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AERC Report



**Agro-Economic
Research Centre
(AERC)**

Working of Pressurized Irrigation Network Systems (PINS) in Maharashtra State

**Dilip Kajale
Ulhas Apte**



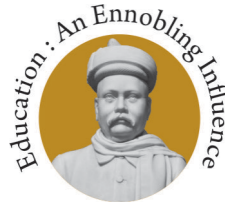
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Submitted to
**Department of Agriculture, Cooperation and Farmers Welfare
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FORWARD

In India, the Government's policies and programmes at national and state level created substantial level of irrigation potential. The results of these can be seen in the country, e.g. the irrigation potential has been created to the tune of 107 Mha at national level and 12.6 Mha in Maharashtra state. Despite these developments, according to the World Water Council, major part of the India faces high to very high water stress. This indicates the need for timely action plan for the efficient utilization of water in India. The most common method of irrigation in India is Flood/Flow irrigation. In this method the water utilization is very high, there are advanced techniques developed to overcome the problems of this method, such as micro-irrigation(MI). To motivate the farmers for the use of micro-irrigation the Government of India (GoI) provides a subsidy for to individual farmers for installation of MI, while more visionary step was taken by the Gujarat government, provides 100% subsidy for Pressurized Irrigation Network System(PINS) for the farmers, through a separate govt. undertaking. Such systems are being developed under Narmada canal system. In India, since the PINS concept is new, few studies are available on this issue. Moreover, so far there is no study available on Maharashtra state; hence this is the first study of this kind in the state. Since the PINS require considerably high capital from farmers' point of view, this study evaluates the functioning, economic benefits and costs of PINS. The study assesses the effectiveness of institutional arrangements for management of PINS projects and the bottlenecks for their smooth functioning.

In Maharashtra state three types of PINS are developing, namely (i)Govt. lift schemes – only couple of examples; (ii)cooperative lift irrigation schemes getting converted into MI in Southern part of Maharashtra; and (iii)lifts owned by individual farmers. An evaluation study of three types of the PINS was undertaken by AERC of our Institute. The study covers the (i)cash crops taken by farmers on MI, (ii)capital and operation & Maintenance Costs range for farmers under three types of PINS; (iii)awareness of farmers on operators, companies, testing & quality norms of MI components and testing facilities around; (iv)problems faced by the farmers etc.

The Government of Maharashtra(GoM) has recently decided to introduce pipe distribution system on all irrigation projects, which is expected to work on gravitational head (and not pressurised system). The Maharashtra Water Resources Regulatory Authority (MWRRA) has also made it compulsory to use water by micro irrigation for all perennial crops (12 monthly crops). The findings and recommendations in the report would, therefore, be very important for the GoM.

I thank Dr. Dilip Kajale and Mr. Ulhas K Apte for undertaking the study.

Rajas Parchure
Officiating Director

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We thank to heads of Micro Irrigation companies namely Netafim irrigation India Pvt Ltd, Pune as well Jain Irrigation Systems Ltd., Jalgaon, for making us available their updated lists on works of conversion of lift flow irrigation into lift micro irrigation systems. We also appreciate co-operation received in data collection by canvassing questionnaires, from no. of (i)office bearers, (ii)beneficiary & non-beneficiary farmers of co-operatives lift schemes from the districts: Kolhapur, Sangli, Buldhana and Yavatmal. Visits to small farms with micro irrigation systems in Pune, Nasik and Ahmednagar districts over the year, proved very useful to our experts, thanks to these farmers. The data collection by canvassing questionnaires on number of micro irrigation schemes/projects was done by our team of research assistants namely – Mr. Arvind Rithe, Ms. Kanchan Ghugre, Mr. Ravindra Giakwad and Ms. Rukaiya Khan. Support for data compilation was also extended by other two research assistants Mr. Shaikh Zuber and Mr. Hansraj Suryavanshi. We highly appreciate their inputs and efforts.

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Dr. Dilip Kajale

Executive summary

Working of Pressurized Irrigation Network System (PINS) in Maharashtra State

The contribution of agriculture and allied sector to India's Gross Domestic Product is 15%. Around 58% of the population directly or indirectly engaged in this sector. The crucial factor of production for an agricultural production system is water. The most important source of water for irrigation is rainfall, which in India is the monsoon. The govt policies and programmes at national and state level such as National Water Policy (1987, 2002 and 2012), Accelerated Irrigation Benefits Programme (AIBP), Command Area Development Programme (CADP) and Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) created substantial level of irrigation potential. The results of these can be seen from the created irrigation potential of 107 Mha at national level and 12.6 Mha in Maharashtra. Despite these developments, according to the World Water Council, major part of the India faces the high to very high water stress. This indicates the need for timely action plan for the efficient utilization of water in India. The most common method of irrigation in India is Flood/Flow irrigation. In this method the water utilization is very high, there are advanced techniques developed to overcome the problems of this method, such as micro-irrigation (MI).

To motivate the farmers for the use of micro-irrigation the Government of India (GoI) provides a subsidy for farmers, while more visionary step was taken by the Gujarat government, provides 100% subsidy for Pressurized Irrigation Network System (PINS) for the farmers through the Gujarat Water Resources Development Corporation (GWRDC). The Gujarat government's Sardar Sarovar Narmada Nigam Limited (SSNNL) conceptualized the PINS, it is the interface between the water source (canal/tube well) and the MI system at the farm. In India, since the PINS concept is new, few studies are available on this issue. Moreover, so far there is no study available on Maharashtra state; hence this is the first study of this kind on the state of Maharashtra. Since the PINS require considerably high capital from farmers' point of view, this study evaluates the functioning, economic benefits and costs of PINS. The studies assess the effectiveness of institutional arrangements for management of PINS projects and the bottlenecks for their smooth functioning.

The specific objectives of this study are as following:

1. To undertake a broad situation analysis of various PINS programs in Maharashtra.
2. To assess the extent of adoption and performance of PINS in terms of costs, benefits and adoptability for different crops.
3. To analyses the institutional arrangements for management, operation and maintenance of PINS.
4. To identify the major constraints in adoption, management, operation and maintenance of PINS.
5. To recommend suitable policy measures to enhance the effectiveness and techno-economic performance of PINS.

In Maharashtra state the types of PINS projects are of three types - government supported (these are around 100% government funded), cooperative and private (owned by individual farmer). After discussion with govt. officers and manufactures we decided to collect data from seven districts (Buldhana, Kolhapur, Sangli, Yavtmal Nashik, Pune and Ahmednagar), where the PINS projects were implemented. Data was collected from (i)PINS project operators and the associated Water User Associations (WUAs), (ii)farmers/water users with PINS-MIS or PINS with flood irrigation, non-beneficiary households having no access to PINS-MIS; but having access to surface/flood irrigation around the PINS project area (iii)implementing agencies/companies and (iv)concerned government departments. The total sample of 355 farmers was covered in the study, representing 250 beneficiaries (BH) and 105 non-beneficiary households (NBH).In this study, we have covered 75 PINS projects; among this 19 were govt and coop PINS, and 56 were pvt PINS projects.

A broad situation analysis of various PINS programs in Maharashtra

The Maharashtra state is one of the leading states in adoption of the drip and sprinkler irrigation methods. Maharashtra State has mostly distribution systems with flow/gravity canal irrigation, as such there are no PINS+MIS under canal irrigation. The rotation of canal system (i.e. canal is “on” for about 3 weeks and “shutdown” for about the same period), creates a need to store water for use during “shutdown” period.

The GoM has recently decided to introduce pipe distribution system on all irrigation projects, which is expected to work on gravitational head (and not pressurised system). The Maharashtra Water Resources Regulatory Authority (MWRRA) has also made it compulsory to use water by micro irrigation on all perennial crops (12 monthly crops) under all flow irrigation system¹. These both steps will see PINS in future.

It appears obvious that the farmers go for MIS for cash crops like cotton(28%), sugarcane(16%) banana(10%), Citrus & pomegranate (9% each), Grapes (8%), and other horti. crops about 20%. But if lift schemes get converted into MIS in Sugarcane belt (of western Maharashtra), there will be a major jump.

Adoption of PINS in Maharashtra state

The source of irrigation for all govt PINS was tanks/storages, for coop PINS sources were river and storages/tanks² on the rivers, and for pvt PINS the sources were well and river. It is seen that farmers prefer assured irrigation water source (tank, well and river) for installing PINS. The govt PINS farmers were small and marginal farmers, while coop PINS farmers were mostly small and medium, while majority of pvt PINS farmers were big medium and large farmers.

Since, the govt PINS projects were around 100% funded by the government, there was no cost for the farmers. Regarding the coop PINS farmers, average expenditure was Rs. 47,200 on PINS project, and there was no considerable variation on the expenditure on PINS across the landholding class of farmers. About the pvt PINS farmer, the expenditure on PINS project was Rs. 87,325 and there was not much variation across the farmers' landholding class. These findings suggest that being a part of cooperative system could save PINS project cost by around 50%. The main benefits of coop and govt PINS were an increase in area under irrigation by around 60%, farm income and water saving by more than 35%, and 35% saving in electricity. The majority (80-96%) of the members of the coop PINS WUA were aware about the functioning, while the awareness among the govt PINS was comparatively not good. The entire coop PINS WUA members paid O&M cost regularly.

¹ Maharashtra Water Resources Regulatory Authority's notification dt. 12.06.2015.

² These are the storages created by weirs on the rivers, these weirs are usually weir-cum-bridges types known in Maharashtra as Kolhapur-type-weirs(Kolhapur is the district, wherein these were first introduced in 1950s.

Most important reasons for inadequate supply of water were the inadequate water availability in the water source for PINS and poor rainfall, moreover, for govt PINS inefficient functioning of the PINS system was also an additional reason.

The total cost of the drip under govt PINS was around 20,000 Rs, which was very low, the reason was that in this case the manufacturers of the drip system provided the system at very low rates i.e. 20,000 Rs/acre (because of huge subsidy). Under the coop PINS the average cost of the drip irrigation system was around 50,000 Rs/acre and for sprinkler it was 8863 Rs/acre. The average cost of drip irrigation system under pvt PINS was 48,306 Rs/acre. For drip irrigation system farmers under coop PINS received 19% subsidy, while under pvt PINS received 25% subsidy. For sprinkler the subsidy received was 54% of the total cost of the system.

There is a lack of awareness about ISO standards, training and testing facility for PINS and MIS. Therefore, there is a scope for providing these facilities for farmers at the block level. The main problems faced by the farmers were planning and installation of PINS with MIS, delay in receiving subsidy for MIS, power to run PINS and MIS, quality of components and damage of MIS in field from rodents.

The institutional arrangements for management, operation and maintenance of PINS

Around 15 PINS+MIS are getting developed in Maharashtra are in co-operative sector in southern Maharashtra. These appear to be managed well under the guidance of local sugar-cooperatives. The development or conversion of these lift schemes into PINS+MISs will be trend setting development, which will have positive effect on other schemes. Along with the regular major and medium irrigation projects, the GoM also has taken up 20 lift irrigation projects, which have very large command areas. These are planned with flow/gravity canal system. There is a large scope to have MIS for distribution system of these projects. These PINS+MIS are mostly lift scheme on rivers or storages created by tapping the water within the banks of the rivers. Average life span for PINS is reported as 24 years, which appears for the pumps and rising/pumping mains.

The major constraints in adoption, management, operation and maintenance of PINS

As these are basically lift schemes converted into MIS, the major portion of the O&M cost is for the electrical bills about 70%, while 13% and 17% are the expenses on O&M of PINS, and 17% other expenses. The frequency of maintenance is around 5 times/PINS/Year with the cost of such repairs is around Rs. 1,800/acre, which appears very reasonable.

Office bearers of WUAs give importance to good relations with the water resources department for getting the water on time. As these are mostly the lift in co-op sector, there is no any question arising once the proper water lifting permission/s are obtained. The benefits of good lift co-operatives are numerous WUA bearers give highest marks to (i)water on time & proper water distribution within member farmers and over the time span, (ii)timely communication with the farmers, (iii)enhanced financial condition/position of WUA. Farmers have reported only 3 months during which the less water is available. But we feel that such condition will occur in draught conditions. If federation is formed for all WUAs, it can look into such problems, and pursue the matters with Govt.

We observe that state Govt. have limited testing facilities for MIS components, and then the Agri. Department of such states has to depend on some other units for testing. Hence a comprehensive facilities need to be developed for MIS testing at the state Agricultural Universities.

Policy Implications

- We feel that, if the financial assistance is made available to the lifts Schemes, they would get converted from PINS+Flow into PINS+MIS rapidly, as the trend is already set by 15 schemes in the state.
- The distribution systems of lift projects will also be converted into PINS+MIS, though not envisaged at the conceptual stages. There is an advantage for lifts, that on the way from pumps to the delivery point, there can be sufficient head available to use MIS by directly hooking up to the rising/pumping main.

- There is a large scope for PINS+MINS for (i)Co-operative lifts, (ii)lifts on Other Govt Projects with lift as distribution System, (iii)Govt. Lift irrigation projects themselves, (iv)individual lifts including lifts on Minor Irrigation Schemes, and in the long run of pipe distribution systems in place of flow irrigations.
- The costs of the drip systems were higher under coop and pvt PINS than the govt norms. Therefore it is suggested that the cost norms for drip irrigation system may be revised so that the farmers can afford the drip irrigation system.
- Extension activities for increasing the awareness about efficient use of water under the MIS, water requirement of the crops as per the crops critical growth stages and season wise are recommended.
- There is a lack of awareness about ISO standards, training and testing facility for PINS and MIS. Therefore, there is a scope for providing these facilities for farmers at the block level.
- We observe that some sort of refreshers training etc. need to be arranged at different levels for WUA office-bearers, member farmers etc. Such training should be on running a co-operative, new technologies in irrigation & agriculture-cultivation, processing, post harvesting issues. There is also a need of a body such as federation, which can put forth the issues faced by these WUAs.
- We feel that for Maharashtra, being a leading state in MIS, comprehensive testing facilities for MIS components need to be developed at the state Agricultural Universities.

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Acronym & Abbreviations

BF	Beneficiary farmers
BH	Beneficiary households
BIS	Bureau of Indian Standard
CCA	Culturable Command Area
CIPET	Central Institute of Plastics Engineering & Technology
DWs	Diversion Weirs
GCA	Gross Cropped Area
GoI	Government of India
GoM	Government of Maharashtra
GR	Govt. Resolution
GWRDC	Gujarat Water Resources Development Corporation Limited
ICA	Irrigable Command Area
KTWs	Kolhapur Type Weirs
LS	Large Size
MI	Micro-irrigation
MIS	Micro Irrigation System
MITs	Minor Irrigation Tanks
MS	Medium Size
MWRRA	Maharashtra Water Resources Regulatory Authority
NBF	Non-beneficiary Farmers
NBH	Non-beneficiary households
NMMI	National Mission on Micro Irrigation
O&M	Operations & Maintenance
PIM	Participatory Irrigation Management
PINS	Pressurized Irrigation Network Systems
PTs	Pazar/Percolation Tanks
SS	Small Size
SSNNL	Sardar Sarovar Narmada Nigam Ltd
STs	Storage Tanks
TUA	Tube-well Users Association
WUA	Water Users Association

Chapter I

Introduction

1.1 : Background

The agriculture and allied sector contributes around 15% (2016) to the India's Gross Domestic Product. Around 58% of the population directly or indirectly engaged in this sector. The crucial factor of production for an agricultural production system is water. The most important source of water for irrigation is rainfall, which in India is the monsoon. Currently there is great variation in the rainfall. If the water from rainfall is not stored it goes to the sea via rivers. Dams are constructed to store the water from rainfall, which becomes the source of water for irrigation during no rainfall span and also as the main source of water for the household and industrial consumption. The other sources of water are the rivers which originate from the Himalaya; seasonal snow and glacier meltdown are the main source water for these rivers, which are perennial in nature. These perennial and seasonal rivers (whose source of water is rainfall) help to increase the level of ground water table. The third important source of irrigation water is the dug well and/or tube well, these are feed on the rainfall and the rivers. Though India became self-sufficient in food production in 1970s, there is a question about the future food requirement of the increasing population. Currently more than half of the Indian agriculture is rainfed, hence to fulfill the future need of food, which could be possible through adoption of improved crop varieties and bringing more area under irrigation. Since the water is scarce for irrigation and ongoing impact of the climate change on the hydrological cycles at high scale indicates the need for efficient use of water, in the tropical, arid and semiarid regions of India.

According to the World Water Council, major part of the India faces the high to very high water stress, which is the ratio of water use and water resources (WWC, 2016, Doell et., al. 1999). This indicates the need for timely action plan for the efficient utilization of water in India. The most common method of irrigation in India is Flood/Flow irrigation, where water is applied and spread over the soil by gravity, and water spread is uneven and uncontrolled (ICID, 2016). In this method the water utilization is very high, there are advanced techniques developed to overcome the problems of this method, such as micro-irrigation (MI).

The MI is a system for the regular application of small quantities of water on the surface of soil or under the soil in the form small streams, sprays or drops through the emitters or the applicants placed along a water distribution line, various methods of MI are mist or spray, drip, subsurface drip and bubbler (USDA NRCS, 2013; 2011). The main benefits of this system are the efficient use of water and uniform low volume application of water, helps to maintain the soil moisture, prevent contamination between the ground and surface water and demonstrate desired vegetation (USDA NRCS 2011). The history of MI can be traced back to 1860s, while it became feasible only after the 1960s with the innovation and commercial availability of the low-cost plastic pipes (USDA NRCS, 2013). The MI has benefited the agriculture through the increase in crop yield, improvement in quality of harvest and efficient input nutrient management (USDA NRCS, 2013). The commonly used MI system is the pressured piped irrigation(PPI), which is an installation network, comprising pipes and other devices, designed and installed, through which water is provided under pressure to the farm from the water sources (FAO, 2007). The PPI systems core components include control station (head control unit), mains and sub-mains (pipelines), hydrants, manifolds (feeder pipelines) and laterals (irrigating pipelines) with emitters (FAO, 2007). The advantages and disadvantages of the various irrigation systems are summarized in the table no 1.1.

To motivate the farmers for the use of micro-irrigation the Government of India(GoI) provides a subsidy for farmers, while more visionary step was taken by the Gujarat government, provides 100% subsidy for Pressurized Irrigation Network System(PINS) for the farmers through the Gujarat Water Resources Development Corporation Limited(GWRDC).The Gujarat government's Sardar Sarovar Narmada Nigam Ltd. (SSNNL) conceptualized the PINS, it is the interface between the water source (canal/tube well) and the MI system at the farm(GWRDC, 2016, Viswanathan & Bahinipati, 2015).

Table 1.1: Typical advantages and disadvantages of irrigation systems

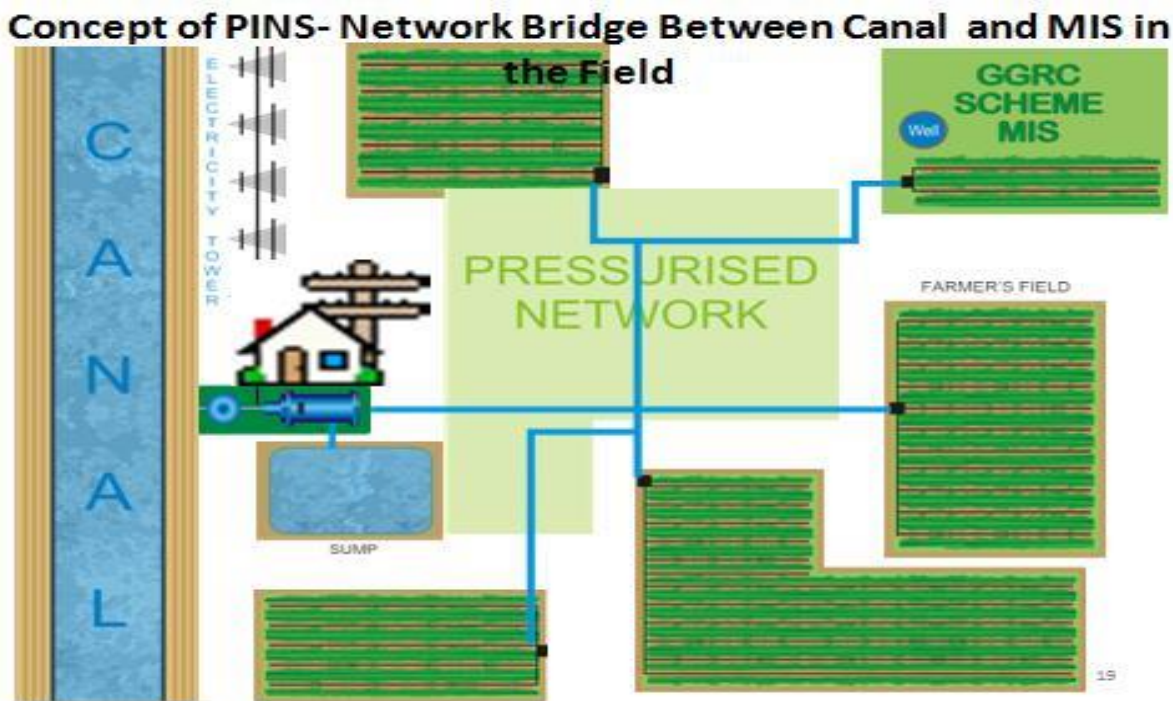
Sr. No.	System type	Advantages	Disadvantages
1	Surface irrigation		
a	Furrow	Low capital and maintenance cost, water flows in small channels.	High labor, less water control, soil erosion, possible runoff and percolation losses
b	Level basin	Efficient with good design, less labor than furrow	Ponded water, sloping fields must be leveled
c	Border	Less labor and less runoff than furrow, easier to manage infiltration depth	Water flows over entire soil surface
2	Sprinkler irrigation		
a	Solid set	Good water control, possible to automate and frequently irrigate, fits odd-shaped fields	High capital costs, system may interfere with field operations
b	Set-move	Lower capital cost than other sprinkler systems	More labor than other sprinkler systems, poor uniformity in windy conditions, greater application depth
c	Moving	High uniformity, low labor	High capital and maintenance costs, not suitable for odd-shaped fields, potential wind and evaporation losses
d	Traveling gun	Lower capital cost than other sprinkler systems	Higher operating costs, wind and evaporation losses
3	Micro Irrigation		
a	Drip Irrigation	Excellent water control, frequent applications possible	Higher capital costs, requires clean water or treatment and filtration

Source: Bjorneberg, 2013

1.2: Importance of Pressurized Irrigation Network System (PINS)

In the Pressurized Irrigation Network System (PINS), water from the source is taken to the field by using pipes, which otherwise is taken by the irrigation channel under the gravitational force. It comprises of Pipe Network with controls, Pumping Installations, Power Supply, filtration, intake well/Diggy. The concept of PINS is presented in following diagram. In the PINS the land requirement for laying down the pipes in the field is less than the land required for open channel in the canal irrigation; hence, the land acquisition problem is not a major issue, which otherwise

is prime concern for most of the public projects. Moreover, PINS also (i) helps to control the illegal lifting of water from the canal, (ii) reduces water losses occurring through leakages and evaporation between the water source & the farm, (iii) reduces seepage in canal and soil salinity problems. Because of these benefits at the global level it is evident that the open canal irrigation network in arid and semi-arid region is successfully replaced by the pressurized pipe irrigation (FAO, 2007).



(Source: anonymous)

1.3: Need for the study

The PINS was firstly conceptualized in 2009 in the state of the Gujarat. Initially around 50 pilot projects in different agro-climatic zones of the Sardar Sarovar (Narmada) project command area were executed for the public tube wells, afterward they were handed over to the respective Water Users Association(WUA) in the command area for Operation & Maintenance (SSNNL, 2016, Viswanathan & Bahinipati, 2015). A recent study in Gujarat state on socio-economic impact of the PINS shows that around 90% of the farmers reported that there was considerable increase in the yield and water savings, moreover majority (55-93%) of the farmers agreed that PINS reduces the use of pesticide and fertilizers, reduces pest infestation and diseases occurrence, reduces weeding cost, saves energy and allocate water efficiently between the

farmers (Viswanathan & Bahinipati, 2015). Since the PINS require considerably high capital from farmers' point of view, this study evaluates the functioning, economic benefits and costs of PINS. For PINS established on canal, river and tube wells, there is a need for effective institutional arrangement for orderly management, operation and maintenance of water releases and distribution system. The studies assess the effectiveness of institutional arrangements for management of PINS projects and the bottlenecks for their smooth functioning. The different kind of irrigation commands such as canals, river and tube wells are covered under the study to capture the dynamics of community based irrigation management. Under different command areas, the study analyses system performance of PINS project with MIS such as sprinklers and drip in terms of their functioning, costs and benefits, adoptability for different soils and field crops. This study is a part of the national level study conducted in four states Rajasthan, Gujarat, Maharashtra and Telengana. This study was conducted for Maharashtra state

1.4: Objectives of the study

The specific objectives of the study are as following:

1. To undertake a broad situation analysis of various PINS programs in Maharashtra.
2. To assess the extent of adoption and performance of PINS in terms of costs, benefits and adoptability for different crops.
3. To analyses the institutional arrangements for management, operation and maintenance of PINS.
4. To identify the major constraints in adoption, management, operation and maintenance of PINS.
5. To recommend suitable policy measures to enhance the effectiveness and techno-economic performance of PINS.

1.5: Data and Research Methodology

In Maharashtra state the types of PINS projects are of three types - government supported (these are around 100% government funded), cooperative and private (owned by individual farmer). From our discussions with government officers and private companies (manufacturers) we found that government PINS (govt PINS) and cooperative PINS (coop PINS) were in Buldhana, Kolhapur, Sangli and Yavtmal districts, while private PINS (pvt PINS) were spread across many districts, with high penetration in districts like Nashik and Ahmednagar. There were defunct

PINS in Pune and Ahmednagar districts. We have observed poly-house cultivation under the pvt PINS, hence these types of few schemes are also included in the sample. Therefore, for this study we have selected seven districts from these districts. The Maharashtra state has mostly distribution systems with flow/gravity canal irrigation, as such there are no PINS+MIS under canal irrigation. The state govt has recently decided to introduce pipe distribution system on all irrigation projects, which is expected to work on gravitational head (i.e. the head available at site, and not head under the pressurised system). However, gravitational pipe distribution may not be feasible everywhere and we feel that lifting of water (PINS) would be unavoidable in future. In the state for PINS, the sources of water are river, tube well, dug well, and storages by weirs, dams etc. Hence, PINS project under study were selected from both surface irrigation command areas (tank and river) and groundwater irrigation command areas (tube well and dug well). Beneficiary households (households having access to irrigation water from govt PINS, Coop PINS and Pvt PINS) were selected from the sample districts. To facilitate comparison, non-beneficiary households from adjacent areas of PINS were covered. Data was collected from (i)PINS project operators and the associated Water User Associations (WUAs), (ii)farmers/water users with PINS-MIS or PINS with flood irrigation, non-beneficiary households having no access to PINS-MIS; but having access to surface/flood irrigation around the PINS project area (iii)implementing agencies/companies and (iv)concerned government departments.

The total sample of 355 farmers was covered in the study, representing 250 beneficiary households (BH) and 105 non-beneficiary households (NBH). The PINS sample size distribution is shown in the Table 1.1. In this study, we have covered 75 PINS projects; among this 19 were govt and coop PINS, and 56 were pvt PINS projects. The district wise sampling of the PINS project is shown in the Table 1.2. The number of pvt PINS was more because from each project we got only one beneficiary, since they were owned by individual farmers.

Further the distribution of sample household and sample PINS projects as per the type of the project is shown in Table 1.3. The projects covered under the study can be classified as per the area covered under scheme - the PINS with micro-irrigation system (MIS) were classified as small (area less than 40 ha, excluding pvt PINS); medium (area 40-70 ha), large (area more than

70 ha), the number of schemes covered under the study were as; three small, seven medium and five large. Apart from this four PINS scheme with flood irrigation and 56 privately owned schemes with MIS were covered in the study.

Table 1.2: PINS Sample Size Distribution (Beneficiary and Non-beneficiary Farmers)

Sr. No.	Districts	Govt PINS With MIS		Coop PINS with MIS		Coop PINS with Flood Irrigation		Pvt PINS With MIS		Govt PINS without any irrigation (defunct)	Total ¹	
		BH	NBH	BH	NBH	BH	NBH	BH	NBH	NBH	BH	NBH
1	Buldhana			31	6	35	15				66	21
2	Kolhapur			17	6						17	6
3	Pune							3		9	3	9
4	Sangli			70	17	2					72	17
5	Yavatmal	39	43								39	43
6	Nasik							26	4		26	4
7	Ahmednagar							27	5		27	5
	State Total	39	43	118	29	37	15	56	9	9	250	105

Notes: BH: Beneficiary households; BF: Beneficiary farmers (BH and BF are synonyms) NBH: Non-beneficiary households; NBF: Non-beneficiary farmers (NBH and NBF are synonyms)

Table 1.3: Distribution of Sample PINS Projects across study districts

Sr. No.	Districts	Govt-PINS With MIS*	Coop -PINS With MIS	Coop -PINS with Flood Irrigation	Pvt. PINS With MIS	Govt-PINS without any irrigation	Overall
1	Buldhana		2	2			4
2	Kolhapur		3				3
3	Pune				3	1	4
4	Sangli		9	1			10
5	Yavtmal	1					1
6	Nasik				26		26
7	Ahmednagar				27		27
	State Total	1	14	3	56	1	75

*The scheme was erected with the funds from Govt , while WUAs will form as cooperative act

¹For possible non-availability of particular type of PIN+MIS scheme in a state, a freedom was given to adjust/make up the short-fall of sample in similar other category/ies. The actual sample size covered under the survey is given in Table 1.2 below. From the same, it can be noted that we have covered more sample size than that works out.

Table1.4: Distribution of sample household and Sample PINS Projects as per the type of the project

Sr. No.	Village	Name (of Scheme)	District	Area (ha)	Number of Farmers	
					BH	NBH
A	Small Size(SS) PINS : less than 40 ha					
1	Daulalwadi	P Jadhav	Kolhapur	16	1	0
2	Vasagade	Shri Hanuman	Sangli	22	5	0
3	Kundal	Satyeshwar	Sangli	34	5	1
				Total	16	1
B	Medium Size(MS) PINS : 40 to 60 ha					
4	Ahirwadi	Bhairvnath-Unit 2	Sangli	40	13	0
5	Ahirwadi	S. Kadam	Sangli	40	3	0
6	Karbharwadi	Shiva Rama	Kolhapur	40	4	2
7	Ahirwadi	Bhairvnath-Unit 1	Sangli	57	0	0
8	Vasagade	Kranti	Sangli	65	6	1
9	KasbaSangaon	Dudhganga	Kolhapur	66	12	4
10	Bibkhed		Buldhana		5	0
				Total	43	7
C	Large Size(LS) PINS : above 60 ha					
11	Kavlapur	Shri Sidhsheshwar	Sangli	97	14	3
12	Gotkhindi	Shri Mahadev	Sangli	246	17	12
13	Janephal		Buldhana	270	26	6
14	Bhambvade	DrBapu Lad	Sangli	302	7	0
15	Dehani*	Dehani Lift	Yavatmal	6,968	39	43
				Total	103	64
D	PINS with Flood Irrigation					
16	Varve (defunct)	MI Tank	Pune	133	0	9
17	Kasari	Storage Tank	Buldhana	153	20	8
18	Bibkhed	Storage Tank	Buldhana	124	15	7
19	Kundal (Flood)				2	0
				Total	37	24
E	Pvt PINS with MIS					
			Pune		3	0
			Nashik		26	4
			Ahmednagar		27	5
					56	9
				MIS	213	81
				Flood	37	24
				Total	250	105

*The scheme was erected with the funds from Govt , while WUAs will form as cooperative act.

- Schemes from 1-19 are cooperative, except scheme 15, which we have considered under gov't PINS

1.6: Review of literature

Rich level of scholarly work is available at global as well as national level on the issues related to the irrigation water management and specifically on the drip irrigation, sprinkler irrigation and participatory irrigation management. The study under investigation is on PINS concept, which

was developed not more than ten years ago in the Gujarat state of India. Since the PINS concept is new, few studies are available on this issue.

