5.1 presents the statistics pertaining to irrigation sources for the surveyed districts; Jodhpur and Bhilwara. Jodhpur constitutes 10.5 percent of the gross irrigated area in the state, while Bhilwara constitutes 2.78 percent of the gross irrigated area in the state.

Figure 5.1: Selected Districts in Rajasthan

Source: *Prepared using Gramener.*

Table 5.1: Source Wise Irrigation, 2018-19 for Survey Districts (Area in Hectares)

District	Gross Irrigated Area					Net Area Irrigated				
	Tank	Tube-wells	Other Wells	Other Sources	Total (%)	Tank	Tube-wells	Other Wells	Other Sources	Total (%)
Bhilwara	1592	28711	181665	1504	213472 (2.78)	1582	24438	151506	1279	178805 (2.85)
Jodhpur	0	801749	3636	1186	806571 (10.5)	0	475408	2702	979	479089 (7.64)
Total	35536	5186810	2298821	164115	7685282	34978	4034468	2034965	161983	6266394

Source: *Compiled from Commissionerate of Agriculture, Rajasthan.*

Since the implementation of the PMSKY-PDMC scheme, a total area of 106048.3 hectares have been covered under micro irrigation[8], out of which drip irrigation constitutes 36.7 percent (38889.270 hectares) and sprinkler irrigation constitutes 63.32 percent (67159.030) of the total area covered under micro irrigation. Table 5.2 provides a brief picture of the status of micro irrigation in the selected districts for the study; the physical and financial achievements are highlighted. It can be seen that the financial achievement per hectare for the state is , while the financial achievement per hectare for both districts is higher in comparison to the state average. In terms of district wise ranking for physical achievement, Bhilwara stood at rank 15 in 2022-23 (upto March 2023), while Jodhpur stood at rank 18 in the same period. Bhilwara was present in the top 10 districts in terms of physical achievement under sprinkler.

[8] Upto March 2023 for physical achievement and upto March, 2022 for financial achievement.

Table 5.2: Area Covered Under Micro Irrigation (Hectares) and Financial Achievement (Lakhs)

District	Physical Achievement			Financial Achievement		
	Drip	Sprinkler	Total	Drip	Sprinkler	Total
Bhilwara	694.060	1980	2674.06	58.53	60.38	118.91
Jodhpur	743.320	1347	2090.320	73.83	38.11	111.94
Total	38889.270	67159.030	106048.3	2000.93	621.15	2622.08

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

The major crops wherein micro irrigation is adopted (in terms of area) include wheat, guar, bajra groundnut, potato and cumin; major crops under drip include potato, lime/lemon/citrus, groundnut, carrot, capsicum and cotton, while the major crops under sprinkler irrigation include wheat, mustard, groundnut and guar (cluster bean).

Table 5.3 provides details of the district wise top five crops under micro irrigation.

Table 5.3: Major Crops Under Micro Irrigation in Rajasthan, 2022-23

District	Major Crops Total (Area in Hectares)	Major Crops under Drip (Area in Hectares)	Major Crops under Sprinkler (Area in Hectares)
Bhilwara	Wheat (1355), Mustard (288), Cotton (344.59)	Cotton (344.59), Capsicum (147.68), Barley (44)	Wheat (1355), Mustard (288), Groundnut (165)
Jodhpur	Wheat (371.95), Groundnut (372.15), Carrot (236.63)	Carrot (207.63), Wheat (76.95), Groundnut (73.15)	Groundnut (299), Wheat (295), Cumin (187)
Total (Rajasthan)	Wheat (4462), Guar (4034), Bajra (2339.41)	Potato (4563), Lime/Lemon/ Citrus (949.81), Groundnut (1198.57)	Wheat (4461.20), Cumin (2500), Guar (4034)

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

5.2 Sample Profile: An Overview

The following sections expound on each district in greater detail; first the district wise profile is examined with specific emphasis on the chosen talukas. This is followed by the primary data analysis at the district and block level.

388 cultivators[9] were sampled across 2 high coverage districts; Jodhpur and Bhilwara. The share of respondents in both the districts are more or less the same with 195 respondents in Bhilwara district and 193 respondents in Jodhpur. 90.21 percent of the respondents interviewed were small and marginal farmers, 9.53 percent of the sample were semi-medium and medium farmers, while only one respondent can be categorized as a large farmer. The district and taluk wise distribution of farmers as per land categories is presented in Table 5.4.

[9] While 400 farmers were sampled, we have discussed 388 farmers based on the data received after eliminating missing values.

Table 5.4: District and Taluk Wise Distribution of Farmers as per Land Categories

District	Block	Land Category				
		Marginal	Small	Semi-medium	Medium	Large
Jodhpur	Bhopalgadh	17	19	13	1	-
	Tinwari	82	42	14	4	1
Bhilwara	Mandal	44	3	2	-	-
	Mandalgarh	129	14	2	1	-

Source: *Compiled from survey*

Further, the adoption distribution of the above-mentioned land categories is presented in Table 5.5 60.29 percent of the marginal farmers are adopters as opposed to 39.71 percent of the non-adopters. A large percentage of the small farmers- 83.33 percent have adopted the technology. In the case of semi-medium farmers 61.29 percent of the farmers have adopted the technology while 38.71 percent of the respondents in the same category have not adopted the same. Moreover, out of 6 medium farmers, 5 farmers are adopters (close to 83.33%).

Table 5.5: Distribution of Farmers as Per Land Categories: Adopters and Non-Adopters

Land Category (%) / Adoption	Marginal	Small	Semi-medium	Medium	Large	Total
Adopters	164 (60.29)	65 (83.33)	19 (61.29)	5 (83.33)	1 (100)	254 (65.46)
Non-Adopters	108 (39.71)	13 (16.67)	12 (38.71)	1 (16.67)	0	134 (34.54)
Total	272	78	31	6	1	388

Source: *Compiled from survey*

The average household size of the sample is 6, of which 381 (98.2 %) of the population are Hindus and just 7 (1.8%) of the sample are Muslims. If we look at the social category wise distribution, more than half of the sample- 68.81 percent belonged to the OBC category, close to 16 percent of the sample belong to the general category, 10.82 percent were SCs and 4 percent were STs.

Around 65.46 percent of the sample (252 individuals) have adopted micro irrigation (either drip or sprinkler or both) as compared to 34.54 percent (134 individuals) non-adopters. Majority of adopters of micro irrigation belong to the OBC category (due to their larger distribution in the sample). Among the OBCs, 71.91 percent have adopted micro-irrigation as compared to 28.09 percent who did not adopt. Close to 59 percent of the general category farmers have adopted micro-irrigation. Among SCs, 40.48 percent of the individuals have adopted micro-irrigation and 59.52 percent of the individuals have not adopted micro-irrigation. Among STs, 50 percent of the total ST sample have adopted micro irrigation.

It was observed that all respondents had a ration card; 293 individuals (75.26%) had an 'above poverty line' card and 83 individuals (21.39%) had a 'below poverty line' card.

95.62 percent of the sample had a mobile phone; out of these 47.16 percent had a smartphone. Every individual of the sample with a smartphone used their smart phone in order to avail information related to agriculture. 26.97 percent of these were accessing information associated

with the weather forecast, 31.48 percent accessed information related to best cultivation practices, and only 4.26 percent accessed information related to market information. 24.90 percent availed information related to government schemes in agriculture and the allied sector, and only 4.52 percent availed information related to insurance in the agriculture sector. 51.57 percent of adopters of micro irrigation had a smartphone; in comparison, 38.81 percent of non-adopters of micro irrigation had a smartphone.

In terms of any household member having membership in organisations, 34.27 percent of the sample households had members who were part of a farmer cooperative, 15.98 percent had a member in the Gram Panchayat and only 0.51 percent were in self-help groups (SHGs) and Mandal Parishad Territorial Constituencies. 62.89 percent of the sample households did not have any members in any organisation. Table 5.6 further expounds on membership at the district level.

Table 5.6: Membership in Organisations (%)

District	SHGs	FPOs	Farmer Cooperative	Gram Panchayat	Mandal Parishad	Others (Water Users Association, Youth Associations)	Not a Member of any Organisation
Jodhpur	0(3.5)	2 (0.51)	66 (17.01)	30 (7.73)	1 (0.25)	0	123(31.70)
Bhilwara	2 (0.51	1 (0.25)	67 (17.27)	32 (8.25)	1 (0.25)	0	121 (31.19)
Total	2(0.51)	3 (0.77)	133 (34.27)	62 (15.98)	2 (0.51)	0	244(62.89)

Source: *Compiled from survey*

56.41 percent of the sample had availed credit; this was true for almost 50 percent of adopters of micro irrigation.

Table 5.7 provides the descriptive statistics for household and farm characteristics.

Table 5.7: Descriptive Statistics for Household and Farm Characteristics

Variables	Mean	Number of Observations
Household Size	6.08 (2.96)	388
Number of Working Members	1.65 (.998)	388
Presence of Ration Card	1 (0)	388
Farm Size (Acres)	6.25 (9.41)	388
Farm Size for Adopters (Acres)	7.09 (10.996)	254
Farm Size for Non-Adopters (Acres)	4.66 (4.84)	134
Number of Plots Cultivated	2.33(1.393)	356
Number of Plots Cultivated (Adopters)	2.38 (1.45)	239
Number of Plots Cultivated (Non-Adopters)	2.26 (1.267)	117
Annual Income from Agriculture	267061 (303798.90)	388
Income from Agriculture (Adopters)	292525 (336537.30)	254
Income from Agriculture (Non-Adopters)	218793.30 (222540.10)	134
Income Farm Output	191786.80 (163998)	387
Income from Farm Output (Adopters)	211116.10 (165969.4)	254
Income from Farm Output (Non-Adopters)	154872.20 (154143.80)	133

Note: *Standard deviation is given in parentheses*

5.3 Bhilwara: Primary Analysis

As per the Census 2011, the population of Bhilwara district was 2.40 million. The total geographical area is 10,455 sq. km. Total number of villages in the district is 143. The rural and urban population of the district is 18,95,869 and 5,12,654 respectively. The net sown area is around 443433 hectares. Two taluks were selected in Bhilwara; high coverage Mandalgarh and low coverage Mandal.

5.3.1 Income and Cost of Cultivation

The average annual income for the respondents in Bhilwara district was INR 208850; the average income from farm output was INR 138879.50. Table 5.8 presents the taluk wise average income from different sources for the district, including the income from sale of farm output. Table 5.9 and 5.10 looks at the average income as per land category in both the taluks.

Table 5.8: Taluk Wise Distribution of Average Annual Income from Various Sources

Taluk	Income from Livestock	Income from Self Employment	Income from Salary	Income from Agriculture Wages	Income from Agriculture Labour	Income from other Sources	Income from Farm Outputs	Income from sale of by-products	Total income
Mandal	48004	141666.7	206000	45000(-)		6000	151020.4	14938.78	612629.88
Mandalgarh	56602.47	364166.7	98200	21160		6100	134804.8	12368.15	693402.09

Table 5.9: Taluk Wise Distribution of Average Total Annual Income per Land Category

Taluk	Marginal	Small	Semi-Medium	Medium	Large
Mandal	183843.2	493333.3	206000	45000(-)	-
Mandalgarh	165806.6	467114.3	700500	1115000	-

Table 5.10: Taluk Wise Distribution of Average Income from Farm Output per Land Category

Taluk	Marginal	Small	Semi-Medium	Medium	Large
Mandal	129318.2	433333.3	205000	45000(-)	-
Mandalgarh	117608.5	234285.7	250000	730000 (-)	-

The major crops cultivated by respondents in Bhilwara district include *cotton, maize and wheat* in Mandal taluk and *groundnut, maize and wheat* in Mandalgarh taluk. Table 5.11 (a) and (b) presents the costs of cultivation for the three crops, with a comparison of adopters and non-adopters.

Table 5.11 (a): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Mandal

Category	Variable	Crops					
		Cotton		Maize		Wheat	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	2311 (1943.047)	2136.364 (1032.737)	2666.667 (2348.049)	4474.545 (6347.148)	3550 (2965.516)	3223.077 (2603.775)
	Chemical Fertilizer	4370 (3559.042)	6495.455 (8403.287)	1820.833 (1532.001)	3253.576 (3664.569)	2631.25 (1753.962)	3517.92 (2441.775)
	Asset Rent	3710 (3250.453)	3045.455 (1724.16)	4270.833 (3010.32)	5077.273 (4317.68)	3281.25 (2265.571)	4132.692 (2597.266)

Category	Variable	Crops					
		Cotton		Maize		Wheat	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
	Labour Cost	5660 (7007.964)	9000 (8980.535)	3125 (2947.457)	6054.545 (6349.069)	5187.5 (3769.592)	7759.615 (6244.39)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	1100 (141.4214)	1940.909 (1247.16)	800 (355.9026)	920 (1171.812)	1766.667 (1537.314)	2773.913 (1433.279)
	Cost of Electricity	1500 (707.1068)	1920 (1186.423)	1125 (1314.978)	1594.118 (1060.937)	1000 (1000)	3086.087 (1651.087)
Cost of micro-irrigation technology	Labour Cost	2006.25 (1624.904)		1883.333 (1869.135)		2600 (1635.543)	
	Cost of Electricity	1062.5 (417.2615)		800 (209.7618)		2400 (1854.724)	

The survey indicated that adopters are characterised by higher average input costs for cotton and wheat (seed and chemical fertilizers) in comparison to non-adopters. For maize, the results differ as the average input cost for adopters is less than the non-adopters. Other than for cotton, the average cost of asset rent is lower for adopters as compared to non-adopters. The average labour costs (excluding supervision and irrigation) are seen to be lower for adopters as opposed to non-adopters for all the three crops. It can be seen that in the case of wheat, the average electricity costs (overall) for non-adopters are higher as compared to adopters. In terms of irrigation related costs, the average labour costs and average cost of electricity were lower for adopters as compared to non-adopters for all the three crops.

Table 5.11 (b): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Mandalgarh

Category	Variable	Crops					
		Groundnut		Maize		Wheat	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	8566.338 (7448.131)	7080.769 (4706.338)	3922.632 (4262.424)	3157.955 (2328.363)	4202.949 (5048.196)	3713.514 (2779.605)
	Chemical Fertilizer	4398.31 (4291.703)	2751.923 (1665.322)	3759.574 (4911.553)	3165.909 (5332.304)	4261.538 (4550.139)	3309.459 (2164.673)
	Asset Rent	3892.676 (2301.213)	3884.615 (3967.84)	5873.684 (7255.463)	4025 (2940.268)	5696.154 (8726.619)	5218.421 (4145.715)
	Labour Cost	7287.324 (7975.998)	4480.769 (2669.984)	7565.789 (10463.67)	6847.727 (8885.145)	6730.128 (9685.712)	7328.947 (11262.9)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	1315 (863.4717)	1189.474 (859.3568)	1590 (1800.526)	983.3333 (728.2751)	3005 (2093.153)	3134.706 (2532.1)
	Cost of Electricity	1690 (1034.741)	1844.211 (1793.873)	1980 (1941.724)	1811.25 (12109.811)	2971 (1845.501)	2482.353 (1738.531)
Purchased	Labour Cost	600 (-)	-	-	1800 (-)	-	2400 (-)
	Cost of Electricity	-	2800 (-)	-	1500 (-)	-	4000 (-)

Category	Variable	Crops					
		Groundnut		Maize		Wheat	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
User charges for govt. canal	Cost of Electricity	2.5 (.7071068)	-	3 (-)	-	-	-
Cost of micro-irrigation technology	Rental Charge	200 (-)	-	300 (-)	-	-	-
	Labour Cost	1545.238 (1505.386)		1159.677 (923.5462)	-	2525.862 (1932.439)	-
	Cost of Electricity	1382.54 (1248.02)		1490 (2086.126)	-	2988.276 (2298.466)	-

The survey findings indicated that the input costs are uniformly higher across groundnut, maize and wheat for adopters as compared to non-adopters. The asset rental is also more for adopters in comparison for non-adopters across all three crops. In case of labour costs, the cost for adopters is more than that of non-adopters for all the crops except for wheat. In the case of groundnut, the average electricity costs for irrigation using farm ponds, open well, shallow well, bore well, tube-well are lower for adopters as compared to non-adopters. The average electricity costs are higher for adopters in the case of cotton and groundnut in comparison to non-adopters.

5.3.2 Asset Ownership

The survey documented the ownership of major farm assets owned by the respondents included tractors (42.27 percent of the total sample surveyed in the district), harvester combiners, drip and sprinkler irrigators, tube wells and borewells, electric pumps, hand hoes, sprayers, pick axes, weed hooks etc. Table 5.12 looks at the number of respondents with ownership of select major assets, the average cost of the asset as well as the average current value of the asset. This is further analysed in terms of the ownership of assets for adopters and non-adopters, as well as the average number of units owned for each category.

Table 5.12: Asset Ownership

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Mandal	10 (6.10)	10	0	482500	327000
	Mandalgarh	28 (17.07)	28	0	490232.10	384107.10
Thresher	Mandal	1(7.69)	1	0	1700002	38000
	Mandalgarh	5 (38.46)	5	0	66020	80000
Drip irrigation	Mandal	6 (20.69)	6	0	63166.67	6333.33
	Mandalgarh	9 (31.03)	9	0	67777.78	5333.33
Sprinkler Irrigation	Mandal	10 (4.13)	0	10	22100	3140
	Mandalgarh	97 (40.08)	0	97	23415.46	4205.67
Diesel Pump	Mandal	6 (66.67)	6	0	8616.36	6000
	Mandalgarh	2 (22.22)	2	0	14142.14	10500
Electric Pump	Mandal	16 (9.47)	15	1	74062.50	35357.14
	Mandalgarh	68 (40.24)	55	13	53250	17161.29

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Bore Well	Mandal	15 (10.00)	13	2	156400	0
	Mandalgarh	48 (32.00)	35	13	95364.58	0

Table 5.13: Asset Ownership Amongst Adopters and Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Tractor	Mandal	2 (1.53)	8 (24.24)	1	1
	Mandalgarh	26 (19.85)	6 (6.06)	1	1
Drip	Mandal	6 (22.22)	NA	1	NA
	Mandalgarh	9 (33.33)	NA	1	NA
Sprinkler	Mandal	5 (3.78)	1(25)	6.89	5
	Mandalgarh	96 (40.34)	1 (25)	20.10	10
Electric Pump	Mandal	5 (3.57)	11 (37.93)	1	1.09
	Mandalgarh	56 (40.00)	12 (41.38)	1.23	1.08
Bore Well	Mandal	5 (4.07)	10 (37.04)	1	1.3
	Mandalgarh	37 (30.08)	11 (40.74)	1.49	1.18

A greater percentage of adopters own a tractor as opposed to non-adopters in Mandalgarh, whereas, only a small percentage of adopters own a tractor in Mandal. In addition, a small percentage of adopters in both the taluks have a bore well (4.07% in Mandal and 30.08% in Mandalgarh); i.e. access to an assured source of irrigation.