A recent study in India reports that the micro irrigation can save various costs at 30-40% and increase production by 40-50% (NMMI, 2014). Moreover, despite the few unresolved issues regarding the participatory irrigation management; findings show that it assists to increase an area under irrigation and also helps to solve the issues of problematic soils (Uphoff, 1986; Gandhi, and Namboodiri, 2011: 2002: Singh, 1991). Chavan (2016) studied PINS in Gujarat, he reports that use of pressurized irrigation networking with micro irrigation helps to bring more area under irrigation, he also reports that there was substantial improvement in the operation, maintenance and management of the system because of active participation of both farmers and Gujarat Water Resource Development Corporation Ltd. (GWRDC), also suggest that government officers should create conducive environment for this cause, which will give better results and micro irrigation systems should be mandatory for the irrigation based on the public water sources. Viswanathan and Bahinipati (2015) studied performance of the 122 public tube wells having PINS and MIS in Banaskantha district of the north Gujarat, they reported that there was considerable increase in crop yield during three seasons, savings on all inputs, saving of energy and expenditure on weeding, they also found that shortage of water during summer season was the reason behind restricted adoption of MIS for few crops. Contribution of these studies is truly valuable. Plenty of issues related to PINS are not explored in the available literature; therefore this research project focuses on the unaddressed issues related to PINS. Moreover, so far there is no study available on Maharashtra state; hence this is the first study of this kind on the state of Maharashtra.

1.7: Limitations of the study

As we have noted earlier that in the Maharashtra state, govt, coop and pvt PINS projects were present at the time of study and the number of PINS projects were small and the spread was across few districts. Hence the study is based on few districts only. Moreover, the source of water for PINS was only river and tanks; hence comparison based on various sources of water for PINS was not possible. The govt PINS were around 100% subsidy based hence, it was bit difficult to estimate various cost of related components.

1.8: Chapters Plan

The study is divided in to six chapters. The first chapter introduces the concept of PINS, research objectives, data and methodology. The second chapter discusses the irrigation development, policies and programmers in India, including the status of drip and sprinkler irrigation. The chapter three gives overview of PINS programmes in Maharashtra state. Chapter four talk about adoption, performance and management of PINS by farmers. Chapter five is based on the adoption, performance and management of PINS by WUAs. The last chapter summarizes the research findings and provides policy implications.

Chapter II

Irrigation Development and Management in India and Maharashtra

2.1: Introduction

Irrigation is the process of application of water to the crops on regular basis as per the crops requirement. The concept of irrigation is not a new, it can be traced back to the 6th millennium BCE in Mesopotamia and Egypt, where barely was grown in an inadequate rainfall area, it evidences the use of irrigation (Kang, 1972). In relation to Indian continent, by 2600 BC, the Harappan economy was based on pastoralism and craft production, where barley and wheat were the important crops; moreover, peas, linseed, grape, dates, millets, lentils, cotton etc. were also cultivated, multi-cropping system was also adopted (Wright, et., al. 2008). Cultivation of variety of crops would not have been possible without irrigation, which was confirmed by the evidences of the presence of small scale canal network (Francfort, 1992).

Over the time irrigation methods have been developed across the world. Current irrigation methods can be divided in to main four types, surface irrigation, drip/micro irrigation, sprinkler and sub irrigation. In surface irrigation, water flows over the soil by gravity; in sprinkler method water is applied by sprinkling droplet (creating artificial rain) from moving or fixed pipes. Water in the form of small droplets is frequently applied to the root zones of the crops in the drip/micro irrigation. Sub surface drains or ditches are used to raise water table near the root zones in the sub irrigation method (Bjorneberg, 2013).

At global level, it is reported that about 85% of the crop productions is from irrigated land (ICID, 2016). China and India irrigate around 60 Mha(Million hectares) area each, in the United States and Pakistan area under irrigation is around 20 Mha area each (Bjorneberg, 2013), majority of land in India and China is irrigated by using surface irrigation. The US stands first for the use of micro irrigation and sprinkler. In the US, around 54% of the irrigated land is under sprinkler irrigation and 7% under is the micro irrigation (Bjorneberg, 2013, USDA NASS, 2008). It is evident that there has been great development in the irrigation systems, where various cutting

age technologies are used, which resulted in the considerable level of application efficiency, as shown in the table 2.1.

Table 2.1: Typical application efficiencies for irrigation systems

Sr. No.	System type	Application efficiency
1	Surface irrigation	
A	Furrow	50-70%
B	Level basin	60-80%
C	Border	60-75%
2	Sprinkler irrigation	
A	Solid set	60-85%
B	Set move	60-75%
C	Moving	75-95%
D	Traveling gun	55-65%
3	Micro irrigation	80-95%
4	Sub irrigation	50-80%

Source: Bjorneberg, 2013

2.2: Irrigation development in India and Maharashtra

2.2.1: Irrigation development in India

The total geographic area of India is 328.7 Mha, of which net sown area is 43% (139.9 Mha) and gross cropped area is 194.4 Mha, while around 66 Mha area is under irrigation (DAC&FW, 2016). Agriculture sector plays crucial role directly and indirectly in Indian economy, since there is great variation in the climate across India, the development of this sector is vastly depend on the availability and development of irrigation facilities. In India, Fruztughlug (1351-86) was the first who built canal for irrigation, in 15th century. Moreover it is argued that the presence of irrigation facilities was one of the reasons for the expansion of the Vijayanagar Empire in the southern part of India (Manivanan, 2006). The first systematic attempt for the irrigation development was done in 1850 by British rule through private companies, which was an abortive effort, therefore in 1866, the policy was developed for irrigation, which states that the projects will be funded by the states through public loans, while the barrier of states political boundaries were kept away to provide the best solutions (Mohile, 2007).

Between 1836-1866, the British rule completed first four major projects: the Upper Ganga Canal, the Upper Bari Doab Canal, the Krishna, and the Godavari Delta Systems, followed by Lower

the Ganga, the Sirhind, the Mutha and the Agra canal and the Periyar Dam (Manivanan, 2006). This kind of man made works brought 7.5 Mha area under irrigation at the end of 19th century. At the time of partition, net irrigated area was 28.2 Mha, of which 8.8 Mha went to Pakistan and 19.4 Mha area remained in India (Manivanan, 2006).

The irrigation projects are mainly classified into three types: major, medium and minor irrigation projects. Major irrigation projects which envisage culturable command area (CCA) more than 10,000 ha, medium irrigation projects envisage CCA 2000-10,000 ha, and minor irrigation projects envisage CCA less than 2000 ha². The Table 2.2 shows the list of 12 major irrigation projects were completed before the independence of India.

Table 2.2: Irrigation Projects Completed before Independence

Sr. No.	Important irrigation works	Year of completion	Irrigation benefits (lakh ha)
Andhra Pradesh			
1	Godavari delta system	1890	5.58
2	Krishna delta system	1898	4.42
Bihar			
3	Sone canal system	1874	3.47
Haryana			
4	Western Yamuna canal system	1820	4.31
Punjab			
5	Upper Bari Doab canal	1859	3.35
6	Sirhind canal	1873	6.00
Rajasthan			
7	Gang canal	1927	3.04
Tamil Nadu			
8	Cauvery delta system	1889	5.05
Uttar Pradesh			
9	Upper Gang canal system	1856	6.99
10	Lower Gang canal system	1880	6.28
11	Eastern Yamuna canal system	1830	1.91
12	Sarda canal system	1926	6.12

Source: Sen, Shreyasi (2016)

The Central Water Commission (CWC) of India divided the country in to 20 river basin (river basin is the basic hydrological unit for water resources planning and management). The Table

² In Maharashtra, the classification of projects is based on the ICA(Irrigable Command Area).

2.3 presents the major river basins in India with catchment area, water resource potential and utilizable surface water resource for each river basin.

Table 2.3: Major River Basins

Sr. No.	River Basin	Catchment Area (sqkm)	Average Water Resources Potential (Bcum)	Utilizable Surface Water Resources (Bcum)
1	Indus (up to Border)	321,289	73.31	46.0
2	Ganga- Brahmaputra-Meghna			
	a) Ganga	861,452	525.02	250.0
	b) Brahmaputra	194,413	537.24	24.0
	c) Barak & Others	41,723	48.36	
3	Godavari	312,812	110.54	76.3
4	Krishna	258,948	78.12	58.0
5	Cauvery	81,155	21.36	19.0
6	Subernarekha	29,196	12.37	6.8
7	Brahamani & Baitarni	51,822	28.48	18.3
8	Mahanadi	141,589	66.88	50.0
9	Pennar	55,213	6.32	6.9
10	Mahi	34,842	11.02	3.1
11	Sabarmati	21,674	3.81	1.9
12	Narmada	98,796	45.64	34.5
13	Tapi	65,145	14.88	14.5
14	West Flowing Rivers From Tapi to Tadri	55,940	87.41	11.9
15	West Flowing Rivers From Tadri to Kanyakumari	56,177	113.53	24.3
16	East Flowing Rivers Between Mahanadi & Pennar	86,643	22.52	13.1
17	East Flowing Rivers Between Pennar And Kanyakumari	100,139	16.46	16.5
18	West Flowing Rivers Of Kutch and Saurashtra including Luni	321,851	15.10	15.0
19	Area of Inland drainage in Rajasthan	-	Negligible	-
20	Minor River Draining into Myanmar (Burma) & Bangladesh	36,302	31.00	-
	Total		1,869.37	690.1

Source: Central Water Commission, Ministry of Water Resources govt. India

According to the CWC, the water resources potential, which is the natural run off in the rivers in the country is about 1,869 Billion Cubic Meters (Bcum), from this around 690 Bcum is utilizable. The completed major & medium irrigation projects created 253.4 Bcum storage capacities and the projects under construction will create additional 51 Bcum, hence the total storage capacity will be around 304.3 Bcum. The Ganga-Brahmaputra-Meghna (GBM Delta) river basin is the biggest river basin in India with water resource potential of 1,111 Bcum, which

is 60% of the total water resource potential of India. In India the total length of the rivers and canals is about 2 lakh km.

After independence, governments focus was on creation of irrigation infrastructure, which was reflected in the first five year plan (1951-56), the expenditure on irrigation sector was Rs. 441 Crores, which was 23% of the total plan expenditure. The plan wise expenditure on irrigation and flood control sector is shown in the table 2.4. After the first plan the share of the expenditure on irrigation has been considerably decreased.

Table 2.4: Plan wise expenditure incurred on Irrigation and Flood Control Sectors

(Rs in Crores)

Sr. No.	Plan Period	Major & Medium Irrigation	MI/MI & CAD	Total Irrigation	Flood Control	Total Plan Expenditure All Sectors	Percentage expenditure on Irrigation
1	First (1951-56)	376.2	65.6	441.8	13.2	1960	22.54
2	Second (1956-61)	380.0	161.6	541.6	48.1	4672	11.59
3	Third (1961-66)	576.0	443.1	1019.1	82.1	8577	11.89
4	Annual (1966-69)	429.8	560.9	990.7	42	6625	15.04
5	Fourth (1969-74)	1242.3	1173.4	2415.7	162	15779	15.31
6	Fifth(1974-78)	2516.2	1409.6	3925.8	298.6	28653	14.22
7	Annual (1978-80)	2078.6	1344.9	3423.5	330	22950	14.27
8	Sixth (1980-85)	7368.8	4159.9	11528.7	787	109292	10.55
9	Seventh (1985-90)	11107.3	7626.8	18734.1	941.6	218730	8.56
10	Annual (1990-92)	5459.2	3649.5	9108.7	460.6	123120	7.4
11	Eighth (1992-97)	21071.9	13885.3	34957.2	1691.7	483060	7.59
12	IX Plan(1997-02)	49289.0	13760	83049.0	3038	941041	6.7
13	X Plan (2002-07)	83647.0	16458.9	100105.9	4344.18	1618460	6.19
14	XI Plan (2007-12) Outlay(Projection)	165350	46350	211700	20100	3644718	5.81

Source: Central Water Commission, Ministry of Water Resources govt. India

The state wise list of the large dams completed and under construction is shown in Table 2.5. We can say that the output of the governments' expenditure on the irrigation sector is that 4877 large dam are ready for water storage and 313 dams are under construction. While there are 198 dams in India whose construction year is unknown. Highest numbers of dams are in Maharashtra 1845, followed by Madhya Pradesh (906) and Gujarat (632).

Table 2.5: State wise abstract of large dams

Sr. No.	State	Total completed dams with known construction year(no.)	Under Construction (no.)	Year of construction not available (no.)	Total
1	Andaman & Nicobar Islands	2			2
2	Andhra Pradesh	142	25	46	167
3	Arunachal Pradesh	1	3		4
4	Assam	3	1		4
5	Bihar	24	2		26
6	Chhattisgarh	248	10	1	258
7	Goa	5			5
8	Gujarat	619	13	5	632
9	Himachal Pradesh	19	1	2	20
10	Haryana	1			1
11	Jammu & Kashmir	14	3	3	17
12	Jharkhand	50	29	3	79
13	Karnataka	230	1	16	231
14	Kerala	61	1	0	62
15	Madhya Pradesh	898	8	28	906
16	Maharashtra	1693	152	3	1845
17	Manipur	3	1		4
18	Meghalaya	8			8
19	Mizoram		1		1
20	Nagaland	1			1
21	Odisha	199	5	4	204
22	Punjab	14	2		16
23	Rajasthan	201	10	8	211
24	Sikkim	2			2
25	Tamil Nadu	116	0		116
26	Telangana	162	20	79	182
27	Tripura	1			1
28	Uttar Pradesh	115	15		130
29	Uttarakhand	16	9		25
30	West Bengal	29	1		30
	Grand Total	4877	313	198	5190

Source: Central Water Commission, <http://www.cwc.nic.in/main/downloads/new%20nrlld.pdf>

The minor irrigation schemes (MnrIS) are the structures either in ground water or in surface water having culturable command area (CCA) up to 2,000 ha. The ground water schemes include dug well, shallow tube well, deep tube well; and the surface water schemes include surface flow and surface lift schemes.

Minor irrigation accounts for 65% of the total irrigation potential utilised, in the country. Currently there are around 2.1 crores MnrIS spread across 609 districts and 6.4 lakh villages.

Around 97% of the MnrIS are owned privately while only 3% are owned by the public sector. In 1970, The National Commission on Agriculture had recommended that the census of source of minor irrigation may be carried out once in five years, on this recommendation first minor irrigation census was carried out in 1986-87, and followed by three censuses in the years 1993-94, 2000-01 and 2006-07. Table 2.6 summarizes the census of minor irrigation schemes.

Table 2.6: Census of Minor Irrigation schemes

Census	No of schemes (in Million)	Ground water (in Mha)		Surface water (in Mha)	
		Irrigation potential created	Irrigation potential utilized	Irrigation potential created	Irrigation potential utilized
Census I (1986-87)	8.24	24.02	21.24	6.04	4.6
Census II (1993-94)	9.3	33.3	26.63	8.01	5.15
Census III (2000-01)	19.76	62.4	44.96	11.9	6.97
Census IV (2006-07)	21.4	72.5	57.3	13.2	7.8

Source: Minor Irrigation Census, Govt. India, (2006-2007). <http://micensus.gov.in/>

State wise status of the MnrISs is shown in the table 2.7. Maximum numbers of schemes are in Uttar Pradesh 42.7 lakhs, followed by Andhra Pradesh 23 lakhs, Maharashtra 22.7 lakhs, Tamil Nadu 19 lakhs, and Madhya Pradesh 19 lakhs. The spread of minor irrigation is highest in Uttar Pradesh around 1 lakhs villages, followed by Madhya Pradesh 0.56 thousand villages, Odisha 50 thousand villages, Bihar 45 thousand villages and Maharashtra 44 thousand villages. The numbers of schemes per village are recorded highest in Kerala 183, followed by Tamil Nadu 111, Punjab 91, Andhra Pradesh 82, Haryana 66, Gujarat 62, Delhi 52 and Maharashtra 51.

The total annual flow from all the river basins in India is 1,869.4 Bcum, from this the total utilizable surface water is 690 Bcum, out of this the created storage capacity can store 253 Bcum water and under construction project will add around 51 Bcum storage capacity which will lead to total live storage capacity of 304 Bcum. The basin wise live storage capacity is shown in the table 2.8, which shows that highest live storage capacity is in Ganga river basin 56.3 Bcum, followed by Krishna river basin 54.8 Bcum, Godavari river basin 43.4 Bcum and Narmada river basin 24.4 Bcum. Only 16% of the average annual flow in the all basin can be stored in all the water storage projects. Overall, this indicates that there is considerable scope for increasing the live storage capacity.

Table 2.7: State wise minor irrigation schemes in India

Sr. No.	States	Ground Water (Dug well /shallow and deep tube well/ (no.)	Surface Water (Surface flow and lift schemes)(no.)	Total (no.)	No of Village Schedules (no.)
1	Andhra Pradesh	21,99,551	1,05,816	23,05,367	28,162
2	Arunachal Pradesh	35	4,983	5,018	3,865
3	Assam	1,04,312	6,442	1,10,754	26,062
4	Bihar	6,51,242	12,127	6,63,369	45,421
5	Chhattisgarh	3,32,290	84,318	4,16,608	20,324
6	Goa	4,423	2,651	7,074	389
7	Gujarat	11,18,335	33,304	11,51,639	18,511
8	Haryana	4,67,846	494	4,68,340	7,083
9	Himachal Pradesh	5,081	12,293	17,374	20,723
10	Jammu & Kashmir	3,157	4,888	8,045	6,422
11	Jharkhand	1,42,547	53,079	1,95,626	31,853
12	Karnataka	9,77,702	1,20,776	10,98,478	29,336
13	Kerala	1,69,789	23,607	1,93,396	1,057
14	Madhya Pradesh	16,66,349	2,39,802	19,06,151	56,324
15	Maharashtra	20,54,025	2,19,160	22,73,185	44,253
16	Manipur	0	588	588	2,390
17	Meghalaya	222	8,269	8,491	6,200
18	Mizoram	0	5,371	5,371	757
19	Nagaland	103	20,792	20,895	1,149
20	Odisha	4,72,443	88,710	5,61,153	50,141
21	Punjab	11,78,272	2,834	11,81,106	12,948
22	Rajasthan	14,99,446	9,393	15,08,839	42,760
23	Sikkim	0	1,485	1,485	905
24	Tamil Nadu	18,66,302	45,968	19,12,270	17,271
25	Tripura	2,091	2,780	4,871	1,040
26	Uttar Pradesh	42,53,255	25,459	42,78,714	106,879
27	Uttarakhand	53,498	31,820	85,318	16,359
28	West Bengal	5,19,439	78,622	5,98,061	41,825
29	Andaman & Nicobars	1,372	1,886	3,258	253
30	Chandigarh	91	0	91	13
31	Dadra & Nagar Haveli	645	557	1,202	72
32	Daman & Diu	0	0	0	0
33	Delhi	9,824	134	9,958	192
34	Lakshadweep	0	0	0	0
35	Puducherry	4,133	445	4,578	123
	Total	1,97,57,820	12,48,853	2,10,06,673	6,41,062

Source: Minor Irrigation Census, Govt. India, (2006-2007). <http://micensus.gov.in/>

Table 2.8: Basin Wise live Storage in India

Basin Code as per WRIS	Basin Name	Average annual flow (BCM)	Total Live Storage Capacity (BCM)			
			Completed Projects	Under Construction Projects	Total	% of average Annual flow
1	Indus	73.3	16.223	0.1002	16.323	22.3
2a	Ganga	525.0	48.677	7.649	56.326	10.7
2b	Brahmaputra	537.2	1.718	0.795	2.513	0.5
2c	Barak & Others	48.4	0.719	9.172	9.891	20.4
3	Godavari	110.5	35.033	8.412	43.444	39.3
4	Krishna	78.1	50.651	4.156	54.807	70.2
5	Cauvery	21.4	9.083	0.015	9.098	42.5
6	Subernarekha	12.4	0.309	2.150	2.459	19.8
7	Brahmani&Baitarni	28.5	5.515	0.703	6.218	21.8
8	Mahanadi	66.9	13.006	1.461	14.467	21.6
9	Pennar	6.3	2.938	2.141	5.079	80.6
10	Mahi	11.0	5.017	0.150	5.167	47.0
11	Sabarmati	3.8	1.577	0.109	1.686	44.4
12	Narmada	45.6	17.622	6.835	24.457	53.6
13	Tapi	14.9	9.137	1.558	10.695	71.8
14	WFR from Tapi to Tadri	87.4	14.668	2.430	17.098	19.6
15	WFR fomTadri to Kanyakumari	113.5	11.023	1.416	12.439	11.0
16	EFR between Mahanandi and Pennar	22.5	2.676	1.181	3.857	17.1
17	EFR between Pennar and Kanyakumari	16.5	1.441	0.015	1.456	8.8
18	WFR of Saurashtra and Kutchh including Luni	15.1	6.336	0.511	6.847	45.3
19	Area of Inland Drainage of Rajasthan	-	0.000	0.000	0.000	--
20	Minor River Draining into Myanmar and Bangladesh	31.0	0.019	0.000	0.019	0.1
20a	Area of North Ladakh not draining into Indus	0.00	0.000	0.000	0.000	--
	Total in BCM	1869.4	253.388	50.959	304.348	16.3

Source : Central Water Commission (WM Directorate), as on 31.03.2013

The table 2.9 shows state wise live storage capacity of reservoirs in India. Highest water storage capacity is created in Maharashtra state 48 Bcum, followed by Andhra Pradesh 35.7 Bcum,

Madhya Pradesh 34.7 Bcum and Karnataka 32.6 Bcum. While in future, the live storage capacity will be added in the states Maharashtra, Manipur, Gujarat, Jharkhand and Andhra Pradesh, from the under construction projects.

Table 2.9: State wise Live Storage Capacity of Reservoirs in India

Sr. No.	Name of State	Total Storage Capacity (Bcum)		
		Completed Projects	Under, Construction Projects	Total
1	Andhra Pradesh	28.716	7.062	35.778
2	Assam	0.012	0.547	0.559
3	Arunachal Pradesh	0.000	0.241	0.241
4	Bihar	2.613	0.436	3.049
5	Chhattisgarh	6.736	0.877	7.613
6	Goa	0.290	0.000	0.290
7	Gujarat	18.359	8.175	26.534
8	Himachal Pradesh	13.792	0.100	13.891
9	Jammu and Kashmir	0.029	.000	0.029
10	Jharkhand	2.436	6.039	8.475
11	Karnataka	31.896	0.736	32.632
12	Kerala	9.768	1.264	11.032
13	Madhya Pradesh	33.075	1.695	34.770
14	Maharashtra	37.358	10.736	48.094
15	Manipur	0.407	8.509	8.916
16	Meghalaya	0.479	0.007	0.486
17	Mizoram	0.000	0.663	0.663
18	Nagaland	1.220	0.000	1.220
19	Orissa	23.934	0.896	24.830
20	Punjab	2.402	0.00002	2.402
21	Rajasthan	9.708	0.443	10.152
22	Sikkim	0.007	0.000	0.007
23	Tamil Nadu	7.859	0.013	7.872
24	Tripura	0.312	0.000	0.312
25	Uttarakhand	5.670	1.613	7.283
26	Uttar Pradesh	14.263	0.724	14.987
27	West Bengal	2.027	0.184	2.212
28	Andaman & Nicobar island	0.019	0.000	0.019
	Total in BCM	253.388	50.959	304.348

Source : Central Water Commission (WM Directorate)

The output of the huge investment in the irrigation sector is the irrigation potential of around 107 Mha area is created, while 86.9 Mha potential is utilized and ultimately gross area under irrigation is 86.4 Mha.

State wise irrigation potential created, utilised and gross irrigated area by the major and medium projects and minor projects is shown in table 2.10. Highest irrigation potential is created in Uttar Pradesh 33.7 Mha, followed by Bihar 8 Mha, Andhra Pradesh 7.2 Mha, Maharashtra 6.8 Mha and Punjab 6 Mha. The maximum irrigation potential is utilized in Uttar Pradesh 27 Mha followed by Andhra Pradesh 6 Mha, Punjab 5.8 Mha, Bihar 5.6 Mha and Maharashtra 5 Mha. Overall it is clear from the irrigation development in India that good amount of irrigation potential is created in last century, there is need for efficient utilization of this created potential to bring more area under irrigation.

Table 2.10: Irrigation Potential Created, Utilised and Gross Irrigated Area by State

Sr. No.	Name of the State/UTs.	Potential Created Up to 2009-10 (000 ha)			Potential Utilized* Up to 2009-10 (000 ha)			Gross Irrigated Area* 2009-10(000 ha)
		Major & Medium	Minor	Total	Major & Medium	Minor	Total	
1	Andhra Pradesh	3967	3245	7211	3245	2844	6089	5764
2	Arunachal Pradesh	1	127	128	1	87	87	56
3	Assam	349	715	1064	211	509	720	225
4	Bihar	2896	5125	8021	1815	3793	5608	4625
5	Chhattisgarh	1199	642	1842	948	378	1326	1487
6	Goa	46	25	71	24	22	46	38
7	Gujarat	3095	2047	5142	1843	1900	3743	4933
8	Haryana	2206	1638	3843	1893	1584	3477	5545
9	Himachal Pradesh	23	180	203	8	145	153	188
10	Jharkhand	411	705	1115	246	501	747	155
11	Jammu & Kashmir	205	445	650	181	392	573	480
12	Karnataka	2809	1684	4494	2225	1635	3859	4096
13	Kerala	693	742	1434	591	629	1221	455
14	Madhya Pradesh	2197	2442	4638	1173	2217	3391	7162
15	Maharashtra	3780	3099	6878	2313	2648	4961	4352
16	Manipur	123	100	224	81	73	155	52
17	Meghalaya	0	69	69	0	54	54	74
18	Mizoram	0	43	43	0	17	17	10
19	Nagaland	0	107	107	0	72	72	85
20	Orissa	2046	1771	3817	1879	1442	3321	3197
21	Punjab	2647	3475	6122	2511	3368	5879	7714
22	Rajasthan	3100	2482	5582	2526	2374	4901	7309
23	Sikkim	0	38	38	0	26	26	18
24	Tamil Nadu	1574	2264	3838	1557	2128	3685	3238
25	Tripura	20	141	161	10	116	127	106
26	Uttar Pradesh	8946	24808	33754	7324	19798	27123	18896
27	Uttarakhand	289	559	848	191	409	600	567
28	West Bengal	1765	4070	5835	1574	3320	4894	5525
Total States		44388	62752	107174	34370	52482	86852	85353
Total U.Ts.		7	58	64	4	38	42	70
Grand Total		44394	62810	107238	34374	52520	86894	86423

Source: Ministry of Agriculture (DE & S), Planning Commission. Govt. of India.

* : Provisional

2.2.2: Irrigation development in Maharashtra

The Maharashtra state is having history of use of one of the oldest (200-300 years old) community based method of irrigation *Phad irrigation*. In this method water is diverted in to the farm from the river, canal or *nala* by creating *bandharas* or wier in these water sources (Patil & Belsare, 2011). The state of Maharashtra was formed on 1st May 1960, before the formation of the state, the irrigation development was progressive in the state as compared with other states, this can be seen from the number of dams created before the state was formed, around 75 dams were created (WRIS, 2016). Before 1960, the water was the subject under the department of public works, which was divided in to irrigation department and building and communication department, the irrigation department was renamed as the water resource department in 2004 (WRD, 2016). The state of Maharashtra is having 22.5 Mha cultivable area, from this around 40% area is drought prone area and 7% is flood prone (MWRRA, 2016, WRD, 2016). The crated irrigation water potential in 1960 was 0.39 Mha, which is increased to 12.6 Mha, of which 4.1 Mha is based on ground water and 8.5 Mha is based on surface water (WRD, 2016).

The Maharashtra state has been divided into five river basins: Godawari, Tapi, Narmada, Krishna and west flowing rivers. The table 2.11 summarizes the river basins in Maharashtra. The biggest river basin in the state is Godawari with geographic spread of 15.43 Mha, which is 50% of the geographic area of the state and 11.3 Mha culturable area. The total annual average availability of water in the state is 163820 million cubic meter (Mcm). The 75% dependable yield is 131562 Mcm. While the permissible use of water for the state is 125936 Mcm, as per the decisions of the various central govt appointed tribunals.

Table 2.11: River Basins in Maharashtra

Sr. No.	Name of Basin	Geographical area (Mha)/ Percent of Area w.r. to Maharashtra	Culturable area (Mha)	Annual Average Availability (Mcm)	75% Dependable yield (Mcm)/ Percentage with respect to state	Permissible use as per Tribunal award / committee report (Mcm)
1	Godawari	15.43/49.5%	11.25	50880	37300/28.35%	34185
2	Tapi	5.12 /16.7%	3.73	9118	6977/5.30%	5415
3	Narmada	0.16/0.5 %	0.06	580	315/0.24%	308
4	Krishna	7.01/22.6%	5.63	34032	28371/21.56%	16818
5	West Flowing	3.16/10.7%	1.86	69210	58599 /4.54%	69210
	Maharashtra	30.80/100.0%	22.53	163820	131562 /100%	125936

Source: Maharashtra Water Resources Regulatory Authority

The projects related to irrigation water in the state are mainly divided as projects under the water resource department and minor irrigation local sector and Zilla Parishad. Further the projects under water resource department are classified as major and medium projects and minor project under state sector. The projects under minor irrigation local sector are Kolhapur type weirs (K.T. weirs), percolation tanks, lift irrigation, minor irrigation tanks and others. The Table 2.12 summarizes number of irrigation projects, irrigation potential created and utilised in the Maharashtra state. The total number of projects under the water resource department and minor irrigation local sector are 3909 and 75,297 respectively. Till 2014, total irrigation potential created was 54.91 lakh ha and irrigation potential utilized was 33.4 lakh ha. This indicates that around half of the irrigation potential is not utilized, the major reasons might be the incomplete water distribution network and defunct lift irrigation schemes.

Table 2.12: Number of irrigation projects, irrigation potential created and utilised

Item	Projects of Water Resources Department			Minor Projects (local sector)					
	Major and Medium	Minor (State sector)	Total	K.T. Weirs	Percolation tanks	Lift irrigation	M.I. tanks	Others	Total
(A) No. of projects as on 30th June, 2015									
i. Completed	403*\$	3,506*\$	3,909*\$	11,006	21,317	2,652	2,608	37,714	75,297
ii. Ongoing	0	0	0	1,658	1,178	89	566	4,440	7,931
(B) Irrigation potential (lakh ha)									
i) Created up to June, 2014	34.30*@	14.36*@	48.66*@	3.13	6.48	0.39	2.29	3.96	16.25
(ii) Area under irrigation by canal in 2014-15	15.53++	4.81++	20.34++	1.09	(-)	0.14	0.8	(-)	2.03
(iii) Area under irrigation by wells in command area during 2014-15	9.88	1.15	11.03	(-)	(-)	(-)	(-)	(-)	(-)
Total irrigation potential utilised	25.41*	5.96*	31.37*	1.09	(-)	0.14	0.8		2.03

\$ completed & ongoing components together * provisional

@ As per the recommendations of Chitale Committee, the data has been compiled by MWRDC, based on information from all Chief Engineers of WRD.

++ Includes actual irrigation by project, canals, lift & water released in rivers and nallas

Source: Economic Survey of Maharashtra 2015-16

2.3: Policies & Programmes on Irrigation Development in India and Maharashtra

2.3.1: Policies & Programmes on Irrigation Development in India

Historically, irrigation was the subject under the Public Works Department (PWD) which was created in 1855, while this subject got more attention only after the famine in 1858, by appointing *an* inspector general of canals. Further, this subject was taken much seriously and an irrigation expert was appointed as an Inspector General of Irrigation, under the Government of India Act 1919. Irrigation is provincial subject and the Centre's role is to advice, co-ordinate and settle the water related dispute between the states (MWR, 2016). Only in 1952, a separate ministry for water was created, namely Ministry of Irrigation and Power. In 1969, Irrigation Commission was established to look after the irrigation development programme in the comprehensive manner, while in 1980, separate ministry of irrigation was established from the Ministry of Irrigation and Power. In January 1985, again the irrigation ministry was combined with power as Ministry of Irrigation and Power. Further in September 1985 it was bifurcated, and irrigation ministry was renamed as Ministry of Water Resources, which was renamed in July 2014, as the Ministry of Water Resources, River Development & Ganga Rejuvenation (MWR, 2016).

It is noted that during the early British rule in India, the irrigation development works were divided in to commercial and social works and it was expected that commercial projects will get completed in ten years and return from projects were expected with 6% rate of return on capital invested for canal irrigation. While after the independence, they fall under the public sector as the part of essential infrastructure for agriculture sector, with the reduction of rate of return from 6% to 3.75 % (Mohile, 2007; Gulati. *et., al.* 2005). Mohile (2007) argues that documented evidences related water policy were not available prior to 1987, while documents such as reports of the second water commission and documents related to discussion on flood control in the parliament, provides few guidelines.

In 1980, under the chairmanship of the Prime Minister of India, the National Water Resource Council (NWRC) was formed, which was represented by the ministers in central government and also state governments, they formalized the national water policy in September 1987. In

September 1990, National Water Body (NWB) was constituted to look after the progress of implementation of stipulations of National Water Policy (NWP), under the chairmanship of secretary, Ministry of Water Resources, which reports to the NWRC. The NWRC finalized the NWP, which covers mainly the policies related to irrigation management, asset management, operational and procedural changes (Mohile, 2007). The summary of important policies related to the water management is presented in the Table 2.13.