5.3.3 Micro Irrigation Ownership

The data illustrates that in Mandal and Mandalgarh, a majority of drip irrigation adopters are *small and marginal farmers*. This is also the case for sprinkler irrigation adopters, as is apparent from Table 5.14.

Table 5.14: Adopters as Per Land Category

Land Category	Mandal		Mandalgarh	
	Adopters with Drip	Adopters with Sprinkler	Adopters with Drip	Adopters with Sprinkler
Marginal	5	7	7	81
Small	1	2	2	12
Semi-medium	0	0	0	2
Medium	0	0	0	1
Large	0	0	0	0

If the supply network for micro irrigation in terms of its presence and accessibility is analysed, the survey found that the average number of dealer shops in the 2 districts were 7. Almost 81 percent of these shops were either located in the gram panchayat or district headquarters, but not in the

villages themselves. The average distance from the villages is 12.8 km.

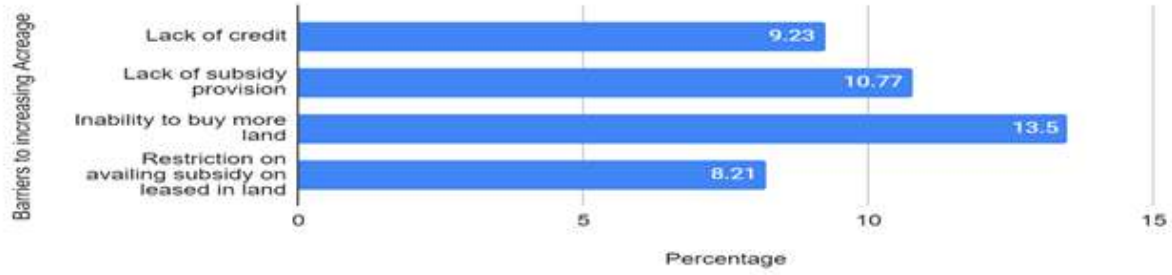
Table 5.15: Drip and Sprinkler Adopters per Land Category

Land Category	Bhopalgadh		Tinwari	
	Adopters with Drip	Adopters with Sprinkler	Adopters with Drip	Adopters with Sprinkler
Marginal	0	1	2	67
Small	5	6	0	39
Semi-Medium	3	2	2	13
Medium	0	0	0	4
Large	0	0	0	1

5.3.4 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

The average acreage under MI for Bhilwara district was 1.59 acres (0.63 hectares); 0.32 acres (0.13 hectares) in low coverage Mandal and 1.98 acres (0.80 hectares) in high coverage Mandalgarh. 30.51 percent of the adopter respondents wanted to increase acreage under micro irrigation in Bhilwara. The major barriers to increasing acreage are provided in Figure 5.2.

Figure 5.2: Barriers to Increasing Acreage



Source: *Primary Survey*

The major barriers to increasing acreage at a taluk level included: inability to buy more land (29.79% of adopters) and restriction for availing subsidy on leased in land (20.69 %) in Mandalgarh and lack of subsidy provision (5.71%) in Mandal (see Figure 5.3).

Figure 5.3: Barriers to Increasing Acreage at Taluk Level

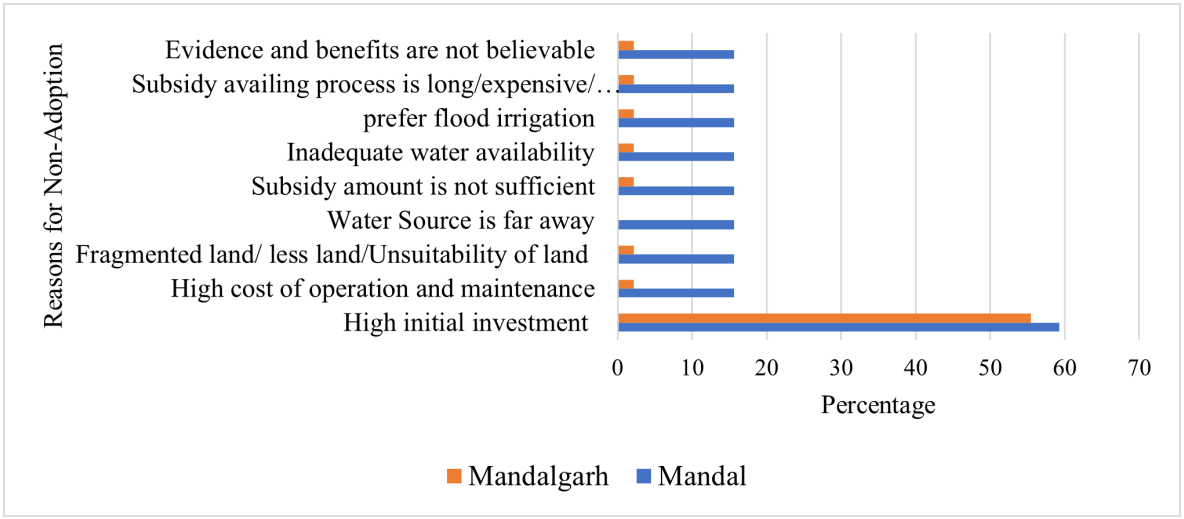
Source: *Primary Survey*

5.3.5 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

The survey revealed that out of the total respondents in Bhilwara district, 87.2 percent of respondents were aware of the PMKSY subsidy for micro irrigation; 66.27 percent were aware in low coverage Mandal while 86.39 were aware in high coverage Mandalgarh. 64.88 percent of the sample were adopters of micro irrigation in the district. The average acreage under MI for Bhilwara district was 1.59 acres (0.63 hectares).

It has been observed that the major reasons for adoption in Bhilwara district included (a) suitability of the crop (100 percent of the adopters) and (b) learning of its benefits from peers/ friends (100 percent of adopters) in both the taluks. We further examine the reasons for non-adoption at a district level. These have been provided in Figure 5.4. More than 50 percent of respondents in both districts did not adopt the technology due to the high level of initial investment required. In Mandal, factors that seemed to matter more included insufficient subsidy amount, land being fragmented and a traditional preference for flood irrigation. Non-adoption was attributed majorly to unavailability of spare parts (mentioned by all adopters who discontinued) and the fragmented nature of land (66.6 percent of adopters who discontinued).

Figure 5.4: Reasons for Non-Adoption



***Source**: Primary Survey*

Major reasons for disuse after initial adoption were seen to be high maintenance and operation costs.

5.4 Jodhpur District - Profile

Jodhpur is the second most populous district, as per the Census 2011, after Jaipur with a population of 3.69 million. The total geographical area is 22,56,405 hectares. The total number of villages in the district is 139. The rural and urban population of the district is 2421621 and 1264060 respectively.

The net sown area is around 13,71,703 hectares, which is 60.79 percent of the total geographical area of the district. The annual replenishable ground water resource of the district has been estimated as 420.8565 MCM, and net annual ground water availability as 388.8043 MCM. The gross ground water draft for all uses is estimated as 809.7057 MCM.

Two talukas, namely low coverage (in terms of micro irrigation) Bhopalgadh and high-coverage Tinwari were covered in the district of Jodhpur. Bhopalgadh holds the second rank in terms of cultivated area in the district and also has the maximum irrigated area in the district. Tinwari block has witnessed one of the highest declines in groundwater.

5.4.1 Income and Cost of Cultivation

The average annual income for the respondents in Jodhpur district was INR 325875.10; the average income from farm output was INR 245520.80. Table 5.16 presents the taluk wise average income from different sources for the district, including the income from sale of farm output. Table 5.17 and 5.18 looks at the average income as per land category in both the taluks.

Table 5.16: Taluk Wise Distribution of Average Annual Income from Various Sources

Taluk	Income from Livestock	Income from Self Employment	Income from Salary	Income from Agriculture Wages	Income from Agriculture Labour	Income from other Sources	Income from Farm Outputs	Income from sale of by-products	Total income
Bhopalgarh	102435.3	240000 (-)	160500	7000		6108.10	286816.3	26967.35	775,377.06
Tinwari	54945.71	1207500	300000	20666.67		6560.345	231370.6	20094.41	1583112.38

Table 5.17: Taluk Wise Distribution of Average Total Annual Income per Land Category

Taluk	Marginal	Small	Semi-medium	Medium	Large
Bhopalgarh	204905.9	424800	496784.6	226000	N/A
Tinwari	219801.2	443647.6	323442.9	621250	985000

Table 5.18: Taluk Wise Distribution of Average Income from Farm Output per Land Category

Taluk	Marginal	Small	Semi-medium	Medium	Large
Bhopalgarh	167625	332105.3	374000	200000	N/A
Tinwari	159536.6	313857.1	283714.3	N/A	850000

The major crops cultivated by respondents in Jodhpur district include *bajra, cotton and moong* in Bhopalgadh taluk and *bajra, carrot and guar* in Tinwari taluk. Table 5.19 presents the costs of cultivation for the three crops, with a comparison of adopters and non-adopters.

Table 5.19 (a): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in

Bhopalgadh

Category	Variable	Crops					
		Bajra		Cotton		Moong	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	2821.429 (2029.467)	1580 (1528.951)	6812.5 (2840.24)	5112.5 (2014.54)	4200 (3057.076)	2080.64 (1704.39)
	Chemical Fertilizer	7892.857 (8903.021)	3537.5 (4305.737)	19437.5 (14029.15)	11712.5 (10278.89)	5062.5 (6258.922)	2701.667 (3125.217)
	Bio Fertilizer	24000 (11949.9)	10500 (8043.631)	-	-	-	-
	Asset Rent	8692.857 (15008.07)	7940.862 (5938.605)	19087.5 (19612.05)	10437.5 (5960.81)	20337.5 (31366.45)	7612.903 (7837.718)
	Labour Cost	8076.923 (9990.175)	9203.333 (9293.397)	36025 (25567.66)	21500 (13554.12)	9700 (10939.7)	10129.03 (15266.48)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	466.6667 (152.752)	2300 (2965.998)	2500 (-)	2964.286 (962.0786)	2500 (-)	1381.25 (858.5442)
	Cost of Electricity	566.6667 (404.1452)	2402.222 (2059.14)	1500 (707.1068)	3242.857 (2818.899)	1200 (-)	2015 (2068.284)
Cost of micro-irrigation technology	Rental Charge	500 (-)		300 (-)			
	Labour Cost	1225 (877.02)		3875 (2412.209)			
	Cost of Electricity	2514.286 (2249.76)		1783.333 (649.3587)			

The survey indicated that adopters are characterised by higher average input costs for all the crops viz., cotton, bajra and moong (seed, chemical fertilisers and bio fertilisers) in comparison to non-adopters. Even in the case of average cost of asset rent, the cost is higher for adopters as compared to non-adopters. Other than for cotton, the average labour costs (excluding supervision and irrigation) are lower for adopters as compared to non-adopters. In terms of irrigation related costs, the average labour costs is lower for adopters than for non-adopters for bajra and cotton but is higher for adopters than for non-adopters for Moong. The average cost of electricity is lower for adopters as compared to non-adopters for all the three crops.

Table 5.19 (b): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in

Tinwari

Category	Variable	Crops					
		Bajra		Carrot		Guar	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	2115.534 (2370.129)	1529.333 (896.21)	26329.73 (39734.53)	32250 (39244.43)	2705.5 (2188.556)	1742.857 (782.8519)
	Chemical Fertilizer	3074.584 (4495.874)	2426.667 (2285.503)	12682.43 (15975.16)	7250 (7424.621)	3323.077 (3536.361)	2900 (2969.848)
	Bio Fertilizer	17825 (14035.69)	2000 (-)	-	-	-	-
	Asset Rent	5687.129 (4861.037)	7733.333 (11990.87)	18885.81 (37362.6)	28000 (31112.7)	7101 (7186.541)	3642.857 (1463.85)
	Labour Cost	7132.039 (7152.351)	4028.571 (2713.904)	44790.54 (79162.57)	70000 (77781.75)	9159 (14177.96)	3428.571 (1272.418)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	1607.895 (1071.896)	680 (311.4482)	3750 (1060.66)	3600 (3394.11)	1033.333 (728.4687)	200 (-)
	Cost of Electricity	1937.5 (2353.434)	1850 (1385.28)	2200 (2545.58)	6800 (3959.80)	600 (346.4102)	2000 (-)
Purchased	Labour Cost	-	2500 (-)	-	-	-	2500 (-)
	Cost of Electricity	-	4000 (-)	-	-	-	4000 (-)
User charges for govt. canal	Cost of Electricity	3.11 (1.54)		13 (4.24)	-	-	-
Cost of micro-irrigation technology	Rental Charge	788.4615 (525.6059)	-	-	-	-	-
	Labour Cost	1246.429 (1026.772)	-	6206.25 (7027.391)		1406.757 (1067.523)	-
	Cost of Electricity	2938.852 (2923.44)	-	4856.806 (4262.044)	-	1751.892 (1048.644)	-

It can be observed that input costs (seed costs, chemical fertilizer and bio-fertilizer) are higher for adopters than for adopters for all the crops except in the case of seed cost for carrots, where the average cost is lower for adopters than for non-adopters. The average cost for asset rent is lower for adopters than for non-adopters for bajra and carrot but is higher for adopters than for non-adopters in case of Guar. The average labour costs (excluding supervision and irrigation) are higher for adopters as compared to non-adopters for all the crops except for carrot, where the average cost is lower for adopters than for non-adopters. In terms of irrigation related costs, the average labour costs is higher for adopters than for non-adopters for all the crops; for electricity costs, the average cost is lower for adopters than for non-adopters for all the crops, except for bajra.

5.4.2 Asset Ownership

The survey documented the ownership of major farm assets owned by the respondents.

Table 5.20: Taluk Wise Asset Ownership and Cost

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Bhopalgarh	30 (18.29)	30	0	430600	270800
	Tinwari	96 (58.54)	93	3	340520.80	217854.20
Drip	Bhopalgarh	10 (34.48)	10	1	176200	7500
	Tinwari	4 (13.79)	4	0	117500	51750
Sprinkler	Bhopalgarh	11 (4.55)	0	11	58154.55	6090.909
	Tinwari	124 (51.24)	0	124	102803.10	12993.55
Electric Pump	Bhopalgarh	6 (3.55)	5	1	61666.67	65000
	Tinwari	79 (46.75)	69	10	55582.28	19500
Bore Well	Bhopalgarh	10 (6.67)	8	2	242500	0
	Tinwari	77 (51.33)	57	20	260026	0

Table 5.21: Asset Ownership Amongst Adopters and Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Tractor	Bhopalgarh	12 (9.16)	18 (54.55)	1	1
	Tinwari	91 (69.47)	5 (15.15)	1.03	1
Drip	Bhopalgarh	8(29.63)	2 (100)	1	1
	Tinwari	4 (14.81)	NA	1	NA
Sprinkler	Bhopalgarh	9 (3.78)	2(50)	74.89	25
	Tinwari	124 (52.10)	NA	125.58	NA
Electric Pump	Bhopalgarh	4 (2.86)	2 (6.90)	1.5	1
	Tinwari	75 (53.57)	4 (13.79)	1.24	1
Bore Well	Bhopalgarh	4 (3.25)	6 (22.22)	1	1.33
	Tinwari	77 (62.60)	0	1.44	0

5.4.3 Micro Irrigation Ownership

The data illustrates that in Bhopalgadh and Tinwari, a majority of sprinkler irrigation adopters are *small and marginal farmers* (see Table 5.22).

Table 5.22: Drip and Sprinkler Adopters per Land Category

Land Category	Bhopalgadh		Tinwari	
	Adopters with Drip	Adopters with Sprinkler	Adopters with Drip	Adopters with Sprinkler
Marginal	0	1	2	67

Land Category	Bhopalgadh		Tinwari	
	Adopters with Drip	Adopters with Sprinkler	Adopters with Drip	Adopters with Sprinkler
Small	5	6	0	39
Semi-Medium	3	2	2	13
Medium	0	0	0	4
Large	0	0	0	1

5.4.4 Accessibility and Presence

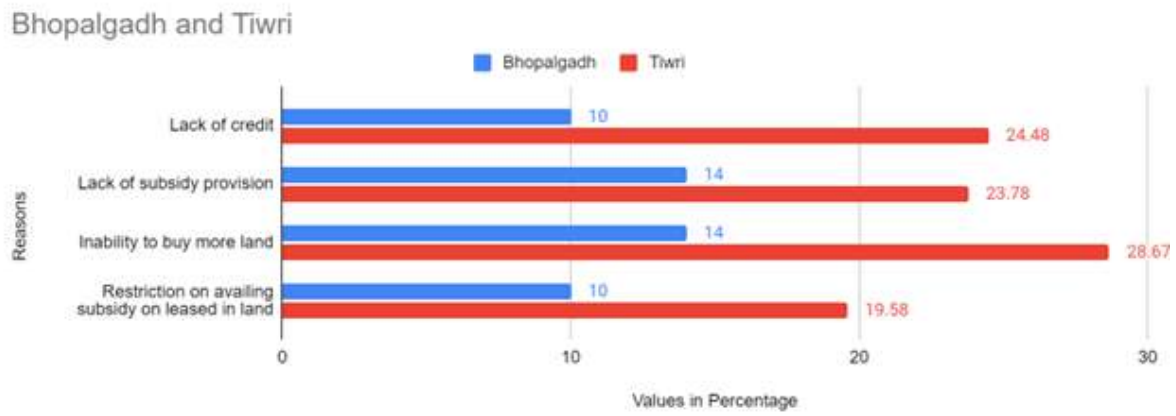
If the supply network for micro irrigation in terms of its presence and accessibility is analysed, the survey found that the average number of dealer shops in the 2 districts was 10. Almost 68 percent of these shops were either located in the gram panchayat or district headquarters, but not in the villages themselves. The average distance from the villages is 12.8 km.

5.4.5 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

The average acreage under MI for Jodhpur district was 1.06 hectares; 0.89 hectares in low coverage Bhopalgarh and 1.76 hectares in high coverage Tinwari. 30 percent of the adopter respondents wanted to increase acreage under micro irrigation in Jodhpur.

The major barriers to increasing acreage are provided in Figure 5.5. The major barriers were an inability to buy more land, lack of credit, and lack of subsidy provision.

Figure 5.5: Barriers to Increasing Acreage Under Micro Irrigation



5.4.6 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

The survey revealed that out of the total respondents in Jodhpur district, 94.84 percent of respondents were aware of the PMKSY subsidy for micro irrigation; 86.27 percent were aware in low coverage Bhopalgadh while 97.9 percent were aware in high coverage Tinwari. 73 percent of the sample were adopters of micro irrigation in the district.

It has been observed that the major reasons for adoption in Jodhpur district include (a) suitability of the crop (100 percent of the adopters), (b) learning of its benefits from peers/ friends (100 percent of adopters) and (d) dropping groundwater levels (mentioned by all adopter respondents).

More than 90 percent of respondents in both districts did not adopt the technology due to the high level of initial investment required. Factors that seemed to matter more included a high cost of

operation and maintenance, unsuitability of land, the benefits under micro irrigation not seeming to be believable (mentioned by more than 40 percent of respondents). This was seen across both districts. Non-adoption was attributed majorly to high operation and maintenance costs (faced by all adopters who discontinued), as well as few respondents mentioned issues such as unsuitable land, inadequate water, defective parts.

5.5 Skill Gap in Micro Irrigation

The key informant interviews as well as the primary survey identified several arenas of skill gap in the case of Rajasthan. A key observation that was emerging was that while uptake was present in the initial 1-2 years of taking the subsidy, farmers cease usage after that due to a lack of adequate knowledge about drip/sprinkler requirements for a crop. Thus, sustenance was a greater concern. In terms of awareness of micro irrigation components, 76 percent respondents could identify drip irrigation and 86 percent could identify sprinkler irrigation on being shown pictures by the survey team. There was potential for increased awareness on functionality, maintenance and sustenance.

- **Need for Increased Awareness on Drip/ Sprinkler Components and their Functions**: The survey found that around 57 percent of respondents did not know how to determine the distance between drip lines (that it was determined by the company due to uniform equipment). 41.64 percent of respondents could not identify a fertigation tank. This was despite the survey having consisted of a major proportion of micro irrigation adopters. However, 95.62 percent knew the importance of filtration; i.e. that a lack of it could lead to pump failure and inadequate water distribution. Thus, there was a need to ensure training clearly explains components, their usage and functionality. Amongst adopters, more than 80 percent were aware of the need for integrating agronomic practices, ie the climate, soil requirement, type of micro irrigation to be used as per the crop, thus the information gap was limited in this area. However, 65 percent of the adopters did not know of the importance of water quality and its impact on micro irrigation systems; thus, training on this can be focused on. While none of the adopters were provided an irrigation schedule, none of them thought that they would be needing one as well.
- **Traditional Perception that Flood Irrigation is Required for Maximum Benefits still Present:** Unlike the state of Gujarat, where awareness of the benefits of micro irrigation is more established, many farmers in the state of Rajasthan continue to hold the view that traditional flood irrigation is beneficial in comparison to micro irrigation, and water conveyance through micro irrigation is inadequate. The sustenance of micro irrigation is hindered by this perception. Farmers also think that drip irrigation is effective when the crops are seedlings as they require a limited amount of water. Then they switch to flooding through surface irrigation, which is a setback. The Rajasthan government has been working on changing this perception, and creating awareness of the benefits of micro irrigation. This perception changing exercise is crucial; as is in the case of other states such as Gujarat, the government can highlight success stories of micro irrigation farmers who have seen a rise in income and yield after adoption, and present this through print media as well as in the form of videos in the course of training. Farmers need to be cognizant of the benefits of micro irrigation to incentivise them to adopt, and subsequently engage in maintenance for long term returns.
- **Lack of Personnel for Outreach and Target Based Training Required:** The key informant interviews revealed that the Horticulture department was in charge of implementation of the PMKSY subsidy and was also responsible for extension related activities. There was a tendency to borrow personnel from the agriculture department, since their outreach network to the

villages was better. However, due to the diverse nature of functions expected of personnel, not merely restricted to micro irrigation promotion, there was a lack of focus on training which needed to be worked upon. According to government representatives, there was a need of such government training to be complemented by supplier training, especially in clusters (of particular crops), which had potential to ensure that information and awareness generation reached a maximum amount of people. The existent training also did not operate through a target-based approach; there can be block and cluster wise targets set based on the allocation of the budget to the relevant district. High coverage blocks can be covered first to maximise coverage and strengthen skill competencies, and then the focus can be shifted to low coverage blocks,

- **Technical and Financial Concerns:** The major challenges seen included accumulation of contaminants (salts, dirt, algae) (faced by all adopters and resolved on their own), blockage of sprinkler nozzle (faced by all adopters and resolved on their own). All adopters mentioned that the most important constraint for them was an insufficient subsidy, high investment required and a high maintenance and operation cost which disincentivized sustenance beyond a point, even after initial uptake.

CHAPTER 6:

Maharashtra

6.1 Introduction

As per the Census 2011, the state of Maharashtra is spread over an area of 307713 square km, constituting around 9.3 percent of the total geographical area of the country. The net cultivable area is around 28.19 percent of the geographical area. The net sown area was 22.68 percent of the net cultivable area, and the irrigated area was 18.52 percent of the net sown area. The contribution of agriculture and allied activities in the overall gross state domestic product was 11.9 percent in 2019-20 (Government of Maharashtra, 2021).

The population of the state was 112.374 million in 2011, marking an increase of percent from 2001. Out of this, 48.4 percent of the workforce is engaged in agriculture as per the Census 2011. According to the Agriculture Census of India, 2015-16, the average size of operational landholdings (for agricultural production) in Maharashtra is 1.44 hectares.

According to the Agriculture Census of India 2015-16, the gross irrigated area in Maharashtra is 36.94 lakh hectares; out of this, 48 percent is irrigated through wells and tube wells, 20 percent through canals and 32 percent through other sources such as tanks, ponds etc. The gross irrigated area was 45.83 million hectares in 2019-20, while the net irrigated area was 37.45 million hectares in the same year. In Maharashtra, the estimated average annual availability of water resources of the State is 198 billion cubic metres (BCM); 164 BCM of this is surface water and 34 BCM of this is groundwater. The average annual rainfall is 1150 mm as per the Meteorological Department.

Figure 6.1 presents the selected districts in Maharashtra; Ahmadnagar and Amravati. Table 6.1 presents the key statistics pertaining to agriculture and irrigation in the selected districts.

Figure 6.1: Selected Districts in Maharashtra

Source: *Prepared using Gramener*

Table 6.1: Key Agricultural Statistics for Survey Districts

District	Geographical Area ('000 hectares)	Cultivable Area ('000 hectares)	Major Soils	Gross Irrigated Area	Net Irrigated Area
Ahmednagar	1702.0	1146.3	Shallow grey soil, medium deep block soil, deep black	362.0	330.0
Amravati	1304	766	Deep black, medium black, shallow black	63.8	51.3

Source: *Model Agriculture Contingency Plan, Government of Maharashtra*

Since the implementation of the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More Crop scheme, a total area of 113479.07 hectares have been covered under micro irrigation[10], out of which drip irrigation constitutes percent (64205.660 hectares) and sprinkler irrigation constitutes percent (49273.41 hectares) of the total area covered under micro irrigation. Table 6.2 provides a brief picture of the status of micro irrigation in the selected districts for the study; the physical and financial achievements are highlighted. Ahmednagar holds the top rank in the physical coverage under micro irrigation amongst all districts, and the top rank in coverage of drip irrigation specifically.

Table 6.2: Area Covered Under Micro Irrigation (Hectares) and Financial Achievement (Lakhs)

District	Physical Achievement			Financial Achievement		
	Drip	Sprinkler	Total	Drip	Sprinkler	Total
Ahmednagar	8519.610	3865.900	12385.510	2177.77	692.91	2870.68
Amravati	2463.220	3190.040	5653.260	415.34	328.87	744.21
Total	64205.660	49273.410	113479.070	16058.89	6574.60	22633.49

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

6.2 Sample Profile: An Overview

400 cultivators were sampled across 2 high coverage districts; Ahmednagar and Amravati. 31 percent of the respondents interviewed were small farmers, 19.39 percent were semi-medium farmers, 42.8 percent of the sample were semi-medium farmers, 6.29 percent were medium farmers while 0.7 percent were large farmers. A majority of adopters of micro irrigation interviewed were either small or marginal farmers (66.65) and 32.44 percent were semi-medium or medium farmers.

The socio-economic profile is presented. The average household size was 4 members, and the average number of working members was more than 2. Almost 56.25 percent of the sample was an adopter of micro irrigation (either drip or sprinkler or both) while the rest are either non-adopters or have discontinued adoption at present.

A majority of respondents (more than 98%) had a ration card. 30 percent of the total sample had an above poverty line card, and more than 65 percent had a below poverty line ration card. 68 percent of adopters had a below poverty line, while 62 percent of non-adopters had a below poverty line card.

[10] Upto March 2022

96.25 percent of the sample had a mobile phone; out of these 68 percent had a smartphone. The entire sample with a smartphone used their smart phone in order to avail information related to agriculture. 68 percent of both adopters and non-adopters of micro irrigation had a smartphone.

In terms of any household member having membership in organisations, 47.46 percent of the sample households had members who were part of a SHGs, 13 percent had a member in farmer cooperatives and 15 percent had members in the Gram Panchayat. Table 6.3 further expounds on membership at the district level.

Table 6.3: Membership in Organisations (%)

District	SHGs	FPOs	Farmer Cooperative	Gram Panchayat	Mandal Parishad
Ahmednagar	26(13.83)	35(18.62)	14 (7.45)	53 (28.19)	11 (5.85)
Amravati	142 (86.14)	14 (8.43)	2 (1.20)	2 (1.20)	0 (0.00)
Total	169(47.74)	49 (13.84)	16 (4.52)	62 (15.98)	11 (3.11)

Source: *Compiled from survey*

44.7 percent of adopters of micro irrigation were part of SHGs, while 14.43 percent were part of farmer cooperatives. With respect to non-adopters, 50 percent of non-adopters were members of SHGs and 15 percent were part of the Gram Panchayat.

79 percent of the sample had availed credit; this was true for 74 percent of adopters and 85 percent of non-adopters.

Table 6.4 provides descriptive statistics for household and farm characteristics.

Table 6.4: Descriptive Statistics for Household and Farm Characteristics

Variables	Mean	Number of Observations
Household Size	3.78 (1.09)	400
Number of Working Members	2.50 (.52)	400
Presence of Ration Card	1.05 (0.12)	400
Farm Size (Acres)	4.08 (3.95)	400
Number of Plots Cultivated	1.15(0.42)	400
Number of Plots Cultivated (Adopters)	1.17 (.47)	225
Number of Plots Cultivated (Non-Adopters)	1.11(.34)	175
Availed loan	1.188 (.391)	393
Annual Income from Agriculture	225022.31(224734.1)	400
Annual Income from Agriculture (Adopters)	252558.7 (265331.7)	225
Annual Income from Agriculture (Non-Adopters)	189618.3 (151465.9)	175
Income Farm Output	222755.8(222220.2)	396
Income Farm Output (Adopters)	247518.3(262075.4)	224
Income Farm Output (Non-Adopters)	190507(150499.3)	172

Note: *Standard deviation is given in parentheses.*

6.3 District Wise Analysis

Two talukas were selected in Ahmednagar district; a micro irrigation low coverage taluk Shevgaon and a high coverage taluk- Kopargaon. Similarly, two talukas were selected in Amravati; a micro irrigation low coverage taluk Chandurbazaar and a high coverage taluk Warud.

6.3.1 Income and Cost of Cultivation

Table 6.5 (a) presents the taluk wise average income from different sources for the district, including the income from sale of farm output. Table 6.5 (b) looks at the average income as per land category in the selected taluks.

Table 6.5 (a): Taluk Wise Distribution of Average Income from Various Sources

District	Taluk	Income from Livestock	Income from Self Employment	Income from Salary	Income from Wages (Non-Agricultural labour)	Income from other Sources	Income from Farm Outputs	Income from sale of by-products	Total income
Ahmednagar	Kopargaon	77991.49	40230	100287.1	28250	N/A	318120.6	45878.57	480289.5
	Shevgaon	129540.5	63666.67	149614.3	142666.7	N/A	384868.4	160000	654537.5
Amravati	Chandur Bazar	20307.69	59500	41000	28692.31	N/A	107591.8	N/A	128760
	Warud	20636.36	50000	31842.11	30625	12000	116879.2	N/A	124360

Table 6.5 (b): Taluk Wise Distribution of Average Total Annual Income per Land Category

District	Taluk	Marginal		Small		Semi-Medium		Medium	
		Mean	No of Observations	Mean	No of Observations	Mean	No of Observations	Mean	No of Observations
Ahmednagar	Kopargaon	440643.6	145	863533.3	15	N/A	0	N/A	0
	Shevgaon	585532.3	31	992500	8	90000	1	N/A	0
Amravati	Chandur Bazar	106097.6	41	259666.7	6	176666.7	3	N/A	0
	Warud	87609.38	128	223235.3	17	330000	3	1327500	2

Source: *Inputs from survey*

The major crops cultivated by respondents in Ahmednagar district include onion, sugarcane, soyabean in Kopargaon and *sugarcane and onion* in Shevgaon. Table 6.6 (a) and Table 6.6 (b) present the costs of cultivation for the major crops, with a comparison of adopters and non-adopters. It can be observed that in the case of Kopargaon, the seed costs for all three crops are higher for non-adopters than adopters. For onion and soyabean, the chemical fertilizer cost and asset is higher for non-adopters than adopters. The labour cost soyabean is lower for adopters than non-adopters. In Shevgaon, it can be observed that in the case of sugarcane, the input costs of seed and chemical fertilizer, as well as asset rental and labour costs is higher for non-adopters as compared to adopters. In onion, the input costs of seed and chemical fertilizer, as well as asset rental and labour costs are higher for adopters as compared to non-adopters.

Table 6.6 (a): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Kopargaon

Category	Variable	Crops					
		Onion		Sugarcane		Soyabean	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	10941.18 (4464.73)	13595.74 (6261.20)	14922.22 (11551)	18000 (9536.77)	15230.56 (8116.23)	27666.67 (9086.62)
	Chemical Fertilizer	6235.29 (2405.20)	65893.62 (1155.97)	9914.82 (7702.38)	5500 (3154.36)	5827.78 (5047.61)	7000 (2449.49)
	Asset Rent	6382.35 (2607.26)	8250 (2042.35)	4629.63 (2768.62)	3236.36 (1778.92)	5686.25 (3541.00)	6083.33 (3072.73)
	Labour Cost	41058.82 (17448.03)	36900 (12404)	14200 (8668.64)	6818.18 (3765.12)	22540.49 (12714.37)	23516.67 (5079.53)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	N/A	3563.30 (814.54)	1000 (-)	1045.46 (187.69)	N/A	3958.33 (510.31)
	Cost of Electricity	N/A	2686.17 (517.28)	500(-)	2400 (842.62)	N/A	4750 (612.37)
Cost of micro-irrigation technology	Rental Charge	N/A	N/A	N/A	N/A	N/A	N/A
	Labour Cost	1911.76 (661.09)	N/A	1361.54 (779.72)	N/A	4488.82 (1020.92)	N/A
	Cost of Electricity	2240 (480)	N/A	1192.31 (779.20)	N/A	4694.17 (860.99)	N/A
Fertigation Equipment	Rental Charge	N/A	N/A	N/A	N/A	N/A	N/A
	Labour Cost	247.06 (48.32)	N/A	86.92 (35.64)	N/A	686.81 (179.98)	

Table 6.6 (b): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Shevgaon

Category	Variable	Crops			
		Onion		Sugarcane	
		Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	5030.77 (3775.44)	3585.71 (2356.15)	16875 (6520.48)	23285.71 (9086.88)
	Chemical Fertilizer	4169.23 (2411.22)	3357.14 (1375.81)	4843.75 (1457.38)	5142.86 (1676.16)
	Asset Rent	2673.08 (1890.95)	2457.14 (1302.38)	6550 (1634.22)	8642.86 (2267.79)
	Labour Cost	39769.23 (57360.2)	21428.57 (9311.41)	25387.5 (13956.4)	35785.71 (19737.56)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	N/A	1614.29 (601.19)	N/A	4107.14 (609.94)
	Cost of Electricity	N/A	1400 (824.62)	N/A	4500 (1154.70)

Category	Variable	Crops			
		Onion		Sugarcane	
		Adopter	Non-Adopter	Adopter	Non-Adopter
Cost of micro-irrigation technology	Rental Charge	N/A	N/A	N/A	N/A
	Labour Cost	2496.15 (1470.33)	N/A	4757.81 (1101.58)	N/A
	Cost of Electricity	1969.23 (1068.79)	N/A	5075 (1175.02)	N/A
Fertigation Equipment	Rental Charge	N/A	N/A	N/A	N/A
	Labour Cost	376.92 (196.44)	N/A	381.25 (203.20)	N/A

The major crops cultivated by respondents in Amravati district include cotton, orange and tur in Warud and cotton and orange in Chandurbazaar. Table 6.7 (a) and Table 6.7 (b) present the costs of cultivation for the major crops, with a comparison of adopters and non-adopters. It can be seen that in Warud, cotton is characterised by lower input costs for adopters as compared to non-adopters. However, in Chandurbazaar, the input costs are significantly higher for adopters as compared to non-adopters.