Table 2:13: The important policies related to water- Government of India

Sr. No.	Year	Government of India- Water-Related Policies
1	1866	The government is given the main role in irrigation development
2	1935	Transferred 'irrigation' to the states
3	1950	Beginning of planned development
4	1972	Second irrigation commission report
5	1980	The RashtriyaBarhAyog (National Commission on Floods) submitted its report
6	1986	Formulation of National Water Resource Council (NWRC)
7	1987	National Water Policy (1987) finalized in the first meeting of NWRC
8	1994	Modified draft of National Policy for water allocation amongst states, circulated to the states
9	1998	Water sector review by GoI and World Bank(WB)
10	1999	Second meeting of NWRC considered water allocation and river basin authorities
11	1999	Report of the National Commission on Integrated Water Development
12	2000	Water vision by India water partnership
13	2002	National Water Policy (2002)
14	2004	Country Policy Support Program (CPSP) India studies by International Commission on Irrigation and Drainage- <i>International Association of Hydrogeologists</i> (ICID-IAH)
15	2008	launched National Action Plan on Climate Change (NAPCC)
16	2011	Approved a "Comprehensive National Water Mission (NWM) Document
17	2012	National Water Policy(2012)
18	2016	National Water Framework Bill, 2016

Source: Mohile (2007), MWR(2016)

First time, the government of India has adopted a National Water policy in 1987, which was revised in 2002 and 2012. On June 2016, the Ministry of Water Resources, River Development & Ganga Rejuvenation released the draft of National Water Framework Bill, 2016. The new bill tries to provide a legal framework for water with respect to protection, conservation, regulation and management. The new bills covers the main aspects as: (i)Right to water for life (ii)Basic principles as water as common heritage and resource, river rejuvenation, people centric water management and standards for water quality and water footprints (iii)Integrated river basin development and management (iv)Planning for water security and pricing, and water regulators

(v) Urban, industrial and participatory irrigation management (vi) Access to and transparency of water data, promotion of innovation and knowledge management (vii) Inter-state river water conflicts prevention and resolution (MWRM, 2016). This bill suggests that water management should be done at the level of river basin and river basin authority (RBA) shall be established, the RBA shall prepare a master plan for a river basin and this shall remain in the public domain. Overall the new bill will bring more transparency and is having a more decentralized management approach.

The government of India has launched various programmes for the irrigation water management. The most important programmes are Accelerated Irrigation Benefits Programme (AIBP), Command Area Development Programme (CADP) and Pradhan Mantri Krishi Sinchayee Yojana (PMKSY).

2.3.1.1: Accelerated Irrigation Benefits Programme (AIBP)

The irrigation related projects require huge capital investment. Since the irrigation is a state subject, planning, designing and implementation of the irrigation project is done by the state governments. It was observed that many of the major and medium irrigation projects were incomplete because of the unavailability of capital at the state level. Hence, in 1996-97, the central government initiated the program, which was titled as “Accelerated Irrigation Benefits Programme (AIBP)” to provide Central Loan Assistance (CLA) for completion of the projects which were in advance stage of completion and those were beyond the resource capacity of the states. The priority was given for the tribal and drought prone area. From 1996-97 to 2014, Rs. 64,905.57 crores CLA was provided to states, and 143 major/medium projects and 12,083 surface MnrISs have been completed. In 2009, national important projects were attached to this scheme, for the AIBP and National Projects Rs. 55,200 crores are allocated in the XII plan (MWR, 2014).

2.3.1.2: Command Area Development Programme (CADP)

The Second Irrigation Commission (1972) suggested that there is a need for systematic development of command area of irrigation projects to fully utilize the created irrigation potential. In view of this, the Ministry of Irrigation and Power set up a committee of ministers, which recommended in 1973 for the formation of a broad based area development authority for

each Major Irrigation Project should be set up to undertake the work of comprehensive command area area development(MWR, 2016). On the basis of this suggestion, in 1974, a central government funded programme titled “Command Area Development Programme(CADP)” was created to achieve speedy utilization of irrigation potential created and also to improve productivity in selected irrigated commands(MWR, 2016; Sekhar, 2007). The components of the CADP are (i)field channels and field drains, (ii)land leveling and shaping, (iii)realignment of field boundaries, (iv)consolidation of holdings, (v)enforcement of rotational water supply (“warabandi”), (vi)adaptive trials, demonstrations, & training, (vii)sprinkler, drip, (viii)groundwater development and (ix)incentives for farmers participation(Sekhar, 2007).

In the 10th Plan, the CADP was renamed as “Command Area Development and Water Management Programme (CADWM Programme)” to make it more farmer centric and comprehensive. In the initial phase, around 60 medium and major projects covering around 15 million ha (Mha) CCA were taken up under this programme. Currently 150 projects covering 16.3 Mha CCA is under this project, the total outlay under the XII Plan was Rs. 15,000 Crores.

2.3.1.3: Pradhan Mantri Krishi SinchayeeYojana (PMKSY)

To ensure access to some means of protective irrigation to farms to bring rural prosperity, the central government started Pradhan Mantri Krishi SinchayeeYojana(PMKSY) programe in 2015. This programme is the combination of the various schemes such as [i]Accelerated Irrigation Benefit Programme (AIBP) of Ministry of Water Resources, River Development & Ganga Rejuvenation, [ii]Integrated Watershed Management Programme (IWMP) of Department of Land Resources; and [iii]On Farm Water Management(OFWM) component of National Mission on Sustainable Agriculture (NMSA) of Department of Agriculture and Cooperation.

The PMKSY is adopting decentralized State level planning and projectised execution, states have to prepare District Irrigation Plan (DIP), which is the starting point of the PMKSY and State Irrigation Plan (SIP). The main components of PMKSY are [a] Accelerated Irrigation Benefit Programme (AIBP), [b] PMKSY- Har Khet ko Pani, PMKSY - Per Drop More Crop and [c]PMKSY -Watershed Development. The outlay of Rs. 50,000 Crores is provided for PMKSY

for a period of 5 years from 2015-16 (PMKSY- 2016). The results of the three programmes [i.e. AIBP, CADP & PMKSY] is very positive, despite this success there is need to focus on the efficient use of water for irrigation at field level.

2.3.1.4: Policies & Programmes on Irrigation Development in Maharashtra

Before the Maharashtra state was formed the region was governed by the three irrigation acts: western Maharashtra Bombay irrigation act 1879, *central provinces irrigation Act 1931* and Hyderabad irrigation act 1952, while the state has formed its own act: the Maharashtra irrigation act 1976 (WRD, 2016). In the state the water resource department is headed by the minister, Maharashtra Water Resources Department, and administered by the principal secretary, water resources project and development (WRP & D). Between the period 1996 and 1998 the state established five irrigation development corporations (IDCs) for construction and management of irrigation projects through various acts. The IDCs receives initial grants from the state government and they raises capital from public. The five IDCs are:

- i) Maharashtra Krishna Valley Development Corporation (MKVDC)
- ii) Vidarbha Irrigation Development Corporation (VIDC)
- iii) Konkan Irrigation Development Corporation (KIDC)
- iv) Tapi Irrigation Development Corporation (TIDC)
- v) Godavari Marathwada Irrigation Development Corporation (GMIDC)

Since the formation of IDCs, around one thousand projects are completed and around six hundred are ongoing projects. Table 2.14 presents the status of irrigation projects under the five IDCs. The target and achievement of the IDCs is presented in the table 2.15, it can be seen from the table that the target was 657 TMC, while only 58% (382 TMC) target was achieved.

Table 2.14: IDC- wise status of completed and ongoing irrigation projects

Sr. No.	IDC	Number of ongoing projects handed over on formation of IDC	Number of new projects taken up	Total projects	Completed (June2013)	Number of projects on going as on June 2013
1	MKVD	186	321	507	413	94
2	GMIDC	199	285	484	356	128
3	VIDC	10	310	320	63	257
4	KIDC	38	70	108	29	64
5	TIDC	95	99	194	136	58
	Total	528	1085	1613	997	601

Source: CAG, 2014, Figures furnished by the IDCs.

Table 2.15: IDC-wise target and achievement of storage as of June 2013 (in TMC)

Sr. No.	Name of IDC	Targeted storage of IDC	Storage achieved (June2013)
1	MKVDC	175.00	160.86
2	GMIDC	86.58	75.57
3	VIDC	314.05	101.60
4	TIDC	81.67	44.10
	Total	657.30	382.13

Source: CAG, 2014, Information furnished by the IDCs. Note: There was no storage target for KIDC

Apart from the formation of the IDCs, the state also established institutions related to the irrigation management. The institutions are as;

- I. Maharashtra Engineering Research Institute, Nasik
- II. Maharashtra Engineering Training Academy, Nasik
- III. Hydrology Project, Nasik
- IV. Central Design Organisation, Nasik
- V. Dam Safety Organisation, Nasik
- VI. Mechanical Organisation, Nashik
- VII. Water and Land Management Institute, Aurangabad
- VIII. Quality Control Organisation, Pune
- IX. Director of Irrigation Research and Development, Pune

The Maharashtra state was the first to start water audit and benchmarking of irrigation projects in the country (CAG, 2013), the various important policies acts and directives related the water resource department are presented in Table 2.16.

Table 2.16: The important policies, Acts, developments and directives related to water in Maharashtra

Sr. No.	Name of Development, Acts and Policies	Year
1	Central Designs Organisation	1958
2	Maharashtra Engineering Research Institute	1959
3	Engineering Staff College	1959
4	Maharashtra State First Irrigation Commission	1960
5	Creation of Mechanical Organisation	1964
6	Directorate of Irrigation Research & Development	1969
7	Report of the National Irrigation Commission	1972
8	Report of the VasantdadaPatil Committee	1973
9	Creation of the Command Area Development Authority	1974
10	Maharashtra Irrigation Act, 1976	1976
11	New Irrigation Act	1976
12	Rehabilitation Act for project displaced people	1976
13	National Agricultural Commission	1976
14	Award of Narmada Water Dispute Tribunal	1979
15	Award of Godavari Water Dispute Tribunal	1980
16	Water & Land Management Institute	1980
17	Creation of Dam Safety Organisation	1980
18	Annexing Maharashtra Land Development Corporation to the Department	1980
19	Governor's directive - "Development Boards for Vidarbha, Marathwada and Rest of Maharashtra order, 1994	1994
20	Maharashtra Krishna Valley Development Corporation Act, 1996 (MKVDC)	1996
21	Vidarbha Irrigation Development Corporation Act, 1997 (VIDC)	1997
22	Godavari Marathwada Irrigation Development Corporation Act, 1998 (GMIDC)	1998
23	Tapi Irrigation Development Corporation Act, 1998 (TIDC)	1998
24	Konkan Irrigation Development Corporation Act, 1998 (KIDC)	1998
25	High Power Committee for determining priority in execution of projects	2001
26	High Power Committee for sectoral allocation of water	2003
27	State Water Policy 2003	2003
28	Maharashtra Water Resources Regulatory Authority Act, 2005 (MWRRA)	2005
29	Maharashtra Management of Irrigation System by Farmers Act, 2005 (MMISF)	2005

Source: The Water Resources Department, govt of Maharashtra. CAG, (2014): Report of the Comptroller and Auditor General of India, on Management of Irrigation Projects.

In 2014, the GoM has launched the '*Jalyukta Shivar Abhiyaan*' (waterful surrounding campaign) for the drought free Maharashtra state by 2019. As per GoM resolution on the *Jalyukta Shivar Abhiyaan (JSY)*, the core activities taken under this campaign are as following (GoM, 2014):

- I. Watershed development activities
- II. Chain cement concrete canal dam work to be conducted including canal deepening / widening
- III. To reinstate old water structures
- IV. To repair existing micro irrigation structures (K.T. ware/ storage dam)
- V. To repair, renovate, and reinstate capacity of percolation tank, micro irrigation tank (RRR)
- VI. To extract sludge from percolation tank/ village tank / storage tank / Shivakalin Tank / Britishkalin tank/ Nijamkalin tank / soil canal dam
- VII. To make provision for actual utilization of medium and large projects according to irrigation capacity
- VIII. To implement small canal joining projects
- IX. To refill well/bore well
- X. Efficient utilization of available water
- XI. To empower drinking water sources
- XII. To empower water usage organisation
- XIII. To repair the canal.

The target of JSY is to make 5000 villages free from water scarcity problem, around 6000 villages were selected in two years(2014-15 and 2015-16) under this programme, the total works completed under this campaign were 1.3 lakh and around 35,000 were ongoing by the end of 2015,and total expenditure on this campaign was Rs. 1,544 crore (ESM, 2016). The outcome of this campaign is very much positive.

2.4: Growth in area covered under different sources of irrigation in India and Maharashtra

The various sources of irrigation are canals, tanks and wells. The area under irrigation by source wise is shown in table 2.17for the period 1950-51 to 2013-14. The total area irrigated from

different sources has been increased from 20 Mha to 60 Mha. Area under the government canal irrigation has been increased from 7 Mha to 16 Mha, while area under private canal has been decreased from 1 Mha to 0.8 Mha. Area under tanks decreased from 3.6 Mha to 1.8 Mha. Area under tube well is increased from 0.1 Mha to 31 Mha and area under other wells decreased from 6 Mha to 11 Mha. The area under other sources increased from 2.9 Mha to 7.5 Mha. Increase in area under government canal and tube well is the outcome of governments various irrigation development policies. Overall, this shows that govt canals and tube wells are playing important role in the irrigation.

Table 2.17: Net area under irrigation by sources in India

(In ' 000 ha)

Year	Canals			Tanks	Wells		Other Source	Total
	Govt.	Pvt.	Total		Tube wells	Other-Wells		
1950-51	7158	1137	8295	3613	(a)	5978	2967	20853
1951-52	7490	1193	8683	3489	(a)	6517	2360	21049
1952-53	7511	1350	8861	3303	(a)	6521	2437	21122
1953-54	7545	1314	8859	4228	(a)	6685	2097	21869
1954-55	7832	1235	9067	4025	(a)	6726	2270	22088
1955-56	8025	1360	9385	4423	(a)	6739	2211	22758
1956-57	7916	1357	9273	4492	(a)	6566	2202	22533
1957-58	8303	1349	9652	4536	(a)	6818	2150	23156
1958-59	8391	1279	9670	4759	(a)	6686	2286	23401
1959-60	8809	1305	10114	4631	(a)	7083	2209	24037
1960-61	9170	1200	10370	4561	135	7155	2440	24661
1961-62	9339	1163	10502	4612	258	7094	2418	24884
1962-63	9686	1146	10832	4781	901	6748	2403	25665
1963-64	9862	1160	11022	4599	1028	6756	2483	25888
1964-65	10080	1143	11223	4780	1087	6988	2522	26600
1965-66	9859	1099	10958	4258	1293	7360	2475	26344
1966-67	10221	1026	11247	4424	1706	7489	2041	26907
1967-68	10295	948	11243	4493	2112	6999	2346	27193
1968-69	10985	907	11892	3926	3087	7714	2390	29009
1969-70	11724	881	12605	4059	3739	7438	2356	30197
1970-71	11972	866	12838	4112	4461	7426	2266	31103
1971-72	12246	869	13115	3734	4745	7535	2417	31546
1972-73	12134	862	12996	3619	5393	7571	2255	31834
1973-74	12196	869	13065	3900	5604	7679	2298	32546
1974-75	12657	857	13514	3544	6583	7646	2422	33709
1975-76	12933	858	13791	3972	6843	7601	2386	34593
1976-77	13016	845	13861	3901	7432	7655	2300	35149
1977-78	13734	842	14576	3904	7641	7943	2482	36546
1978-79	14304	845	15149	3937	8159	8270	2544	38059
1979-80	13931	843	14774	3481	9307	8557	2405	38524
1980-81	14450	842	15292	3182	9531	8164	2551	38720
1981-82	15456	490	15946	3376	10334	8403	2444	40503
1982-83	15716	469	16185	2936	10770	8577	2223	40691
1983-84	16294	470	16764	3533	10922	8470	2260	41949
1984-85	15884	470	16355	3034	11550	8618	2454	42010
1985-86	15715	464	16180	2765	11903	8515	2502	41865
1986-87	16039	456	16495	2677	12298	8524	2575	42569

Continued on next page

(In ' 000 ha)

Year	Canals			Tanks	Wells		Other Source	Total
	Govt.	Pvt.	Total		Tube wells	Other-Wells		
Continued from last page								
1987-88	15446	460	15906	2523	13185	8479	2828	42921
1988-89	16581	478	17059	2997	13720	9199	2819	45794
1989-90	16543	478	17021	2935	14049	9401	2756	46161
1990-91	16973	481	17453	2944	14257	10438	2932	48023
1991-92	17327	464	17791	2991	15168	10869	3048	49867
1992-93	16503	483	16986	3179	15815	11105	3211	50296
1993-94	16653	485	17138	3170	16376	11220	3435	51339
1994-95	16799	480	17279	3276	17189	11722	3533	52999
1995-96	16561	559	17120	3118	17910	11787	3467	53402
1996-97	16889	220	17109	2821	19338	12457	3388	55112
1997-98	17186	211	17397	2597	19680	12431	3106	55210
1998-99	17099	212	17311	2795	21394	12606	3329	57436
1999-00	17247	194	17440	2539	22042	12597	2912	57531
2000-01	15809	203	16012	2466	22566	11252	2909	55205
2001-02	14993	209	15202	2196	23245	11952	4342	56936
2002-03	13867	206	14073	1811	25627	8727	3658	53897
2003-04	14251	206	14458	1916	26691	9693	4299	57057
2004-05	14553	214	14766	1734	25235	9956	7538	59229
2005-06	16490	227	16718	2083	26026	10044	5966	60837
2006-07	16802	224	17027	2078	26942	10698	5999	62744
2007-08	16531	217	16748	1973	28497	9864	6107	63189
2008-09	16686	195	16881	1981	28367	10389	6020	63638
2009-10	14789	188	14978	1587	28371	9992	7008	61936
2010-11	15472	171	15643	1980	28543	10629	6864	63659
2011-12	15833	172	16005	1919	29943	10595	7236	65697
2012-13	15506	165	15672	1753	30543	10763	7536	66266
2013-14	16115	163	16278	1842	31126	11312	7542	68100

Note: (a) : Included under "Other Wells" as separate figures were not collected during these years

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India & Past Issues. (ON1260)

The net area irrigated by source wise in the Maharashtra state is shown in table 2.18. The area under well irrigation has been increased from 5,95,000 ha to 21,59,000 ha from year 1960-61 to 2009-10, 5,95,000 ha, while area under other sources (mainly canal irrigation) increased from 4,77,000 ha to 11,62,000 ha from year 1960-61 to 2009-10, 5,95,000 ha. This shows that in Maharashtra the dominating source of irrigation is well with around 65% share in net irrigated area (33,21,000 ha).

Table 2.18: Area Irrigated by various Sources in Maharashtra

Area Irrigated (000 Ha)

Year	Area Irrigated (000 Ha)			
	Wells	Other Sources	Net Area	Gross Area
1960-61	595	477	1072	1220
1965-66	711	496	1206	1388
1970-71	768	579	1347	1570
1975-76	1084	717	1802	2171
1980-81	1055	780	1835	2415
1985-86	1162	787	1949	2420
1990-91	1672	999	2671	3319
1993-94	1571	996	2567	3149
1994-95	1760	1017	2778	3377
1995-96	1870	1010	2880	3550
1996-97	2059	1028	3087	3769
1997-98	2090	1050	3140	3828
1998-99	1904	1042	2946	3630
1999-00	1400	1168	2568	3374
2000-01	1912	1047	2959	3647
2001-02	1922	1053	2975	3667
2002-03	1931	1040	2971	3668
2003-04	1914	1030	2944	3636
2004-05	1942	1001	2943	3665
2005-06	2077	1070	3147	3810
2006-07	2109	1137	3246	3958
2007-08	2151	1160	3311	4037
2008-09	2115	1140	3255	3970
2009-10	2159	1162	3321	4050

Sources: Inidastat. Directorate of Economics & Statistics, Planning Department, Govt. of Maharashtra

2.5: Growth in area covered under sprinkler and drip in India and Maharashtra

To fulfill the food demand, one of the ways is to increase area under the production by bringing more area under the cultivation. While availability of water for irrigation is the main constraint, huge capital is required for the irrigation projects and also numbers of years are required to complete these projects. Hence the solution is to use water efficiently. The solution is the drip and sprinkler irrigation. In India, this technology was imported from the developed world, in around 1970. A study conducted by National Mission on Micro Irrigation in 2014, suggests that

productivity can be increased by 42% for fruit crops and 52% for vegetable crops, respectively. Energy, fertilizer consumption and irrigation cost can be saved up to 30% (NMMI, 2014). State wise area covered under drip and sprinkler irrigation is shown in table 2.19. Total area under drip and sprinkler irrigation is 7.7 Mha. Maharashtra state reports highest area under drip irrigation 0.9 Mha, followed by Andhra Pradesh, Gujarat and Karnataka. Rajasthan state reports highest area under sprinkler 1.5 Mha followed by Haryana, Gujarat, Karnataka and Maharashtra. The penetration of micro and sprinkler irrigation at the national level is around 5% (Grant Thornton, 2016).

Table 2.19: State-wise area covered under Drip & Sprinkler Irrigation

Sr. No.	State	Drip (ha)	Sprinkler (ha)	Total (ha)
1	Andhra Pradesh	834865	328441	1163306
2	Arunachal Pradesh	613	0	613
3	Assam	310	129	439
4	Bihar	4610	97440	102050
5	Chhattisgarh	15553	241420	256973
6	Goa	965	899	1864
7	Gujarat	411208	418165	829373
8	Haryana	22682	550458	573140
9	Himachal Pradesh	291	684	975
10	Jharkhand	6303	9919	16222
11	Karnataka	429903	417005	846907
12	Kerala	22516	6948	29464
13	Madhya Pradesh	166358	185759	352117
14	Maharashtra	896343	374783	1271125
15	Manipur	47	30	77
16	Mizoram	1727	425	2152
17	Nagaland	200	5005	5205
18	Odisha	18431	82147	100579
19	Punjab	30805	12161	42966
20	Rajasthan	170098	1514451	1684549
21	Sikkim	5544	2769	8312
22	Tamil Nadu	290009	30436	320445
23	Telangana	25299	5293	30592
24	Tripura	100	392	492
25	UP	15519	21164	36682
26	Uttarakhand	696	316	1012
27	West Bengal	604	50576	51180
28	Others	15500	31000	46500
Grand Total		3371597	4357215	7728812
Source: http://www.indiastat.com				

As can be seen from the table 2.19, the Maharashtra state is one of the leading states in adoption of the drip and sprinkler irrigation methods. The status of sprinkler and drip irrigation in the Maharashtra state is summarized in the table 2.20, 2.21 and 2.22. The total area under drip irrigation was 13,66,000 ha and under sprinkler was 5,21,038 ha, which sum up together 18,87,038 ha. Around 50% area under drip and sprinkler irrigation was reported in the western Maharashtra region, followed by Marathwada(24.4%), Vidharbha(24.4%) and Konkan(0.7%) region. In the state highest area under drip was reported for cotton crop i.e. 3,76,944 ha(27%), followed by sugarcane 2,25,079 ha(16%), banana 1,49,382 ha(11%) and pomegranate 1,24,044 ha (9%). Table 2.22 presents year wise sprinkler and drip irrigation set distributed in the state and total government expenditure. Around 45,000 sprinkler sets per year were distributed, which added every year around 44,000 ha area under sprinkler irrigation. Around 90,000 drip sets per year were distributed in the state, which leads to per year increase in 88,000 ha area under drip irrigation. The state government provides 60% subsidy on drip for small and marginal farmers and 50% for others. In recent year (2014-16), the state expenditure on drip and sprinkler irrigation sets was Rs 688 crore.

Despite the considerable level of adoption of drip and sprinkler in the state, overall, it shows that there is a huge potential in the state as well as national level.

Table 2.20: Distribution of Sprinkler and Drip in Maharashtra

District-wise & Division-wise area covered under Drip & Sprinkler Irrigation from 1986 to March 2015

Sr. No. Division)	District	Area under Drip (ha)	Area under Sprinkler (ha)	Total (ha)	% to state Total
1	Thane	5355.98	127.32	5483.30	0.29
2	Raigad	1602.39	46.52	1648.91	0.09
3	Ratnagiri	3701.33	77.13	3778.46	0.20
4	Sindhudurg	2182.49	29.38	2211.87	0.12
Kokan		12842.19	280.35	13122.53	0.70
5	Nashik	121947.98	11790.44	133738.42	7.09
6	Dhule	55516.01	3077.68	58593.69	3.11
7	Nandurbar	22473.09	1170.35	23643.45	1.25
8	Jalgaon	253505.18	10345.86	263851.04	13.98
9	A.nagar	86230.90	26553.28	112784.18	5.98
10	Pune	68141.42	5537.14	73678.56	3.90
11	Solapur	146765.71	7003.75	153769.45	8.15
12	Satara	24945.28	13530.05	38475.33	2.04
13	Sangli	60822.41	19025.56	79847.98	4.23
14	Kolhapur	11949.85	2033.43	13983.28	0.74
Western Maharashtra		852297.85	100067.54	952365.39	50.47
15	A.bad	76539.97	10830.65	87370.62	4.63
16	Jalana	54883.78	13874.06	68757.84	3.64
17	Beed	30509.85	9239.17	39749.02	2.11
18	Latur	30910.94	32444.21	63355.16	3.36
19	O.bad	32695.88	8088.41	40784.28	2.16
20	Nanded	45270.28	33286.47	78556.76	4.16
21	Parbhani	38688.72	8903.73	47592.45	2.52
22	Hingoli	15445.48	18912.94	34358.42	1.82
Marathwada		324944.90	135579.64	460524.55	24.40
23	Buldhana	65218.30	69253.99	134472.28	7.13
24	Akola	16256.93	29693.40	45950.33	2.44
25	Washim	5262.56	31759.88	37022.44	1.96
26	Amrawati	49409.06	47050.35	96459.41	5.11
27	Yeotmal	16578.61	51889.68	68468.30	3.63
28	Wardha	8248.85	31620.31	39869.16	2.11
29	Nagpur	10473.81	12909.37	23383.19	1.24
30	Bhandara	1198.47	1746.96	2945.43	0.16
31	Gondia	792.34	1367.45	2159.79	0.11
32	Chandrapur	2398.01	7135.96	9533.97	0.51
33	Gadchiroli	78.11	683.11	761.23	0.04
Vidarbha		175915.06	285110.47	461025.53	24.43
State total		1366000.00	521038.00	1887038.00	100.00

Source: Directorate of Horticulture, Maharashtra State, Pune

Table 2.21: Crop wise area covered under Drip Irrigation in Maharashtra 2015

Sr. No.	Crop	Area (ha)	% area
1	Cotton	376943.6	27.59
2	Sugarcane	225078.9	16.48
3	Banana	149381.8	10.94
4	Pomegranate	124044.3	9.08
5	Citrus group	117659.9	8.61
6	Grapes	108952.2	7.98
7	Vegetables	100563.9	7.36
8	Mango	19124.34	1.4
9	Papaya	13769.5	1.01
10	Flowers	10145.59	0.74
11	Ber	8223.87	0.6
12	Coconut	4538.96	0.33
13	Sapota	4113.85	0.3
14	Custard apple	3083.44	0.23
15	Guava	2710.54	0.2
16	Fig	1962.16	0.14
17	Amala	1581.99	0.12
18	Tamarind	871.4	0.06
19	Cashewnut	672.81	0.05
20	Arecanut	390.16	0.03
21	Others	92186.86	6.75
	Total Drip	1366000.00	100.00

Source: Directorate of Horticulture, Maharashtra State, Pune

Table 2.22: Year wise sprinkler & drip irrigation sets distributed and expenditure incurred

Year	Sprinkler		Drip		Expenditure incurred (Rs. crore)
	No. of sets	Area (ha)	No. of sets	Area (ha)	
2009-10	36,329	37,552	91,058	81,660	192.11
2010-11	38,030	38,029	1,40,764	1,27,967	407.88
2011-12	38,959	37,904	1,77,150	1,50,995	448.04
2012-13	79,630	79,630	1,78,310	1,62,100	574.85
2013-14	30,296	30,296	89,108	81,008	305.57
2014-15	52,180	43,098	2,00,496	1,70,719	688.41

Source: Economic Survey of Maharashtra 2014-15, 2015-16

2.6: Progress in Participatory Irrigation Management in India and Maharashtra

The Participatory Irrigation Management (PIM) is the participation of the farmer in the management of the irrigation systems at all levels of system (-full physical limits of the system-) and with respect to all aspects (i.e. from design and planning to the evaluation) (Groenfeldt & Sun. 1997). It is found that in developing countries, governments incur high cost when they are

involved in the irrigation management functions which otherwise farmers could handle. Farmers have solid incentives to manage water productivity than a government administration, and decentralized irrigation management to farmers will result in quick response to the various problems of the irrigation systems (Groenfeldt & Svendsen, 2000; Brewer et al., 1999). Therefore, we can say that PIM is benefiting to both governments and farmers.

In 1987, Farmers' participation in the irrigation water management has been accepted as the policy of the central government in the National Water Policy (NWP). The NWP says "Efforts should be made to involve farmers progressively in various aspects of management of irrigation systems, particularly in water distribution and collection of water rates. Assistance of voluntary agencies (Non-Government Organisation – NGOs) should be enlisted in educating the farmers in efficient water-use and water management." The PIM should not only include farmers, but also other stakeholder as well government agencies (including local bodies). The ministry of water resources set up broad objectives for the PIM policy as follow:

- I. To create a sense of ownership of water resources and the irrigation system among the users, so as to promote economy in water use and preservation of the system.
- II. To improve service deliveries through better operation and maintenance.
- III. To achieve optimum utilization of available resources through sophisticated deliveries, precisely as per crop needs.
- IV. To achieve equity in water distribution.
- V. To increase production per unit of water, where water is scarce and to increase production per unit of land where water is adequate.
- VI. To make best use of natural precipitation and ground water in conjunction with flow irrigation for increasing irrigation and cropping intensity.
- VII. To facilitate the users to have a choice of crops, cropping sequence, timing of water supply, period of supply and also frequency of supply, depending on soils, climate and other infrastructure facilities available in the commands such as roads, markets cold storages, etc., so as to maximize the incomes and returns.

VIII. To encourage collective and community responsibility on the farmers to collect water charges and payment to Irrigation Agency.

IX. To create healthy atmosphere between the Irrigation Agency personnel and the users.

The Ministry of Water Resources (MWR) set up a model act for the PIM policy, which is to be adopted by state government for facilitating the PIM in the states, the PIM model act was enacted by 15 states (MWR, 2014). The list of states including their positions on the act is shown in the table 2.22. The model act provides legal framework for formation of water users' organization at three levels, The Water Users Association/s (WUAs), which is a formal group of farmers at a minor or group of outlets or a minor, the Distributary Committee, which is represent five or more WUAs, and the Project Committee, which is an apex committee of the irrigation system (MWR, 2014).

Table 2.23: State-wise Position of Enactment of New Act/Amendment of existing Irrigation Act

Sr. No.	Name of State	Position of issue / amendment of Irrigation Act
1	Andhra Pradesh	Enacted "Andhra Pradesh Farmers' Management of Irrigation Systems Act, March, 1997"
2	Assam	The Assam Irrigation Water Users Act 2004
3	Bihar	"The Bihar Irrigation, Flood Management and Drainage Rules, 2003" under the Bihar irrigation Act, 1997
4	Chhattisgarh	Enacted "Chhattisgarh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhinyam, 2006".
5	Goa	Enacted "Goa Command Area Development Act 1997 (Goa Act27 of 1997)"
6	Gujarat	Gujarat Water Users Participation Management Act, 2007
7	Karnataka	Promulgated an Ordinance on 7 th June 2000 for amendment of the existing Karnataka Irrigation Act 1957.
8	Kerala	Enacted "The Kerala Irrigation and Water Conservation Act2003".
9	Madhya Pradesh	Enacted "Madhya Pradesh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhinyam, 1999" during September 1999.
10	Maharashtra	"The Maharashtra Management of Irrigation Systems by Farmers Act,2005"
11	Orissa	Enacted "The Orissa Pani Panchayat Act, 2002".
12	Rajasthan	Passed the "Rajasthan Sinchai Pranali Ke Prabandh Me Krish kon Ki Sahabagita Adhinyam, 2000".
13	Sikkim	"Sikkim Irrigation Water Tax 2002" and "Sikkim Irrigation Water Tax (Amendment) Act 2008"
14	Tamil Nadu	Enacted the "Tamil Nadu Farmers' Management of Irrigation Systems Act, 2000".
15	Uttar Pradesh	Enacted the "Uttar Pradesh Irrigation Management Act, 2009"

Source: Ministry of Water Resources (2014), Status of Participatory Irrigation management <http://wrmin.nic.in/writereaddata/CAD-WUA-20140331.pdf>

Most of the states are supporting the formation of WUAs for the management irrigation water, nationwide around 63 thousand WUAs are formed, which covers around 14.62 Mha area (MWR, 2014). State wise status of the WUAs is shown in the Table 2.23.

Table 2.24: State-wise Number of Water Users' Associations (WUAs) and Area covered by them

Sr. No.	Name of State	No. of WUAs formed	Area in (000 ha)
			Area covered
1	Andhra Pradesh	10748	4169.00
2	Arunachal Pradesh	43	9.02
3	Assam	720	47.04
4	Bihar	80	209.47
5	Chattisgarh	1324	1244.56
6	Goa	57	7.01
7	Gujarat	1834	486.64
8	Haryana	2800	200.00
9	Himachal Pradesh.	876	35.00
10	J & K	39	2.758
11	Jharkhand	0	0.00
12	Karnataka	2662	1363.07
13	Kerala	4163	174.89
14	Madhya Pradesh	1687	1692.26
15	Maharashtra	2815	1102.42
16	Manipur	73	49.27
17	Meghalaya	151	18.75
18	Mizoram	110	14.00
19	Nagaland	23	3.15
20	Orissa	18989	1692.60
21	Punjab	957	116.95
22	Rajasthan	1130	983.07
23	Sikkim	0	0.00
24	Tamil Nadu	1641	840.94
25	Tripura	0	0.00
26	Uttar Pradesh	245	121.21
27	Uttarakhand	0	0.00
28	West Bengal	10000	37.00
	Total	63167	14620

Source: Ministry of Water Resources (2014), Status of Participatory Irrigation management
<http://wrmin.nic.in/writereaddata/CAD-WUA-20140331.pdf>

The Maharashtra state has a tradition of PIM, the *Phad* systems and *Malgujari tanks* are the traditional examples of PIM, in 1990, the first WUA was formed in the state in the Mula irrigation project (Patil & Belsare 2011). In the state, it was reported that under the irrigation development corporations (IDCs), substantial level of irrigation potential was created but the distribution network was incomplete, hence the potential was not utilized (World Bank, 2005). To address this problem the state government has taken various policy measures, one of the measures was that the state govt passed the Maharashtra Management of Irrigation Systems by Farmers (MMISF) Act 2005 (World Bank, 2005). Under this act the management of irrigation water was transferred to farmers and water charges were allowed to collect on volumetric basis from the WUAs. The status of WUAs in the state is summarized in the table 2.24. The WUAs in the state were formed as per MMISF and Cooperative societies Acts. In the state till 2016, around 5026 WUAs were formed covering area of 19, 92,038 ha area. While only 3102 WUAs were functioning covering area of 12,43,115 ha. In 1969, the state govt. established the Directorate of Irrigation Research and Development (DIRD) for drainage works and irrigation management (Patil & Belsare 2011).

Regarding the irrigation water management, several scholars have recommended that the government should focus on irrigation system at main level, while farmers should look after the operation and management (O&M) of the system (Meinzen-Dick and Mendoza 1996; Subramanian, 1997; Vaidyanathan, 1999). It is reported that PIM helps to increase the area under cultivation, solid improvement in water use efficiency, resolving water related issues, solved soil related problems as water logging (Uphoff, 1986; Gandhi, and Namboodiri, 2011: 2002: Singh, 1991).

Table 2.25: Status of WUAs in the Maharashtra state

Name of regional office	As per MMISF Act 2005		As per cooperative Act 1960		As per MMISF Act 2005		As per cooperative Act 1960		As per cooperative Act 1960		Total Formed WUA on all stages & including both act	
	Functioning		Functioning		Registration agreement yet to be done		Registration agreement yet to be done		Agreement done Yet to be functioning		No	CCA (Ha)
	No	CCA (Ha)	No	CCA (Ha)	No	CCA (Ha)	No	CCA (Ha)	No	CCA (Ha)	No	CCA (Ha)
CE WRD Pune	274	137982	56	14236	1	411	0	0	8	1408	339	154037
CE(SP) WRD Pune	307	143034	292	73822	20	11341	166	49103	1	640	786	277940
CE CADA Aurangabad	49	19165	393	189699	27	11737	216	101228	36	13061	721	334890
CE WRD Aurangabad	71	42224	113	54985	56	27501	36	12871	23	9748	299	147329
CE(SP) WRD Amravati	175	63989	137	43813	45	18066	113	37526	0		470	163394
CE WRD Amravati	22	5607	95	29480	117	35788	282	107994	104	34028	620	212897
CE WRD Nagpur	371	154368	42	18026	88	37626	158	75308	79	34631	738	319959
CE Goshikhurd WRD Nagpur	0	0	0	0	75	29927	0	0	0	0	75	29927
CE NMR WRD Nashik	349	127388	252	78146	11	5066	11	5473	0		623	216073
CE Tapi Jalgaon	79	35627	13	9615	76	31344	118	34987	7	4909	293	116482
CE WRD Konkan Mumbai	10	1028	2	881	50	17201			0		62	19110
Total	1707	730412	1395	512703	566	226008	1100	424490	258	98425	5026	1992038

Note: Total functioning WUA as per both act : 3102 (1243115 Ha)

Source: DIRD, Govt. of Maharashtra, http://www.dird-pune.gov.in/UntitledFrameset-6_.html As on 17th June 2016

The Directorate of Irrigation Research & Development (DIRD) conducted a study on working of 439 WUAs in the Maharashtra state. The study reports that after the WUAs took over the water management, irrigation efficient was increased by 66%, 34% WUAs followed diversified cropping pattern and around 31% of WUAs reported balance in their accounts (Patil & Belsare 2011). Performance of the WUAs was carried out for three states in Gujarat, Maharashtra and Andhra Pradesh. The study reports that there is considerable progress in farmers' participation and decentralization of power for irrigation management, which helped to increase the performance related to water resource management. The study also focuses on (i) the issues which need to be addressed; (ii) inputs in institutional design, institution building, trainings, (iii) greater accountability through proper audit, performance evaluation, social audit, financial viability and sustainability of WUAs (Gandhi and Namboodiri, 2011). Despite the considerable success of the PIM in the country, the ministry of water resources status report on PIM reports that there are few constrains in adoption of the PIM. The issues pointed out in the report are such as (a) lack of legal back up and policy changes in many states, (b) system deficiency in older projects, (c) uncertainty of water availability, (d) fear of financial viability, (e) lack of technical knowledge, (f) lack of leadership, (g) lack of publicity and training, (h) demographic diversity, (i) complexity of mega irrigation projects, (j) WUAs v/s Panchayats & PIM in efficient systems (MWR, 2014). It is clear from the experience of PIM in India that it has helped the nation to improve irrigation management at certain level but still there is wider scope.

Chapter III

Overview of PINS Programmes in Maharashtra

3.1: Introduction

The Growth in area covered under sprinkler and drip in India is discussed in section 2.8 in the chapter 2. As can be seen in Table 2.12 the Maharashtra state is one of the leading states in adoption of the drip and sprinkler irrigation methods. The overall development in the micro irrigation field in the state is discussed in the following section.

3.2: Overview of PINS Programmes in Maharashtra

The overall position of the irrigation in Maharashtra State is presented in Table 3.1. From the same it can be seen that (i) the ground water potential is half that of surface irrigation potential; (ii) there are 403 major irrigation projects, 3,506 are medium and minor irrigation projects in state sectors. There are large no. of minor irrigation schemes under the local sector.

Table 3.1: PINS Programmes in Maharashtra

Item	Particulars	
• Culturable Command Area(CCA):	225 lakhs ha	
• Ultimate Potential of Irrigation ³ :	○ Surface Irrigation:	85 lakhs ha
	○ Ground Water Irrigation:	41 lakhs ha
	○ Total Potential:	126 lakhs ha
• Potential Developed ⁴	○ Major Irrigation Projects(more than 10,000 CCA):	403 no.
	○ Medium & Minor(State Sector-251-2,500 ha) Projects:	3,506 no.
	○ Minor Irrigation(Local Sector- below 250 ha) ⁵ :	More than 65,000 no.

Source: Maharashtra Water & Irrigation Commission Report 1999 & others

³ Maharashtra Water & Irrigation Commission Report 1999

⁴ Govt. Resolution (GR), Water Resources Dptt, dt. 04.10.2016

⁵ Minor Irrigation Schemes include Minor Irrigation Tanks(MITs), Storage Tanks(STs), Kolhapur Type Weirs(KTWs), Pazar/Percolation Tanks(PTs), Diversion Weirs(DWs), small Lifts(LI).

Change in Water Distribution System in Maharashtra

Maharashtra State has mostly distribution systems with flow/gravity canal irrigation, as such there are no PINS+MIS under canal irrigation. The rotation of canal system (i.e. canal is “on” for about 3 weeks and “shutdown” for about the same period), creates a need to store water for use during “shutdown” period.

The GoM has recently decided to introduce pipe distribution system on all irrigation projects, which is expected to work on gravitational head (and not pressurised system). However, gravitational pipe distribution may not be feasible everywhere and we feel that lifting (PINS) would be unavoidable in no. of cases. The Maharashtra Water Resources Regulatory Authority (MWRRA) has also made it compulsory to use water by micro irrigation on all perennial crops (12 monthly crops) under all flow irrigation system⁶. These both steps will see PINS in future.

PINS in form of Co-op. Lifts Schemes in Maharashtra

However, there are large no. of lift irrigation schemes in co-operative sector, in southern part of western Maharashtra (1,01,205 ha) in Krishna basin (i.e. on Krishna river and its tributaries). These lifts can be considered as PINS with flood irrigation. However, over the years, the lands under them are becoming saline/water logged. For this reason, as well to save labour, fertilizers and water, initiatives have been taken through some schemes for converting the flow distribution systems into MIS. We obtained a list of 15 such schemes (from the micro irrigation manufacturing companies), and included some of them in our survey. The list of these schemes is presented in Annexure1. There could be more schemes (around 15 schemes) under the proposals of conversion, but MIS companies observe secrecy, till such proposals actually get materialized.

There are other 11 irrigation projects, under which flow/canal irrigation systems are not economical, as these projects have command mainly located in hilly region). In such cases, the water is let down from the storages in the parent water sources, which is tapped in the course (of parent water source) by weirs and lifted by farmers at various locations on the course/parent. This arrangement is similar to that for the lifts on Krishna and its tributaries, mentioned above. The total area under these 11 projects is 54,100 ha. With the area under lifts on Krishna etc., the total ICA works out to (54,100+ 101,205=) 1, 55,305 ha.

⁶ Maharashtra Water Resources Regulatory Authority's notification dt. 12.06.2015.

We feel that, if the financial assistance is made available to these lifts, they would get converted from PINS+Flow into PINS+MIS rapidly, as the trend is already set by 15 schemes converted.

Govt. Lift irrigation Projects in Maharashtra

Besides, regular flow/canal irrigation projects, GoM has also taken up around 20 Lift Irrigation projects for 5.89 lakh ha, these are at various stages of development/completion. The CCA of individual projects ranges from 1,873 ha for Andhali Lift (Dist:Satara) to 2.240 lakhs ha for Krishna-Koyna Lift (Southern Western Maharashtra).

Under these projects, once water is lifted, further irrigation is under gravity/flow canal. As mentioned above, the GoM has recently decided to introduce pipe distribution system on all irrigation projects, which is expected to work on gravitational head (and not under additional head created similar to pressurised system). Thus, the distribution systems of these lift projects will also be converted into PINS+MIS, though not envisaged at the conceptual stages. There is an advantage for lifts, that on the way from pumps to the delivery point, there can be sufficient head available to use MIS by directly hooking up to the rising/pumping main.

Lift Irrigation as Distribution System of Irrigation Projects (with mainly gravity canal irrigation system) in Maharashtra

Though the distribution of water is under gravity/flow under regular irrigation projects; in some projects, the lift irrigation is also adopted for water distribution, e.g. on two irrigation projects (i.e. along with the water distribution by gravity flow), they are [i]Dahini lift scheme on Bembala Project in Yavatmal District – 6,968 ha, [ii] Tajnapur Lift under Nathasagar (Godavari) Project in Aurangabad District: 6,960 ha, Dahini Lift is functioning partially so, we have covered it under the survey, other two projects are still at planning stage.

Under Minor Irrigation Schemes, except Minor Irrigation Tanks (MITs), there is no gravity flow system but lift irrigation on Storage Tanks(STs), Kolhapur-Type-Weirs(KTWs these are weir-cum-birdges), Storage Weirs(SWs). Usually these lifts belong to small and individual farmers or

to a small group of farmers. If financial assistance is made available to them, these can easily get converted into PIN+MIS. A group of four such schemes is functioning well on a Storage Tank at Janephal in Buldhana District. This was developed under a German KfW bank's assistance for participatory irrigation development⁷. We have covered these lifts under the survey.

For possible non-availability of particular type of PIN+MIS scheme in a state, a freedom was given to adjust/make up the short-fall of sample in similar other category/ies. The actual sample size covered under the survey is given in Table 3.1 below. From the same, it can be noted that we have covered more sample size than that works out.

The district-wise break-up of the sample is given in Table 3.2, From the same it can be seen that PINS+MIS schemes with Drip as well Sprinklers are covered under co-op lifts from Buldhana, Sangli and Kolhapur Districts, while individual PIN+MIS owner farmers are taken up from Nasik and Ahmednagar districts.

3.3: Irrigation source-wise coverage of PINS

3.3.1: Numbers of the PINS Project implemented and List of Agencies implementing the PINS-MIS Scheme in the State (till 2015-16)

Only two companies have responded to provide this information, they are (i).Jain Irrigation Systems Ltd, Jalgaon and (ii). Netafim Irrigation India Pvt. Ltd, Pune. There appears two more players for PINS+MIS who indicated that they were undertaking similar assignments, but declined to disclose the assignments (probably in Kolhapur & Sangli Districts), as those assignments were under negotiation stages. These companies are [i]EPC Industrié limited (Mahindra Group), Nasik; [ii]FinolexPlastroPasson (India). Pune⁸. The information on the no. of PINS projects installed in the state is given below in Table 3.1, 3.2 and 3.3. From these tables, it can be seen that 12 co-operative PINS-MIS(Drip based) are located in southern western Maharashtra, and while a sprinkler based unit is located in Vidarbha. One more drip based unit is partially completed in Govt sector and it is also located in Vidarbha.

⁷ The programme was known as MIP-M (Minor Irrigation Programme-Maharashtra), 2001-2011.

⁸ However, for these two companies (along with for two others companies), GoM has imposed the ban in the state, for 10 years in Jul 2016.

There are 104 companies registered with the GoM. The list of dealers for supply of drip as well sprinkler sets is also published by the GoM, in which 4,965 dealers are included from Western Maharashtra & Marathwada, and 1,497 from Vidarbha region.

Table 3.2: Numbers of the PINS Project implemented and List of Agencies implementing the PINS-MIS Scheme in the State (till 2015-16)

Districts covered	Name of the implementing Agency/Company	Head Quarters and Address of implementing Agency/Company	No. of PINS Installed	Year of implementation of PINS Project
Sangli	Jain Irrigation System Limited,	Jain Hills, Jalgaon, 425 001	5 no. (268 ha)	2012- 2015
	Netafim Irrigation India Pvt. Ltd.	101 & 102, First floor, C-1 Building, Saudamini complex, Bhusari Colony, Kothrud, Pune. Pin.411 038	5 no. (730 ha)	2010—2014
Kolhapur	Jain Irrigation System Limited,	Jain Hills, Jalgaon, 425 001	1 no. (40 ha)	2015
	Netafim Irrigation India Pvt. Ltd.	101 & 102, First floor, C-1 -- as above --	1 no. (66 ha)	2014
Buldhana	Jain Irrigation System Limited,	Jain Hills, Jalgaon, 425 001	1 no. (295 ha)	2011
Yavatmal	Saisanket, Mumbai	Data not available	1 no.	Partly functioning

Source: Data given by the companies and collected by us.

Sr. No.	District	Mango	Tamarind	Ber	Sapota	Guava	Cashew nut	Areca nut	Papaya	Citrus group	Custard apple	Fig	Amala	Coconut	Total Drip
16	Jalana	478.83	7.62	94.37	87.12	80.49	0.00	0.00	206.41	14618.00	199.64	146.27	50.15	2855.21	18824.12
17	Beed	802.11	49.77	65.51	112.05	26.91	0.00	0.00	387.13	2099.96	48.65	20.81	65.46	11.28	3689.65
	Aurangabad Div.	2086.21	93.82	1184.94	413.15	309.43	0.00	27.03	984.85	32587.74	452.39	180.82	132.27	2871.03	41323.68
18	Latur	1506.72	50.87	199.57	64.57	24.01	1.00	0.00	416.97	440.83	35.20	153.32	27.18	4.31	2924.53
19	O.bad	1001.92	32.12	165.73	106.71	29.57	0.00	0.00	658.09	709.30	54.80	158.55	47.66	0.00	2964.45
20	Nanded	705.48	178.39	172.64	212.18	188.96	0.00	0.00	1111.93	2310.42	24.34	0.00	20.58	1069.69	5994.61
21	Hingoli	607.47	5.68	9.95	31.74	1.22	0.00	0.00	100.92	1028.66	11.59	23.90	105.16	0.00	1926.29
22	Parbhani	998.16	5.34	67.30	286.60	17.05	0.00	0.00	1303.18	5072.34	409.64	12.21	188.63	1.02	8361.47
	Latur Div.	4819.75	272.41	615.20	701.79	260.80	1.00	0.00	3591.08	9561.55	535.57	347.97	389.21	1075.02	22171.35
23	Buldhana	294.44	0.00	98.38	40.56	71.10	0.00	0.00	188.01	3118.73	196.81	0.00	58.52	0.80	4067.35
24	Akola	99.32	11.61	25.45	23.41	28.56	0.00	0.00	283.43	4090.74	27.08	0.00	44.35	0.00	4633.94
25	Washim	87.18	0.00	5.73	5.01	15.08	0.00	0.00	505.18	1868.68	6.82	1.50	11.20	0.00	2506.38
26	Amrawati	171.47	33.36	161.80	48.10	83.04	0.00	0.00	676.56	32817.34	148.27	0.00	24.90	0.00	34164.82
27	Yeotmal	94.03	2.88	61.26	27.11	27.26	0.00	0.00	534.58	4773.52	30.29	0.00	8.60	0.00	5559.54
	Amaravati Div.	746.43	47.85	352.62	144.18	225.04	0.00	0.00	2187.76	46669.01	409.27	1.50	147.57	0.80	50932.03
28	Wardha	96.70	0.00	25.29	10.77	12.42	0.00	0.00	195.59	3015.15	20.16	0.00	25.17	0.00	3401.26
29	Nagpur	200.94	0.00	49.15	21.23	17.34	0.00	0.00	239.38	6547.14	3.32	0.00	27.01	0.00	7105.50
30	Bhandara	173.39	0.00	0.00	1.43	0.00	0.00	0.00	76.22	105.72	0.00	0.00	3.77	0.00	360.53
31	Gondia	44.96	0.00	0.00	0.00	0.00	0.00	0.00	8.27	10.63	0.00	0.00	0.00	0.00	63.86
32	Chandrapur	86.85	0.00	3.09	3.57	2.44	0.00	0.00	23.34	120.52	0.00	0.00	5.50	0.00	245.31
33	Gadchiroli	15.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.28
	Nagpur Div.	618.12	0.00	77.54	36.99	32.20	0.00	0.00	542.79	9799.16	23.48	0.00	61.45	0.00	11191.73
	State total	19124.34	871.40	8223.87	4113.85	2710.54	672.81	390.16	13769.50	117659.90	3083.44	1962.16	1581.99	4538.96	178702.92

Source: Directorate of Horticulture, Maharashtra State, Pune

Table 3.3: District-wise and irrigation project wise distribution of PINS Projects implemented (till 2015-16)

District	Irrigation basin/project	No. of PINS Installed	Year of Installations	Avg. Life span	Area covered (Ha)	Total number of beneficiaries
Kolhapur, Sangli & Satara [Co-op. Lift Schemes].	No. of projects in these districts (water is let down and lifted by Co-op. L I Schemes.)	12 PINS (are converted into PINS+MIS).	2010-2015	7 years	1098 ha	1372 No.
Yavatmal	Bembala irrigation Project	1 PINS Dahini Lift Scheme)	Partly completed.	7 years	4121 Ha	1948 No.

Source: Data given by the companies and collected by us.

Table 3.4: Feeder Irrigation Source wise Distribution of PINS in the state

District	Irrigation basin/ Project	No. of PINS Installed		Total number of beneficiaries		Area covered (Acre)	
		River	River	River	River	River	River
Kolhapur, Sangli & Satara [Co-op. Lift Schemes].	No. of projects in these districts (water is let down and lifted by Co-op. L I Schemes.)	12		1372 No.		1,098 ha	
Yavatmal	Bembala irrigation Project	1 PINS Dahini Lift Scheme)		1948 No.		4121 Ha	

Source: Data given by the companies and collected by us.

3.4: Irrigated Area & Crop Coverage under Drip & Sprinkler Irrigation in the State (up to March 2015)

The Table 3.5a and Table 3.5b below present the crop-wise area under MIS in the state, the major area is under cotton followed by the sugarcane. In horticulture, banana is the major crop followed by the citrus.

Table 3.5a: Total District-wise & Crop-wise area covered under Drip & Sprinkler Irrigation in Maharashtra (from 1986 to March 2015)

Sr. No.	District	Mango	Tamarind	Ber	Sapota	Guava	Cashew nut	Areca nut	Papaya	Citrus group	Custard apple	Fig	Amala	Coconut	Total Drip
1	Thane	710.55	0.00	0.00	457.38	9.75	47.41	16.34	248.06	63.60	3.85	0.00	14.05	93.99	1664.98
2	Raigad	581.95	0.00	0.00	35.77	7.32	53.08	96.06	11.17	12.46	3.83	0.00	0.00	69.41	871.05
3	Ratnagiri	1712.81	0.00	0.00	36.14	9.75	268.53	200.36	20.48	0.00	6.96	0.00	16.29	166.37	2437.70
4	Sindhudurg	1276.34	0.00	0.00	30.08	0.00	150.42	41.17	0.00	10.00	0.00	0.00	5.38	130.35	1643.73
	Kokan Div.	4281.65	0.00	0.00	559.38	26.82	519.44	353.94	279.71	86.06	14.63	0.00	35.72	460.11	6617.46
5	Nashik	711.06	0.00	152.17	162.33	206.03	97.54	0.00	238.96	236.30	65.29	8.16	87.11	0.00	1964.95
6	Dhule	202.66	0.00	234.03	37.66	33.49	0.00	0.00	732.04	512.03	71.89	4.69	114.78	0.00	1943.28
7	Nandurbar	36.02	0.00	0.00	0.00	0.00	0.00	0.00	1280.16	25.22	2.32	0.00	4.07	0.00	1347.79
8	Jalgaon	395.27	18.50	46.75	64.41	93.31	0.00	0.00	885.38	5516.59	152.74	14.57	119.30	0.00	7306.84
	Nashik Div	1345.02	18.50	432.95	264.40	332.84	97.54	0.00	3136.54	6290.14	292.24	27.43	325.26	0.00	12562.86
9	A.nagar	987.68	174.37	409.13	704.31	1012.87	0.00	9.19	235.21	6602.67	287.31	850.03	124.76	28.35	11425.90
10	Pune	915.15	70.33	716.06	253.89	250.79	10.81	0.00	754.02	2563.98	474.99	459.70	17.92	12.25	6499.88
11	Solapur	1187.78	97.15	3794.41	482.56	123.38	0.00	0.00	1684.15	2977.52	430.05	35.45	148.45	9.38	10970.29
	Pune Div.	3090.61	341.85	4919.60	1440.76	1387.05	10.81	9.19	2673.38	12144.17	1192.35	1345.18	291.14	49.99	28896.07
12	Satara	911.12	82.36	119.68	210.40	62.23	0.00	0.00	154.86	91.08	55.67	45.81	186.48	7.18	1926.88
13	Sangli	701.58	0.00	506.36	221.84	55.65	0.00	0.00	162.02	221.54	93.48	10.33	6.68	4.36	1983.83
14	Kolhapur	523.86	14.61	14.99	120.95	18.48	44.02	0.00	56.52	209.45	14.36	3.11	6.20	70.48	1097.04
	Kolhapur Div.	2136.56	96.98	641.03	553.19	136.37	44.02	0.00	373.39	522.07	163.51	59.25	199.37	82.02	5007.75
15	A.bad	805.27	36.43	1025.06	213.98	202.03	0.00	27.03	391.30	15869.78	204.10	13.74	16.66	4.53	18809.91

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Table 3.5b: Total District-wise & Crop-wise area covered under Drip & Sprinkler Irrigation in Maharashtra (from 1986 to March 2015)

Sr. No.	District	Cotton	Vegetables	S,cane	Grapes	Pomegranate	Banana	Flowers	Others	Total Drip(B)	Total Drip (A)	Area under Sprinkler (C)	Grand Total (A+B+C)
1	Thane	0.00	2673.84	0.00	0.00	0.00	238.18	182.90	596.08	3691.01	1664.98	127.32	5483.30
2	Raigad	0.00	423.43	24.20	0.00	0.00	33.59	4.01	246.11	731.34	871.05	46.52	1648.91
3	Ratnagiri	0.00	812.21	7.62	0.00	0.00	99.53	47.10	297.18	1263.64	2437.70	77.13	3778.46
4	Sindhudurg	0.00	142.04	7.91	0.00	0.00	197.02	6.55	185.23	538.75	1643.73	29.38	2211.87
	Kokan Div.	0.00	4051.53	39.73	0.00	0.00	568.31	240.57	1324.59	6224.73	6617.46	280.35	13122.53
5	Nashik	1711.78	8642.88	8200.65	61122.10	29121.92	1601.42	1999.52	7582.76	119983.03	1964.95	11790.44	133738.42
6	Dhule	29284.71	7497.26	1958.25	603.38	8093.09	3308.06	56.02	2771.97	53572.73	1943.28	3077.68	58593.69
7	Nandurbar	10616.10	2521.39	676.67	28.41	51.92	5281.21	4.01	1945.58	21125.30	1347.79	1170.35	23643.45
8	Jalgaon	141998.45	7805.80	3733.23	214.90	1201.35	83104.76	182.77	7957.09	246198.35	7306.84	10345.86	263851.04
	Nashik Div	183611.04	26467.34	14568.81	61968.78	38468.28	93295.45	2242.32	20257.39	440879.41	12562.86	26384.34	479826.60
9	A.nagar	5241.04	9228.86	34922.75	4005.30	13011.98	2182.24	1168.80	5044.04	74805.01	11425.90	26553.28	112784.18
10	Pune	36.20	10920.25	25549.25	5836.35	6178.16	5231.37	1509.13	6380.83	61641.54	6499.88	5537.14	73678.56
11	Solapur	6795.23	13150.12	47771.36	11369.26	39084.29	11771.80	1006.18	4847.17	135795.41	10970.29	7003.75	153769.45
	Pune Div.	12072.46	33299.24	108243.36	21210.91	58274.43	19185.41	3684.11	16272.04	272241.96	28896.07	39094.16	340232.19
12	Satara	1298.25	3210.99	7731.44	1383.63	3990.43	1046.34	1399.52	2957.81	23018.40	1926.88	13530.05	38475.33
13	Sangli	1801.27	3464.74	18566.82	14409.90	13920.81	1060.77	1161.24	4453.03	58838.58	1983.83	19025.56	79847.98
14	Kolhapur	0.00	1048.37	7168.51	761.54	31.04	744.85	237.75	860.75	10852.81	1097.04	2033.43	13983.28
	Kolhapur Div.	3099.51	7724.10	33466.78	16555.07	17942.28	2851.96	2798.50	8271.60	92709.80	5007.75	34589.04	132306.59
15	A.bad	31222.20	7088.93	2322.88	663.81	2018.18	1745.89	280.68	12387.48	57730.06	18809.91	10830.65	87370.62
16	Jalana	20977.67	2708.50	6693.97	625.62	1134.34	2180.89	62.12	1676.54	36059.66	18824.12	13874.06	68757.84
17	Beed	9030.14	1353.20	10993.76	310.29	1846.12	705.17	45.81	2535.71	26820.20	3689.65	9239.17	39749.02

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Sr. No.	District	Cotton	Vegetables	S,cane	Grapes	Pomegranate	Banana	Flowers	Others	Total Drip(B)	Total Drip (A)	Area under Sprinkler (C)	Grand Total (A+B+C)
Continued from last page													
	Aurangabad Div.	61230.02	11150.64	20010.61	1599.72	4998.64	4631.96	388.61	16599.73	120609.92	41323.68	33943.88	195877.48
18	Latur	2563.52	4273.30	16211.59	2157.34	1197.36	490.21	44.55	1048.54	27986.42	2924.53	32444.21	63355.16
19	O.bad	1890.98	2435.75	15644.31	4368.51	1209.04	1598.44	86.31	2498.10	29731.43	2964.45	8088.41	40784.28
20	Nanded	9448.04	966.46	9465.58	99.14	160.70	11398.74	150.88	7586.13	39275.67	5994.61	33286.47	78556.76
21	Hingoli	3028.79	243.80	420.04	25.41	5.24	4928.13	16.26	4851.53	13519.19	1926.29	18912.94	34358.42
22	Parbhani	13338.13	1197.53	4242.55	239.07	547.84	3753.73	49.60	6958.80	30327.25	8361.47	8903.73	47592.45
	Latur Div.	30269.45	9116.83	45984.07	6889.47	3120.17	22169.25	347.60	22943.11	140839.96	22171.35	101635.76	264647.07
23	Buldhana	53501.50	3690.13	139.12	526.16	342.21	1639.85	12.10	1299.86	61150.95	4067.35	69253.99	134472.28
24	Akola	8366.04	650.15	185.26	20.93	199.73	1288.16	36.12	876.60	11622.99	4633.94	29693.40	45950.33
25	Washim	1482.11	436.36	108.20	5.66	112.81	123.74	7.66	479.64	2756.18	2506.38	31759.88	37022.44
26	Amravati	9148.89	1656.13	434.10	115.81	402.92	2108.43	32.46	1345.50	15244.24	34164.82	47050.35	96459.41
27	Yeotmal	7671.39	728.91	657.12	58.67	148.62	759.24	67.30	927.82	11019.07	5559.54	51889.68	68468.30
	Amaravati Div.	80169.92	7161.68	1523.81	727.23	1206.30	5919.42	155.64	4929.42	101793.43	50932.03	229647.29	382372.76
28	Wardha	2842.48	312.34	561.36	0.00	16.79	474.38	20.63	619.61	4847.59	3401.26	31620.31	39869.16
29	Nagpur	1733.57	707.43	332.26	0.73	12.92	25.60	267.61	288.18	3368.32	7105.50	12909.37	23383.19
30	Bhandara	0.00	285.00	253.06	0.00	0.00	91.77	0.00	208.12	837.95	360.53	1746.96	2945.43
31	Gondia	0.00	171.00	81.78	0.00	0.00	78.97	0.00	396.72	728.48	63.86	1367.45	2159.79
32	Chandrapur	1915.13	76.66	13.25	0.25	4.52	87.27	0.00	55.63	2152.70	245.31	7135.96	9533.97
33	Gadchiroli	0.00	40.10	0.00	0.00	0.00	2.02	0.00	20.71	62.83	15.28	683.11	761.23
	Nagpur Div.	6491.18	1592.53	1241.71	0.98	34.24	760.01	288.24	1588.97	11997.87	11191.73	55463.18	78652.77
	State total	376943.58	100563.89	225078.88	108952.17	124044.34	149381.77	10145.59	92186.86	1187297.08	178702.92	521038.00	1887038.00

Source: Directorate of Horticulture, Maharashtra State, Pune

Table 3.6: Crop wise area covered under Micro Irrigation in Maharashtra

Sr. No.	Crop	Area	% area
1	Mango	19,124.34	1.40
2	Tamarind	871.40	0.06
3	Ber	8,223.87	0.60
4	Pomegranate	124,044.34	9.08
5	Sapota	4,113.85	0.30
6	Guava	2,710.54	0.20
7	Cashewnut	672.81	0.05
8	Arecanut	390.16	0.03
9	Papaya	13,769.50	1.01
10	Grapes	108,952.17	7.98
11	Banana	149,381.77	10.94
12	Citrus group	117,659.90	8.61
13	C, apple	3,083.44	0.23
14	Fig	1,962.16	0.14
15	Amala	1,581.99	0.12
16	Coconut	4,538.96	0.33
17	Vegetables	100,563.89	7.36
18	Flowers	10,145.59	0.74
19	Cotton	376,943.58	27.59
20	S,cane	225,078.88	16.48
21	Others	92,186.86	6.75
Sub Total A	Total Drip	1,366,000.00	100.00
Sub Total B	Area under Sprinkler	521,038.00	
	Grand Total	1,887,038.00	

Source: Directorate of Horticulture, Maharashtra State, Pune

3.5: Cost pattern on PINS

We have obtained latest cost-estimate for a 100 ac (40 ha) PINS scheme namely Shiva Rama Pani Puvatha Sanstha Shivaram Water Supply(Lift) Society Ltd, at Karbharwadi, Tal- Karveer, Dist- Kolhapur. This can be considered as a typical cost for a PINS, in which the cost of MIS can be added based on the norms of the individual states. From the table, it can be seen that the installation cost is about 12% of the equipment cost. It needs to be noted that the cost of equipment will vary depending the head for the pumps and the length of the rising/pumping main.