Table 6.7 (a): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Warud

Category	Variable	Crops					
		Cotton		Orange		Tur	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	3721.88 (2735.28)	4371.80 (4246.54)	N/A	N/A	1861.91 (1897.76)	1035.42 (632.19)
	Chemical Fertilizer	3350 (1611.85)	4897.44 (3897.00)	12170.31 (8719.03)	21140.63 (34432.08)	5785.71 (5337.54)	2916.67 (2163.06)
	Asset Rent	2212.5 (1445.44)	3115.90 (2905.05)	N/A	N/A	2776.19 (2171.84)	2441.67 (896.33)
	Labour Cost	25484.38 (14875.55)	26230.77 (17406.08)	28293.65 (25266.9)	51218.75 (155558)	9238.10 (7562.44)	6625 (3987.07)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	N/A	1796.15 (791.10)	N/A	5789.06 920.44)	497.62 (520.69)	757.08 (771.74)
	Cost of Electricity	N/A	1232.05 (443.44)	N/A	3228.12 (638.16)	204.76 (15.04)	1237.5 (310.42)
Purchased	Labour Cost	N/A	N/A	N/A	N/A	N/A	N/A
	Cost of Electricity	N/A	N/A	N/A	N/A	N/A	N/A
User charges for govt. canal	Cost of Electricity	N/A	N/A	N/A	N/A	N/A	N/A

Category	Variable	Crops					
		Cotton		Orange		Tur	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Cost of micro-irrigation technology	Rental Charge	N/A	N/A	N/A	N/A	N/A	N/A
	Labour Cost	2202.81 (897.80)	N/A	4888.89 (3461.13)	N/A	N/A	N/A
	Cost of Electricity	1768.75 (686.48)	N/A	4053.33 (1513.67)	N/A	N/A	N/A
Fertigation Equipment	Rental Charge	N/A	N/A	N/A	N/A	N/A	N/A
	Labour Cost	492.19 (165.64)	N/A	213.59 (75.50)	N/A	N/A	N/A

Table 6.7 (b): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Chandurbazaar

Category	Variable	Crops			
		Cotton		Orange	
		Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	10400 (9584.15)	3684.62 (3670.60)	N/A	N/A
	Chemical Fertilizer	17500 (25957.66)	6661.54 (11785.55)	20718.75 (17999.97)	17868.97 (23750.6)
	Asset Rent	N/A	N/A	N/A	N/A
	Labour Cost	63833.33 (78333.69)	21892.31 (13847.41)	45187.5 (44013.97)	26431.03 (15002.22)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	N/A	2338.46 (1312.94)	N/A	5560.34 (1057.83)
	Cost of Electricity	N/A	1600 (845.33)	N/A	3765.52 (1194.41)
Cost of micro-irrigation technology	Rental Charge	N/A	N/A	N/A	N/A
	Labour Cost	3486.67 (2244.16)	N/A	4368.75 (4899.89)	N/A
	Cost of Electricity	2543.33 (1276.90)	N/A	3280 (736.12)	N/A
Fertigation Equipment	Rental Charge	N/A	N/A	N/A	
	Labour Cost	2483.33 (160.21)	N/A	210.62 (76.20)	

6.3.2 Asset Ownership

The survey documented the ownership of major farm assets owned by the respondents included tractors, harvester combiners (100 percent of the sample), drip and sprinkler irrigators (tube wells and bore wells, electric pumps, hand hoes, sprayers, pickaxes, weed hooks etc. Table 6.8 looks at the number of respondents with ownership of select major assets, the average cost of the asset as well as the average current value of the asset. This is further presented in terms of the ownership of assets for adopters and non-adopters, as well as the average number of units owned for each category. A similar analysis is done in the case of Amravati.

Table 6.8: Taluk Wise Asset Ownership and Cost in Ahmednagar

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Kopargaon	80 (77.67)	79	0	462183.5	279025.3
	Shevgaon	18 (17.48)	18	0	436388.9	217388.9
Drip irrigation	Kopargaon	115 (45.10)	65	50	77938.26	21980
	Shevgaon	29 (11.37)	18	11	63482.76	14362.07
Sprinkler Irrigation	Kopargaon	48(72.73)	36	12	37572.92	13489.58
	Shevgaon	3(4.55)	3	0	11333.33	11666.67
Diesel Pump	Kopargaon	2(25)	2	0	18750	4500
	Shevgaon	2(25)	2	0	17500	3000
Electric Pump	Kopargaon	159 (40.77)	120	39	15421.07	6656.60
	Shevgaon	38 (9.74)	36	2	15420.51	4769.23
Bore Well	Kopargaon	13 (25.49)	13	0	31076.92	9653.85
	Shevgaon	8 (15.69)	8	0	20562.5	6375
Tube Well	Kopargaon	12(92.31)	12	0	18083.33	8125
	Shevgaon	1(7.69)	1	0	12000	8000

Table 6.9: Taluk Wise Asset Ownership: Adopters versus Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Tractor	Kopargaon	52 (76.47)	28(80.00)	1	1
	Shevgaon	12 (17.65)	6(17.14)	1	1
Drip	Kopargaon	95 (43.98)	NA	1.79	1.1
	Shevgaon	24 (11.11)	NA	2.04	1
Sprinkler	Kopargaon	40(75.47)	NA	1.32	1.12
	Shevgaon	3(5.66)	NA	1	N/A
Electric Pump	Kopargaon	101 (46.12)	58 (33.92)	1.32	1.12
	Shevgaon	24 (10.96)	14(8.19)	1.04	1.13
Bore Well	Kopargaon	12 (38.71)	1(5.00)	1	1
	Shevgaon	7 (22.58)	1(5.00)	1	1

Table 6.10: Taluk Wise Asset Ownership and Cost in Amravati

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Dhoraji	19 (38)	19	0	347052.6	177578.9
	Jam Kandorana	79 (52.66)	77	2	342772.2	194050.6
Drip	Dhoraji	9 (18)	9	0	94222.22	46333.33
	Jam Kandorana	51 (34)	51	0	96450.98	92980.39
Sprinkler	Dhoraji	13 (26)	4	9	37192.31	16692.31
	Jam Kandorana	9 (0.06)	2	7	24611.11	13888.89
Electric Pump	Dhoraji	33 (66)	26	7	42459.46	19756.76
	Jam Kandorana	71 (47.33)	51	20	35914.52	23717.34
Bore Well	Dhoraji	13 (26)	12	1	99000	81153.85
	Jam Kandorana	39 (78)	29	10	118461.5	110512.8
Tube Well	Dhoraji	8 (16)	7	1	106875	135000
	Jam Kandorana	31 (20.6)	22	9	129838.7	154838.7

Table 6.11: Taluk Wise Asset Ownership: Adopters versus Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Chandur Bazar	2 (1.94)	2	0	350000	250000
	Warud	3 (2.91)	3	0	586666.7	156666.7
Drip irrigation	Chandur Bazar	23 (9.02)	22	1	51826.09	7521.74
	Warud	88 (34.51)	84	62	53933.16	13345.24
Sprinkler Irrigation	Chandur Bazar	11 (16.67)	10	1	19454.55	6772.73
	Warud	4 (6.06)	3	1	50750	8000
Diesel Pump	Chandur Bazar	0	N/A	N/A	N/A	N/A
	Warud	0	N/A	N/A	N/A	N/A
Electric Pump	Chandur Bazar	50(12.82)	39	11	32208.16	9142.86
	Warud	143(36.67)	137	6	24643.36	7804.19

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Bore Well	Chandur Bazar	0	N/A	N/A	N/A	N/A
	Warud	0	N/A	N/A	N/A	N/A
Tube Well	Chandur Bazar	0	N/A	N/A	N/A	N/A
	Warud	0	N/A	N/A	N/A	N/A

6.3.3 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

The survey revealed that out of the total respondents in the districts surveyed, 82.04 percent were aware of the PMKSY subsidy. At the taluk level, the awareness ranged from 80 percent in low coverage Shevgaon and 86 percent in high coverage Kopargaon in Ahmadnagar district. The awareness level was 73.3 percent in low coverage Chandurbazaar and 78 percent in high coverage Warud in Amravati district. In Ahmadnagar, 64 percent of the sample size were adopters while in Amravati, 49.5 percent of the sample was an adopter of micro irrigation. In Chandurbazaar[11], the average acreage under micro irrigation was 6.5 acres, while in the Ahmadnagar district, the average acreage under micro irrigation was 2.7 acres.

The major barriers to increasing acreage in Ahmadnagar included lack of credit (mentioned by 79.5 percent of adopters), and lack of subsidy provision (as mentioned by 77.1 percent). In Amravatri, the major barriers to increasing acreage included lack of credit (mentioned by 33 percent of adopter respondents).

In both districts, the major reasons for adoption were seen to be stakeholders such as the government, NGOs, peers and companies informing farmers of the benefits of micro irrigation (this was mentioned by 100 percent of the adopters). Other reasons included dropping groundwater levels, as mentioned by almost 50 percent of adopters.

Disuse after initial adoption was seen to be majorly due to delayed subsidy (mentioned by 100 percent of respondents), installation issues (mentioned 69 percent of respondents), inadequate training (mentioned by 76 percent of respondents), and high cost of spare parts (mentioned by 71 percent of respondents).

Non-adoption was attributed to high cost of investment and high cost of operational maintenence (mentioned by 100 percent of non-adopters across districts), insufficient subsidy (mentioned by 93 percent of non-adopters), and cultivation majorly for the purpose of self-consumption (mentioned by 97 percent of non-adopters).

6.4 Skill Gap in Micro Irrigation

The key informant interviews as well as the primary survey identified several arenas of skill gap in the case of Maharashtra. At the initial level, sustenance was severely hampered by the delayed nature of the subsidy payment by the government; unlike other states like Gujarat wherein the money is transferred to the company's account, in the case of Maharashtra, the farmer is expected to pay the entire amount upfront and receives the subsidy amount in his/ her bank account.

[11] The data pertaining to acreage under micro irrigation for Warud is not present

Furthermore, the rising costs of inputs led to the need for greater investment by the farmer.

- **Limited Awareness of Micro Irrigation Components**: The survey indicated that while most to all respondents could identify basic components of a drip/ sprinkler system such as a drip or sprinkler system and a fertigation tank, they could not differentiate the different types; for instance, mini sprinkler/ rain gun/ mini sprinkler or identify which type of system is best suited for a particular crop and climate.
- **Paucity of Maintenance Related Training**: While the adopters of micro irrigation were observed to be aware of maintenance requirements, the frequency of maintenance such as checking for leaks and correcting for pressure, inspecting and the dripping and ensuring water is reaching all the corners of the plot/ field, removing accumulated dirt from the nozzle head of sprinklers, washing filters etc had scope to be increased beyond once a season (as was primarily seen) to the recommended maintenance requirements. 54 percent of the adopters were not aware of chemical treatment, and the reason why it is undertaken. Only 46 percent of the adopters had an irrigation schedule provided to them.
- **Technical Issues:** There were several technical issues faced by adopters of the technology which served to hamper its continued uptake. This included the presence of contaminants such as salt and dirt (mentioned by all adopters), insufficient discharge from drippers, blockages (76.5 percent of adopters) and leakage of water from laterals or emitters (67 percent of adopters). In the case of presence of contaminants, distributors were approached who managed to solve the issue.

CHAPTER 7:

Andhra Pradesh

7.1 Introduction

As per the Census 2011, the state of Andhra Pradesh is spread over an area of 160205 square km, and is the seventh largest state in the country. constituting around 4.87 percent of the total geographical area of the country. The net cultivable area is around 47.57 percent of the geographical area (58.22 lakh hectares). The net sown area is around 43.61 lakh hectares, constituting 74.9 percent of the net cultivable area, and the irrigated area constitutes 58.08 of the net sown area. The contribution of agriculture and allied activities in the overall gross state domestic product was 33 percent in 2020-21 (PRS, 2021).

The population of the state was 84.58 million in 2011. Out of this, 60 percent of the workforce is engaged in agriculture and allied sectors as of 2018-19 (IWWAGE, 2020). According to the Agriculture Census of India, 2015-16, the number of operational landholdings (for agricultural production) in Andhra Pradesh is 8.52 million, marking an increase of 11.85 percent as compared to the Agriculture Census 2010-11.

The gross irrigated area in Andhra Pradesh was 35.67 lakh hectares in 2016-17; the net irrigated area was 27.43 lakh hectares and the irrigation intensity was 1.29. Out of this, 46.32 percent is irrigated through wells and tube wells, and the rest is canals (39.27 %), tanks (10.88%) and other sources (3.52%). In Andhra Pradesh, the estimated average annual availability of water resources of the State is 32.95 BCM. The rainfall varies from 561 mm in Rayalseema to around 1113 mm in the northeastern part of the state. (Ministry of Water Resources, Government of India).

The selected districts in Andhra Pradesh were Prakasam and Chittoor. Table 7.1 presents the key statistics pertaining to agriculture and irrigation in the selected districts.

Table 7.1: Key Agricultural Statistics for Survey Districts (Lakh Hectares)

District	Geographical Area	Cultivable Area	Sown Area	Net Irrigated Area
Prakasam	43.55	16.56	9.97	10.5
Chittoor	37.43	4.08	16.01	4.33

Source: *Water Resources Department, Government of Andhra Pradesh*

Since the implementation of the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More Crop scheme, a total area of 14654 hectares have been covered under micro irrigation as of 2021-2022[12], out of which drip irrigation constitutes 86.35 percent (12654 hectares) and sprinkler irrigation constitutes 13.64 percent (2000 hectares) of the total area covered under micro irrigation. Table 6.2 provides a brief picture of the status of micro irrigation in the selected districts for the study; the physical and financial achievements are highlighted. It can be seen that the financial achievement per hectare for the state is 2.07, while the financial achievement per hectare for both districts is lower in comparison to the state average. Chittoor holds the second rank in physical achievement of drip irrigation amongst all districts, while Prakasam holds the third rank with respect to drip

[12] Upto March 2022.

irrigation. Table 7.3 presents the coverage of major crops in each district in the state.

Table 7.2: Area Covered Under Micro Irrigation (Hectares) and Financial Achievement, 2021-22 (Lakhs)

District	Physical Achievement			Financial Achievement			Total Financial Achievement (Per hectare)
	Drip	Sprinkler	Total	Drip	Sprinkler	Total	
Prakasam	1286	151	1483	770.47	17.42	788.19	1.63
Chittoor	1419	64	1437	752.11	6.25	758.36	1.89
Total	12654	2000	14654	6812.68	237.95	7050.63	2.07

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

Table 7.3: Major Crops Under Micro Irrigation in Andhra Pradesh, 2022-23

District	Major Crops Total (Area in Hectares)	Major Crops under Drip (Area in Hectares)	Major Crops under Sprinkler (Area in Hectares)
Prakasam	Red Chillies (1714), Green Chillies (769), Chilli (419)	Red Chillies (1711), Green Chillies (769), Chilli (419)	Groundnut (169), Bengal Gram (143), Black Gram (141)
Chittoor	Tomato (1845), Mango (979), Potato (103)	Tomato (1845), Mango (979), Potato (103)	Groundnut (58)
Total (Andhra Pradesh)	Groundnut (10033), Tomato (8452), Orange (5906)	Tomato (8436), Orange (5906), Mango (4429)	Groundnut (9302), Blackgram (1793), Bengal Gram (1017)

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

7.2 Sample Profile: An Overview

400 cultivators were sampled across two high coverage districts; Chittoor and Prakasam. 23.25 percent of the respondents interviewed were marginal farmers, 24 percent were marginal farmers, 46.25 percent were semi-medium and medium farmers. All respondents were adopters of micro irrigation.

The socio-economic profile is presented. The average household size was more than three members, and the average number of working members was more than two.

A majority of respondents (more than 89%) had a ration card. Out of this, 92 percent of the sample with a ration card were below the poverty line. The entire sample had a mobile phone; out of this, 85 percent had a smartphone. The entire sample with a smartphone used their smart phone in order to avail information related to agriculture, which was mostly pertaining to best cultivation practices, and government schemes in the agricultural sector.

In terms of any household member having membership in organisations, 98 percent of the sample households had members who were part of a SHGs, and the rest of the sample were members of youth associations, gram panchayat or mandal parishad. 100 percent of the sample had availed credit from formal sources.

Table 7.4 provides the descriptive statistics for household and farm characteristics.

Table 7.4: Descriptive Statistics for Household and Farm Characteristics

Variables	Mean	Number of Observations
Household Size	3.78 (1.09)	400
Number of Working Members	2.06 (.57)	400
Presence of Ration Card	1.11 (0.34)	399
Farm Size (Acres)	5.51 (3.75)	400
Number of Plots Cultivated	2.42(1.22)	400
Availed a loan	1.188 (.391)	393
Annual Income from Agriculture	326915.4(211877.1)	400
Income Farm Output	265341.9(186269.8)	400

Note: *Standard deviation is given in parentheses.*

7.3 District Wise Analysis

Two talukas were selected in Prakasam district; a micro irrigation low coverage taluk Thallur and a high coverage taluk- Yerragondapalem. Similarly, two talukas were selected in Chittoor; a micro irrigation low coverage taluk Irala and a high coverage taluk Ramakuppam.

7.3.1 Income and Cost of Cultivation

Table 7.5 (a) presents the taluk wise average income from different sources for the district, including the income from sale of farm output. Table 7.5 (b) looks at the average income as per land category in the selected taluks.