Table 3.7: Initial capital cost on PINS equipment's and installations at WUA level (Rs./WUA)

Sr. No.	PINS-MIS Equipment	Equipment Cost (Rs)	Installation Cost (Rs)	Total Cost (Rs)
A	Water Supply System			
1	Pump Sets and power unit	2,25,000	25,000	2,50,000
2	Control Head/ control box	3,00,000	50,000	3,50,000
3	Storage Facility/ Wells	----	---	---
4	Filters/Filtration	6,50,000	35,000	6,85,000
	Water Supply System Subtotal			
B	System Layouts			
5	Main/ Sub-main PINS pipes/ PVC Pipes	33,50,000	5,25,000	38,75,000
6	Valves, Flush valves, Fittings and Bushings	3,50,000	25,000	3,75,000
	System Layouts Subtotal			
C	Automated Water control System, if any			
7	Monitoring Storage	---	----	---
8	Float device and float switch			
9	Automation equipment	8,50,000	25,000	8,75,000
	Automated Water control System Subtotal			
D	Total PINS System (Excluding MIS) for 100ac(40 ha)	57,25,000	6,85,000	64,10,000

Source: Field survey

3.6: Prospects and Constraints in promotion of PINS

As can be seen from Section 3.4, the total area under lift schemes in southern Maharashtra is about 1.50 lakhs ha. Twelve schemes are already converted in from flow to micro irrigation in this belt, on their own. We feel that some financial incentive should be extended for such conversions. Similarly there are other large & small co-op. lift schemes and individual schemes. More than 2 lakhs minor irrigation schemes are located in Maharashtra. They include schemes which have no canals, but have lifts. If some financial assistance is extended to them, these schemes will get converted into micro irrigation systems.

It is also mentioned in the earlier section that there are around 20 Govt Lift projects, which can have MIS as distribution systems.

Chapter IV

Adoption, Performance and Management of PINS by Farmers

4.1: Introduction

The rate of adoption of any technology carries vital role because the desired outcome of any technology depends on at what scale the technology is adopted by the end users, same applies for PINS or MIS. It was found that high investment, marginal landholding, non-access to assured water source, lack of technical knowledge and economic situation of farmers were the major factors influencing the adoption of micro irrigation in India (Namara, et. al, 2005). The adoption of micro irrigation is important not only because it saves water, but also it has other crucial benefits such as reduction in various input costs (fertilizer cost, wedding cost, power cost) for farmers, reduction in the environmental problems such as soil salinity and water logging (NMMI, 2016). Apart from rate of adoption, the users should follow the recommended operating procedures and the operations management should be hassle free for the users, otherwise even after high rate of adoption, it will be unlikely to see the expected end results. It is argued that after adoption of micro irrigation farmers have stopped using it because of various reasons such as unreliable water supply and maintenance issues (Kulecho, and Weatherhead, 2005). Therefore, while studying or working on PINS, despite the well known facts about the benefits of MIS and also the proven benefits of PINS in Gujarat state, there is a need to look in to the adoption, performance and management of PINS in the Maharashtra state, which will provide further direction for implementation of PINS projects effectively in the state and elsewhere also.

4.2: Socio-economic profile of water users

Table 4.1 summarizes the socio-economic characteristics of the households. The household's characteristics are presented separately for govt, coop and pvt PINS. For govt PINS, 47.6% of farmers were beneficiary farmers (BF = BH) and 52.4% were non beneficiary farmers (NBF = NBH). We have conducted interviews of total 355 farmers. The average age of the respondent was 51 years. Respondents' average education was nine years of schooling. Most of the farmers' main occupation was the agriculture. Around 96% of respondents were male, while only 4% were female, this shows that still farming is dominated by male, or in other words the decisions

related farming are carried out by the male; despite that females contribution is high in the farming. Average family size of household was around 6 members; from this around 50% of members were actively participating in the farming. The average years of farming experience of the respondents was around 28 years, which shows that most of the respondents were in farming business since their young age. Around 57% of the farmers were members of at list one association/organization. The cast wise distribution of farmers' shows that around 9% of farmers were SC, 1% were ST, 36% were OBC and 53% were from general category. If you look at the cast wise classification of the farmers, it is reported that in case of pvt PINS around 92% of farmers were from general category, while for govt PINS participation of other casts farmers was comparatively more. This might be the output of the government's policy related to the social inclusion.

Table 4.1: Socio-economic characteristics of sample households

Sr. No.	Particulars	Govt PINS		Coop PINS		Pvt PINS		Total		Grand Total
		BH	NBH	BH	NBH	BH	NBH	BH	NBH	
1	Number of sample farmer households	39	43	155	53	56	9	250	105	355
2	Average age of respondent (years)	49.3	52.1	52.1	52.5	48.5	54	50.0	52.9	51.4
3	Average years of respondent education	9.4	8.4	8.5	8.9	11.4	7.3	9.8	8.2	9.0
4	Agriculture as main occupation (% of respondents)	100	100	98.1	100	96.4	100	98.2	100.0	99.1
5	Gender (% of respondents):									
a	Male (%)	97.4	100	94.8	94	94.6	100	95.6	98.0	96.8
b	Female (%)	2.6	0	5.16	6	5.36	0	4.4	2.0	3.2
6	Average family size (No.)	5.4	5.6	6.6	6.4	7.6	5	6.5	5.7	6.1
7	Average number of people engaged in agriculture	2.7	2.1	2.7	2.5	3.3	2.7	2.9	2.4	2.7
8	Average years of experience in farming	26.9	27.8	29.0	26.8	25.4	33.9	27.1	29.5	28.3
9	% of farmers being a member of any association	35.9	18.6	54.8	54.7	91.1	88.9	60.6	54.1	57.3
10	Caste (% of households):									
a	SC	12.8	16	13.5	0	3.6	11	10.0	9.0	9.5
b	ST	2.6	2	0.6	0	0	0	1.1	0.7	0.9
c	OBC	76.9	63	30.3	43	3.6	0	36.9	35.3	36.1
d	General	7.7	19	55.5	57	92.9	89	52.0	55.0	53.5

Notes: BF: Beneficiary Farmers; NBH: Non- Beneficiary Farmers, govt PINS: Government supported PINS, coop PINS: cooperative PINS, pvt PINS: private PINS; Source: Field survey data.

4.3: Land holdings, asset holding and sources of credit

Operational landholding of the sampled household is presented in table 4.2. Under the govt PINS category the net operated area of BH was 5.04 acres while of NBH was 6.04 acre. For the coop

PINS, the operational landholding of BH was 3.92 acres, and of NBH was 4.43 acres. For the pvt PINS the operational landholding of BH was 12.36 acres and of NBH was 2.91 acres. It looks that the BH under pvt PINS have maximum operational landholding as compared with the govt PINS and coop PINS farmers, it may be because the larger farmers can afford the cost of private PINS. Moreover, we also found that the farmers who were having pvt PINS were leasing in and leasing out the land, while coop PINS farmers were also leasing in the land but of very small size (0.02 acre), this might be because the pvt PINS farmers are comparatively wealthy farmers and have more capital than the other two groups for leasing in. The other issue might be that farmers while leasing out land, might be thinking that bigger farmers will pay the rent on right time than the other farmers, hence bigger farmers are preferred while leasing out the land.

Table 4.2: Operational Landholding of the Sample Households

(Acre/household)

Sr. No	Particulars	Govt PINS		Coop PINS		Pvt PINS	
		BF	NBF	BF	NBF	BF	NBF
1	Owned land	5.04	6.04	4.00	4.43	13.77	2.91
2	Owned cultivated land	5.04	6.04	3.90	4.43	12.25	2.91
3	Leased-in	0.00	0.00	0.02	0.00	0.18	0.00
4	Leased-out	0.00	0.00	0.00	0.00	0.06	0.00
5	Net operated area (NOA)	5.04	6.04	3.92	4.43	12.36	2.91
6	Net irrigated area	4.86	3.45	3.92	3.22	12.36	2.91

Notes: BF: Beneficiary Farmers; NBF: Non- Beneficiary Farmers;

Source: Field Survey

Distribution of farm assets is shown in table 4.3. Presently with increasing farm labor problem, tractor is becoming most important farm machinery. Govt PINS BFs own 8 tractors per 100 farmers and NBFs own 5 tractors per 100 farmers. Coop PINS farmers tractor ownership rate was 27 tractors per 100 farmers and NBFs ownership rate was 21 tractors per 100 households. Pvt PINS BFs and NBFs tractor ownership rate was 125 and 22 tractors per 100 farmers, respectively. The pvt PINS BFs ownership rate of tractor was very high may be because the average land operated area by them was comparatively higher than others. The harrow and cultivator ownership rate of govt PINS BFs was 13 units per 100 farmers and of NBFs was 10 units per farmers. The harrow and cultivator ownership rate of coop PINS BFs was 13 units per 100 farmers and of NBF was 10 units per farmers. Private PINS BFs reported the highest

ownership rate 111 units of harrow and cultivator per 100 households, while NBFs ownership rate was 33 units per 100 households. The ownership of tractor equipment was high among the pvt PINS farmers because they also own higher no. of tractors as compared to other two groups (coop and govt PINS). The electric motor ownership rate of the govt PINS BF and NBF was 51 units per 100 household and 63 units per 100 household, respectively. The ownership rate of electric motor for coop PINS beneficiary and non-beneficiary farmers was 70 units per 100 household and 98 units per household, respectively. While there were 3 electric motors with each pvt PINS BF and 2 electric motors with NBFs. The ownership of electric motor was higher among the pvt PINS farmers may be because their operated land holding was high. The diesel engine ownership rate of govt PINS BF and NBF was 3 and 2 per 100 households, respectively. About coop PINS BF and NBF diesel engine ownership rate was 19 and 9 units per 100 household, respectively. The pvt PINS farmers' diesel ownership rate was 11 units per 100 household. Govt PINS BF own one drip system per acre, while 5 drip units per 100 acre were owned by NBFs. The ownership of drip system of coop PINS BF and NBF was 50 unit per 100 acre and 13 units per 100 acre, respectively. The drip system ownership of pvt PINS BF was 1 unit per acre and 67 units per 100 acres was for NBFs. Area under drip system per household for govt PINS BF and NBF was 5.04 acres and 0.12 acre, respectively. Regarding coop PINS BF the area under drip was 0.5 acre and for NBFs it was 0.13 acre. About govt PINS BF was around 11 acres per household and 1.15 acres per household for NBFs. The ownership of drip system per household of govt and private PINS was higher than the coop PINS may be because for govt PINS it was 100 % subsidized and for private PINS farmers could afford it, and which impacted on the area under drip irrigation positively and resulted in the same trend. Under the govt PINS category only NBFs were using sprinkler and the ownership rate of sprinkler system was 29 units per 100 acres. The coop PINS BF sprinkler ownership rate was 21 units per 100 farmers and 11 units per 100 NBFs. The govt PINS NBFs area under sprinkler was 2.23 acres per household. Regarding the coop PINS BF and NBFs the area under sprinkler irrigation was 0.97 and 0.57 acre per household, respectively.

Overall, the pvt PINS BF ownership of various farm related assets was higher as compared to govt and coop PINS BF, may be because their land holding was higher as well as the net operated area was also higher than the others.

Table 4.3: Distribution of Farm Assets

Sr. No.	Particulars	Govt PINS		Coop PINS		Pvt PINS	
		BF	NBF	BF	NBF	BF	NBF
1	Tractor, Trailer/trolley (no./hh)	0.08	0.05	0.27	0.21	1.25	0.22
2	Harrow and cultivator(no./hh)	0.13	0.10	0.23	0.09	1.11	0.33
3	Electric motor, (no./hh)	0.51	0.63	0.70	0.98	2.93	1.89
4	Diesel engine(no./hh)	0.03	0.02	0.19	0.09	0.11	0.22
5	Drip system (No./hh)	1.00	0.05	0.54	0.13	1.00	0.67
6	Drip system (Area-ac /hh)	5.04	0.12	1.96	0.66	10.96	1.15
7	Sprinkler system (No./hh)	0.00	0.29	0.21	0.11	0.00	0.00
8	Sprinkler system (Area-ac/hh)	0.00	2.23	0.97	0.57	0.00	0.00

Note: HH- Household

Source: Field Survey

Credit is one of the most important factors of production in agriculture. The source wise credit taken and outstanding credit by govt PINS BFs and NBFs are shown in table 4.4a. The main sources of credit for farmers were the commercial banks, co-operative banks, other banks and informal sources as money lender, traders, commission agents and friends. The BFs major chunk of credit was from the co-operative banks (Rs. 65,778) followed by other banks (Rs. 10,257), commercial banks (Rs. 7,037) and informal source (Rs. 3,704). Govt PINS NBFs have taken major part of loan from the commercial banks (Rs. 73,209) followed by co-operative banks (Rs. 9,767) and private source (Rs. 2,442).

The rate of interest varies from 6 –12%; the lowest was for the loan taken from commercial banks and highest was for the private sources (money lenders). The average credit taken by pvt PINS BFs was around Rs. 80,000 and outstanding was around 66%, while the average credit taken by NBFs was Rs. 85,000 and outstanding credit was around 75%. It shows that the farmers under govt PINS have less outstanding credit than the non PINS farmers, this might be explained as PINS helps farmers to increase their repaying capacity, hence have less outstanding than other farmers.

Table 4.4b summarizes the source wise credit taken and outstanding credit by coop PINS BFs and NBFs. Farmers under coop PINS: BFs and NBFs received credit from cooperative and commercial banks. The BFs took credit of equal amount (around Rs. 1 lakh) from both the

sources, and around 50% of the loan was outstanding. The NBFs preferred cooperative banks than commercial banks for loan, the credit taken from commercial bank was around Rs. 41,000 and from cooperative banks was Rs. 77,000. The outstanding loan of non-beneficiary farmers was around 90%. The amount of credit taken by the beneficiary farmers was around Rs. 200,000, while by non-beneficiary farmer was Rs. 120,000.

Table 4.4c summarizes the source wise credit taken and outstanding credit by pvt PINS BFs & NBFs. The sources of credit were commercial and cooperative banks. The total credit taken by PINS BFs was Rs. 730,000 and around 70% of the credit was from commercial banks. The outstanding loan of PINS BFs was around 50%. The credit taken by PINS NBFs was Rs. 175,000 and 100% loan was outstanding.

The sources of credit for govt PINS farmers were commercial banks, cooperative banks, other banks and informal sources, while for coop and pvt PINS the sources of credit were commercial and cooperative banks. The amount of credit taken by the pvt PINS BFs was around Rs. 700,000 and pvt PINS NBFs was Rs. 180,000. The coop PINS BFs took credit of around Rs. 200,000, while coop PINS NBFs took credit of Rs. 120,000, while both BFs and NBFs under govt PINS took the credit of same amount: Rs. 80,000. The outstanding loan amount was more than 90% for the NBFs, while it was around 50% for the BFs.

Table 4.4a: Agricultural Credit Outstanding by the Sample Households (2015-16)–govt PINS

Sr. No.	Sources	Beneficiary Farmers			Non-beneficiary		
		Amount of loan taken (Rs)	Rate of interest (%)	Amount of loan outstanding (Rs)	Amount of loan taken (Rs)	Rate of interest (%)	Amount of loan outstanding (Rs)
1	Commercial banks	7,037	7	7,037	73,209	6.3	55,767
2	Co-operative Credit Societies	65,778	8.9	37,037	9,767	6.0	5,581
3	Other banks	10,259	7.4	5,259	0	0	0
4	Informal sources*	3,704	12	3,704	2,442	4	2,442
	Total	79741	8.8	53037	85418	5.4	63790

Source: Field Survey. * (Money lenders, Traders/ Commission agents etc)

Table 4.4b: Agricultural Credit Outstanding by the Sample Households (2015-16) – Coop PINS

Sr. No.	Sources	Beneficiary Farmers			Non-beneficiary Farmers		
		Amount of loan taken (Rs)	Rate of interest (%)	Amount of loan outstanding (Rs)	Amount of loan taken (Rs)	Rate of interest (%)	Amount of loan outstanding (Rs)
1	Commercial banks	99,516	7.3	55,510	41,094	7.2	35,623
2	Co-operative Credit Societies	1,00,378	7.4	77,490	77,283	7.2	59,132
3	Other banks	2,653	12.0	265	0	0	0
	Total	2,02,546	7.4	1,33,265	1,18,377	7.2	94,755

Source: Field Survey

Table 4.4c: Agricultural Credit Outstanding by the Sample Households (2015-16) -Pvt PINS

Sr. No.	Sources	Beneficiary Farmers			Non-beneficiary Farmers		
		Amount of loan taken (Rs)	Rate of interest (%)	Amount of loan outstanding (Rs)	Amount of loan taken (Rs)	Rate of interest (%)	Amount of loan outstanding (Rs)
1	Commercial banks	5,00,000	10.3	3,20,000	88,889	5.5	88,889
2	Co-operative Credit Societies	2,31,240	2.9	56,840	86,111	4.625	84,444
	Total	7,31,240	5.8	3,76,840	1,75,000	4.8	1,73,333

Source: Field Survey

The purposes of credit taken by farmers are mainly classified in to three categories: for seasonal crop cultivation, purchase of farm machinery or implements and non-farm expenditure. The purpose of loan availed is shown in table 4.5. About 70-90 % of BFs (govt, coop and pvt PINS) took credit for seasonal crop cultivation, while 8 % of govt, 30% of coop and 17 % pvt PINS BFs used loan for purchase of farm machinery or equipments, while only 2-3 % of BFs used loan for non-farm purposes. Regarding the NBFs, most (80-90%) of them used the loan for non-farm purpose. Overall this findings show that most of BFs used loan productive purpose, while majority of NBFs used loan for non-farm non-productive purposes. It is bit difficult to find out the reasons behind this behavior of farmers.

Table 4.5: Purpose of agricultural loan availed (2015-16)

Sr. No.	Purpose	Beneficiary Farmers % to total farmers			Non-beneficiary Farmers % to total farmers		
		Govt PINS	Coop PINS	Pvt PINS	Govt PINS	Coop PINS	Pvt PINS
1	Seasonal crop cultivation	89.19	69.13	80.85	1.9	0	20
2	Purchase of tractor and other implements, livestock	8.11	28.86	17.02	7.5	4.5	0
3	Consumption expenditure, marriage and social ceremonies etc.	2.70	2.01	2.13	90.6	95.5	80
	Total Farmers	100	100	100	100	100	100

Source: Field Survey

4.4: Reasons behind adoption of PINS

The main water sources of irrigation are canal, well, tank and river. The source of irrigation for all govt PINS was tanks/storages, for coop PINS sources were river and storages/tanks⁹ on the rivers, and for pvt PINS the sources were well and river. For NBF the sources of water were well, tank and river. Unfortunately not a single farmer in beneficiary or non-beneficiary group reported that they used canal as irrigation source. Since, most of the canals in Maharashtra were not providing water through the years, most of the PINS sources of water were tank, river or well, and therefore the non PINS farmers were also not depending on the canal as a source of water for farming. Overall it indicated that farmers prefer assured irrigation water source for installing PINS.

Table 4.6: Sources of Irrigation*(% of net irrigated area)*

Sr. No	Particulars	Govt PINS		Coop PINS		Pvt PINS	
		BF	NBF	BF	NBF	BF	NBF
1	Canal	0	0	0.0	0	0	0
2	Open/ dug well	0	91.2	0.0	67.5	67.3	100
3	Tube- well	0	2.7	0.0	18.8	0.0	0
4	Tank	100	0	47.3	0.7	0.0	0
5	River	0	6.1	52.7	13	32.7	0

Source: Field Survey

⁹ These are the storages created by weirs on the rivers, these weirs are usually weir-cum-bridges types known in Maharashtra as Kolhapur-type-weirs(Kolhapur is the district, wherein these were first introduced in 1950s.

The distribution of farmers according to area under PINS is shown in table 4.7. Around 90% of govt PINS farmers' area under PINS was between 2.5-5 acres, while 10% farmers' area under PINS was between 1-2.5 acres. About govt PINS farmers, around 40% of farmers' area under PINS was between 2.5-5 acres, 30 farmers between 1-2.5 acres, 17% farmers between 5-10 acres, 11% farmers less than 1 acre and 3% more than 10 acres. About pvt PINS farmers' 50% farmers area under PINS was more than 5 acres, and around 20% farmers area under PINS was less than 2.5 acres, while 30 % farmers' area under PINS was between 2.5-5 acres. Overall it suggests that govt PINS farmers were small and marginal farmers, while coop PINS farmers were mostly small and medium, while majority of pvt PINS farmers were big medium and large farmers.

Table 4.7: Distribution of farmers according to area under PINS

Sr. No.	Area under PINS (Area in acre)	Govt PINS (% farmers)	Coop PINS (% farmers)	Pvt PINS (% farmers)
1	Up to 1 .0	0.0	11.0	1.8
2	1.01-2.50	10.3	31.0	21.4
3	2.51 to 5.00	89.7	38.1	28.6
4	5.01 to 10.00	0.0	16.8	17.9
5	10.01 or more	0.0	3.2	30.4

Source: Field Survey

Classification of average area under PINS project by farmer category is shown in table 4.8. About the govt PINS farmers under marginal farmers class the average area was 2.5 acres and under small farmers 4.2 acres. Regarding the coop PINS farmer average area under the large farmer class was 14.6 acres, and under medium farmer class 7.2 acres. About the pvt PINS farmer under the large farmers class the average area was around 26 acres, under medium class around 7 acres, under small class 3.6 acres and under marginal class 2 acres.

Table 4.8: Average area under PINS Project by farmer category

(in acres)

Sr. No	Farmer category	Govt PINS	Coop PINS	Pvt PINS
1	Marginal (up to 2.50 ac)	2.5	1.7	2.0
2	Small (2.51 to 5.0 ac)	4.2	4.0	3.6
3	Medium (5.01 to 10.0)	0.0	7.2	7.3
4	Large (>10.0)	0.0	14.6	25.9

Source: Field survey

The cost of PINS is the most important factors for making decisions regarding adoption of PINS. Expenditure on PINS project is shown in table 4.9. Since, the govt PINS projects were around 100% funded by the government, there was no cost for the farmers. Regarding the coop PINS farmers, average expenditure was Rs. 47,200 on PINS project, and there was no considerable variation on the expenditure on PINS across the landholding class of farmers. About the pvt PINS farmer the expenditure on PINS project was Rs. 87,325 on PINS project and there was not much variation across the farmers' landholding class. These findings suggest that being a part of cooperative system could save PINS project cost by around 50%.

Table 4.9: Amount spent on PINS project

(Rs/acre)

Sr. No.	Farmer category	Govt PINS*	Coop PINS	Pvt PINS
1	Marginal (up to 2.50 acres)	0	45,616	87,495
2	Small (2.51 to 5.0 acres)	0	34,250	97,118
3	Medium (5.01 to 10.0 acres)	0	49,350	87,945
4	Large (>10.0 acres)	0	49,370	83,265
	All farmers	0	47,200	87,325

Note:* Around 100% Subsidy for Govt PINS

Source: Field Survey

The reasons for adoption of PINS are shown in Table 4.10 a-c. Total 39 farmers' responses are noted in the table. About the govt PINS farmers, most of the farmers reported three most important reasons for adoption of PINS; to get assured amount of water for irrigation, to get better and stable yield and farm income, and to save water so that more area can come under irrigation. Among all these three reasons the first reason was the prime motive behind the joining of PINS. Farmers also reported for other two reasons; avoid conflicts among farmers and

efficient distribution of water among the farmers, but these reasons were not strongly supported. Total 155 farmers responses were noted for the reasons behind adopting coop PINS. Around 80% farmers strongly reported that assured water for irrigation was the reason for PINS adoption. While around 50% farmers strongly agreed that they adopted coop PINS to get better and stable yield, and to save water so that they can cover more area under irrigation. Around 30% respondents strongly agreed that they adopted PINS to avoid conflicts among farmers and efficient distribution of water among the farmers.

Total 56 pvt PINS adopter farmers' responses were noted for the reasons behind adopting coop PINS. More than 80% farmers strongly reported that they adopted pvt PINS to get assured water for irrigation and get better and stable yield. While around 40% farmers strongly agreed that they adopted pvt PINS to save water so that they can cover more area under irrigation. While to avoid conflicts among farmers and efficient distribution of water among the farmers were not at all important reasons for them.

Overall the findings about the reasons for adoption of the PINS under different category suggests that reasons to adopt govt PINS and coop PINS were nearly the same except for the coop PINS additional important reason was to avoid conflict among the farmers. While the reasons for adopting pvt PINS were to get assured water, better yield and saving of water to cover more area under irrigation. It shows that pvt PINS adopter farmers were interested in personal benefits rather than community based benefits.

Table 4.10 a: Reasons behind adoption of PINS MIS -Govt PINS

Sr. No.	Reasons	(1-5; strongly agree to strongly disagree), multiple responses possible. (% of farmers agreed)				
		1	2	3	4	5
1	To get assured amount of water for irrigation	43.6	28.2	23.1	2.6	0.0
2	To get better and stable crop yield and farm income	17.9	46.2	25.6	5.1	0.0
3	To save more water and to cover more area under irrigation thereby	28.2	30.8	12.8	2.6	2.6
4	To avoid unnecessary conflicts with other farmers	7.7	10.3	38.5	2.6	2.6
5	To facilitate judicious or efficient distribution of water among the water users	7.7	20.5	33.3	2.6	0.0

Source: Field survey

Table 4.10 b: Reasons behind adoption of PINS MIS -Coop PINS

Sr. No.	Reasons	(1-5; strongly agree to strongly disagree), multiple responses possible(% of farmers agreed)				
		1	2	3	4	5
1	To get assured amount of water for irrigation	80.6	9.0	5.2	0.0	1.3
2	To get better and stable crop yield and farm income	57.4	36.8	2.6	1.3	0.0
3	To save more water and to cover more area under irrigation thereby	49.0	21.9	12.3	2.6	0.0
4	To avoid unnecessary conflicts with other farmers	29.7	11.6	16.1	9.7	1.9
5	To facilitate judicious or efficient distribution of water among the water users	34.2	18.1	14.2	3.2	5.2

Source: Field survey

Table 4.10 c: Reasons behind adoption of PINS MIS -Pvt PINS

Sr. No.	Reasons	(1-5; strongly agree to strongly disagree), multiple responses possible (% of farmers agreed)				
		1	2	3	4	5
1	To get assured amount of water for irrigation	96.4	3.6	0.0	0.0	0.0
2	To get better and stable crop yield and farm income	82.1	17.9	0.0	0.0	0.0
3	To save more water and to cover more area under irrigation thereby	39.3	46.4	10.7	0.0	1.8
4	To avoid unnecessary conflicts with other farmers	0.0	3.6	1.8	0.0	1.8
5	To facilitate judicious or efficient distribution of water among the water users	1.8	1.8	0.0	1.8	0.0

Source: Field Survey

4.5: Benefits accrued by participating in WUA

The benefits realizations of joining WUA are presented in table 4.11. Around 60% of the farmers who joined WUA under the govt PINS reported that there was an increase in area under irrigation, farm income and water saving by more than 35%, further; only 30% responded that there was around 35% saving in electricity. Regarding the coop PINS farmers, majority of them agreed that there was an increase in area under irrigation, farm income, water saving and electricity saving. Because of joining WUA under the coop PINS, the area under irrigation increased by 64%, income increased by 40%, water saved by 32% and electricity saved by 21%. Around 20-35% of the farmers reported indirect benefits of joining of WUA under pvt PINS such as; timely information regarding water release, information on judicious use of water, information on crops and less conflict. More than 70% of the coop PINS WUA participant reported indirect benefits such as timely information regarding water release, information on judicious use of water, information on crops and less conflict. Overall it shows that joining the WUA under coop PINS benefits farmers more than the govt PINS farmers, may be because under coop PINS the management might be working better than under the govt PINS.

Table 4.11: Benefits accrued by participating in WUA

Sr. No.	Benefits accrued	Govt PINS		Cooperative PINS	
		% farmers benefited	Extent of benefit (% increase)	% farmers benefited	Extent of benefit (% increase)
1	Area under irrigation has increased	69.2	63.7	95.5	64.29
2	Agricultural income has increased	61.5	34.6	96.8	40.51
3	Water saving due to judicious use of water	59.0	36.7	96.1	32.82
4	Electricity saving	30.8	37.9	72.9	21.32
5	Water arrives in time	23.1	--	91.6	--
6	Timely information on release of water from canal	23.1	--	87.7	--
7	More information on how to use water judiciously	28.2	--	89.7	--
8	proper distribution of water among farmers	23.1	--	91.6	--
9	Less conflicts around water or less water theft	25.6	--	76.1	--
10	More information on crops and technologies	30.8	--	81.3	--
11	Improved maintenance of the system	10	--	11.9	--

Source: Field survey

4.6: Farmers' Awareness and perceptions about functioning of WUA

Farmers' awareness and perceptions about the functioning of WUA is shown in table 4.12. Only around 50% of the govt PINS WUA members were aware about the rules and regulations of WUA and awareness about the WUA office bearer, while regarding coop PINS WUA members' majority of them were aware about the rules and regulations of WUA and awareness about the WUA office bearer. Regarding the political influence on selection of WUA office bearer, around 25% coop PINS WUA members see political influence, while only 10% govt PINS WUA member see the political influence, further those who responded yes for political influence were asked whether the influential persons take all major decision, around 40% of the coop PINS and 25% of the govt PINS members responded that influential persons use to make important decisions. Regarding the payment of operations and maintenance (O&M) cost of PINS around

98% of the respondents paid it regularly, while 62% paid annually and 38% paid after harvest of the crops. Since the govt PINS were around 100% funded by the govt, there was no question about payment of operation and maintenance cost.

As far as the findings about the awareness and perception about the functioning of the WUA are concerned, it can be seen that majority (80-96%) of the members of the coop PINS WUA were aware about the functioning, while the awareness among the govt PINS was comparatively not good. This might be because in govt PINS there was no cost to farmers, while it was there in coop PINS, since farmers have to pay in coop PINS, they might be interested to know how their money were utilized, hence they might be keeping themselves informed, while in case of govt PINS, there was no cost to farmers, hence they might not be interested in knowing functioning of WUA. Nearly all of the coop PINS WUA members paid O&M cost regularly, might be because they have understood the importance of the regular water supply and also to avoid the criticism in the society for not paying the bills.

Table 4.12: Farmers’ awareness and perceptions about functioning of WUA

Sr. No.	Particulars	Coop PINS (% farmers with positive response)	Govt PINS (% farmers with positive response)
1	Do you know rules and regulations of WUA	96.13	53.85
2	Do you know who are the office bearers of WUA	81.94	51.28
3	Do you see any influence of political parties in selection of office bearers of WUA	24.52	10.26
4	If yes, whether influential persons in WUA take all major decisions regarding activities of WUA	39.47	25.00
5	Do you pay operation and maintenance cost of PINS project and water rates regularly	97.42	0.00
	If Yes, It is paid:		
a	Annually	61.94	0.00
b	half-yearly	0.00	0.00
c	Quarterly	0.00	0.00
d	After Harvesting	38.06	0.00

Source: Field survey

The reasons for non-payments of operation and maintenance (O&M) cost are shown in table 4.13. Regarding the non-payment issue of O&M cost of PINS, we found that since the govt PINS were around 100% funded and maintained by govt, there was no cost to farmers, while regarding the coop PINS all farmers were paying charges timely, and for pvt PINS, since, the ownership was individual, there was no question about non-payment of O&M cost.

Table 4.13: Reasons for non-payment of operation and maintenance costs of PINS

Sr. No.	Reasons	Govt PINS	Cooperative PINS	Pvt PINS
1	Did not get enough water	Since, it was around 100% funded by the govt, there was no cost to farmers.	Around 98% of the farmers paid the cost regularly	Not Applicable, since the ownership was individual.
2	MIS system did not work			
3	PINS Project implementation was defective and did not work			
4	Not satisfied with maintenance of the system			
5	Crop failure due to natural calamities			
6	Crop failure due to pest attack			
7	Crop output was not sold in time			
8	Good price of crop output was not realized			
9	Heavy household consumption			
10	Any other (please mention)			

Source: Field survey

Locations of the plots in the command area of the PINS projects and sufficiency of irrigation water are shown in table 4.14. Around 50% of the plots were in middle region, 30% plots were at the tail region and remaining were at the head region of both the gov and pvt PINS schemes. Around 93% of the farmers in govt PINS projects were getting water throughout the year; while only 32% of the farmers in coop PINS were getting water throughout the year. Moreover, it was also reported that for a period of three months farmers were not getting sufficient water. From these findings it looks like that the majority of farmers under govt PINS were getting sufficient water but very few farmers under the coop PINS were getting sufficient water. This might be

because the govt PINS were on more assured source of water than the coop PINS. It was also reported that for one season both govt and Pvt PINS farmers were facing water problem.

Table 4.14: Location of plot in the command area of the PINS project and sufficiency of irrigation water

Sr. No.	Particulars	Govt PINS (% farmers agreed)	Coop PINS (% farmers agreed)
1	Location of plot under PINS:		
a	Head region	25.2	12.8
b	Middle region	46.5	56.4
c	Tail region	28.4	30.8
2	Do you get sufficient water throughout the year		
a	% farmers not getting sufficient water throughout the year	92.31	32.90
b	% of months not with sufficient water (months)	25.00 (around 3 months)	33.33 (around 3 months)

Source: Field survey

The reasons for insufficient supply of water to farm plot are shown in table 4.15. Regarding the govt PINS farmers the most important reasons for the inadequate supply of water were inadequate water at the source of water for PINS (around 86% farmers reported this reason), followed by inefficient functioning of PINS system(66% farmers reported), water theft (58% farmers reported) and poor rainfall (43% farmers reported). Regarding the coop PINS, farmers reported that inadequate water at the sources (63% farmers reported) and poor rainfall (41% farmers reported) were the main reasons for insufficient supply of water for PINS.

It can be noted from these findings that most important reasons for inadequate supply of water were the inadequate water availability in the water source for PINS and poor rainfall, moreover, for govt PINS inefficient functioning of the PINS system was also an additional reason.

Table 4.15: Reasons for inadequate supply of water to the farm plot

(Multiple responses, % of farmers agreed)

Sr. No.	Reasons	Govt PINS	Coop PINS
1	Water availability is inadequate in canal/river/tank/tube well	86.1	62.7
2	PINS system is not functioning properly	66.7	11.8
3	MIS fitted on my land is not functioning properly.	7.8	0.0
4	Non-payment of water rate and maintenance charges by the member	16.7	0.0
5	Wastage of water due to mismanagement of water distribution by WUA members	22.2	2.0
6	Partiality in water distribution by WUA members	14.3	0.0
7	Unresolved conflicts among WUA members	17.1	0.0
8	Water theft by others	58.3	21.6
9	Land is located in tail region	8.6	11.8
10	Poor rainfall	42.9	41.2

Source: Field survey

Table 4.16 presents major reasons for the conflicts among the water users. Overall there were very few responses for conflicts among the users. The coop PINS farmers reported that inadequate water availability, mismanagement and unresolved conflicts among the WUA members were the main reasons for conflict. While govt PINS farmers reported that there was only one reason; unresolved conflicts among the WUA members. This shows that the conflicts among the PINS users were not a serious issue.

4.16: Major causes of conflicts among water users/WUA members

(% of farmers agreed)

Sr. No.	Causes of conflicts in water distribution	Govt PINS	Coop PINS
1	Water availability is inadequate	0.0	13.0
2	Mismanagement / Partiality in water distribution by WUA members	0.0	1.7
3	Unresolved conflicts among WUA members	2.6	0.9
4	Different political affiliation of WUA office bearers and WUA members	0.0	0
5	Any other (please elaborate)	0.0	0

Source: Field survey

4.7: Details of Adoption of PINS and MIS

Table 4.17 summarizes adoption of micro irrigation systems (MIS) under the PINS programs. From table it can be seen that all of govt PINS farmers adopted drip irrigation system because it was mandatory for them to have micro-irrigation. For coop PINS around 55% of the farmers adopted drip irrigation and 20% adopted sprinkler and remaining were using flood irrigation method. All of the pvt PINS farmers were using drip irrigation system. Average area under drip irrigation of the govt PINS farmers was 4.3 acres per household. Coop PINS farmers average area under drip irrigation was 3.5 acres and average area under sprinkler was 4.6 acres. Average area under drip irrigation of the pvt PINS farmer was 11 acres. The total cost of the drip under govt PINS was around Rs 20,000, which was very low, the reason was that in this case the manufacturers of the drip system provided the system at very low rates i.e. 20,000 Rs/acre. Moreover they received special subsidies from govt from different department, which counted to total subsidy of 90% for the drip system. Hence, the final contribution of the farmers was around 2000 Rs/acre for drip irrigation system. Under the coop PINS the average cost of the drip irrigation system was around 50,000 Rs/acre and for sprinkler it was 8863 Rs/acre. The average cost of drip irrigation system under pvt PINS was 48,306 Rs/acre. For drip irrigation system farmers under coop PINS received 19% subsidy, while under pvt PINS they received 25% subsidy. For sprinkler the subsidy received was 54% of the total cost of the system, which was higher because the installation was quite old, at that time the subsidy was at higher rate. The variation in subsidy was because the farmers were not getting the subsidy immediately after the installation of the system, hence, the farmers received subsidy only for some area under drip irrigation at the time of survey. Farmers reported that they were not getting subsidy on time, in some cases they have to wait for 2-3 years.

Table 4.17: Adoption of Micro Irrigation Systems (MIS) under PINS Programs

Sr. No.	Type of MIS used	Category Of PINS	% of farmers used	Average area under MIS (Acre/hh)	Total cost of the system (Rs/hh)	Amount paid by the farmers (Rs/Acre)	Subsidy (%)*	Total cost of the system (Rs/Acre)	Amount paid by the farmers (Rs/Acre)	Who gives the subsidy	Name of the subsidy programme
1	Drip	govt	100	4.3	85,707	8,620	90	19,707	1,982	State govt	NMMI
		coop	55.5	3.5	1,77,419	1,43,543	19	50,197	40,613	State govt	NMMI
		pvt	100	11.0	5,29,643	3,99,064	25	48,306	36,397	State govt	NMMI
2	Sprinkler	coop	20.6	4.6	41,066	18,849	54	8,863	4,068	State govt	NMMI

Note:*The variation in subsidy received by the farmers was because they received subsidy only for some part of area under drip at the time of survey, while for remaining part they were waiting for subsidy to receive.

Source: Field survey

Table 4.18 presents distribution of farmers according to subsidy received on MIS. Since, the govt PINS scheme was funded by the state govt., all of the farmers received 90% subsidy on MIS. Regarding the coop PINS farmers, around 15% of drip adopter and 7% of sprinkler adopter have not received any subsidy. Around 50% of the drip adopter under coop PINS received subsidy between 25-50%, while around 30% received subsidy up to 25%. Around 75% of the sprinkler adopter under the coop PINS received subsidy between 25-30%. Regarding the drip adopter under the pvt PINS, 33% adopter were without any subsidy, 35% were with subsidy up to 25%, and around 30% were with 25-50% subsidy. Overall it shows that considerable numbers of farmers were without subsidy. Since, initially farmers have to bare entire cost, which is quiet high amount for them, and the farmers get subsidy after long period of installation of MIS. This might be the major reason for farmers not to go for MIS. Hence, there should be some mechanism, so that farmers get subsidy on time.

Table 4.18: Distribution of farmers according to subsidy received on MIS

Sr. No.	Subsidy Received on MIS	(% farmers)			
		Govt PINS	Coop PINS		Pvt PINS
		Drip	Drip	Sprinkler	Drip
1	0 per cent	0	14.3	6.5	33.9
2	1 to 25 per cent	0.0	28.6	0.0	35.7
3	25- 50 per cent	0.0	46.8	74.2	28.6
4	50 -75 per cent	0.0	7.8	6.5	1.8
5	More than 75 per cent	100	2.6	12.9	0.0
	All farmers	100	100	100	100

Source: Field survey

Table 4.19a presents crop wise coverage of MIS under the govt PINS. The main crops grown under the govt PINS were soybean(48 acre), soybean tur mix cropping(59 acre) and cotton (56 acre), while crops such as tur, cotton tur mix cropping, vegetables and ground nut were grown at small scale. For all the crops the drip irrigation was used, and the drip spacing used was 5feet x1.25 feet. The govt PINS projects were in the Vidharbha region of Maharashtra state, hence the main crops (soybean, cotton and tur) of this region were dominating in the list of the crops under the govt drip PINS. The cost structure was around 20,000 Rs/acre irrespective of the crops grown. Which was quiet lower than the state governments cost norms; the reason might be that since most of the project was funded by the govt.

The crop wise coverage of MIS under coop PINS is show in table 4.19b. 15 types of different crops were grown under the coop PINS i.e. soybean, soybean intercrop, cotton, groundnut, mung, udid, corn, various types of vegetables, wheat, gram, jowar, turmeric, onion, grape and sugarcane. The main crops grown were sugarcane, soybean, wheat and grapes. The methods of irrigation used were drip and sprinkler. The spacing of drip system varied as per the crops, while the sprinkler spacing was 15 feet x 30 feet. Since, sprinkler sets can be moved in the farm plot, most of the time farmers followed this, which leads to reduction in the cost of sprinkler sets. The cost of sprinkler for all the crops was 8,863 Rs/acre. For all crops cost of sprinkler irrigation system was lower than cost of drip irrigation set. The cost of drip irrigation set was highest for soybean crop i.e. Rs. 52,222/acre, followed by corn (Rs. 50,467/acre), grapes (Rs. 48,781/acre) and sugarcane (Rs. 48,093/acre), while the lowest cost was for wheat Rs.30,000 Rs/acre. These

costs were quiet high as compared to the cost norms given by the state agricultural department for drip system i.e. cost of the drip system for a crop spacing of 1.8 m x 0.6 m crop was Rs. 31,028 /acre¹⁰. The cost of the portable sprinkler was Rs. 10,074 /acre¹ as per state govt norms, which was bit on higher side than the cost reported in our studies. Overall it shows that the costs of the drip system were higher than the cost norms set by the state govt for subsidy purposes.

Table 4.19a presents crop wise coverage of MIS under pvt PINS. Under pvt PINS, the major crops cultivated by the farmers were maize, fodder, wheat, sugarcane, vegetables, grape, pomegranate, banana and other horticultural crops, among these highest area was under the pomegranate (160 acre) and grape (237 acre). All farmers were using only drip irrigation system. The drip system spacing was varied as per the crops. Highest cost of drip system was reported for sugarcane crop i.e. Rs. 61,057 /acre, followed by horticultural crops (Rs. 55,000 /acre) and lowest was reported for maize and fodder crops (Rs. 30,000 /acre). Here it is reported that the costs were higher than the state govt norms for drip systems.

We have found that the costs of the drip systems were higher under coop and pvt PINS than the govt norms. Therefore it is suggested that the cost norms for drip irrigation system may be revised so that the farmers can afford the drip irrigation system.

Table 4.19a: Crop wise coverage of Micro Irrigation Systems (MIS) under govt PINS

Sr. No	Name of crops	Spacing Row x Plant (ft x ft)	Type of MIS	Total area irrigated (Acre)	Total Cost (Rs.)
1	Soybean	5 X 1.25	Drip	48.08	947531
2	Tur	5 X 1.25	Drip	8.92	175790
3	Soybean+ Tur	5 X 1.25	Drip	59.08	1164312
4	Cotton	5 X 1.25	Drip	56.05	1104599
5	Cotton +Tur	5 X 1.25	Drip	12.3	242401
6	Vegetables	5X 1.25	Drip	2.25	44342
7	Ground Nut	5 X 2.0	Drip	5.92	116668

Source: Field Survey

¹⁰ Department of agriculture, Govt. of Maharashtra. http://mahaethibak.gov.in/ethibak/r_costnorms.php#

Table 4.19b: Crop-wise coverage of Micro Irrigation Systems (MIS) under coop PINS

Sr. No.	Name of crops	Spacing Row x Plant (Feet x Feet)	Type of MIS	Total area irrigated (Acre)	Total Cost	Per Acre Cost
1	Soybean	5 X 1.5	Drip	7	365554	52222
		15 X 3.0	Sprinkler	19.75	175054	8863
2	Soybean (Intercrop Tur)	5 X 1.5	Drip	--	--	--
		15 X 3.0.	Sprinkler	133.78	1185757	8863
3	Cotton	5 X 1.5	Drip	--	--	--
		15 X 30.	Sprinkler	1	8863	8863
4	Ground nut	5 X 2	Drip	6.5	301230	46343
			Sprinkler	--	--	--
5	Mung		Drip	--	--	--
		15 X 3.0	Sprinkler	2	17727	8863
6	Udid		Drip	--	--	--
		15 X 3.0	Sprinkler	1	8863	8863
7	Turmeric	5 X 1.5	Drip	3.5	--	--
			Sprinkler	--	--	--
8	Corn	5 X 1.5	Drip	1.5	75701	50467
			Sprinkler	--	--	--
9	Vegetables	5X 1.5	Drip	7.18	350248	48781
			Sprinkler	--	--	--
10	Wheat	5 X 1.5	Drip	1	30000	30000
		15 X 3.0	Sprinkler	37.5	332381	8863
11	Gram		Drip	4	--	--
		15 X 3.0	Sprinkler	25	221587	8863
12	Jowar		Drip	--	--	--
		15 X 3.0	Sprinkler	1	8863	8863
13	Onion (Seed)		Drip	--	--	--
		15 X 3.0	Sprinkler	10.53	93332	8863
14	Grape	8.5 X 5	Drip	47.11	2298073	48781
			Sprinkler	--	--	--
15	Sugarcane	6 X 2	Drip	224.13	10779084	48093
			Sprinkler	--	--	--

Source: Field survey

Table 4.19c: Crop-wise coverage of Micro Irrigation Systems (MIS) under pvt PINS

Sr. No.	Name of crops	Spacing Row x Plant (Ft x Ft)	Type of MIS	Total area irrigated (Acre)	Total Cost (Rs)	Per Acre Cost (Rs)
1	Maize	5 X 1.25	Drip	7	210000	30000
2	Fodder	5 X 1.5	Drip	5	150000	30000
3	Vegetables	5 X 1.5	Drip	16.5	747879	45326
4	Wheat	5 X 1.5	Drip	12	360000	30000
5	Sugarcane	6 X 2	Drip	72	4396104	61057
6	Grape	8.5 X 5	Drip	237	10384866	43818
7	Pomegranate	12 X 9	Drip	159.93	5766436	36056
8	Banana	7 X 5	Drip	17	935000	55000
9	Other Horticulture	12 X 10	Drip	29.5	1622500	55000

Source: Field survey

4.8: Operation and Maintenance Costs incurred by farmers on PINS and MIS

The annual operating costs of cultivation (A2+FL) with govt PINS MIS for Kharif season crops are presented in table 4.20a. The main crops were soybean, tur, cotton and vegetables. The operating cost was higher for vegetables (Rs. 36,133 /acre), followed by cotton (Rs. 25,387 /acre) and tur (Rs. 20,947 /acre) and soybean (Rs. 20,270 /acre). The major cost components were seed, pesticide and fertilizers and land preparation.

Table 4.20b shows the annual operating cost of cultivation (A2+FL) with coop PINS MIS for kharif season crops. The main crops cultivated by farmers during kharif season were, soybean, tur, groundnut, mung, urid, cotton, turmeric, corn and various vegetables. The highest operating cost was reported for turmeric (Rs. 1,22,600 /acre), followed by vegetables (Rs. 68,717 /acre), corn (Rs. 48,000 /acre), groundnut (Rs. 26,523 /acre), cotton (Rs. 15,545 /acre) and soybean (Rs. 14,200 /acre). The major cost components were seed, pesticide and fertilizers and land preparation.

The annual operating costs of cultivation (A2+FL) with pvt PINS MIS for kharif season crops are presented in table 4.20c. The main crops were soybean, maize, fodder crops and vegetables. The highest operating cost was for vegetables (Rs. 84,475 /acre), followed by soybean (Rs.

16,719 /acre), maize (Rs. 15899 Rs/acre) and fodder (Rs. 7620 /acre). For soybean, maize and vegetables the major costs were seed, land preparation, pesticide, weeding and harvesting. While for, fodder the major costs were land preparation seed and weeding.

Overall these findings show that the crops under PINS MIS during kharif season were soybean, tur, cotton, groundnut, mung, udid, turmeric, corn, fodder crops and various types of vegetables. The highest operating cost was reported for turmeric (Rs. 1,22,600 /acre), and vegetables (Rs. 84,475 /acre). While for most of the kharif season crop the major cost components were seed, pesticide and fertilizers and land preparation.

Table 4.20a: Annual operating cost of cultivation (A2+FL) with govt PINS MIS (Kharif season)

(Rupees per Acre)

Sr. No	Operating Cost	Soybean	Tur	Soybean (Intercrop Tur)	Tur (Intercrop Soybean)	Cotton	Cotton (Intercrop Tur)	Tur (Intercrop Cotton)	Vegetables
1	Crop Area	48.1	9	59.1	59.1	56.1	12.3	12.3	2.3
2	Land preparatory work	3,700	3,070	1,662	1,662	3,093	2,500	2,500	2,489
3	Seed and seed sowing	2,941	1,927	2,188	1,547	2,652	3,750	1,216	3,200
4	Fertilizers/FYM	2,722	2,420	1,091	1,708	4,527	3,374	3,374	8,222
5	Pesticides	3,518	6,633	1,148	2,079	3,764	2,398	2,398	2,889
6	Labour cost on fertilizer/pesticide application	1,368	1,020	530	1,285	3,295	232	232	10,444
7	Weeding and intercultural	2,156	2,717	604	1,416	3,244	1,699	1,699	2,267
8	Irrigation water rate	0	0	0	0	0	0	0	2,667
9	PINS and MIS maintenance, repair and replacement cost	78	112	76	127	375	0	0	0
10	Annual energy cost of pumping	0	0	0	41	0	0	0	1,156
11	Labour charges for irrigation	458	0	80	118	375	0	0	0
12	Harvesting cost	2,431	1,782	1,658	1,740	2,767	1,951	2,114	1,111
13	Marketing cost	389	1,042	460	239	1,046	325	203	1,689
14	Others	510	224	34	0	250	0	0	0
	Total	20,270	20,947	9,529	11,961	25,387	16,230	13,736	36,133

Source: Field survey

Table 4.20b: Annual operating cost of cultivation (A2+FL) with coop PINS MIS (Kharif season)

Sr. No.	Operating Cost	(Rupees per acre)										
		Soybean	Soybean (Intercrop Tur)	Tur (Intercrop Soybean)	Ground Nut	Mung	Udid	Cotton	Turmeric	Corn	Vegetables	
1	Crop Area	65.2	187.0	187.0	6.5	8.75	5.0	15	3.5	1.5	7.7	
2	Land preparatory work	2,771	1,333	1,205	3,185	3,074	3,400	2,247	4,314	5,000	9,941	
3	Seed and seed sowing	2,401	2,675	887	3,192	1,497	2,260	1,847	42,143	10,000	9,290	
4	Fertilisers / FYM	2,731	1,045	1,505	3,554	1,566	1,400	3,597	24,286	5,000	13,792	
5	Pesticides	1,182	319	767	1,723	823	790	3,007	3,857	2,000	10,065	
6	Labour cost on fertiliser/pesticide application	643	499	943	431	343	230	767	15,000	10,000	8,756	
7	Weeding and intercultural	1,108	299	512	1,046	811	1,570	910	3,429	0	4,313	
8	Irrigation water rate	1,160	526	186	7,231	177	180	372	10,714	6,000	4,091	
9	PINS and MIS maintenance, repair and replacement cost	144	65	18	3,492	0	0	0	571	0	2,606	
10	Annual energy cost of pumping	130	59	0	0	0	0	100	1,429	0	0	
11	Labour charges for irrigation	73	518	274	308	0	0	0	0	0	0	
12	Harvesting cost	1,685	1,867	1,154	2,300	1,200	1,000	2,460	16,857	10,000	2,150	
13	Marketing cost	171	266	226	62	326	320	240	0	0	2,150	
14	Others	0	1,314	668	0	0	0	0	0	0	1,564	
	Total	14,200	10,786	8,344	26,523	9,817	11,150	15,545	1,22,600	48,000	68,717	

Source: Field survey

Table 4.20c: Annual operating cost of cultivation (A2+FL) with pvt PINS MIS (Kharif season)

(Rupees per Acre)					
Sr. No.	Operating Cost	Soybean	Maize	Fodder	Vegetables
	Crop Area (Acre)	20.0	27.3	5.0	17.5
1	Land preparatory work	3,650	3,589	1,800	7,829
2	Seed and seed sowing	2,660	2,651	900	13,329
3	Fertilizers/FYM	1,568	3,028	0	13,232
4	Pesticides	1,050	1,083	0	12,686
5	Labour cost on fertilizer/pesticide application	610	710	0	8,171
6	Weeding and intercultural	1,553	2,090	3,600	5,491
7	Irrigation water rate	0	0	0	3,486
8	PINS and MIS maintenance, repair and replacement cost	1,200	84	200	1,200
9	Annual energy cost of pumping	0	440	727	4,286
10	Labour charges for irrigation	1,475	128	293	86
11	Harvesting cost	2,775	1,321	100	7,829
12	Marketing cost	119	139	0	3,480
13	Others	60	635	0	3,372
	Total	16,719	15,899	7,620	84,475

Source: Field survey

Table 4.21b presents annual operating cost of cultivation of rabi season crops with coop PINS MIS. The main crops grown were wheat, gram and jowar. The average operating cost of gram was (11,231 Rs/acre), wheat (8278 Rs/acre) and jowar (6465 Rs/acre). The major cost components were seed, land preparation and fertilizers.

Annual operating cost of cultivation of rabi season crops with pvt PINS MIS is shown in table 4.2c. Main crops cultivated in rabi season were wheat jowar, gram and onion. The operating costs of onion was 42,923 Rs/acre, gram 18,000 Rs/acre, wheat 11814 Rs/acre and jowar 11,680 Rs/acre. The major cost components were seed, fertilizer, and weeding and land preparation.

It can be seen from the findings that the in rabi season main crops cultivated were gram, onion, wheat and jowar under the PINS MIS. The main cost components were seed, fertilizer, and weeding and land preparation.

4.21a: Annual operating cost of cultivation (A2+FL) with coop PINS MIS -Rabi season

(Rupees per Acre)

Sr. No.	Operating Cost	Wheat	Gram	Jowar
	Crop Area (Acre)	90.5	41.0	19.5
1	Land preparatory work	1,635	2,144	1,885
2	Seed and seed sowing	1918	2,078	706
3	Fertilizers/ FYM	1576	1,207	856
4	Pesticides	144	2,315	667
5	Labour cost on fertilizer /pesticide application	212	229	77
6	Weeding and intercultural	456	355	497
7	Irrigation water rate	582	788	95
8	PINS and MIS maintenance, repair and replacement cost	2.21	5	0
9	Annual energy cost of pumping	0.00	0	0
10	Labour charges for irrigation	215	137	256
11	Harvesting cost	1,295	1,752	1,087
12	Marketing cost	245	222	246
13	Others	0.00	0	92
	Total	8,278	11,231	6,465

Source: Field survey

Table 4.21b: Annual operating cost of cultivation (A2+FL) with pvt PINS MIS-Rabi season

(Rupees per Acre)

Sr. No.	Operating Cost	Wheat	Jowar	Gram	Onion
	Crop Area (Acre)	36.0	5.0	1.0	56.0
1	Land preparatory work	2,583	1,800	2,500	4,628
2	Seed and seed sowing	2,151	2,600	2,500	11,680
3	Fertilisers/FYM	1,518	0	1,500	5,957
4	Pesticides	44	0	1,500	5,194
5	Labour cost on fertilizer pesticide application	275	0	500	1,214
6	Weeding and intercultural	1,571	2,500	2,000	4,845
7	Irrigation water rate	0	0	0	165
8	PINS and MIS maintenance, repair and replacement cost	194	300	0	499
9	Annual energy cost of pumping	111	0	0	955
10	Labour charges for irrigation	764	0	0	622
11	Harvesting cost	1,633	2,000	1,000	3,634
12	Marketing cost	201	0	500	1,914
13	Others	767	2,480	6,000	1,617
	Total	11,814	11,680	18,000	42,923

Source: Field survey

Table 4.22a presents annual operating cost of cultivation of summer crops under the govt PINS with MIS. Only one crop was reported i.e. groundnut under in summer season. The average operating cost was (19,359 Rs/acre), while the major cost components were seed fertilizer, harvesting and land preparation.

Annual operating cost of cultivation of summer season crops with coop PINS MIS is given in table 4.22b1. Under this system only two crops; groundnut and onion (for seed purpose) were grown. The operating cost of seed onion was 29,676 Rs/acre and for groundnut 15,672 Rs/acre. The major cost components were seed, fertilizer, harvesting and land preparation.

The findings show that main crops grown in the summer season under the coop PINS MIS were groundnut and seed onion. The major cost components were seed, fertilizer, harvesting and land preparation.

Table 4.22a: Annual operating cost of cultivation (A2+FL) with govt PINS -MIS(summer season)

(Rupees per Acre)

Sr. No.	Operating Cost	Groundnut
	Crop Area	5.9
1	Land preparatory work	3,008
2	Seed and seed sowing	3,346
3	Fertilizers/ FYM	2,665
4	Pesticides	1,501
5	Labour cost on fertilizer/pesticide application	506
6	Weeding and intercultural	4,414
7	Irrigation water rate	0
8	PINS and MIS maintenance, repair and replacement cost	0
9	Annual energy cost of pumping	0
10	Labour charges for irrigation	0
11	Harvesting cost	2,255
12	Marketing cost	1,664
13	Others	0
	Total	19,359

Source: Field survey

Table 4.22b1: Annual operating cost of cultivation (A2+FL) with coop PINS MIS-summer season

		<i>(Rupees per Acre)</i>	
Sr. No.	Operating Cost	Groundnut	Onion seed
	Crop Area	30.5	25.51
1	Land preparatory work	2,174	1,948
2	Seed and seed sowing	4,761	17,276
3	Fertilizers/ FYM	1,767	2,646
4	Pesticides	730	1,886
5	Labour cost on fertilizer/pesticide application	616	968
6	Weeding and intercultural	757	1,192
7	Irrigation water rate	1,462	824
8	PINS and MIS maintenance, repair and replacement cost	133	125
9	Annual energy cost of pumping	0	39
10	Labour charges for irrigation	66	274
11	Harvesting cost	2,708	1,940
12	Marketing cost	498	557
13	Others	0	0
	Total	15,672	29,676

Source: Field survey

The annual operating cost of cultivation of perennial season crops with coop PINS MIS is shown in Table 4.22b2. The perennial crops grown were sugarcane, grapes and banana. The operating cost of grape was 1,15,684 Rs/acre, of banana 80,500 Rs/acre and of sugarcane was 54,837 Rs/acre. The major cost components were seed, fertilizer and land preparation. For grape pesticide cost (40,076 Rs/acre) was the most important cost component.

Table 4.22c summarizes the annual operating cost of cultivation of perennial crops with pvt PINS MIS. The main crops grown in this system were sugarcane, grape, pomegranate banana and other horticultural crops. The operating cost of grape was 1,73,843 Rs/acre, pomegranate 1,30,605 Rs/acre, banana 69608 Rs/acre, sugarcane 50,328 Rs/acre and other horticultural crops 21,521 Rs/acre. The major cost components were seed, fertilizer, weeding and intercultural and land preparation. In addition to these the major cost component for grape and pomegranate was pesticide cost 53,360 Rs/acre and 42,666 Rs/acre, respectively.

The study shows that the perennial crops grown under the pvt PINS MIS were high value crops and perennial i.e. sugarcane, grape, pomegranate and banana. The major cost components were seed, fertilizer, weeding and intercultural and land preparation. In addition to these costs for grape and pomegranate pesticide and micronutrient costs were the highest costs.

Table 4.22.b2: Annual operating cost of cultivation (A2+FL) with coop PINS MIS- Perennial Season

(Rupees per Acre)

Sr. No.	Operating Cost	Sugarcane	Grape	Banana
	Crop Area	228	47	1
1	Land preparatory work	8,265	5,048	10,000
2	Seed and seed sowing	10,598	14,491	20,000
3	Fertilizers/ FYM	16,568	26,969	25,000
4	Pesticides	3,559	40,076	0
5	Labour cost on fertilizer/pesticide application	3,827	4,834	4,000
6	Weeding and intercultural	2,829	6,846	7,000
7	Irrigation water rate	7,814	6,527	0
8	PINS and MIS maintenance, repair and replacement cost	310	138	9,500
9	Annual energy cost of pumping	267	170	0
10	Labour charges for irrigation	93	0	0
11	Harvesting cost	101	6,050	0
12	Marketing cost	0	1,167	5,000
13	Others	605	3,368	0
	Total	54,837	1,15,684	80,500

Source: Field survey

Table 4. 22c: Annual operating cost of cultivation (A2+FL) with pvt PINS MIS-Perennial Season

(Rupees per Acre)

Sr. No.	Row Labels	Sugarcane	Grape	Pomegranate	Banana	Other Horticulture
	Sum of Crop Area	81.5	237	160	17	29.5
1	Land preparatory work	5,658	7,601	5,532	5,447	1,800
2	Seed and seed sowing	10,845	23,360	17,089	12,997	6,435
3	Fertilizer/ FYM	13,121	53,414	24,666	29,412	0
4	Pesticides	1,319	51,511	42,881	1,765	0
5	Labour cost on fertilizer/pesticide application	1,563	4,666	5,390	0	0
6	Weeding and intercultural	5,301	7,993	9,994	4,235	678
7	Irrigation water rate	429	713	2,347	0	0
8	PINS and MIS maintenance, repair and replacement cost	2,577	1,418	950	882	864
9	Annual energy cost of pumping	3,884	3,116	1,625	1,085	2,635
10	Labour charges for irrigation	625	620	285	603	1,064
11	Harvesting cost	74	5,224	7,263	2,794	443
12	Marketing cost	0	2,516	2,597	176	2,242
13	Others	4,933	11,692	9,986	10,212	5,359
	Total	50,328	1,73,843	1,30,605	69,608	21,521

Source: Field survey

4.9: Planning and Installation of PINS and MIS

Efficient functioning of any system is likely to depend on the agencies involved in the planning and installation of a system. Table 4.23 presents the summary of planning and installation of MIS at the farm. All MIS under govt, pvt and coop PINS were installed by the representatives of the authorized dealers of manufacturers, except for coop PINS around 3% of MIS was installed by the farmers. All the MIS systems were purchased from the authorized distributors of the manufacturers.

About the fertigation and chemigation, nearly all farmers under pvt PINS were following it, while 44% coop MIS farmers and only 4% of the govt MIS farmers were following this practice. Among those follow fertigation, the highest area under fertigation was observed under 9.5 acre per household, and around 4 acre per household under the govt and coop PINS. Around 30% of the farmers under pvt and coop PINS were applying insecticides/herbicides through the MIS for

improved crop production, while no farmer under govt PINS was following this. Around 30% of the farmers under govt PINS were using saline water for MIS, while around 12% of coop PINS and only 5% of the govt PINS farmer were following it. The affected saline area under coop PINS was around 24% of the area under MIS, followed by govt PINS around 22% and pvt PINS around 13%. There was a major concern about the water quality testing before the installation of MIS, only 60% of the pvt PINS farmers carried out it, while around 36% of the coop PINS farmer and 16% of the govt PINS farmers did it.

The findings show that all farmers were purchasing and installing the MIS system through authorized distributors. This indicates that authorized distributors of manufactures play important role implementation of MIS system. Moreover, around 96% of the pvt PINS farmers and 45% of the coop PINS farmers were following fertigation, this indicates that only pvt PINS farmers were using the MIS effectively than the other two (govt PINS and coop PINS). Also the water testing before installation was not done by most of the farmers, which causes various problems for dripper and sprinklers.

Table 4.23: Planning and Installation of MIS

Sr. No.	Particulars	<i>(% farmers agreed)</i>		
		Govt PINS	Coop PINS	Pvt PINS
1	Agencies installed MIS on farmer's field			
	a) Representatives of authorized dealers of manufacturers (jain/netafin)	100	97.45	100
	b) Government Agency (Extension Agency/Irrigation Advisory Services/University)			
	c) Private consultants			
	d) Farmers themselves	0	2.54	0
2	Channel for supply/purchase of MIS equipment's/material:			
	a) Through dealers (distributors appointed by manufacturers)	100	100	100
	b) Through Govt. Agency			
	c) Through local market			
3	Fertigation and chemigation practices followed:	12.82	44.07	96.43
	If yes,			
	a) Average area under fertigation (Acre)	3.89	3.83	9.5
	b) Proportion of micro irrigated area supplied with insecticides/herbicides	0	30	31.5
4	Used saline water in MIS	5.1	12.7	30.4
	If yes,			
	a) % of micro irrigated area affected by saline area (avg.)	22.5	24	12.9
5	water quality testing has been carried out prior to installation of MIS	15.38	35.59	60.71

Source: Field survey

4.10: Impact of PINS and MIS on Cropping Pattern and Production

Cropping pattern of BF and NBF sample households under the govt PINS is shown in table 4.24a. The findings show that kharif season was the major season for the BFs and NBFs, only one crop; groundnut was grown in the summer season on 3% of the gross cropped area (GCA). The main crops were soybean, tur and cotton. Intercropping was the most common practice; tur was an intercrop in soybean and cotton. There was not much variation in the cropping pattern between BFs and NBFs under the govt PINS.