Table 7.5 (a): Taluk Wise Distribution of Average Income from Various Sources

District	Taluk	Income from Livestock	Income from Self Employment	Income from Salary	Income from Wages (Non-Agricultural labour)	Income from Farm Outputs	Total income
Chittoor	Irala	48785.71	131461.50	71000	72700	254335	347584.50
	Ramakuppam	56388.89	197916.70	69000	71615.38	292609.3	394463.80
Prakasam	Thallur	57452.38	131863.60	76000	72150	290481.2	383360.70
	Yerragondapalem	53738.10	126909.10	73333.33	72850	223942.3	314166.70

Table 7.5 (b): Taluk Wise Distribution of Average Total Annual Income per Land Category

District	Taluk	Marginal		Small		Semi-medium	
		Mean	Number of observations	Mean	Number of observations	Mean	Number of observations
Chittoor	Irala	279237.1	66	476056.8	33	618920	1
	Ramakuppam	292519	67	594958.6	31	701945	2
Prakasam	Thallur	246439.1	63	586160.5	32	810652.6	5
	Yerragondapalem	209094.4	70	525175.9	25	730133.2	5

Source: *Inputs from survey*

The major crops cultivated by respondents in Prakasam district include acid lime, chillies and cotton in Yerragondapalem and acid lime, chillies and guava in Thallur. Table 7.6 (a) and Table 7.6 (b) presents the costs of cultivation for the major crops.[13]

Table 7.6 (a): Cost of Cultivation for Major Crops in Yerragondapalem

Category	Variable	Crops					
		Acid lime		Chillies		Cotton	
		Average	N	Average	N	Average	N
Input Costs	Seed Cost	0	19	9851.74 (5299.75)	79	20466.21 (12126.06)	100
	Chemical Fertilizer	23409.21 (8164.79)	19	12624.49 (6450.59)	79	23169.19 (13424.26)	100
	Bio Fertilizer	6376.31 (2217.94)	19	5890.35 (3121.19)	79	7066.70 (4058.40)	100
	Asset Rent	N/A	N/A	N/A	N/A	36830.97 (21474.84)	100
	Labour Cost	37802.63 (13267.96)	19	13451.90 (7402.02)	79	95776.05 (56076.07)	100
	Cost of Electricity	N/A	N/A	N/A	N/A	N/A	N/A
Cost of micro-irrigation technology	Labour Cost	N/A	N/A	N/A	N/A	N/A	N/A
	Cost of Electricity	N/A	N/A	N/A	N/A	2092.66 (1223.11)	100

Table 7.6 (b): Cost of Cultivation for Major Crops in Thallur

Category	Variable	Crops					
		Acid lime		Chillies		Guava	
		Average	Number	Average	Number	Average	Number
Input Costs	Seed Cost	0	100	11570.73 (6702.52)	41	65558.8 (52624.02)	54
	Chemical Fertilizer	24965.42 (17463.41)	100	14120.18 (8394.37)	41	11790.05 (9419.29)	54
	Bio Fertilizer	6896.08 (4717.40)	100	6347.26 (3926.46)	41	5264.63 (4386.83)	54
	Asset Rent	N/A	N/A	28762.75 (13001.79)	32	42159.64 (24039.59)	83
	Labour Cost	40650.78 (28407.32)	100	15317.07 (8746.43)	41	34505.09 (28058.75)	54
	Cost of Electricity	N/A	N/A	N/A	N/A	N/A	N/A
Cost of micro-irrigation technology	Labour Cost	N/A	N/A	N/A	N/A	N/A	N/A
	Cost of Electricity	N/A	N/A	1624.57 (960.29)	41	N/A	N/A

[13] Given that the survey in Andhra Pradesh only had adopter respondents, the comparison between adopters and non-adopters cannot be undertaken.

The major crops cultivated by respondents in Chittoor district include groundnut, mango and sugarcane in Irala and cabbage, cauliflower and tomato in Ramakuppam. Table 7.7 (a) and Table 7.7 (b) present the costs of cultivation for the major crops.

Table 7.7 (a): Cost of Cultivation for Major Crops in Irala

Category	Variable	Crops					
		Groundnut		Mango		Sugarcane	
		Average	Number of observations	Average	Number of observations	Average	Number of observations
Input Costs	Seed Cost	16263.89 (6816.45)	18	0	100	8758.33 (4696.82)	18
	Chemical Fertilizer	6806.94 (3218.62)	18	62688.75 (41432.55)	100	14916.67 (7067.72)	18
	Bio Fertilizer	3354.17 (1839.04)	18	29388.15 (36427.79)	100	5978.33 (2769.61)	18
	Asset Rent	N/A	N/A	N/A	N/A	N/A	N/A
	Labour Cost	8927.78 (4194.30)	18	72856.75 (84193.19)	100	14252.78 (5522.53)	18
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	N/A	N/A	N/A	N/A	N/A	N/A
	Cost of Electricity	N/A	N/A	N/A	N/A	N/A	N/A
Cost of micro-irrigation technology	Labour Cost	650 (111.14)	18	3089 (495.51)	100	627.78 (91.11)	18
	Cost of Electricity	N/A	N/A	45 (0)	100	N/A	N/A

Table 7.7 (b): Cost of Cultivation for Major Crops in Ramakuppam

Category	Variable	Crops					
		Cabbage		Cauliflower		Tomato	
		Average	Number	Average	Number	Average	Number
Input Costs	Seed Cost	19214.81 (13069.06)	27	26440.79 (10594.11)	38	25848.42 (17479.26)	100
	Chemical Fertilizer	21335.65 (13831.22)	27	28828.95 (10787.43)	38	29511.42 (19773.52)	100
	Bio Fertilizer	4641.30 (3068.41)	27	6159.87 (2237.98)	38	8717.11 (6175.64)	100
	Asset Rent	N/A	N/A	N/A	N/A	42159.64 (24039.59)	83
	Labour Cost	10903.7 (7385.65)	27	15181.58 (5914.68)	38	49591.8 (34027.77)	100
Cost of micro-irrigation technology	Labour Cost	N/A	N/A	N/A	N/A	N/A	N/A
	Cost of Electricity	N/A	N/A	45 (0)	100	2560.16 (1769.54)	100

7.3.2 Asset Ownership

The survey documented the ownership of major farm assets owned by the respondents included tractors, harvester combiners, drip and sprinkler irrigators, tube wells and bore wells, electric pumps, hand hoes, sprayers, pick axes, weed hooks etc. Table 7.8 looks at the number of respondents with ownership of select major assets, the average cost of the asset as well as the average current value of the asset for Prakasam district. All the adopters are observed to have drip irrigation systems, and none have sprinklers. A similar presentation is done in the case of Chittoor (see Tables 7.9)

Table 7.8: Taluk Wise Asset Ownership and Cost in Prakasam

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Thallur	33 (27.50)	10	0	584848.5	488484.8
	Yerragondapalem	26 (21.67)	28	0	575961.5	470000
Drip irrigation	Thallur	100 (25)	36	64	2962.58	3202.64
	Yerragondapalem	100 (25)	38	62	5897.90	5991.20
Sprinkler Irrigation	Thallur	0	N/A	N/A	N/A	N/A
	Yerragondapalem	0	N/A	N/A	N/A	N/A
Diesel Pump	Thallur	0	N/A	N/A	N/A	N/A
	Yerragondapalem	0	N/A	N/A	N/A	N/A
Electric Pump	Thallur	100 (25)	100	0	15239.5	12139.36
	Yerragondapalem	100 (25)	100	0	16285	12890.66
Bore Well	Thallur	100 (25)	100	0	156299.2	120463.6
	Yerragondapalem	100 (25)	100	0	156299.2	121303.6
Tube Well	Thallur	0	N/A	N/A	N/A	N/A
	Yerragondapalem	0	N/A	N/A	N/A	N/A

Table 7.9: Taluk Wise Asset Ownership and Cost in Chittoor

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Irala	32 (26.67)	32	0	586718.8	487968.8
	Ramakuppam	29 (24.17)	29	0	541379.3	440689.7
Drip irrigation	Irala	100 (25)	40	60	37008.28	36972.22
	Ramakuppam	100 (25)	42	58	4654.47	4788.14
Sprinkler Irrigation	Irala	0	N/A	N/A	N/A	N/A
	Ramakuppam	0	N/A	N/A	N/A	N/A
Diesel Pump	Irala	0	N/A	N/A	N/A	N/A
	Ramakuppam	0	N/A	N/A	N/A	N/A

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Electric Pump	Irala	100 (25)	100	0	14727	12169.85
	Ramakuppam	100 (25)	100	0	15792.5	12603.92
Bore Well	Irala	100 (25)	100	0	156299.2	120065.5
	Ramakuppam	100 (25)	100	0	156299.2	120837.9
Tube Well	Irala	0	N/A	N/A	N/A	N/A
	Ramakuppam	0	N/A	N/A	N/A	N/A

7.3.3 Micro Irrigation Ownership

All respondents surveyed were adopters of micro irrigation, specifically drip irrigation. All respondents in both districts, i.e., Chittoor and Prakasam were aware of the PMKSY subsidy scheme.

In Chittoor district, the average acreage under micro irrigation was 5.4 acres. The reason for an inability to increase acreage under micro irrigation was lack of subsidy for all respondents. The major reasons to adopt micro irrigation included suitability for the crop and dropping groundwater levels, as well as the peer effect of micro irrigation being adopted by fellow farmers. The government stakeholders also were seen to be a key influence in enhancing adoption, especially through promotion of the technology as 'yield enhancing'.

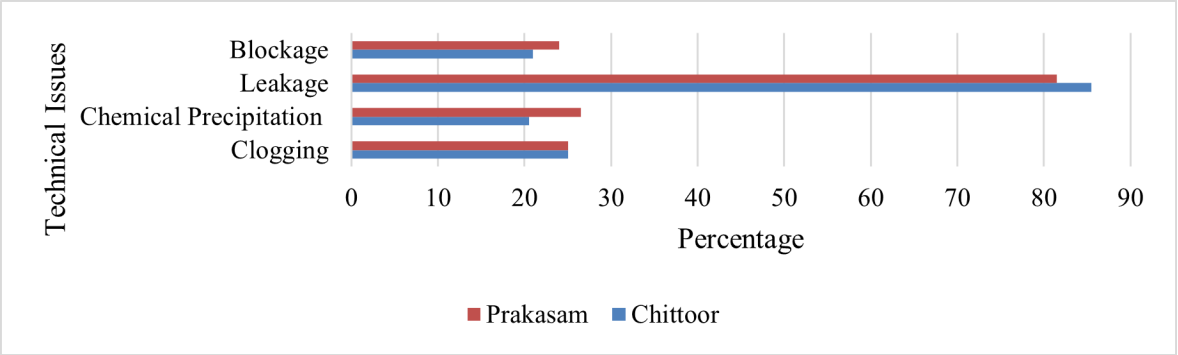
In Prakasam district, the average acreage under micro irrigation was 5.5 acres. The reasons for an inability to increase acreage under micro irrigation were l lack of subsidy provision (66%), lack of credit (19% of the adopters), inability to buy more land (16% of adopters). The major reasons to adopt micro irrigation included the impact of government agents, company agents, distributors (mentioned by almost all adopters) as well as dropping groundwater levels, as experienced by 92 percent of adopter respondents.

7.3.4 Skill Gap in Micro Irrigation

The key informant interviews with APMIP revealed that micro irrigation was preferred in areas that were water scarce, especially in the Rayalaseema belt wherein drip was almost a norm given that drought prone nature of the zone. PMKSY subsidy was not operational in the state for the last two years. A number of factors were contributing to a skill gap, and have been elucidated below.

- **Affordability:** Given that 80 percent of farmers in the state are small and marginal, affordability is a concern. Further, the small size of the landholding is a limiting factor for enhanced coverage under micro irrigation.
- **Technical Issues**: A large number of adopter respondents experienced clogging of emitters, which they attempted to solve themselves. Figure 7.2 presents the key technical areas of concern. Further, there is a paucity of qualified technicians, which can be detrimental in issues such as pipe damages and leakages.

Figure 7.1: Technical Challenges Faced by Adopters



- **Lack of Availability of Spare Parts:** It was observed that in Rayalaseema, borewells are very deep and salt accumulation is high, thus impacting micro irrigation components. The lack of availability of spare parts, and the unavailability of spare parts at the district level as well as lack of timely provision of service has the potential to reduce the likelihood of sustenance reduces after a period of 6 months. However, in places like Anantapur, spare part showrooms are more available in comparison to other districts.
- **Lacunae in R&D:** An important finding that emerged was that there is a paucity of updated and reliable research on crop and area specific micro irrigation adoption, as well as irrigation and fertigation schedules. For instance, the right drip selection is dependent on soil type, crop variety, and other such factors through which the right drip discharge should be selected.
- **Right Drip Selection**: Right drip selection can be a further challenge when a variety of crops are grown, given that drip discharge is not adjustable and is fixed. At present, micro irrigation companies are recommending a two litre per hour discharge model, wherein the emitter-to-emitter distance is 40 cm.
- **Delay in Subsidy Approval and Clearance of Other Bills:** The interviews with companies revealed that subsidies are approved only after the geo-coordinates of installed micro irrigation systems are verified. There is a delay in subsidy approvals due to server issue, which can impact non-adoption for an entire season. Further, the government has not cleared the bills of micro irrigation companies due to budget concerns.

CHAPTER 8:

Karnataka

8.1 Introduction

As per the Census 2011, the state of Karnataka is spread over an area of 191791 square km, constituting around 5.83 percent of the total geographical area of the country. As of 2018-19, the net sown area is around 10664; the gross cropped area is 13551 and the gross irrigated area is 4745, with the gross irrigated area to gross cropped area amounting to 35.01. The contribution of agriculture and allied activities in the overall gross state domestic product was 13.15 percent in 2020-21, as opposed to 12.16 percent in 2019-20 (Government of Karnataka, 2021).

The population of the state was 61095 million in 2011, marking an increase of 15.6 percent from 2001. Out of this, more than 60 percent of the workforce is engaged in agriculture (Institute for Social and Economic Change, 2013). According to the Agriculture Census of India, 2015-16, the average size of operational landholdings (for agricultural production) in Karnataka is 1.36 hectares, and the number of operational holdings accounted to 11805.

As per the latest data, the net irrigated area is 3.6 million hectares; out of this 0.39 million is through wells, 0.85 million is through tube wells and 1.8 million is through pumps. In Karnataka, the annual replenishable ground water resources are 15.93 BCM while the net annual ground water availability is 15.30 BCM. The average annual rainfall is 1179 mm as per the Ministry of Water Resources, Government of India.

Figure 8.1 presents the selected districts in Karnataka; Hassan and Haveri. Table 8.1 presents the key statistics pertaining to agriculture and irrigation in the selected districts.

Figure 8.1: Selected Districts in Karnataka

Source: *Prepared using Gramener.*

Table 8.1: Key Agricultural Statistics for Survey Districts

District	Geographical Area ('000 hectares)	Net Sown Area ('000 hectare)	Major Soils	Gross Irrigated Area ('000 hectare)	Net Irrigated Area ('000 hectare)
Haveri	485.2	366.0	Sandy loam, black soil	71.7	62.6
Hassan	662. 6	370	Red soil	97.4	88.6

Source: *Agriculture Contingency Plan, Government of Karnataka*

Since the implementation of the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More Crop scheme, a total area of 336052.870 hectares have been covered under micro irrigation[14], out of which drip irrigation constitutes 10.7 percent (35934.730 hectares) and sprinkler irrigation constitutes percent 89.30 (300118.140 hectares) of the total area covered under micro irrigation. Table 8.2 provides a brief picture of the status of micro irrigation in the selected districts for the study; the physical and financial achievements are highlighted. It can be seen that the financial achievement per hectare for the state is 15.55, while the financial achievement per hectare for Hassan districts is higher in comparison to the state average, while the achievement per hectare for Haveri is lower. Hassan and Haveri hold the top 2 ranks in terms of sprinkler irrigation coverage (area) in the state.

Table 8.2: Area Covered Under Micro Irrigation (Hectares) and Financial Achievement (Lakhs)

District	Physical Achievement			Financial Achievement			Total Financial Achievement (Per hectare)
	Drip	Sprinkler	Total	Drip	Sprinkler	Total	
Hassan	1342.63	33145	34487.630	229.35	820.52	1049.87	32.84
Haveri	1319.850	15522	16841.85	255.67	859.28	1114.95	15.10
Total	35934.730	300118.140	336052.870	8918.67	12686.87	21605.54	15.55

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

8.2 Sample Profile: An Overview

342[15] cultivators were sampled across two high coverage districts; Haveri and Hassan. Almost 40 percent of the respondents interviewed were marginal farmers, 36.55 percent were small farmers, 19.30 percent of the sample were semi-medium farmers, 3.80 percent were medium farmers while 0.88 percent were large farmers. A majority of adopters of micro irrigation interviewed were either small and marginal farmers (65%) and 31 percent were semi-medium or medium farmers.

The socio-economic profile is presented. The average household size was almost 5 members, and the average number of working members was more than 2. 52.05 percent of the sample was an adopter of micro irrigation (either drip or sprinkler or both) while the rest are either non-adopters or have discontinued adoption at present.

A majority of respondents (more than 97%) had a ration card. 91.9 percent of the sample had a below poverty line card and 7.8 percent had an above poverty line card.

[14] Upto March 2022

[15] While the total respondents were 400, there were a lot of data entry errors which could not be rectified.

97 percent of the sample had a mobile phone; out of these 73 percent had a smartphone. 94 percent of the sample with a smartphone used their smart phone in order to avail information related to agriculture; this was mostly with respect to government schemes for agriculture. 78 percent of adopters had a smartphone while 68 percent of non-adopters had a smartphone.

In terms of any household member having membership in organisations, 27.08 percent of the sample households had members who were part of a SHGs, while almost 4 percent of the households had members who were part of FPOs or cooperatives. 80 percent of adopters had membership in some organization, while the percentage for non-adopters for the same was 70 percent.

Table 8.3 further expounds on membership at the district level.

Table 8.3: Membership in Organisations (%)

District	SHGs	FPOs	Farmer Cooperative	Gram Panchayat	Mandal Parishad	Others (Water Users Association, Youth Associations)
Hassan	44(26.35)	9(5.39)	9 (5.39)	7 (4.20)	7 (4.20)	2(1.2)
Haveri	47 (27.81)	3 (1.78)	4 (2.37)	3 (1.78)	4 (2.37)	2(1.18)
Total	91(27.08)	12(3.57)	13 (3.87)	10 (2.98)	11 (3.27)	4(0.6)

Source: *Compiled from survey*

94.15 percent of the sample had availed credit; this was true for 95.51 percent of adopters and 92.68 percent of non-adopters.

Table 8.4 provides descriptive statistics for household and farm characteristics.

Table 8.4: Descriptive Statistics for Household and Farm Characteristics

Variables	Mean	Number of Observations
Household Size	4.83(2.07)	338
Number of Working Members	2.25(2.25)	338
Presence of Ration Card		
Farm Size (Acres)	4.43(6.77)	338
Number of Plots Cultivated	1.64(.94)	338
Number of Plots Cultivated (Adopters)	1.78(1.03)	175
Number of Plots Cultivated (Non-Adopters)	1.49(0.80)	163
Availed loan		
Annual Income from Agriculture	87102.96(133591.9)	338
Annual Income from Agriculture (Adopters)	123479.7(172291.8)	175
Annual Income from Agriculture (Non-Adopters)	48048.16(47731.38)	163
Income Farm Output	85284.32(131883.8)	338
Income Farm Output (Adopters)	121405.4(169943.8)	175
Income Farm Output (Non-Adopters)	46503.99(47324.2)	163

Note: *Standard deviation is given in parentheses.*

8.3 District Wise Analysis

Two talukas were selected in Haveri district; a micro irrigation low coverage taluk Siggaon and a high coverage taluk- Savanur. Similarly, two talukas were selected in Hassan; a micro irrigation low coverage taluk Arsikere and a high coverage taluk Hassan.

8.3.1 Income and Cost of Cultivation

Table 8.5 (a) presents the taluk wise average income from different sources for the district, including the income from sale of farm output. Table 8.5 (b) looks at the average income as per land category in the selected taluks.

Table 8.5 (a): Taluk Wise Distribution of Average Income from Various Sources

District	Taluk	Income from Livestock	Income from Self Employment	Income from Salary	Income from Wages (Non-Agricultural labour)	Income from Farm Outputs	Income from sale of by-products	Total income
Hassan	Arasikere	26976.74	38980.77	56617.02	7397.78	77246.15	760.87	156937.2
	Hassan	17029.41	18243.24	54166.67	35700	62471.91	2578.95	114414.6
Haveri	Savannuru	92444.47	65844.44	16130.43	3721.88	123287.7	2127.66	241311.6
	Shiggaon	9464.29	57085.11	48200	25425.53	86079.7	1994.12	142423.3

Table 8.5 (b): Taluk Wise Distribution of Average Total Annual Income per Land Category

District	Taluk	Marginal		Small		Semi-Medium		Medium	
		Mean	Number	Mean	Number	Mean	Number	Mean	Number
Hassan	Arasikere	135891.2	68	363000	8	51500	1	45000	1
	Hassan	112974.7	83	158200	5	N/A	0	15000	1
Haveri	Savannuru	182615.4	52	188277.8	9	406000	1	715000	2
	Shiggaon	126861.2	94	373833.3	6	216800	1	N/A	0

***Source**: Inputs from survey*

The major crops cultivated by respondents in Hassan district include cotton, maize and ragi in Arasikere and in Hassan both. Table 8.6 (a) and Table 8.6 (b) present the costs of cultivation for the major crops, with a comparison of adopters and non-adopters. It can be observed that in the case of cotton and ragi, input costs are higher for adopters in comparison to non-adopters for the taluk of Arasikere. In the case of maize, non-adopters were seen to witness higher input costs.

In the case of Hassan taluk, the input costs for most inputs are higher for adopters of cotton and maize, as compared to non-adopters. However, in the case of ragi, the input costs are lower for adopters. Thus, a taluk wise difference is observed for the same type of crops.

Table 8.6 (a): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Arasikere

Category	Variable	Crops					
		Cotton		Maize		Ragi	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	18323.81 (43559.18)	15195.45 (16208.34)	2380 (998.66)	2987.5 (888.72)	4620.58 (10186.31)	1355.83 (1201.68)
	Chemical Fertilizer	21880.95 (53007.05)	5333.33 (6154.57)	3590 (2020.70)	3625 (1093.82)	153212.9 (604789.6)	3816.66 (4629.93)
	Bio Fertilizer	9485.71 (7409.07)	6175 (5042.03)	3200 (4939.64)	3625 (3583.20)	3675.62 (5417.15)	1869.56 (2853.30)
	Asset Rent	10118.18 (10617.04)	8491.67 (7451.35)	8190 (14761.24)	4150 (1781.65)	17105.88 (21488.96)	3995.83 (3956.33)
	Labour Cost	221754.55 (54887.15)	5208.33 (4054.06)	3230 (1204.67)	4500 (1336.31)	16835.29 (60128.14)	2335.42 (2970.45)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	5163.64 (15824.59)	700 (1545.96)	4000 (12649.11)	0	9470.59 (19290.92)	166.67 (483.04)
	Cost of Electricity	3750 (10794.34)	1136.36 (2050.50)	5000 (15811.39)	0	8676.47 (16010.68)	357.14 (1195.23)
Purchased	Labour Cost	2045.45 (5268.75)	1800 (3359.90)	4000 (12649.11)	0	6176.47 (10829.56)	666.67 (2243.51)
	Cost of Electricity	3613.67 (11015.07)	1045.46 (1680.10)	5000 (15811.39)	0	8205.88 (16279.84)	309.52 (1123.34)
	Cost of Electricity	0	0	0	0	0	0
Cost of micro-irrigation technology	Rental Charge	2672.22 (7900.40)	NA	1333.33 (4000)	NA	5014.29 (8897.44)	NA
	Labour Cost	1927.27 (3153.56)	NA	555.56 (1666.67)	NA	3285.71 (4397.18)	NA
	Cost of Electricity	0	NA	0	NA	242.86 (577.41)	NA
Fertigation Equipment	Rental Charge	42.10 (183.53)	NA	0	0	0	0
	Labour Cost	42.10 (183.53)	NA	0	0	0	0

Table 8.6 (b): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Hassan

Category	Variable	Crops					
		Cotton		Maize		Ragi	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	3886.96 (2110.00)	2973.68 (863.35)	14936.36 (10891.95)	11750 (10010.22)	1376.47 (1025.62)	2257.5 (4832.63)
	Chemical Fertilizer	5886.96 (4337.82)	4652.63 (1959.13)	11363.64 (8429.39)	5750 (2094.37)	4750 (5993.90)	4837.5 (4792.48)
	Bio Fertilizer	4904.35 (5332.70)	3157.90 (3009.49)	6090.91 (5682.51)	2583.33 (3051.33)	3456.25 (3590.35)	1781.25 (2664.39)
	Asset Rent	3682.61 (2017.12)	3873.68 (1481.68)	4536.36 (1807.91)	6483.33 (10603.76)	4558.82 (5263.92)	9306.25 (14764.21)
	Labour Cost	4834.78 (4335.96)	2473.68 (1160.38)	5272.73 (2695.96)	4912.5 (2445.97)	2420.59 (2493.06)	2071.88 (1610.79)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	0	0	0	454.54 (1507.56)	176.47 (528.59)	1538.46 (3152.13)
	Cost of Electricity	0	0	0	227.27 (753.78)	441.18 (1321.48)	2115.38 (5575.82)
Purchased	Labour Cost	0	0	0	454.54 (1507.56)	235.29 (664.21)	1538.46 (3152.13)
	Cost of Electricity	0	0	0	227.27 (753.78)	1617.64 (6055.81)	961.54 (1919.87)
User charges for govt. canal	Cost of Electricity	0	0	0	0	0	0
Cost of micro-irrigation technology	Rental Charge	58.82 (242.54)	0	0	0	0	0
	Labour Cost	40 (178.89)	0	2018.18 (2463.26)	0	625 (1767.77)	625 (1767.77)
	Cost of Electricity	0	0	0	0	250 (707.11)	3125 (8838.84)
Fertigation Equipment	Rental Charge	0	0	0	0	0	0
	Labour Cost	0	0	0	0	0	0

The same analysis is done in the case of Haveri district. The major crops cultivated by respondents in Haveri district include cotton, maize and groundnut in Savannuru and cotton, maize and soyabean in Shiggaon. Table 8.7 (a) and Table 8.7 (b) present the costs of cultivation for the major crops, with a comparison of adopters and non-adopters. It can be observed that adopters of micro irrigation have lower labour costs in the case of cotton (in terms of inputs)

Table 8.7 (a): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Savannuru

Category	Variable	Crops					
		Cotton		Groundnut		Maize	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	5538.46 (10480.98)	5671.43 (5956.56)	12179.17 (10602.9)	6800 (5755.87)	8470.33 (9587.70)	2921.74 (2394.49)
	Chemical Fertilizer	50923.08 (136498.3)	21400 (43403.86)	6368.33 (3665.07)	5666.67 (4054.32)	29026.67 (90287.27)	3730.44 (3321.48)
	Bio Fertilizer	19323.08 (54517.49)	2807.14 (2956.47)	1208.33 (1724.93)	2994.44 (1345.00)	9940 (36091.18)	3958.70 (10218.22)
	Asset Rent	59076.92 (135819.9)	28314.29 (78608.35)	4975 (2533.46)	4455.56 (1744.36)	33567.5 (91297.87)	5695.65 (5514.24)
	Labour Cost	3988.46 (5401.47)	4535.71 (4260.89)	6516.67 (3977.63)	3555.56 (1609.43)	7387.5 (10955.14)	2656.52 (1935.10)
Irrigating using farm pond, open well, shallow well, bore well, Tube-well	Labour Cost	6461.54 (8771.31)	1428.57 (3631.36)	0	0	3845 (7248.31)	1521.74 (5097.86).
	Cost of Electricity	1746.15 (2163.18)	714.28 (1815.68)	0	0	2673.33 (6333.11)	434.78 (1440.52)
Purchased	Labour Cost	5192.31 (8528.23)	1428.57 (3631.36)	0	0	3116.67 (6580.64)	978.26 (4179.16)
	Cost of Electricity	4038.46 (7037.00)	535.71 (1447.34)	0	0	1466.67 (2511.81)	217.39 (1042.57)
	Cost of Electricity	0	0	0	0	66.67 (365.15)	0
Cost of micro-irrigation technology	Rental Charge	666.67 (1775.25)	NA	0	0	95.24 (436.44)	0
	LabourCost	625 (1432.18)	NA	566.67 (452.77)	0	447.62 (1105.72)	0
	Cost of Electricity	0	NA	0	0	0	0
	LabourCost	0	0	0	0	714.28 (3273.27)	0

Table 8.7 (b): Cost of Cultivation for Major Crops (Adopters and Non-Adopters) in Shiggaon

Category	Variable	Crops					
		Cotton		Maize		Soyabean	
		Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter
Input Costs	Seed Cost	3700 (3195.83)	3250 (1936.35)	2744.60 (966.65)	2990 (712.81)	3305.26 (1609.86)	3982.61 (1424.99)
	Chemical Fertilizer	4928.57 (2588.90)	10710 (14332.44)	4163.51 (2492.78)	3527.5 (1007.91)	3007.90 (1193.76)	4015.22 (1301.87)
	Bio Fertilizer	1542.86 (1531.73)	4800 (4479.58)	3288.57 (2869.18)	3487.18 (3106.63)	3917.65 (2724.25)	3586.96 (4276.39)
	Asset Rent	3371.43 (1407.97)	5220 (4471.59)	4313.51 (2599.70)	4182.5 (1690.98)	4021.05 (2527.31)	3969.56 (2115.41)
	Labour Cost	4214.28 (1776.16)	7550 (5474.44)	4464.86 (2703.62)	4407.5 (1938.46)	3710.53 (2405.52)	3404.35 (1645.79)
	Cost of Electricity	0	0	0	0	0	0
	Cost of Electricity	0	0	0	0	0	0
User charges for govt. canal	Cost of Electricity	0	0	0	0	0	0
Cost of micro-irrigation technology	Rental Charge	0	NA	57.14 (338.06)	NA	0	NA
	Labour Cost	360 (409.88)	NA	872.22 (1830.47)	NA	473.68 (978.57)	NA
	Cost of Electricity	0	NA	0	NA	0	NA
	Labour Cost	0	0	0	0	0	0

8.3.2 Asset Ownership

The survey documented the ownership of major farm assets owned by adopters and non-adopters. Table 8.8 looks at the number of respondents with ownership of select major assets, the average cost of the asset as well as the average current value of the asset in Hassan. This is further presented in terms of the ownership of assets for adopters and non-adopters, as well as the average number of units owned for each category (Table 8.9). A similar analysis is done in the case of Haveri (see Tables 8. 10 and 8.11).

Table 8.8: Taluk Wise Asset Ownership and Cost in Hassan

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Arasikere	23 (36.52)	21	2	371173.9	337083.4
	Hassan	11 (17.46)	11	0	677272.7	386363.6
Drip irrigation	Arasikere	47 (57.32)	33	14	36712.77	8500.04
	Hassan	23 (28.05)	13	10	16217.39	13318.18
Sprinkler Irrigation	Arasikere	12(8.45)	5	7	11241.67	12333.33
	Hassan	42(29.58)	19	23	13333.33	8904.762
Electric Pump	Arasikere	45 (24.32)	37	8	26261.36	9767.46
	Hassan	58 (31.55)	48	10	32465.52	10603.45
Bore Well	Arasikere	67 (28.51)	50	17	128358.2	32014.99
	Hassan	68 (28.94)	45	23	128347.8	21544.12

Table 8.9: Taluk Wise Asset Ownership: Adopters versus Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Tractor	Arasikere	13 (61.90)	10(50.00)	1.14	1.1
	Hassan	8 (38.10)	3(15.00)	1	1
Drip	Arasikere	40 (9.38)	7(77.78)	2.55	1
	Hassan	21 (28.77)	2 (22.22)	2.86	1
Sprinkler	Arasikere	12(25.00)	-	4.29	2
	Hassan	36(28.13)	6(42.86)	5.08	6.5
Electric Pump	Arasikere	29 (20.14)	16(39.02)	1.24	1.06
	Hassan	45 (31.25)	13(31.71)	1.26	1.07
Bore Well	Arasikere	42 (24.28)	25(40.32)	1.38	1.4
	Hassan	50 (28.90)	18(29.03)	1.52	1.16

Table 8.10: Taluk Wise Asset Ownership and Cost in Haveri

Asset	Taluk	No of Respondents who Own the Asset (% of total)	No of Respondents with 1 unit	No of Respondents with 2 or more	Average Cost of Asset	Average Current Value of Asset
Tractor	Savannuru	20 (31.75)	19	1	656000	380000
	Shiggaon	9 (14.29)	9	0	702222.2	350000
Drip irrigation	Savannuru	8(9.76)	5	3	20911.11	18777.78
	Shiggaon	4 (4.88)	1	3	18750	6666.6
Sprinkler Irrigation	Savannuru	45(31.69)	25	20	5080.49	9353.33
	Shiggaon	43(30.28)	6	37	6123.28	4325.58
Electric Pump	Savannuru	33 (17.84)	30	3	19154.55	9942.42
	Shiggaon	49 (26.49)	44	5	27938.78	8438.80
Bore Well	Savannuru	51 (21.70)	31	20	113351.9	75907.41
	Shiggaon	49 (20.85)	41	8	97708.33	6979.17

***Note**: Diesel pump well has been omitted due to very few observations*

Table 8.11: Taluk Wise Asset Ownership: Adopters versus Non-Adopters

Asset	Taluk	No of Respondents who Own the Asset (at least 1 unit)		Average No of Units Owned	
		Adopter (% of total adopters)	Non-Adopter (% of total non-adopters)	Adopter	Non-Adopter
Tractor	Savannuru	15 (34.88)	5(25.00)	1.06	1
	Shiggaon	7 (16.28)	2(10.00)	1	1
Drip	Savannuru	8 (10.96)	0	2.85	1
	Shiggaon	4 (5.48)	0	6.25	-
Sprinkler	Savannuru	37(28.91)	8(57.14)	2.73	1
	Shiggaon	43(33.59)	0	6.93	N/A
Electric Pump	Savannuru	26 (18.06)	7(17.07)	1.12	1
	Shiggaon	44 (30.56)	5(12.20)	1.11	1
Bore Well	Savannuru	38 (21.97)	13(20.97)	1.76	1.46
	Shiggaon	43 (24.86)	6(9.68)	1.18	1

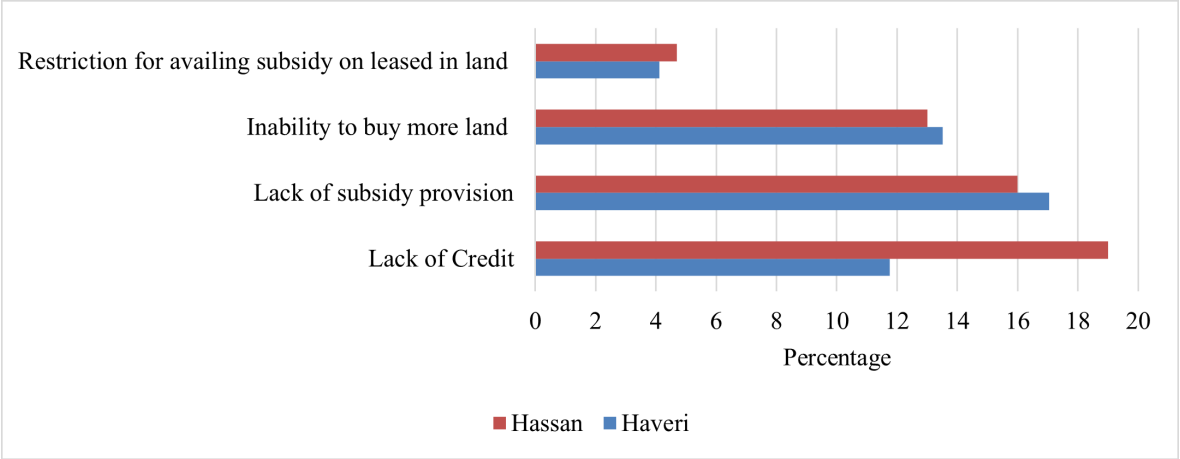
8.4 Micro Irrigation Adoption: Reasons for Adoption and Sustenance

The survey revealed that out of the total respondents in Hassan district, 94.08 (158 farmers) were aware of the subsidy in the state, while in Haveri district, 78.32 percent of farmers were aware of the subsidy. 84.9 percent of farmers were aware in Arsikere (low coverage), 92 percent were aware in Hassan (high coverage). 84 percent were aware in Savannur (high coverage), and 76.23 percent were aware in Shiggaon (which is low coverage). 52.5 percent of the sample were adopters of

micro irrigation in the district. 98 percent of adopters said that they would continue using micro irrigation for the next five years.