Table 4.2b summarizes the cropping pattern of the sample household under the coop PINS. We found that the crops were grown in three seasons; kharif, summer and rabi. In kharif season soybean and tur (intercropping) were the dominating crops. In rabi season wheat and gram were dominating crops. While only beneficiary farmers were growing crops in summer season i.e. groundnut and onion for seeds. Both the BFs and NBFs were growing perennial crops, while share of area under these crops in the GCA was comparatively higher under the beneficiary farmers than the non-beneficiary farmers. The share of the area under cultivation during the rabi, summer and perennial seasons in the GCA was comparatively higher for BFs than the NBFs. While the share of total area under cultivation in kharif season in the GCA was higher under the NBFs than BFs.

Table 4.24c summarizes the cropping pattern of the sample households under the Pvt PINS. In kharif season, soybean, maize, and vegetables were major crops grown by beneficiary farmers, and soybean and maize were grown by the non-beneficiary farmers. During rabi season onion, wheat and jowar crops were grown by the beneficiary farmer, and onion was the major crop grown by the non-beneficiary farmer. The perennial crops grown by the beneficiary farmers were sugarcane, grape, pomegranate and banana, while sugarcane, grape, pomegranate were grown by non-beneficiary farmers. The share of area under perennial crops in the CGA of beneficiary farmers was comparatively higher than the non-beneficiary farmers.

Regarding the cropping pattern it is reported that under the govt PINS, BFs were growing crops in two seasons; Kharif and rabi. The BFs under the coop PINS were growing crops in Kharif,

rabi, summer and perennial seasons, while NBFs were not growing crops in summer season. The share of total area under the perennial crops in to the GCA was higher under the BF than the NBFs. Under the pvt PINS the share of area under the perennial crops in the GCA was higher in the GCA of BF than NBFs and also BF were growing more crops. This indicates that PINS helps to increases the area under cultivation during the summer season or under the perennial crops.

Table 4.24a: Cropping Pattern of the Sample Households under the govt PINS

(Area in acre/hh)

Sr. No.	Season/ crop	Beneficiary Farmers (BF)		Non-beneficiary Farmers (NBF)		percentage change in area of BF over NBF
		Area	% of GCA	Area	% of GCA	
1	Soybean	1.23	24.96	0.9	14.8	41.38
2	Tur	0.23	4.63	0.0	0.0	
3	Soybean (Intercrop Tur)	1.51	30.67	3.6	60.5	-57.5
4	Cotton	1.44	29.10	1.3	21.3	
5	Cotton (Intercrop Tur)	0.32	6.39	0.1	1.6	239.0
6	Udid	0.00	0.00	0.1	1.8	-100.0
7	Vegetables	0.06	1.17	0.0	0.0	
A	Kharif Total	4.79	96.92	5.9	100.0	-18.7
1	Ground Nut	0.15	3.08			
B	Summer Total	0.15	3.08			
C	Gross cropped area	4.94	100.00	5.9	100.00	-16.1

Source: Field Survey

Table 4.24b: Cropping Pattern of the Sample Households under the coop PINS

(Area in acre/hh.)

Sr. No.	Season/ crop	Beneficiary Farmers		Non-beneficiary Farmers		percentage change in area of BF over NBF
		Area	% of GCA	Area	% of GCA	
1	Rice	0.00	0.00	0.06	1.16	-100.0
2	Soybean	0.42	8.33	0.90	18.58	-53.5
3	Soybean (Intercrop Tur)	1.21	23.87	1.42	29.27	-15.3
4	Gr. Nut	0.04	0.83	0.11	2.28	-62.2
5	Mung	0.06	1.12	0.03	0.58	99.5
6	Udid	0.03	0.64	0.03	0.58	14.0
7	Cotton	0.10	1.91	0.00	0.00	
8	Turmeric	0.02	0.45	0.03	0.58	-20.2
9	Corn	0.01	0.19	0.00	0.00	
10	Vegetables	0.05	0.98	0.20	4.07	-75.0
A	Kharif Total	1.94	38.31	2.78	57.10	-30.3
1	Wheat	0.58	11.55	0.16	3.30	264.1
2	Gram	0.26	5.23	0.16	3.30	64.9
3	Jowar	0.13	2.49	0.15	3.10	-16.7
4	Onion	0.00	0.00	0.22	4.56	-100.0
B	Rabi Total	0.97	19.27	0.69	14.25	40.5
1	Ground Nut	0.20	3.89	0.00	0.00	
2	Onion seed	0.16	3.26	0.00	0.00	
C	Summer Total	0.36	7.15	0.00	0.00	
1	Sugarcane	1.47	29.09	1.28	26.32	14.8
2	Grape	0.30	6.01	0.11	2.33	168.5
3	Banana	0.01	0.16	0.00	0.00	
D	Perennial Total	1.78	35.26	1.39	28.65	27.8
E	Gross cropped area	5.05	100.00	4.87	100.00	3.9

Source: Field Survey

Table 4.24c: Cropping Pattern of the Sample Households under the Pvt PINS

(Area in acre/hh)

Sr. No.	Season/ crop	Beneficiary Farmers		Non-beneficiary Farmers		percentage change in area of BF over NBF
		Area	% of GCA	Area	% of GCA	
1	Soybean	0.36	2.9	0.03	1.33	971.4
2	Maize	0.49	3.9	0.08	3.33	483.9
3	Fodder	0.09	0.7	0.00	0.00	
4	Vegetables	0.31	2.5	0.00	0.00	
A	Kharif Total	1.25	10.1	0.12	4.67	967.6
1	Bajara	0.00	0.0	0.11		-100.0
2	Wheat	0.64	5.2	0.03	1.33	1828.6
3	Jowar	0.09	0.7	0.00	0.00	
4	Gram	0.02	0.1	0.06	2.22	-67.9
5	Onion	0.99	8.0	0.42	16.89	134.7
B	Rabi Total	1.74	14.1	0.62	24.89	179.8
1	Sugarcane	1.46	11.8	0.89	35.56	63.7
2	Grape	4.23	34.2	0.08	3.33	4978.6
3	Pomegranate	2.86	23.1	0.79	31.56	262.0
4	Banana	0.30	2.5	0.00	0.00	
5	Other Horticulture	0.53	4.3	0.00	0.00	
C	Perennial Total	9.37	75.8	1.76	70.44	432.3
D	Gross cropped area	12.36	100.0	2.50	100.0	394.4

Source: Field Survey

4.11: Impact of PINS and MIS on Irrigated Crop Area

Table 4.25a summarizes distribution of area under irrigation by type of irrigation method under the govt PINS. Since, it was mandatory for govt PINS to have drip irrigation method, the farmers were using only drip irrigation method.

Table 4.25b presents distribution of area under irrigation by type of irrigation method under the coop PINS. In kharif season area under sprinkler was 48%, drip 13% and flood 39%. In rabi season area under sprinkler was 48%, drip 3% and flood 54%. In summer season area under sprinkler was 70%, drip 4% and flood 54%. Around 98% of the perennial crops were under the drip and 2% were under the flood irrigation. Overall the total gross cropped area was divided in to the type of irrigation as 31% sprinkler, 40% drip and 28% under the flood irrigation method.

The distribution of area under irrigation by type of irrigation method under the pvt PINS is shown in table 4.25c. Under the pvt PINS two methods of irrigation; drip and flood were used. In rabi season the area under drip was 41% and under flood 59%. In rabi season area under drip was 12% and under flood was 88%. Around 98% of the perennial crops were under the drip irrigation and 2% were under the flood irrigation. Overall under the pvt PINS 80% area was under the drip and 20% under flood irrigation.

It is seen from the results that under coop PINS the area under different types of irrigation method was as 31% sprinkler, 40% drip and 28% flood. While under the pvt PINS 80% was under drip and 20% was under flood method. This shows that under the PINS the most preferred method was drip irrigation over sprinkler and flood.

Table 4.25a: Distribution of area under irrigation by type – govt PINS

(Area in acre)

Sr. No.	Season/ crop	Area under drip*
1	Soybean	48.08
2	Tur	8.925
3	Soybean (Intercrop Tur)	59.08
4	Cotton	56.05
5	Cotton (Intercrop Tur)	12.3
6	Vegetables	2.25
	Kharif Total	186.68
1	Ground Nut	5.925
	Summer Total	5.925
	Gross cropped area	192.61

* (Drip irrigation was mandatory for govt PINS mandatory)

Source: Field survey

Table 4.25b. Distribution of area under irrigation by type – coop PINS

(Area in acre)

Sr. No.	Season/ crop	Area under sprinkler		Area under drip		Area under flood		Total Irrigated area	
		Area	%	Area	%	Area	%	Area	%
1	Soybean	7.0	10.7	19.8	30.3	38.5	59.0	65.2	100.0
2	Soybean (Intercrop Tur)	133.8	71.5	0.0	0.0	53.3	28.5	187.0	100.0
3	Cotton	1.0	6.7	0.0	0.0	14.0	93.3	15.0	100.0
4	Ground Nut	0.0	0.0	6.5	100.0	0.0	0.0	6.5	100.0
5	Mung	2.0	22.9	0.0	0.0	6.8	77.1	8.8	100.0
6	Udid	1.0	20.0	0.0	0.0	4.0	80.0	5.0	100.0
7	Turmeric	0.0	0.0	3.5	100.0	0.0	0.0	3.5	100.0
8	Corn	0.0	0.0	1.5	100.0	0.0	0.0	1.5	100.0
9	Vegetables	0.0	0.0	7.2	93.5	0.5	6.5	7.7	100.0
A	Kharif Total	144.8	48.2	38.4	12.8	117.0	39.0	300.2	100.0
10	Wheat	37.5	41.4	1.0	1.1	52.0	57.5	90.5	100.0
11	Gram	25.0	61.0	4.0	9.8	12.0	29.3	41.0	100.0
12	Jowar	1.0	5.1	0.0	0.0	18.5	94.9	19.5	100.0
13	Onion	63.5	42.1	5.0	3.3	82.5	54.6	151.0	100.0
B	Rabi Total	10.5	41.3	0.0	0.0	15.0	58.7	25.5	100.0
14	Onion (seed)	28.5	93.4	2.0	6.6	0.0	0.0	30.5	100.0
15	Ground Nut	39.0	69.7	2.0	3.6	15.0	26.7	56.0	100.0
C	Summer Total	0.0	0.0	1.0	100.0	0.0	0.0	1.0	100.0
16	Banana	0.0	0.0	47.1	100.0	0.0	0.0	47.1	100.0
17	Grape	0.0	0.0	224.1	98.3	3.8	1.7	227.9	100.0
18	Pomegranate	0.0	0.0	272.2	98.6	3.8	1.4	276.0	100.0
19	Sugarcane	247.3	31.6	317.7	40.6	218.3	27.9	783.2	100.0
D	Perennial Total	7.0	10.7	19.8	30.3	38.5	59.0	65.2	100.0
	Gross cropped area	133.8	71.5	0.0	0.0	53.3	28.5	187.0	100.0

Source: Field Survey

Table 4.25c. Distribution of area under irrigation by type – Pvt PINS

(Area in acre)

Sr. No.	Season/ crop	Area under drip		Area under flood		Total Irrigated area	
		Area	%	Area	%	Area	%
1	Soybean	0	0	20	100.0	20	100
2	Maize	7	25.7	20.25	74.3	27.25	100
3	Fodder	5	100.0	0	0.0	5	100
4	Vegetables	16.5	94.3	1	5.7	17.5	100
A	Kharif Total	28.5	40.9	41.25	59.1	69.75	100
5	Wheat	12	33.3	24	66.7	36	100
6	Jowar	0	0.0	5	100.0	5	100
7	Gram	0	0.0	1	100.0	1	100
8	Onion	0	0.0	55.5	100.0	55.5	100
B	Rabi Total	12	12.3	85.5	87.7	97.5	100
9	Sugarcane	72.0	88.3	9.5	11.7	81.5	100
10	Grape	237.0	100.0	0	0.0	237	100
11	Pomegranate	159.9	100.0	0	0.0	159.93	100
12	Banana	17.0	100.0	0	0.0	17	100
13	Other Horticulture	29.5	100.0	0	0.0	29.5	100
C	Perennial Total	515.4	98.2	9.5	1.8	524.93	100
D	Gross cropped area	555.93	80.3	136.25	19.7	692.18	100

Source: Field Survey

The production pattern of the sample household under the govt PINS is summarized in table 4.26 a. Soybean reported production of 4.02 quintals/acre, which was 30% higher than the production under non PINS, while for soybean in intercropping the yield was 5.9 quintals/acre, which was around double of the yield under the non PINS. The production of tur intercrop was 2.9 quintals/acre, which was nearly double than the production under the non PINS. The production of cotton was 8.9 quintals/acre, which was 40% higher than the production of cotton under the non PINS, while the production of cotton intercrop was 3.3 quintals/acre, 60% higher than production of cotton under non PINS. The production of all crops under the PINS was higher than the non PINS.

Table 4.26b summarizes production pattern of various crops under the coop PINS. The production of various crops under the coop PINS was as soybean was 4.8 quintals/acre (66% higher than non PINS), soybean intercrop 6.5 quintals/acre (217% higher than non PINS), tur intercrop 2.7 quintals/acre (108% higher than non PINS), ground nut 9.8 quintals/acre (75%

higher than non PINS), mung 2.7 quintals/acre(18% lower than non PINS), udid 2.2 quintals/acre (19% lower than non PINS), turmeric 39 quintals/acre (133% higher than non PINS), vegetables 50.4 quintals/acre(308% higher than non PINS), wheat 9.2 quintals/acre (33% higher than non PINS), gram 4.9 quintals/acre (132% higher than non PINS), jowar 5.8 quintals/acre (55% higher than non PINS) and sugarcane 55 metric tons/acre (6% higher than non PINS) and grapes 8.7 metric tons/acre (45% higher than non PINS). This suggests that production of most of the crops under the PINS adopter was higher than the non PINS farmers.

The production pattern of various crops of the sample household under pvt PINS is shown in table 4.26.c. The production of various crops under the pvt PINS was as soybean 7.8 quintals/acre (55% higher than non PINS), maize 13.7 quintals/acre (4% higher than non PINS), wheat 9.8 quintals/acre (42% lower than non PINS), gram 3 quintals/acre (50% higher than non PINS), sugarcane 54 metric tons/acre (6% higher than non PINS) and pomegranate 76.5 quintals/acre (150% higher than non PINS). It is seen that majority of crops production was higher for the PINS adopter than the PINS non-adopters.

Overall the findings suggest that for most of the crops the production was reported higher under the PINS farm than for the non PINS farm, this indicates that the PINS improves the productivity of most of the crops.

Table 4.26a: Production pattern of the sample households – govt PINS

Sr. No.	Season/ crop	Beneficiary Farmers (Quintal/acre)	Non-beneficiary Farmers (Quintal/acre)	% change in BF over NBF (Quintal/acre)
	Kharif			
1	Soya	4.02	3.1	29.8
2	Soya (Intercrop Tur)	5.9	3.0	98.8
3	Tur	4.1	--	--
4	Tur (Intercrop soya)	2.9	1.5	93.3
5	Tur (Intercrop Cotton)	2.03	2.0	1.6
6	Udid	0.0	2.3	--
7	Cotton	8.9	6.3	40.4
8	Cotton(Intercrop Tur)	3.3	2.0	62.6
9	Vegetables	220.0	0.0	--
	Summer			
11	Ground Nut	4.05	0	--

Source: Field survey

Table 4.26 b. Production pattern of the sample households – coop PINS

Sr. No.	Season/ crop	Beneficiary Farmers (Quintal/acre)	Non-beneficiary Farmers (Quintal/acre)	% change in BF over NBF (Quintal/acre)
	Kharif			
1	Rice	--	9.8	--
2	Soya	4.8	2.87	65.6
3	Soybean (Intercrop Tur)	6.5	2.04	217.1
4	Tur (Intercrop Soybean)	2.7	1.27	108.3
5	Cotton	5.7	--	--
6	Groundnut	9.8	5.6	74.5
7	Mung	2.7	3.3	-18.2
8	Udid	2.2	2.7	-19.0
9	Turmeric	38.9	16.7	133.1
10	Corn	21.3	--	--
11	Vegetables	260.0	123.0	111.4
	Rabi			
12	Wheat	9.2	6.9	32.9
13	Gram	4.9	2.1	132.1
14	Jowar	5.8	3.8	54.5
15	Onion	--	77.0	--
	Summer			
16	Gr. Nut	4.6	--	--
17	Onion (Seed)	2.8	--	--
	Perennial			
18	Sugarcane	543.8	512.34	6.1
19	Grape	87.2	60	45.4
20	Banana	300.0	0	

Source: Field survey

Table 4.26c: Production pattern of the sample households – pvt PINS

Sr. No.	Season/ crop	Beneficiary Farmers (Quintal/acre)	Non-beneficiary Farmers (Quintal/acre)	% change in BF over NBF (Quintal/acre)
	Kharif			
1	Soybean	7.75	5	55.0
2	Cotton	7.1	--	--
3	Maize	13.7	13.1	4.2
4	Vegetables	230.0	--	--
A	Rabi			
5	Wheat	9.8	16.7	-41.3
6	Jowar	6.0	--	--
7	Gram	3.0	2.0	50.0
8	Onion	141.7	--	--
B	Perennial			
9	Sugarcane	542.6	513	5.8
10	Grape	95.1	--	--
11	Pomegranate	76.5	30.62	150.0
12	Banana	60.0	--	--
13	Other horticulture	49.8	--	--

Source: Field survey

The impact of MIS on the production is shown in table 4.27. Table compares the production of various crops under flood, drip and sprinkler irrigation. For soybean crop the yield was 25% higher under sprinkler irrigation than flood method, while it was same under the flood and drip. While for soybean as intercrop the yield was 77% higher under sprinkler and 74% higher under drip than flood. For tur as intercrop yield was 57% higher under sprinkler and 77% higher under drip than flood. For cotton crop around 66% higher yield under sprinkler and drip than flood. For groundnut yield was 120% higher under drip than flood. For mung yield was 40% lower under drip than flood. For udid yield was 18% lower under sprinkler than flood. For wheat around 4-8% lower yield under drip and sprinkler than flood was reported. For jowar crop 16% higher yield under sprinkler than flood was reported. For gram around 35% higher yield under sprinkler and 28% lower under drip than flood was reported. For onion 22% higher yield under sprinkler than flood was reported. For sugarcane the yield was 6% higher under drip than flood method. The findings shows that the MIS increased yield for soybean, tur, cotton, groundnut, jowar, onion and sugarcane crops, while yield was decreased for udid, mung and wheat under MIS. In general the findings indicate that for majority of crops the yield under MIS was higher than the flood method, while there was not much difference between sprinkler and drip methods.

Table 4.27: Production Impacts of PINS with MIS

Sr. No.	Major Crops	Season	Sprinkler (with PINS) (Quintal/acre)	Drip (with PINS) (Quintal/acre)	Canal/Flood irrigation (both PINS & Non-PINS) (Quintal/acre)	% change in yield under sprinkler over flood	% change in yield under drip over flood
1	Soybean	Kharif	5.17	4.12	4.11	25.72	0.21
2	Soybean (intercrop Tur)	Kharif	5.56	5.47	3.14	76.96	73.88
3	Tur (intercrop Soybean)	Kharif	2.40	2.72	1.53	57.20	77.57
4	Cotton	Kharif	9.07	8.87	5.35	69.62	65.85
5	Groundnut	Kharif	--	10.29	4.68	--	119.82
6	Mung	Kharif	--	9.44	15.87	--	-40.48
7	Udid	Kharif	2.00	--	2.43	-17.70	--
8	wheat	Rabi	9.15	8.62	9.37	-2.39	-8.06
9	Jowar	Rabi	6.00	0.00	5.17	16.06	--
10	Gram	Rabi	5.14	2.75	3.82	34.62	-27.98
11	Summer Onion	summer	3.09	--	2.53	21.99	--
12	Sugarcane (metric tons/acre)	Perennial		53.94	51.44		4.87

Source: Field survey

4.12: Details of Water Used and Impact on Water saving

World over, it is proved that MIS are basically water saving systems. Besides saving, it distributes water evenly over the command area with minimal losses. It has also ability to adjust the water application rate as per the water requirement of the crop.

We observe that though the farmers in India are aware of these, in no. of cases, availability of exact and dependable data on water application vis-à-vis saving etc.(from farmers); becomes difficult to obtain. We feel that though the farmers are aware that the water quantum will depend on the season, stage of the growth of plant/tree as well as crop/fruit, they don't have clear idea about the reduction of water quantum to be made applicable. One possible reason for this, is that there is no harm takes place to the crops even some more water is applied under MIS. So if there is no problem in water availability, there may be a tendency of farmers not to shut off the systems immediately after the required watering is done. We are sure that over the period the farmers will become cautious of this aspect and then reliable data would be available. As discussed earlier, the sample farmers reported that the extent of water saving due to adoption of PINS and participation in WUA was 32.8 per cent in case of cooperative PINS and 36.7 per cent in Govt. PINS (Table 4.11).

4.13: Other Economic, Social and Environmental Benefits of PINS and MIS

Apart from saving water there are other benefits of the PINS, these are presented in table 4.28. Maximum benefits were reported under the coop PINS MIS farmers. More than 50% of the farmers under the govt PINS reported the four main benefits of the PINS with MIS: cultivated land saved due to less need to construct field channels, less maintenance cost compared to conventional flow irrigation, frequency of maintenance is less compared to conventional flow irrigation and less water logging or water salinity. More than 50% of the pvt PINS with MIS farmers reported that reduction in fertilizer use, reduction in weeding cost reduction in labour use were the three main benefits of MIS. Majority of the farmers under coop PINS with MIS agreed with most of the benefits shown in Table 4.28. The findings suggests that apart from water saving the major benefits of PINS with MIS were, saving of land by avoiding field channels, reduction in frequency and maintenance cost of irrigation system, weeding cost, water logging and labor cost.

Table 4.28: Other Economic, Social and Environmental Benefits of PINS with MIS

(% farmers agreed)

Sr. No.	Particulars	Govt PINS	Coop PINS	Pvt PINS
1	Cultivated land saved due to less need to construct field channels	51.3	73.5	30.4
2	Less maintenance cost compared to conventional flow irrigation	64.1	72.9	37.5
3	Frequency of maintenance is less compared to conventional flow irrigation	56.4	62.6	44.6
4	Reduction in over-extraction of ground water	43.6	53.5	46.4
5	Saving of energy consumption due to sharing through common pump set/PINS	48.7	70.3	25.0
6	Reduction in pressure on pump set/tube well due to less extraction	41.0	54.8	16.1
7	Less water logging or water salinity	66.7	58.1	42.9
8	Less pest attack/Reduced use of pesticides	33.3	50.3	42.9
9	Reduction in fertilizer use	35.9	53.5	71.4
10	Reduction in weeding cost	23.1	58.1	69.6
11	Reduction in labour use	30.8	57.4	76.8
12	Effective allocation of water among farmers	23.1	65.8	26.8
13	Reduction in migration of family members due to more availability in water	10.3	40.0	3.6
14	Increase in social cohesion among the water users/villagers in managing the water	48.7	56.1	17.9

Source: Field survey

4.14: Training, Education and Awareness about PINS and MIS

Farmers' awareness about training and education related to the PINS and MIS is presented in the table 4.29. Nearly all the respondents were unaware about the ISO standards for irrigation equipments. Around 56% of the govt PINS farmers and 34% of the coop PINS farmers were aware about the facility for the MIS components, while all pvt PINS farmers were unaware about the testing facility. The average distance of testing center from the farm was 43 km. about 30% govt PINS farmers, 25% coop PINS farmers were aware about the training center for adoption, operation & maintenance of MIS and all pvt PINS farmers were unaware about it. The average distance of the training center from the farm was 40 km. around 75% of the govt PINS farmers, 94% of the coop PINS farmers and 36% of the pvt PINS farmers reported that the repairing of the PINS and MIS was done by company and distributors, while 6% of coop and govt PINS farmers, 65% pvt PINS farmers were doing repairing themselves. This suggests that there is a lack of awareness about ISO standards, training and testing facility for PINS and MIS. Therefore, there is a scope for providing these facilities for farmers at the block level.

Table 4.29: Training, Education and Awareness about PINS-MIS

	Particulars	Response (in %)	Govt PINS	Coop PINS	Pvt PINS	Grand Total
A	Do you know which ISO Standards pertaining to irrigation equipment's	Yes	0.0	1.7	3.6	1.9
		No	100.0	98.3	96.4	98.1
B	Do you know where there is any testing facility for evaluating performance of micro irrigation system components (e.g. Emitters, filters, laterals etc.) in your locality	Yes	56.4	33.8	0.0	29.4
		No	43.6	66.2	100.0	70.6
		Average distance from village	42.1	43.8	Not Reported	43.3
C	Do you know where there is facility for training farmers in adoption, operation & maintenance of MIS in your locality	Yes	30.8	25.2	0.0	19.6
		No	69.2	74.8	100.0	80.4
		Average distance from village	1.9	54.9	Not Reported	39.4
D	In case of any defects found in your system, Who takes care of it	i. company	52	48	13	42
		ii. Dealer	33	46	23	39
		iii. Mechanic	9	0	0	2
		iv. Self %	6	6	65	17
		Average days are required for its repair	2.2	2.1	1.8	2.0

Source: Field survey

4.15: Farmers feedback to improve working and performance of PINS

Despite the benefits of the PINS with MIS, the adoption rate is not very high in the state. The farmers in the survey were asked the problems regarding the adoption of PINS with MIS. Table 4.30 summarizes the problems faced by the farmers. The main problems were; planning and installation of PINS with MIS, delay in receiving subsidy for MIS, power to run PINS and MIS, quality of components and damage of MIS in field from rodents.

Table 4.30: Farmer's feedback on the problems faced in adoption of PINS MIS

(% farmers agreed)

Sr. No.	Particulars	Govt PINS	Coop PINS	Pvt PINS
1	Planning and installation	2.6	28.2	0.0
2	Availability of suitable pump sets and system components	6.5	2.6	1.8
3	Getting subsidy for the system	0.0	43.6	14.3
4	Quality of various components	1.9	20.5	1.8
5	Testing of equipment	0.0	10.3	3.6
6	Water availability and quality	9.7	2.6	7.1
7	Energy supply to PINS MIS	1.3	23.1	30.4
8	Operation and maintenance	9.7	5.1	1.8
9	Scheduling of micro-irrigation	9.7	7.7	1.8
10	Fertigation and Chemigation	1.9	2.6	0.0
11	After sales services by manufacturers	1.9	2.6	17.9
12	Damage from rodents (squirrels, rats etc) and insects	9.0	51.3	7.1

Source: Field survey

4.16: Constraints in Operation and Maintenance of PINS at Household level Suggestions by the farmers

The users of any product or service are the one helps most to make the product or service better over the time. Therefore, their suggestions should be taken in to consideration. The farmers' suggestions to improve the working and performance of PINS and MIS are summarized in table 4.31. The major suggestions from three types of PINS (govt, coop, pvt) with MIS farmers were: supply of regular water and electricity, subsidy on time, reduction in input prices and improvement in PINS system particularly for govt PINS.

Table 4.31: Farmer's suggestions to improve working and performance of PINS MIS
(% farmers agreed)

Sr. No.	Major Suggestions	Govt PINS	Coop PINS	Pvt PINS
1	Good management by WUA	9.5	5.2	1.2
2	Good Quality Material	0.0	0.6	7.0
3	Good Quality Water	2.4	0.0	4.7
4	Improve PINS System	11.9	4.5	0.0
5	Input price should be reduce	0.0	0.6	12.8
6	Lower interest rate	0.0	2.6	0.0
7	More area under MIS	2.4	8.4	3.5
8	MSP	0.0	3.9	11.6
9	Need for the advance technology	2.4	4.5	10.5
10	Regular maintenance	4.8	2.6	5.8
11	Regular water supply should be given	45.2	15.6	4.7
12	Rule should followed by Everyone	7.1	5.8	0.0
13	Subsidy should credited in farmers account & Get on Time	2.4	13.6	12.8
14	To avail electricity regular (day hours)	0.0	25.3	11.6
15	To Control water theft by others	7.1	0.6	0.0
16	To get Training & Guidance for MIS	0.0	2.6	10.5
17	To provide information to all farmers regarding arrive water	4.8	2.6	1.2
18	Water Storage	0.0	0.6	2.3

Source: Field survey

Chapter V

Adoption, Performance and Management of PINS by WUAs

5.1: Introduction

As mentioned in earlier sections, the around 15 PINS+MIS are getting developed in Maharashtra are in co-operative sector in southern Maharashtra. These appear to be managed well under the guidance of local sugar-cooperatives. The development or conversion of these lifts schemes into PINS+MISs will be trend setting development, which will have positive effect on other schemes. Along with the regular major and medium irrigation projects, the GoM also has assured 20 lift irrigation projects, which have very large command areas. These are planned with flow/gravity canal system. There is a large scope to have MIS for distribution system of these projects.

5.2: Details of Associated PINS Project

The PINS+MIS covered under the survey are mostly lift scheme on rivers or storages created by tapping the water within the banks of the rivers. The details about the water sources and command area are given in Table 5.1. Average life span for PINS is reported as 24 years, which appears for the pumps and rising/pumping mains. As can be seen from the table, the lift schemes are located on the rivers/storages in the rivers.

Table 5.1: Details of Associated PINS Project

Sr. No	Particulars	Type of PINS-Coop PINS
1	Average Life Span of the PINS (Years)	24
2	Feeder irrigation source (% distribution):	
A	Canal	
b	Tube well	
c	Tank	
d	River	100
e	Any other	
3	Type of the irrigation project (% distribution):	
a	Major	0
b	Medium and minor	100
4	Total Area covered under the PINS Project WUA (acre/WUA)	434.3
5	Total number of beneficiaries /WUA	185.6
6	Nature of the land in the command area of PINS Project (% distribution):	
a	Very fertile	18.2
b	Moderately fertile	63.6
c	Less fertile due to salinity	9.1
d	Less fertile due to water logging	0.0
e	Less fertile since exposed to erosion/or for any other reason	9.1
7	Type of cultivation practice:	
a	Plots periodically left fallow	27.3
b	Zero or minimum tillage practiced on it	
c	Crop rotation practiced on it	72.7
d	Crops grown during Kharif (2015):	
	Kharif crop-1	Soybean
	Kharif crop-2	Tur
	Kharif crop-3	Cotton
e	Crops grown during Rabi (2015-16)	
	Rabi crop-1	Wheat
	Rabi crop-2	Gram
	Rabi crop-3	Jowar
f	Crops grown during Perennial (2015-16)	
	Perennial Crop-1	Sugarcane
	Perennial Crop-2	Grape
	Perennial Crop-3	Pomegranate

Source: Field survey

5.3: Capital Cost of PINS Equipment & Installation

We have obtained latest cost-estimate for a 100 ac(40 ha) PINS scheme, namely Shiva Rama Pani Puvatha Sanstha [Shivaram Water Supply(Lift)] Society Ltd at Karbharwadi, Tal- Karveer, Dist.- Kolhapur. This can be considered as a typical cost for a PINS. If one adds the cost of MIS, to total cost can be obtained. The equipment cost for 100 ac works out Rs.57.23 lakhs, the installation cost is about 12% of the equipment cost. It needs to be noted that the cost of equipment will vary depending the head for the pumps and the length of the rising/pumping main.

Table 5.2: Initial capital cost on PINS equipment's and installations (Rs.) at WUA level
(Avg per WUA)

Sr. No.	PINS MIS Equipment	Equipment Cost (Rs)	Installation Cost (Rs)	Total Cost (Rs)
A	Water Supply System			
1	Pump Sets and power unit	2,25,000	25,000	2,50,000
2	Control Head/ control box	3,00,000	50,000	3,50,000
3	Storage Facility/ Wells	----	---	---
4	Filters/Filtration	6,50,000	35,000	6,85,000
B	System Layouts			
1	Main/ Sub-main PINS pipes/ PVC Pipes	33,50,000	5,25,000	38,75,000
2	Valves, Flush valves, Fittings and Bushings	3,50,000	25,000	3,75,000
C	Automated Water control System, if any			
1	Monitoring Storage	---	----	---
2	Float device and float switch			
3	Automation equipment	8,50,000	25,000	8,75,000
D	Total PINS System (Excluding MIS) (6+10+15)	57,25,000	6,85,000 (12% of Equipment Cost)	64,10,000

Note: The data is for one WUA - Shiva Rama Pani Puvatha Sanstha [Shivaram Water Supply(Lift)] Society Ltd at Karbharwadi, Tal- Karveer, Dist.- Kolhapur.