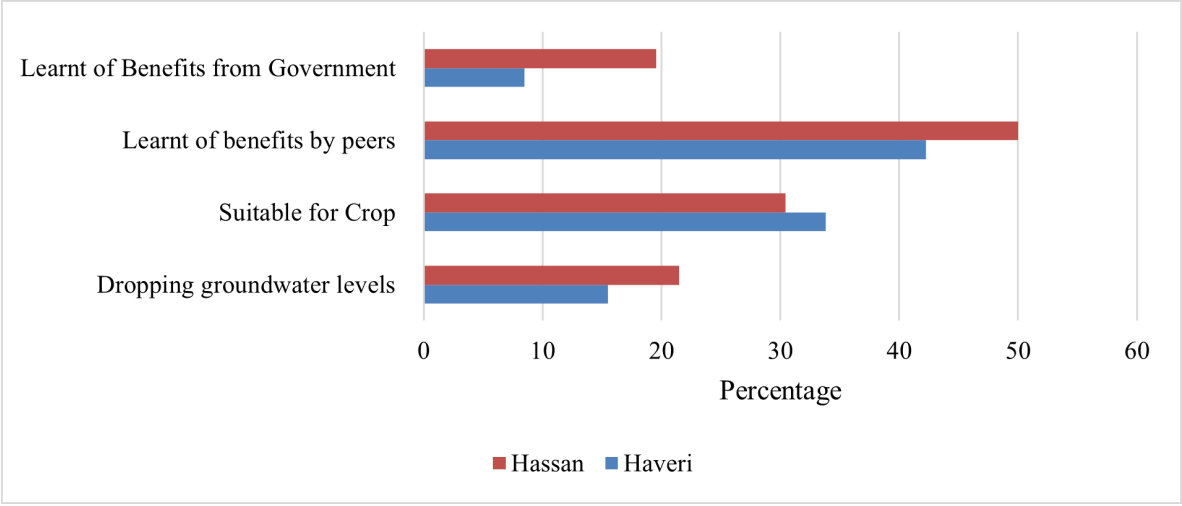
The average acreage under MI for Hassan district was 4.37 acres in Haveri and 2.53 acres in Hassan. Almost 80 percent of adopters wanted to increase acreage under micro irrigation; 78 percent of the adopter respondents wanted to increase acreage under micro irrigation in Hassan, and 52 percent in Haveri. The major barriers to increasing acreage at a district level are provided in Figure 8.2. Lack of credit plays a relatively bigger role in Hassan, while lack of subsidy provision and an inability to buy land are two major disincentives in both districts.

Figure 8.2: Barriers to Increasing Acreage



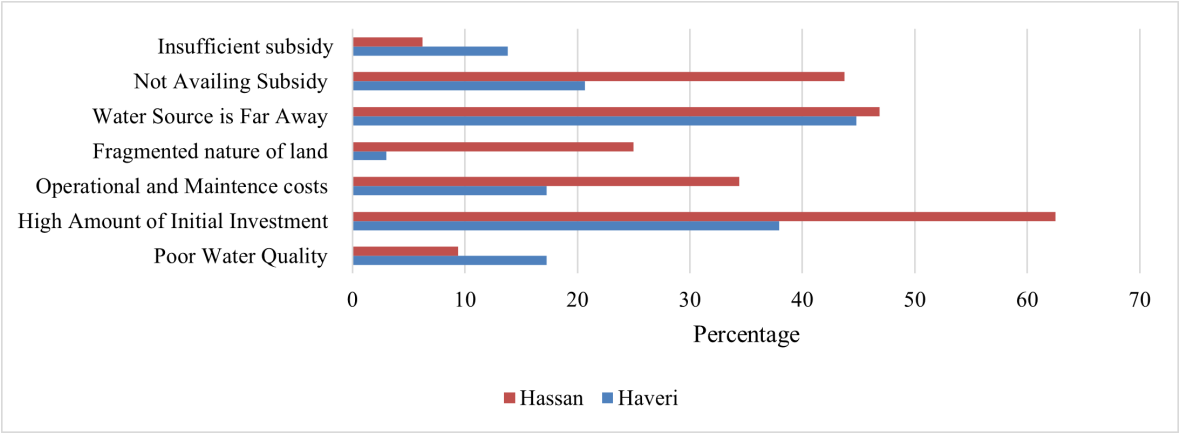
When adoption of micro irrigation is examined, the survey indicated that the major factors that determined adoption included dropping groundwater levels and suitability for the crop. Figure 8.3 presents the district wise (major) reasons for adoption.

Figure 8.3: Reasons for Adoption



The sample had 61 non-adopters (constituting 17.8 percent of the sample) who were aware of micro irrigation but were not using it. Non-adoption was influenced by high investment required (mentioned by 50.82 percent of non-adopters), unavailability of a regular water source (mentioned by 45.90 percent of non-adopters), high operational and maintenance costs (mentioned by 26.23 percent of non-adopters), unavailability of subsidy (32.79 percent of adopters, the fragmented nature of land (14.75 percent of non-adopters), A district wise analysis has been undertaken in Figure 8.4.

Figure 8.4: Reasons for Non-Adoption



Seven percent of the samples had discontinued the use of micro irrigation technologies. When dis-use is considered, the factors that led to this majorly were a delayed subsidy (mentioned by 34.6 % of the adopters who discontinued), high cost of spare parts (30.77%), high operations cost (23.08%), discontinuation of subsidy (15.38%), quality related concerns (15. 38%), unavailability of credit (15.38 %) and installation issues (11.54%).

8.5 Skill Gap in Micro Irrigation

The key informant interviews as well as the primary survey identified several arenas of skill gap in the case of Karnataka:

- **Technical Concerns**: 33.15 percent of the adopters mentioned accumulation of contaminants, 32.02 percent of the sample experienced clogging, 33 percent mentioned that low pressure/ drop in pressure is a concern. 17.42 percent of adopters also faced issues in installation. Most of the respondents either attempted to resolve these themselves or left them unresolved. Thus, there is a need to enhance training in order to enable farmers to be able to take the necessary course of action. Only 9.55 were provided an irrigation schedule from their service provider, and 34.27 percent wanted one. The interviews with government stakeholders also revealed that blocking of sprinkler nozzles was a frequent concern, and there is need for more focused training by service providers to reduce grievances.
- **Damage of MI Systems due to Inter-Cultivation**: The key informant interviews revealed that sustenance of micro irrigation systems such as sprinklers was hindered by frequent inter-cultivation of field crops, which are harvested every three months. This leads to a farmer removing the sprinkler system frequently, which can result in damage. The poor water quality further adds to this damage. Even drip systems have been observed to have faced these issues due to natural forces such as winds and sunlight, as well as rodent damage. The frequent rolling up of laterals can hamper their long-term usage, and thus all micro irrigation systems require replacement after 3-4 years.
- **Rising Input Costs and Lack of Repeated Subsidy even after 7 Years:** The interviews with government representatives revealed that availability of affordable technology is an issue. As per the Government of India guidelines, the quantity of material used for the unit area is fixed, and the upper limit of the subsidy is also fixed. However, in the past few years, input prices have risen, such as PVP pipes for instance but the norms have not factored in for these rising prices. Furthermore, while the quantity of material is fixed, there are cases wherein the source of water is far away from the field, which is not considered in the calculation, and can hike costs. While

the subsidy can be offered to the same beneficiary after a period of 7 years as per the Government of India guidelines, the government of Karnataka is focusing on reaching new beneficiaries and does not provide a subsidy after a period of 7 years.

CHAPTER 9:

Tamil Nadu

9.1 Key Statistics

The state of Tamil Nadu has a total geographical area of 13.033 million hectares; it is the 10th largest state in India. The gross area sown constitutes 45.6 percent of the total geographical area (5.67 million hectares), while the net area sown constituted 36.4 percent of the total geographical area (4.58 million hectares) in 2019-20. The contribution of agriculture and allied activities in the overall gross state domestic product was 13 percent in 2020-21 at current prices.

The population of the state was 72.1 million in 2011, marking an increase of 15.54 percent from 2001. Out of this, more than 56 percent of the workforce is engaged in agriculture and allied sectors, and around 92 percent of farmers belong to the small and marginal category (Department of Environment, Government of Tamil Nadu, 2006). The average size of landholdings was 0.80 hectares in 2010-11.

Table 9.1 presents the land category wise operational holdings and area for the latest year for which the data is available.

Table 9.1: Operational Holdings, 2015-16

Land Category	Holdings	Area (hectares)
Marginal	62,24,319	21,68,706
Small	11,19,229	15,55,482
Semi medium	4,52,236	12,15,345
Medium	1,27,650	7,14,170
Large	14,513	3,17,028

Source: *Salient Statistics on Agriculture, 2021*

Tamil Nadu is a water deficient state, with only 2.5 percent of the country's water resources. The per capita availability of water is 900 cubic meters, in comparison to the national average of 2200 cubic meters. The average annual rainfall is 930 mm. The total water potential of the state is 46540 million cubic metres; out of this surface water constitutes almost half of the total and the utilisable groundwater recharge is around 22423 million cubic metres. 75 percent of the state's water resources are utilised for agricultural purposes.

As per the latest data, the gross irrigated area was 34.10 lakh hectares in 2019-20, constituting 57.39 percent of the gross area sown. The net irrigated area was 26.72 lakh hectares in the same year, constituting 56.40 percent of the net area sown. The key informant interviews were conducted across three districts, namely Villupuram, Thiruvannamalai and Kancheepuram which are in the north-eastern agro climatic zone in the state (see Figure 9.1). The annual rainfall in these districts is 1105 mm. Within these districts, the regions covered included Chengam and Thandarampattu in Tiruvannamalai, Thozhupedu in Kancheepuram and Vanur in Villupuram.

Figure 9.1: Selected Districts for Study

Table 9.2 presents the statistics pertaining to source wise irrigation for these districts. Villupuram constitutes 5.6 percent of the net irrigated area in the state, Thiruvannamalai constitutes and Kancheepuram constitutes as well as the state overall.

Table 9.2: Source Wise Irrigation, 2019-20 for Survey District and State (Hectares)

District	Net Area Irrigated						Gross Irrigated Area					
	Canal	Tank	Tube-wells	Other Wells	Other Sources	Total (%)	Canal	Tank	Tube-wells	Other Wells	Other Sources	Total (%)
Thiruvannamalai	80	7397	4280	149196	0	160953	100	10075	8059	241919	0	160153
Kancheepuram	10	20878	6746	8286	0	35920	20	27619	9198	9946	0	46783
Villupuram	411	12450	42604	79928	0	135989	432	14177	56243	110731	0	126297
Total	647983	351484	518393	115929	3614	2672403	844240	385678	692545	1482483	4285	3410316

Source: *Compiled from Directorate of Agriculture, Gujarat*

9.2 Micro Irrigation in Tamil Nadu

The state of Tamil Nadu held the 2nd rank in terms of micro irrigation coverage in India between the period 2017-21, an improvement from the 8th rank in 2017. Since the implementation of the Pradhan Mantri Krishi Sinchayee Yojana-Per Drop More Crop scheme, a total area of 201846. 640 hectares have been covered under micro irrigation, out of which drip irrigation constitutes 53.08 percent (107154. 910 hectares) and sprinkler irrigation constitutes 46.91 percent (94691.730 hectares) of the total area covered under micro irrigation.

Table 9.3 and 9.4 provide a brief picture of the status of micro irrigation in the selected districts for the study; the physical and financial achievements are highlighted. The financial achievement for 2019-20 is taken, since that is the latest year for which the data is available. With respect to the area under micro irrigation, Tiruvannamalai districts holds the top rank in terms of area under sprinkler irrigation in the state for the period upto February 2022; it also ranks the highest in terms of the financial achievement for sprinkler upto March, 2020. Villupuram ranks amongst the top 5 districts in terms of area under drip irrigation in the state for the period upto February 2022; it also holds the 2nd rank in terms of financial achievement for drip until March, 2020.

Table 9.3: Area Covered Under Micro Irrigation (Hectares) upto February 2022

District	Physical Achievement		
	Drip	Sprinkler	Total
Thiruvannamalai	3447.120	12460.690	15907.810
Kancheepuram	829.340	2319.580	3148.920
Villupuram	1089.140	1897.460	2986.600
Total	107154. 910	94691.730	201846. 640

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

Table 9.4: Financial Disbursement for Micro Irrigation in Tamil Nadu (Lakhs) upto March 2020

District	Financial Achievement			Total Financial Achievement (Per hectare)
	Drip	Sprinkler	Total	
Thiruvannamalai	428.90	687.96	1116.86	0.099
Kancheepuram	371.03	152.35	523.38	0.0001
Villupuram	1870.87	480.73	2351.60	0.127
Total	24753.18	5261.86	30015.04	0.113

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

The major crops wherein micro irrigation is adopted in 2021-22 (in terms of area) include sugarcane, blackgram, and coconut; major crops under drip include sugarcane and coconut, while the major crops under sprinkler irrigation include black gram and Bengal gram.

Table 9.5 provides details of the district wise top crops under micro irrigation.

Table 9.5: Major Crops Under Micro Irrigation in Tamil Nadu, 2021-22

District	Major Crops Total (Area in Hectares)	Major Crops under Drip (Area in Hectares)	Major Crops under Sprinkler (Area in Hectares)
Tirruvannamalai	Sugarcane (958.30), Blackgram (203.43)	Sugarcane (958.30)	Blackgram (203.43)
Kancheepuram	Blackgram (153)	Other Vegetables (69.41), Sugarcane (39.30)	Blackgram (153), Other oilseeds (50.19)
Villupuram	Sugarcane (450.11), Blackgram (910.47)	Sugarcane (450.11)	Blackgram (910.47)
Total (Tamil Nadu)	Sugarcane (7791.86), Blackgram (10855), Coconut (5613.38), Bengalgram	Sugarcane (7791.86), Coconut (5613.38)	Blackgram (10855), Bengalgram (955.33)

Source: *Ministry of Agriculture and Farmers Welfare, Government of India*

9.3 Micro Irrigation Implementation in the State: Key Actors, Functions and Identified Areas of Concern

With a growing demand for water, especially in agriculture, as well as increasing water stress, there has been a recognition that the efficient use of surface and ground water resources can take place by use of irrigation technologies such as drip irrigation in the state. The Pradhan Mantri Krishi Sinchayee Yojana is implemented by providing 100 percent subsidy for small/marginal farmers and 75 percent subsidy for farmers of other categories.

The scheme is implemented by the *Tamil Nadu Horticulture Development Agency (TANHODA),* which initiated the transition to micro irrigation in 2000 and shares the cost of the scheme in a 50:50 share with the Government of India. However, the Department of Horticulture is only responsible for drip irrigation, whereas the Agricultural Engineering Department is responsible for sprinkler irrigation as well as rainguns.

This section will elaborate on the process of availing the subsidy for micro irrigation, and the identified challenges across each tier of delivery of the scheme, as revealed by the key informant interviews in the sites of study.

Table 9.6: Subsidy Disbursement and Associated Challenges

Procedure for Availing Subsidy and Associated Responsibilities	Concerned Stakeholder in Charge	Issue Experienced
1. Registration, Verification and Lock in Period for Eligible Farmer • An eligible farmer registers on a single portal- MMIS. Land documents are collected and land survey number is checked. Land can include owned land, cultivated land or land given on rent. • Verification is carried out through physical inspection of land size by state and block level officials such as Assistant horticulture officer, Horticulture officer and Assistant Director of Horticulture. The subsidy eligible is determined by the land size. • The subsidy can be availed once every 7 years; it was 10 years earlier but has been brought down. The subsidy coverage does not extend to spare parts bought/ replaced during the period of 7 years. If the farmer wishes to extend land coverage during the 7 years period, the work order will be issued only if the farmer has not exhausted the subsidy coverage by hectare.	Implementation of work order is by either the Horticulture/ Agriculture Department depending on the crop the farmer wishes to cultivate. MMIS portal* is managed by TANHODA.	• Given that farmers need to on average replace their drip system every 5 years, and equipment such as membranes and emitters suffer damages easily and have a short life span, **the out- of-pocket expenditure for buying spare parts/ equipment is high.** • However, TANHODA contends that reducing the lock in period or providing coverage for spare parts would disincentivise maintenance of the equipment.

Procedure for Availing Subsidy and Associated Responsibilities	Concerned Stakeholder in Charge	Issue Experienced
2. Generation of Work Order and Installation • The farmers field is visited to design the layout. Geotagging is undertaken. • Quotation for the equipment is provided, to be approved by the farmer. • The block office also checks with the PMKSY guidelines to ensure all required equipment has been included in the quotation, as well as the physical layout plan. Once the block office confirms with the company, they generate the work order for the company. • The system is installed by the company and work order report is uploaded by the company. • The concerned block officer inspects the installation, and on checking that material has been supplied, sanctions the release of 60 percent of the quoted amount to the company. • The remaining 40 percent of funds are released once an agri engineer of the government department verifies the design and working of the system.	Company majorly involved in field visit, providing the quotation as well as layout preparation, installation and supply of materials. The block office monitors the above.	• **Delay in installation**; it has been observed that farmers file for micro irrigation right before the cropping system, it is difficult to cater to the right timeline since the duration of time between receiving a work order from the farmer and installation takes at least 15 days. Also, different parts of the micro irrigation system are sourced from different states as per the manufacturing which elongates the installation.
3. Maintenance post Installation and After Sales Service • Members of the block office monitor the training provided; they ensure that the farmer is able to understand functions such as checking pressure at the valves, working of filters etc. • An operational manual is provided by both the government and company which helps farmers fix simple issues as pipe rejoining and addressing small leakages. Acid treatment, as well as maintenance of equipment is also discussed. • Extension officers are required to provide information and training on a monthly basis. • Companies are mandated to provide 13 compulsory after sales service in 3 years for farmers.	Company engages in training, TANHODA engages in information dissemination regarding optimal use as well as monitoring training.	• Given that farmers lack a thorough knowledge about the after sales service, they cannot cross-check whether provision of after sales service by the company is adequate.

Box 9.1 further elaborates on the information that farmers can avail on the MMIS portal.

Box 9.1: Information Available on the MMIS Portal

- The portal lays down scheme related guidelines and bill of quantities (BOQ) cost values for drip and sprinkler irrigation for cross referencing of quotations provided by companies.
- The portal lays down the list of empanelled companies (currently there are 45) along with their operational manuals, as well as suppliers whose components have received technical approval from CIPHET (ICAR-Central Institute of Post Harvest Engineering and Technology).
- Farmers can submit their request, track their application status, calculate their subsidy as well as register and track their complaint on the website.
- The portal also disseminates information on maintenance of drip irrigation system

Source: *Survey inputs*

Thus, it has been observed that TANHODA/ the concerned government department plays a monitoring role through the process of subsidy disbursement, conducting quality checks of equipment, verifying eligibility, as well as monitoring training on maintenance and after sales service. The concerned company representatives play a key role in explaining the technical aspects of usage to the farmer, as well as provision of after sales service for sustenance of the technology.

9.4 Observed Areas of Skill Gap

The field observations showed that while the implementation of micro irrigation had led to several noticeable benefits such as (a) saving of water in comparison to the practice of bunding followed earlier as well as (b) lowering the cost of labour (in a conventional irrigation system 20-25 labourers were required per hectare, which reduced on adoption of micro irrigation as per farmer interviews), there were various areas wherein a skill gap was observed. These were mainly in the form of information asymmetries in terms of maintenance and after sales service, which required a strengthening of the monitoring system and building skill competencies amongst both beneficiaries as well as in the supply side ecosystem. The factors that serve as an impediment to effective micro irrigation adoption, as well as recommendations to mitigate these are listed below:

- **Monitoring mechanism captures Information Provision, not Actual Absorption by farmer:** While training is provided post installation, and operation manuals are provided, there is no mechanism to oversee whether the farmer has actually understood the process, and is able to regularly undertake the required maintenance practices as to ensure sustenance of the system. This information absorption would also ensure that farmers are able to evaluate the quality of after sales service provided by companies, as well as increase the life span of their systems.
- **Grievance Redressal Mechanism does not Assure or Check for actual Resolution:** TANHODA has a toll-free number as well as provision for registering a complaint through MMIS. Apart from that, farmers can also route their complaints through the companies. But currently, there is no way for TANHODA to check whether a complaint has been resolved if it was registered with the company or the dealers.
- **Understaffing Concerns at the Company Level and Paucity of Qualified Technicians at the Dealer/ Distributor Level:** TANHODA regularly meets with the empanelled companies to discuss performance targets as well as malpractices which need to be addressed. In terms of performance targets the companies must ensure that they (a) cover a minimum of 5000 ha per year and (b) they have a certain staff strength. However, in many cases, companies show their staff strength inclusive of contractual staff and dealers which misleads TANHODA in its assessment. The company may actually be understaffed but have a large network of dealers and distributors, or semi-temporary employees. The non-binding status of these employees

is problematic given that the consequences witnessed included poor after sales service, ineffective complaint resolution and supply of substandard quality of equipment. While quality checks are conducted with suppliers and manufacturers by TANHODA, and non-adherence to benchmark quality may disqualify them from being empanelled again, the quality checks of suppliers in the ecosystem closer to end mile delivery of equipment is missing.

- **Third Party Evaluation apart from TANHODA**: As is the case in other states such as Andhra Pradesh (APMIP) and Gujarat (GGRC), third party evaluations can be done periodically to identify context specific concerns on a regular basis and be able to dynamically resolve for them.

CHAPTER 10:

Bridging the Skill Gap in Micro Irrigation - The Way Forward

Micro irrigation has been identified as an innovative demand management strategy to manage scarce water resources in agriculture, with estimated benefits in the following avenues: a reduced energy footprint, increased yields and income, savings in terms of water, labour, fertilizer and input usage. In this context, the Government of India had launched the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) in 2015-16 to maximise water use efficiency at the field level, and ensure "Per Drop-More Crop" through the promotion of drip and sprinkler irrigation. This chapter unpacks the objectives of the study to summarise (a) the status of micro irrigation coverage in India, with an emphasis on the states of study, namely Gujarat, Rajasthan, Maharashtra, Karnataka, Tamil Nadu and Andhra, (b) summarise the benefits of adoption of micro irrigation as seen by analysing the costs of cultivation across states, (c) examine the factors impacting uptake and adoption across states and (d) identify reasons for disuse or non-adoption of micro irrigation. A framework for skill gap is created, in order to determine the magnitude of skill gap currently existent, and the chapter concludes with a blueprint for reducing this skill gap, and enhancing sustenance of the technology.

10.1 Coverage of Micro Irrigation in India

As per the latest data available, the total physical achievement up until February, 2023 is 476711.310 hectares, in comparison of a physical target of 324951.44 hectares. The area covered under drip irrigation is 256048.750 hectares and area covered under sprinkler irrigation is 256048.750 hectares. In 2017, the top six states in terms of area covered under micro irrigation included Gujarat, Andhra Pradesh, Karnataka, Maharashtra, Telangana, and Madhya Pradesh, constituting almost 80 percent of India's total area under micro irrigation. In 2021, the top six states in terms of area covered under micro irrigation were Karnataka, Tamil Nadu, Gujarat, Andhra Pradesh, Maharashtra, and Rajasthan, constituting 86.2 percent of India's total area under micro irrigation. States such as Sikkim, Punjab, Nagaland, Mizoram, Kerala, Jammu and Kashmir, and Goa have very poor physical coverage and constitute less than 0.5 percent of the total physical achievement. The top 6 states in terms of financial achievement include Karnataka, Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and Telangana; thus, it has been observed that in the period 2017-21, the cumulative financial achievement has been highest for states which are characterised by the highest physical achievement as well.

10.2 Implementation Model Across Study States

The PMKSY-PDMC is implemented across states in a differential manner; depending on the institutional structure present, which defines the roles and responsibilities, pattern of assistance, recipient of subsidy, grievance redressal mechanism, amongst others. Table 10.1 summarises the implementation model across the study states.

Table 10.1: Pradhan Mantri Krishi Sinchayee Yojana: Institutional Model of Implementation Across States

Parameter	% of Assistance	Autonomy	Organizational Structure	Free of Cost After Sales Service	Monitoring Mechanism	Grievance Redressal
Gujarat	70-90% of unit cost	SPV-Semi-autonomous	Centralized; single window operations	5 years	Third party verification to check that system is operational by conducting trial run, and conduct impartial assessment	Complaint redressal by farmers within 15 days of receipt of complaint, otherwise penalty
Andhra Pradesh	90-100% of subsidy for small/ marginal farmers, 70-90 for medium farmers, 50% for big farmers	SPV Under the Horticulture Department	Decentralized: district officers carry out key functions	7 years	IT enabled mechanism supported by TCS to monitor, third party assessments periodically conducted	Online to either company or the project office; it is streamlined to head office and Commissioner if unresolved at lower levels
Tamil Nadu	75-100% subsidy	SPV-Drip irrigation under the Horticulture Department, sprinkler under Agriculture Department	Decentralized: district officers carry out key functions	13 compulsory in 3 years	Inspection carried out by block officer to check equipment supply, and agri-engineer to verify working	Complaints registered through MMIS, complaints also routed through companies
Rajasthan	50-60 % for sprinkler, 50-70% for drip	None; under Commissionerate of Horticulture	Follows structure of relevant Departments (no specific mandate for micro irrigation)	3 years	District Mission Committee to track and review progress, village and block level officers for supervision. Mandated third party field inspections.	Unclear; manual escalation of complaints to company
Karnataka	45-90%	None; 4 Departments work in conjunction- Agriculture, Horticulture, Sericulture, Watershed Management	Multicentric and decentralized	3 years	Monitoring of quality of MIS equipment	Mandatory for companies to have technicians at the village level to resolve concerns
Maharashtra	45-55%	None; Agriculture and Horticulture department	Follows structure of relevant Departments (no specific mandate for micro irrigation)	3 years	Spot verification on field for proposal of MIS installation, no other monitoring	Helpline number on Mahadbt portal

10.3 Impact of Micro Irrigation: Examining the Costs of Cultivation

Table 10.2 provides a comparison of costs of cultivation between adopters and non-adopters across the study states for major crops.

Table 10.2: Cost of Cultivation: A Summarised Comparison of Adopters and Non-Adopters

State	Major Crop	Input Costs (seed, chemical fertilisers)	Labour Costs	Irrigation related Costs (labour)	Electricity Costs
Gujarat	Cotton	Higher for adopters overall	Higher for adopters	Lower for adopters	Higher for adopters
	Groundnut	Higher for adopters	Lower for adopters	Lower for adopters	Higher for adopters
	Wheat	Higher for adopters	Higher for adopters	Lower for adopters	Higher for adopters
	Chilli	Chemical fertiliser costs lower for adopters	Higher for adopters	Inconclusive	Inconclusive
Rajasthan	Cotton	Higher for adopters	Higher for adopters	Lower for adopters	Lower for adopters
	Bajra	Higher for adopters	Lower for adopters	Lower for adopters*	Lower for adopters
	Moong	Higher for adopters	Lower for adopters	Higher for adopters	Lower for adopters
	Carrot	Lower for adopters	Higher for adopters	Higher for adopters	Lower for adopters
Maharashtra	Cotton	Lower for adopters/ Higher depending on the taluk	Inconclusive	Inconclusive	Inconclusive
	Onion	Lower for adopters	Chemical fertiliser costs lower for adopters	Inconclusive	Inconclusive
	Sugarcane	Lower for adopters	Higher for adopters	Lower for adopters	Inconclusive
	Soyabean	Lower for adopters	Chemical fertiliser costs lower for adopters	Inconclusive	Inconclusive
Karnataka	Cotton	Higher for adopters	Inconclusive	Inconclusive	Inconclusive
	Maize	Lower for adopters	Inconclusive	Inconclusive	Inconclusive
	Ragi	Higher for adopters	Inconclusive	Inconclusive	Inconclusive

** The labour cost is variable across survey taluks/districts*

Note: *Andhra Pradesh has not been taken given that the sample size consists of only adopters. Tamil Nadu has not been taken given that interviews were conducted in the state, a primary survey was not undertaken.*

10.4 Impediments to Adoption and Non-Adoption of Micro Irrigation

Table 10.3 summarises the key factors that influence adoption in the study states, while Table 10.4 summarises the key factors that influence non-adoption in the study states.

Table 10.3: Reasons for Adoption

	Decline in Groundwater levels	Suitability of Crop for Micro Irrigation	Learning of Benefits from Peers, Government, Etc	Interacted with a dealer/distributor
Gujarat	✓	✓	✓	×
Rajasthan	✓	✓	✓	×
Maharashtra	✓	×	✓	×
Andhra Pradesh	✓	×	✓	×
Karnataka	✓	✓	×	×

Table 10.4: Reasons for Non-Adoption

	High Level of Initial Investment	Insufficient Subsidy Amount	Fragmented Land	Unavailability of Spare Parts	Production for Self-Consumption	Benefits not being believable	High operation and maintenance costs
Gujarat	✓	×	✓	✓	✓	×	×
Rajasthan	✓	✓	✓	✓	×	✓	✓
Maharashtra	✓	×	×	×	✓	×	✓
Karnataka	✓	×	✓	×	×	×	✓

Based on these, a 5-point strategy is outlined to enhance uptake of the scheme, and ensure sustenance:

- **Awareness Generation with a Focus on 'Income Enhancement & Cultivation Cost-Saving' as Opposed to 'Water Saving', especially in States without a SPV:** Respondents across states such as Andhra Pradesh and Gujarat were seen to have a greater awareness of types of drip and sprinkler irrigation both in terms of identification of components, and basic functions. In states like Rajasthan, awareness was the first criteria which needed to be worked upon. Across states, functionality and maintenance related information, for instance, technical awareness of fertigation and acid treatment, etc remained as an information gap. This needs to be bridged, *and a monitoring mechanism put in place that can actually oversee whether the farmer has actually understood the process and is able to regularly undertake recommended maintenance practices in the frequency required*. In addition, farmers need to be made aware of the benefits of micro irrigation in plantation crops. In the case of vegetables and fruits, farmers are already practicing fertigation, and thus they are aware of the amount of water required for the crops. However, in the case of plantation crops, the amount of water does not affect the yield of the crop, but there is a tendency to flood the crop. Thus, in this case, the farmers need to be informed about the field capacity, water holding capacity, etc and be encouraged to undertake micro irrigation.
- **Accessibility of Spare Parts:** Across states, the availability of spare parts remained a concern, particularly in more interior regions. There were no shops at the village level (unless it was a gram panchayat level village), and delays in access did serve to be hinderance in sustenance. *Across states, a supplier map can be drawn out to identify empanelled suppliers, their distributors and retailer presence, in order to determine density.* In high coverage taluks, companies can be encour-

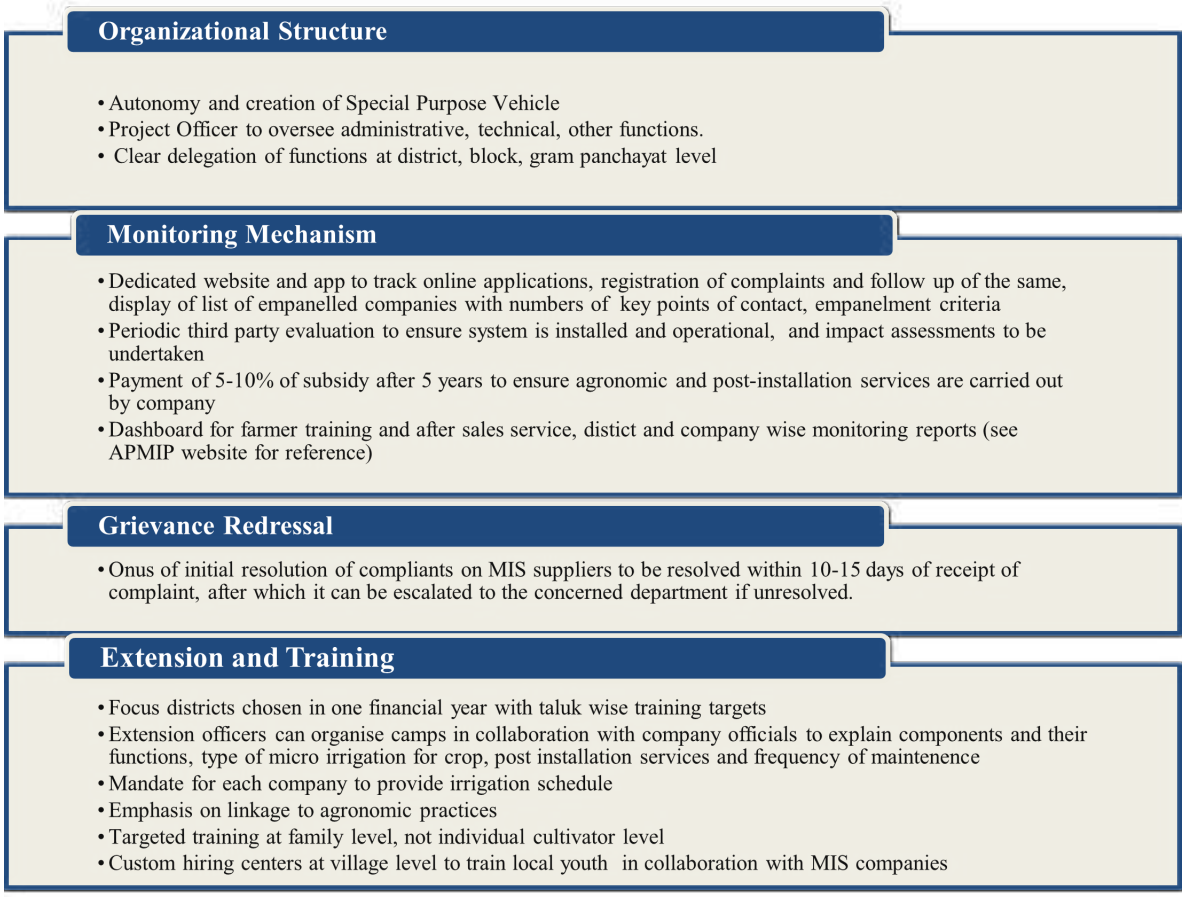
aged to mandatorily have a minimum number of suppliers to route to beneficiary farmers to ensure supply side ease.

- **Need for Reliable Dedicated Trained Technicians and Service Centers at Block & Village Level, as well as Certificate Based Courses in Collaboration with MIS Companies**: The primary survey indicated that a number of technical issues such as blockages, accumulation of contaminants, clogging, pressure building served as an impediment to adoption etc., which was accompanied by understaffing of technicians to address these issues. The semi-temporary nature of the employees of dealers and distributors was problematic in terms of effective after-sales service, complaint resolution and quality of equipment supplied. *Thus, performance assessment needs to ensure that companies are reporting their actual number of employees, and training is being conducted for dealers/ distributors in the network to upskill them.* For every 100 ha or depending on the density of coverage it is recommended that a company have a service center. These service centers can employ rural youth and train them as technicians. *Thus, it is suggested that unemployed youth/ school dropouts in villages can be trained, and a custom hiring center be developed at the village level to facilitate entrepreneurship and employment. A similar exercise was undertaken in the state of Andhra Pradesh in 2019, wherein 500 youth were trained in collaboration in Jain Irrigation.* This can serve the twin purpose of employment provision as well as easy access to trained personnel to resolve grievances in a speedy manner and prevent dis-use, as well as longer term usage. *The service center can have mobile vans which can bring the service to the farmer's doorstep rather than having the farmer go to those service centers.* Companies should additionally be encouraged to launch certificate-based courses to technicians, who can be recruited by micro irrigation companies. This will enable skill building and better imparting of knowledge to the beneficiary as well.
- **Streamlined Process of Subsidy Disbursement and Revised Unit Costs to Incentivise Uptake Among Small and Marginal Farmers:** It has been observed that the prices of raw materials for manufacturing micro irrigation equipment have been fluctuating, which has resulted in an increase in production costs. Farmers also listed high operation and maintenance costs as a key reason for non-adoption. *There is a need for state level and central level price revision committees that reflect market conditions.* This needs to be combined with easier access to credit to make adoption feasible for farmers.
- **Best Practices Demonstrations**: Modules can be created on several aspects; fertigation schedule, acid treatment, *linkage to agronomic practices,* selection of the right system etc. Companies must be mandated to conduct a target level of trainings at the district and taluk level; best practices demonstrations can take place by the government officers and site visits to encourage peer learning can be arranged.

10.5 The Way Forward: An Institutional Blueprint for Reform

It has been observed that the Special Purpose Vehicle Model operational in Gujarat, Andhra Pradesh and Tamil Nadu has been effective in streamlining the implementation of the specific scheme/ horticulture-based schemes. Similar models of governance incorporating 'best of both worlds' in other states such as Rajasthan and Maharashtra might prove to be more effective in allocation of personnel and ensuring end mile access as well as better uptake and maintenance of micro irrigation. At present, in states wherein multiple line departments are in charge of implementation, there is little or no coordination between departments, with each having their own responsibilities, functions and designing their own schemes. An optimal structure would combine autonomy, be characterised by an absence of administrative delays, and have a clear line of authority in terms of administrative procedures (see Figure 10.1)

Figure 10.1: A Suggested Institutional Framework for Reform



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