Source: Field survey

5.4: Annual Operation & Maintenance (O&M) Cost

The costs details for all 10 coop WUAs are given in Table 5.3 based on the total ICA of 4343 ac, the cost per ac works out to Rs. 2,499/-, which appears quite reasonable. Balance Sheet details of a WUA are given in Table 5.7b. We feel that the provisions for other items need to be considered as expenditure, such as sinking funds etc.

Table 5.3: Annual Operation and Maintenance Cost on coop PINS

Sr. No	Particular's	All 10 WUA Total Area: 4,343 ac		Per WUA (Average area per WUA is 434.3 acre)		Per Acre	
		Expenses (Rs.)	As a %age	Expenses (Rs.)	As a %age	Expenses (Rs.)	As a %age
1	Heads of expenses						
2	Electricity Charges	75,85,000	70	7,58,500	70	1,746	70
3	Repairing/Maintenance of tube well /canal PINS	14,40,000	13	1,44,000	13	332	13
4	Other Expenses	18,27,500	17	1,82,750	17	421	17
5	Total annual Operation and Maintenance Cost on PINS (Rs):	1,08,52,500	100	10,85,250	100	2,499	100
6	Frequency of maintenance works undertaken (Number/Year):	48 in 10 Pins. i.e. 4.8/PINS					

Source: Field survey

5.5: Details of PINS-Water Users Association (WUA)

As mentioned above, there are no. of issues related to WUAs are covered under the survey. The average members of the WUAs are around 160, and overall satisfaction of facilitators role is “good”, this appears oblivious in case of WUAs running satisfactorily for long time. There is no any PIN-MIS scheme with tube well in Maharashtra.

As far as the members within command but not joining the WUA of such scheme, are very oblivious and i.e. either they have some other water source, or other group. Table 5.4, gives aspects of functioning below. The average members of the WUAs are around 100.

Table 5.4: Details of PINS-Water Users Association (WUA)

(% WUA agreed)

Sr. No.	Particulars	Coop PINS
1	Who acted as facilitator/catalyst for formation of WUA	
a	Government Department Official	27.27
b	NGO	
c	Community Organizer (farmers own initiative)	72.73
d	Any Other	
2	Satisfaction over the facilitator:	
a	Good	100
b	Average	
c	Poor	
3	Number of members of WUA (No/WUA)	162
a	Number of farmers having land in the PINS Command area but did not become the member of WUA (No/WUA):	99
4	Reasons of their not joining the WUA:	
a	Don't want to pay anything for PINS Project	9.1
b	PINS Project implementation was defective	9.1
c	Getting water from other sources	90.9
d	Not satisfied with office bearers of WUA	9.1
e	Belongs to opposite political parties	27.3
f	Don't want to carry out any agricultural operations on their plots	9.1
g	Don't see agriculture remunerative	9.1
h	Any other	
i	Number of non-members of WUA who avails the facilities of PINS Project (non-members pay higher charges). [reported only in one case].	50

Source: Field survey

5.6: Functioning and Activities of WUA

The no. of issues related to WUAs were covered under the survey, and findings are presented in Table 5.4 to 5.16. The issues covered are (i)development of WUAs, (ii)Functioning & activities of WUAs, (iii)Income & Expenditure, (iv)Relationship with Govt. bodies, (v)Payment of water charges, (vi)benefits accrued, (vii)sufficiency of water, (viii)conflicts, problems etc.

The PINS+MISs surveyed are original lift schemes have been getting converted to MIS, as they face problem of water logging, labour cost etc. They were functioning well and have long standing and experience. So overall they are functioning well, managed well etc. So, overall responses to various questions on the issues related to the WUAs are positive. In fact we feel that these schemes will set an example for future conversions likely to take place.

The average members of the WUAs are around 160, and overall satisfaction of facilitators role is “good”, this appears oblivious in case of WUAs running satisfactorily for long time. There is no any PIN-MIS scheme with tube well in Maharashtra.

Table 5.5 gives details about function of WUAs. They are supposed to meet once in a month, which 11.4 times, it indicates that they meet fairly well. We observe that 36.4% response to the requirement of assistance to WUA. Our past experience also indicate, a necessity of some organisation for solving the problems of WUAs, trainings, refreshers training, and recognition at Govt. level for good WUAs.

Table 5.5: Some aspects of functioning of PINS WUA

(Responses by WUA office bearers)

Sr. No.	Particulars	Coop PINS
1	(a) No. of General Body meetings conducted during 2015-16 (No/WUA)	11.36
2	(b) No. of decisions taken in the meetings during 2015-16 (No/WUA)	21.91
3	(c) No. of decisions implemented during 2015-16(No/WUA)	20.36
4	Is there any influence of political parties in selection of office bearers of WUA (% agreed)	18.18
5	If yes, whether influential persons in WUA take all major decisions regarding activities of WUA? (% agreed)	50
6	Was there any rehabilitation problems generated by Installation of PINS Project (% agreed)	27.27
7	If yes, who did the rehabilitation or construction? (% agreed) :	
8	Contractor	33.3
9	WUA	66.7
10	(c) Does WUA need any assistance for its Management? (% agreed)	36.36
	If Yes, from whom:	
a	Government	
b	NGO	50
c	CBOs	
d	Others	
16	Does the WUA get any annual matching grant from Government for operation and maintenance of PINS project? If Yes,	no
17	Mention the amount (Rs/WUA) :	0

Source: Field survey

The activities of WUAs given in Table 5.6, rightly emphasis on (i) O&M of PINS, (ii)Judicious Water Distribution, (iii)Collection of water charges etc. Table: 5.11 also indicate the importance on water.

Table 5.6: Major activities of PINS WUA

		(% farmers agreed)
Sr. No	Major activities	Coop PINS
1	Operation & Maintenance of PINS Project	90.91
2	Deciding the timing of water release	81.82
3	Judicious water distribution	81.82
4	Collection of water rates	90.91
5	Collection of per capita operation and maintenance cost	72.73
6	Dispute settlements	81.82
7	Seed or Fertiliser distribution	0
8	Produce collection	0
9	Money lending to members	0
10	Any other	0

Source: Field survey

5.7: Details of income and expenditure of WUA:

From the Table 5.7, it can be seen that there are only 2 schemes, which have reported losses, which may be because of the capital cost for the PINS+MISs. The water charges paid to the Water Resources Deppt are around Rs. 250/ac, which are minimal. The water Charges collection is regular and around Rs. 4,400/ac.

5.7: Details of income and expenditure of WUA

Name of PINS	Area Irrigable (ac) ->		Shri Dudhganga Sahkari Pani Purvatha Sanstha Maryadit Kasha Sangaon, Dist-Kolhapur		Shri bhiravnath Sahkari Pani Purvatha Sanstha Maryadit Ahirwadi, Dist- Sangli		Pani Purvatha Sanstha Maryadit Gotkhindi Dist- Sangli		Kanti Pani Purvatha Sanstha Maryadit Vasagade Dist- Sangli		Total area under PINS= 1285	
	Sr. No	Particulars	2015-16	245 acre	2015-16	240 acre	600 acre	200 acre	2015-16	2015-16	Overall	Per Acre
		Inflow to the account (Income)										
a		Water rate collection	2,099,730		1,236,033		2,141,908	178,000		5,655,671	4,401	
b		Annual maintenance fees and Electricity charges collected	0									0
c		Annual electricity/diesel fees collected	0									0
d		Earnings from business activities of the WUA, if any (e.g., sale of fertilizers)	0									0
e		Interest income	322,481		43,713		1,077,301			1,443,495	1,330	
f		Loans from banks or individuals								15,393	15,393	
g		Any other	2,300				102,900	6,455		111,655	107	
k		Loss	0				900,421	286,594		1,187,015	1,484	
		Total Income	2,424,511		1,279,746		4,222,530	486,442		8,413,229	6,547	
		Outflow from the account (Expenses)										
a		Charges to Irrigation Department	56,256		61,188					117,444	242	
b		Expenditure on electricity bill	114,472		517,560		1,712,045	63,510		2,407,587	1,874	
c		Repairing expenses	16,371		72,424		386,930	95,458		571,183	445	
d		Salary expenses	286,300		232,600		461,100	182,100		1,162,100	904	
e		Travel and Conveyance expenditure	37,417		9,348		7,400	38,640		92,805	72	
f		Audit expenses	16,442		43,154		1,500	15,000		76,096	59	
g		Loan repayment/interests paid	988,399				1,404,657	5,052		2,398,108	1,866	
h		Office rent	12,790		700					13,490	28	
i		Miscellaneous expenses	883,593		15,818		79,407	83,522		1,062,340	827	
j		Any other			271,522		169,491	3,160		444,173	427	
k		Profit	12,471		55,432			0		67,903	140	

Source: Field survey

5.8: Relationship of WUA with related Organizations

Table 5.8 emphasizes need of relationship with concerned department, and here naturally Irrigation (water resources) or PW department are on top (In Maharashtra ID(WRD) is the body responsible for making available the water).

Table 5.8: Relationship with the Government Departments and Other Organizations

(% WUA office bearer agreed)

Sr. No.	Particulars	Good	Average	Poor
1	Public Works Department	54.5	27.3	18.2
2	Irrigation Department	90.9	9.1	0.0
3	Department of Agriculture	81.8	18.2	0.0

Source: Field survey

5.9: Water Resource Management by WUA/TUA

In general, all water resource management is taken care of by the WUA. Though there is some flexibility adopted in payment of the water charges by farmers to WUA, majority of them. Table: 5.9 emphasises need of relationship with concerned department, and here naturally Irrigation (water resources) or PW department are on top (In Maharashtra ID(WRD) is the body responsible for making available the water).

Table 5.9: Water Resource Management by WUA/TUA

(% WUA office bearer agreed)

Sr. No.	Particulars	Cooperative PINS
1	Is the Irrigation Management Transferred to WUA?	100
2	Who does the water distribution?	
a	WUA	100
b	Individual farmers	
3	Is the water rates and the operation and maintenance cost of PINS project are being collected by WUA?	100
4	Whether the operation and maintenance cost of PINS project and water rates are paid by its member regularly?	100
5	If Yes, periodicity of its collection the operation and maintenance cost of PINS project:	
a	Annually	72.7
b	half-yearly	0
c	Quarterly	0
d	After Harvesting Crop (Season wise)	27.3

Source: Field survey

As we have stated above, in general the lift societies function well, so there are no reasons reported for “non-payment of O&M charges.

5.10: Benefits Provided by WUA to its Members

The benefits of WUAs are mainly related to water as can be seen from Table 5.10. Proper distribution and related benefits have highest responses, as seen in Table 5.10 and 5.11.

Table 5.10: Benefits accrued by the members of WUA

(% WUA office bearer agreed)

Sr. No.	Benefits accrued	Coop PINS
1	Water arrives in time	100
2	Timely information on release of water from canal	100
3	More information on how to use water judiciously	100
4	proper distribution of water among farmers	100
5	Less conflicts around water or less water theft	90.9
6	More information on crops and technologies	91
7	Improved maintenance of the system	100
8	Environmental problems such as water logging and salinity resolved compared to pre-WUA period	45.5
9	Quality of groundwater improved due to less extraction compared to pre-WUA period	9.1
10	Enhanced financial situation	81.8
11	Any other	

Source: Field survey

Table 5.11: Sufficiency of irrigation water for the WUA members

Sr. No.	Particulars	Cooperative PINS
1	Do WUA members get sufficient water throughout the year (% WUA members agreed)	45.5
2	If No, Average no. of months of insufficient water	3.2

Source: Field survey

5.11: Constraints in Operation and Maintenance of PINS at WUA level

The proper functioning WUA/Co-op. Societies also evident in table 5.12, here the water non-availability or poor-rainfall is the only reason for inadequate water. This is also the reason for conflict as seen in Table 5.13.

Table 5.12: Reasons for inadequate supply of water to the farm plot

(% WUA office bearer agreed)

Sr. No	Reasons	Cooperative PINS
1	Water availability in main irrigation source is inadequate	100.0
2	PINS system is not functioning properly/faulty.	0.0
3	PINS system is not managed properly	0.0
4	Non-payment of water rate and maintenance charges by the member	0.0
5	Mismanagement / Partiality in water distribution by WUA members	16.7
6	Unresolved conflicts among WUA members	0.0
7	Poor rainfall	66.7
8	Any other (please elaborate)	0

Source: Field survey

Table 5.13 and 5.14 are on conflicts and problems faced by WUAs. Water and funds are the two issues reported in both respective issues.

Table 5.13: Causes of conflicts among water users

(% WUA office bearer agreed)

Sr. No.	Reasons	Coop- PINS
1	Water availability is inadequate	100
2	Mismanagement / Partiality in water distribution by WUA members	0
3	Unresolved conflicts among WUA members	0
4	Different political affiliation of WUA office bearers and WUA member	0
5	Any other (please elaborate)	0

Source: Field survey

Table 5.14: Major problems faced by the WUA

(% WUA office bearer agreed)

Sr. No.	Constraints	Coop-PINS
1	Fund constraints	63.64
2	Water availability	45.45
3	Maintenance and repair of PINS	18.18
4	Support from Govt.	72.73
5	Poor participation of WUA members	9.09
6	Non-participation of farmers in the command area	9.09
7	Unsolved conflicts	9.09
8	Political interference	18.18
9	Any other (please mention)	0

Source: Field survey

The Table 5.15 is on constraints of WUAs, in the condition of “before WUA” and “After WUA”. Significant changes/improvements can be observed after formation of WUAs or after introduction of MIS. One of the reasons, the farmer go for micro irrigation, is labour problems.

Table 5.15: Trends in constraints faced by the WUA

(% WUA office bearer agreed)

Sr. No.	Constraints	More	Less	No
1	Before WUA formation:			
a	Water logging	45.45	9.09	45.45
B	Salinity	18.18	27.27	54.55
c	Tank /dug well pollution	0.00	36.36	63.64
d	Groundwater pollution	0.00	27.27	72.73
e	Labour problems	54.55	36.36	9.09
f	Inter and Intra village conflicts	0.00	36.36	36.36
G	Crop yields	18.18	45.45	36.36
2	After WUA formation:			
a	Water logging	9.09	36.36	54.55
b	Salinity	9.09	27.27	63.64
c	Tank /dug well pollution	0.00	27.27	72.73
d	Groundwater pollution	0.00	18.18	81.82
e	Labour problems	9.09	45.45	45.45
f	Inter and Intra village conflicts	0.00	9.09	90.91
g	Crop yields	54.55	36.36	9.09

Source: Field survey

5.12. Testing Facilities for MIS Components

There are some components which are specifically used in MIS only and not likely to be used in any other systems e.g. drippers, sprinklers, mini sprinklers, lateral tubing and its connectors, fertilizer tanks etc. There are other components which are used in MIS as well in other systems also; e.g. pumps, valves, fertilizer/chemical injection systems etc.

Bureau of Indian Standard (BIS) has issued large no. of specifications for various components. There are also specifications on Design, Installations & Field Evaluations of MIS. While giving approval to the manufacturing companies, it is desired that state Govt. arrange to test MIS products of such companies. We observe that state Govts. have limited testing facilities, and then

the Agri. Deptt of such states has to depend on some other units for testing. e.g. [i]for carbon contents in laterals, the AgriDeptt depend on Central Institute of Plastics Engineering & Technology(CIPET, GoI), [ii]the pressure compensating drippers are tested at Vasantdada Sugar Institute(VSI), Pune. For non-pressure compensative drippers, variation in discharges becomes an issue of dispute. At the same time, new electronic gadgets/ controls are also coming up in the market, for which there appears no any specifications available. If available, there is no any facility available with the state Govts. to check these products.

We note that at the Intentional Irrigation Technology Centre, Fresno, USA, all components are tested in no. of laboratories within the compound of the Fresno University. These components include dippers, sprinklers, filters, pumps, even electronic gadgets/controls are tested in the same compound. We feel that for Maharashtra, being a leading state in MIS, such comprehensive facilities need to be developed for MIS testing in the state Agricultural Universities.

Chapter VI

Conclusions and Policy Implications

6.1 Introduction

The contribution of agriculture and allied sector to India's Gross Domestic Product is 15% (2016). Around 58% of the population directly or indirectly engaged in this sector. The crucial factor of production for an agricultural production system is water. The most important source of water for irrigation is rainfall, which in India is the monsoon. The govt policies and programmes at national and state level such as National Water Policy (1987, 2002 and 2012), Accelerated Irrigation Benefits Programme (AIBP), Command Area Development Programme (CADP) And Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) created substantial level of irrigation potential. The results of these can be seen from the created irrigation potential of 107 Mha at national level and 12.6 Mha at the state level (DAC&FW, 2016; WRD, 2016). Despite these developments, according to the World Water Council, major part of the India faces the high to very high water stress, (WWC, 2016, Doell et., al. 1999). This indicates the need for timely action plan for the efficient utilization of water in India. The most common method of irrigation in India is Flood/Flow irrigation. In this method the water utilization is very high, there are advanced techniques developed to overcome the problems of this method, such as micro-irrigation (MI). The various methods of MI are mist or spray, drip, subsurface drip and bubbler (USDA NRCS, 2013; 2011). The MI has benefited the agriculture through the increase in crop yield, improvement in quality of harvest and efficient input nutrient management (USDA NRCS, 2013).

To motivate the farmers for the use of micro-irrigation the Government of India (GoI) provides a subsidy for farmers, while more visionary step was taken by the Gujarat government, provides 100% subsidy for Pressurized Irrigation Network System (PINS) for the farmers through the Gujarat Water Resources Development Corporation Limited (GWRDC). The Gujarat government's Sardar Sarovar Narmada Nigam Ltd. (SSNNL) conceptualized the PINS, it is the interface between the water source (canal/tube well) and the MI system at the farm (GWRDC, 2016, Viswanathan & Bahinipati, 2015). A recent study in Gujarat state on socio-economic impact of the PINS shows that around 90% of the farmers reported that there was considerable

increase in the yield and water savings, moreover majority (55-93%) of the farmers agreed that PINS reduces the various inputs costs (Viswanathan & Bahinipati, 2015).

Rich level of scholarly work is available at global as well as national level on the issues related to the irrigation water management and specifically on the drip irrigation, sprinkler irrigation and participatory irrigation management. The study under investigation is on PINS concept, which was developed not more than ten years ago in the Gujarat state of India. Since the PINS concept is new, few studies are available on this issue ((*Uphoff*, 1986; Gandhi, and Namboodiri, 2011: 2002; Singh, 1991; Chavan, 2016; Viswanathan and Bahinipati, 2015). Moreover, so far there is no study available on Maharashtra state; hence this is the first study of this kind on the state of Maharashtra. Since the PINS require considerably high capital from farmers' point of view, this study evaluates the functioning, economic benefits and costs of PINS. The studies assess the effectiveness of institutional arrangements for management of PINS projects and the bottlenecks for their smooth functioning.

The specific objectives of this study are as following:

1. To undertake a broad situation analysis of various PINS programs in Maharashtra.
2. To assess the extent of adoption and performance of PINS in terms of costs, benefits and adoptability for different crops.
3. To analyses the institutional arrangements for management, operation and maintenance of PINS.
4. To identify the major constraints in adoption, management, operation and maintenance of PINS.
5. To recommend suitable policy measures to enhance the effectiveness and techno-economic performance of PINS.

In Maharashtra state the types of PINS projects are of three types - government supported (these are around 100% government funded), cooperative and private (owned by individual farmer). After discussion with govt. officers and manufactures we decided to collect data from seven districts (Buldhana, Kolhapur, Sangli, Yavtmal Nashik, Pune and Ahmednagar), where the PINS

projects were implemented. Data was collected from (i)PINS project operators and the associated Water User Associations (WUAs), (ii)farmers/water users with PINS-MIS or PINS with flood irrigation, non-beneficiary households having no access to PINS-MIS; but having access to surface/flood irrigation around the PINS project area (iii)implementing agencies/companies and (iv)concerned government departments.The total sample of 355 farmers was covered in the study, representing 250 beneficiaries (BH) and 105 non-beneficiary households (NBH).In this study, we have covered 75 PINS projects; among this 19 were govt and coop PINS, and 56 were pvt PINS projects.

This study is having few limitations. Since in the Maharashtra state, only govt, coop and pvt PINS projects were present at the time of study and the number of PINS projects were small and the spread was across few districts. Hence the study is based on few districts only. Moreover, the source of water for PINS was only river and tanks; hence comparison based on various sources of water for PINS was not possible. The govt PINS were around 100% subsidy based hence, it was bit difficult to estimate various cost related components. The findings and policy implications of the study are presented in following sections.

6.2: Summary of Findings

6.2.1: A broad situation analysis of various PINS programs in Maharashtra

The Maharashtra state is one of the leading states in adoption of the drip and sprinkler irrigation methods. Maharashtra State has mostly distribution systems with flow/gravity canal irrigation, as such there are no PINS+MIS under canal irrigation. The rotation of canal system(i.e. canal is “on” for about 3 weeks and “shutdown” for about the same period), creates a need to store water for use during “shutdown” period.

The GoM has recently decided to introduce pipe distribution system on all irrigation projects, which is expected to work on gravitational head (and not pressurised system). The Maharashtra Water Resources Regulatory Authority (MWRRA) has also made it compulsory to use water by

micro irrigation on all perennial crops (12 monthly crops) under all flow irrigation system¹¹. These both steps will see PINS in future.

6.2.1.1: PINS in form of Co-op. Lifts Schemes in Maharashtra

However, there are large no. of lift irrigation schemes in co-operative sector, in southern part of western Maharashtra (1,01,205 ha) in Krishna basin (i.e. on Krishna river and its tributaries). These lifts can be considered as PINS with flow irrigation. However, over the years, the lands under them are becoming saline/water logged. For this reason, as well to save labor, fertilizers and water, some schemes have taken initiative in converting the flow distribution systems, into MIS. There could be more schemes (than 15 schemes) under the proposals of conversion, but MIS companies observe secrecy, till such proposals actually get materialized.

There are other 11 irrigation projects, under which flow/canal irrigation systems are not economical due to uneven terrain. In such cases, the water is let down from the storages in the parent water sources, which is tapped in the course (of parent water source) by weirs and lifted by farmers at various locations on the course/parent. This arrangement is similar to that for the lifts on Krishna and its tributaries, mentioned above. The total area under these 11 projects is 54,100 ha. With the area under lifts on Krishna etc., the total ICA works out to (54,100+ 101,205) 1,55,305 ha.

6.2.1.2: Govt. Lift irrigation Projects in Maharashtra

Besides, regular flow/canal irrigation projects, GoM has also taken up around 20 big Lift Irrigation projects for 5.89 lakh ha, these are at various stages of development/completion. As mentioned above, the GoM has recently decided to introduce pipe distribution system on all irrigation projects, which is expected to work on gravitational head (and not under additional head created similar to pressurised system).

¹¹ Maharashtra Water Resources Regulatory Authority's notification dt. 12.06.2015.

6.2.1.3: Lift Irrigation as Distribution System of Irrigation Projects(with mainly gravity canal irrigation system) in Maharashtra

Though the distribution of water is under gravity/flow under regular irrigation projects; in some projects, the lift irrigation is also adopted for water distribution, e.g. on two irrigation projects (i.e. along with the water distribution by gravity flow), they are [i]Dahini lift scheme on Bembala Project in Yavatmal District – 6,968 ha, [ii]Tajnapur Lift under Nathasagar(Godavari) Project in Aurangabad District: 6,960 ha,

6.2.1.4: Lifts on Minor Irrigation Projects

Under Minor Irrigation Schemes, except Minor Irrigation Tanks(MITs), there is no gravity flow system but lift irrigation on Storage Tanks(STs), Kolhapur-Type-Weirs(KTWs these are weir-cum-birdges), Storage Weirs(SWs). Usually these lifts belong to small and individual farmers or to a small group of farmers. If financial assistance is made available to them, these can easily get converted into PIN+MIS. A group of four such schemes is functioning well on a Storage Tank at Janephal in Buldhana District. This was developed under a German KfW bank's assistance for participatory irrigation development¹². We have covered these lifts under the survey.

6.2.1.5: Crops on the MIS

It appears obvious that the farmers go for MIS for cash crops like cotton(28%), sugarcane(16%) banana(10%), Citrus & pomegranate (9% each), Grapes (8%), and other horti. crops about 20%. But if lift schemes get converted into MIS in Sugarcane belt(of western Maharashtra), there appears a major jump.

6.2.1.6: Cost-Pattern for PINS + MIS

As seen from earlier section, the major development expected is in conversion of lifts into PINS-MIS. The cost of equipment and installation for a scheme of 100 ac are obtained, which is Rs. 57.25 lakhs and Rs. 6.85 lakhs, i.e. Rs. 64.10 lakhs – Rs. 64,100/ac. This does not include the cost of actual MIS (either drip or sprinklers system). While considering such cost, one will have

¹² The programme was known as MIP-M (Minor Irrigation Programme-Maharashtra), 2001-2011.

to keep it in mind that the cost will depend on the lift head as well as length of the rising(pumping main).

6.2.2: The extent of adoption and performance of PINS in terms of costs, benefits and adoptability for different crops

The rate of adoption of any technology carries vital role because the desired outcome of any technology depends on at what scale the technology is adopted by the end users, same applies for PINS or MIS. It was found that high investment, marginal landholding, non-access to assured water source, lack of technical knowledge and economic situation of farmers were the major factors influencing the adoption of micro irrigation in India (Namara, et. al, 2005). The adoption of micro irrigation is important not only because it saves water, but also it has other crucial benefits such as reduction in various input costs (fertilizer cost, wedding cost, power cost) for farmers, reduction in the environmental problems such as soil salinity and water logging (NMMI, 2016).

6.2.2.1: The socioeconomic profiles, land holdings, asset holding and sources of credit of the farmers

Respondents' average education was nine years of schooling. Most of the farmers' main occupation was the agriculture. Around 96% of respondents were male, while only 4% were female. Average family size of household was around 6 members; from this around 50% of members were actively participating in the farming. The cast wise distribution of farmers' shows that around 9% of farmers were SC, 1% were ST, 36% were OBC and 53% were from general category.

Under the govt PINS category the net operated area of BH was 5.04 acres while of NBH was 6.04 acre. For the coop PINS, the operational landholding of BH was 3.92 acres, and of NBH was 4.43 acres. For the pvt PINS the operational landholding of BH was 12.36 acres and of NBH was 2.91 acres. The pvt PINS BFs ownership of various farm related assets was higher as compared to govt and coop PINS BFs.

The sources of credit for govt PINS farmers were commercial banks, cooperative banks, other banks and informal sources, while for coop and pvt PINS the sources of credit were commercial and cooperative banks. The amount of credit taken by the pvt PINS BFs was around Rs. 700,000 and pvt PINS NBFs was Rs. 180,000. The coop PINS BFs took credit of around Rs. 200,000, while coop PINS NBFs took credit of Rs. 120,000, while both BFs and NBFs under govt PINS took the credit of same amount: Rs. 80,000. The outstanding loan amount was more than 90% for the NBFs, while it was around 50% for the BFs. The findings show that most of BFs used loan productive purpose, while majority of NBFs used loan for non-farm non-productive purposes. It is bit difficult to find out the reasons behind this behavior of farmers.

6.2.2.2: Adoption of PINS in Maharashtra state

The source of irrigation for all govt PINS was tanks/storages, for coop PINS sources were river and storages/tanks¹³ on the rivers, and for pvt PINS the sources were well and river. It is seen that farmers prefer assured irrigation water source (tank, well and river) for installing PINS. The govt PINS farmers were small and marginal farmers, while coop PINS farmers were mostly small and medium, while majority of pvt PINS farmers were big medium and large farmers.

Since, the govt PINS projects were around 100% funded by the government, there was no cost for the farmers. Regarding the coop PINS farmers, average expenditure was Rs. 47,200 on PINS project, and there was no considerable variation on the expenditure on PINS across the landholding class of farmers. About the pvt PINS farmer, the expenditure on PINS project was Rs. 87,325 and there was not much variation across the farmers' landholding class. These findings suggest that being a part of cooperative system could save PINS project cost by around 50%.

The reasons to adopt PINS were to get assured water, better yield and increase in area under irrigation. The pvt PINS adopter farmers were interested in personal benefits in comparison with the govt and coop PINS adopter.

¹³ These are the storages created by weirs on the rivers, these weirs are usually weir-cum-bridges types known in Maharashtra as Kolhapur-type-weirs (Kolhapur is the district, wherein these were first introduced in 1950s).

The main benefits of coop and govt PINS were an increase in area under irrigation by around 60%, farm income and water saving by more than 35%, and 35% saving in electricity.

The majority (80-96%) of the members of the coop PINS WUA were aware about the functioning, while the awareness among the govt PINS was comparatively not good. All of the coop PINS WUA members paid O&M cost regularly.

Most important reasons for inadequate supply of water were the inadequate water availability in the water source for PINS and poor rainfall, moreover, for govt PINS inefficient functioning of the PINS system was also an additional reason.

The total cost of the drip under govt PINS was around 20,000 Rs, which was very low, the reason was that in this case the manufacturers of the drip system provided the system at very low rates i.e. 20,000 Rs/acre (because of huge subsidy). Under the coop PINS the average cost of the drip irrigation system was around 50,000 Rs/acre and for sprinkler it was 8863 Rs/acre. The average cost of drip irrigation system under pvt PINS was 48,306 Rs/acre. For drip irrigation system farmers under coop PINS received 19% subsidy, while under pvt PINS received 25% subsidy. For sprinkler the subsidy received was 54% of the total cost of the system.

The main cost components of operating cost of cultivation were seed, pesticide and fertilizers and land preparation.

The findings suggest that PINS helps to increase the area under cultivation during the summer season or under the perennial crops. It is also reported that the most preferred method of irrigation under PINS was drip irrigation over sprinkler and flood. For most of the crops the production was reported higher under the PINS farm than for the non PINS farm, this indicates that the PINS improves the productivity of most of the crops. The MIS increased yield for soybean, tur, cotton, groundnut, jowar, onion and sugarcane crops, while yield was decreased for urid, mung and wheat under MIS. For majority of crops the yield under MIS was higher than the flood method, while there was not much difference between sprinkler and drip methods. Regarding the water saving under MIS, in principal there is water saving under MIS than flood.

We feel that though the farmers were aware that the water quantum will depend on the season, stage of the growth of plant/tree as well as crop/fruit, they don't have clear idea about the reduction of water quantum to be made applicable.

Apart from water saving the major benefits of PINS with MIS were, saving of land by avoiding field channels, reduction in frequency and maintenance cost of irrigation system, weeding cost, water logging and labor cost.

There is a lack of awareness about ISO standards, training and testing facility for PINS and MIS. Therefore, there is a scope for providing these facilities for farmers at the block level. The main problems faced by the farmers were planning and installation of PINS with MIS, delay in receiving subsidy for MIS, power to run PINS and MIS, quality of components and damage of MIS in field from rodents.

6.2.3: The institutional arrangements for management, operation and maintenance of PINS

Around 15 PINS+MIS are getting developed in Maharashtra are in co-operative sector in southern Maharashtra. These appear to be managed well under the guidance of local sugar-cooperatives. The development or conversion of these lifts schemes into PINS+MISs will be trend setting development, which will have positive effect on other schemes. Along with the regular major and medium irrigation projects, the GoM also has taken up 20 lift irrigation projects, which have very large command areas. These are planned with flow/gravity canal system. There is a large scope to have MIS for distribution system of these projects.

These PINS+MIS are mostly lift scheme on rivers or storages created by tapping the water within the banks of the rivers. Average life span for PINS is reported as 24 years, which appears for the pumps and rising/pumping mains.

Soils of 2/3rd schemes are moderately fertile, around 20% with very fertile and balance are less fertile, getting water logged. Crop pattern has perennials(S'cane and horticultural crops like

grapes, or pomegranates) and seasonal crops for rotation cover soybean, tur, and cotton in Kharif, while wheat, gram and Jowar taken in rabi season.

6.2.4: The major constraints in adoption, management, operation and maintenance of PINS

6.2.4.1: Operational & Maintenance Cost

As these are basically lift schemes converted into MIS, the major portion of the O&M cost is for the electrical bills about 70%, while 13% and 17% are the expenses on O&M of PINS, and 17% other expenses. The frequency of maintenance is around 5 times/PINS/Year with the cost of such repairs is around Rs. 1,800/acre, which appears very reasonable.

The income per acre works out Rs. 6,550/- and expenses are Rs. 6,490/-. Thus, the WUAs are meet all their expenses, but not keeping any amount aside for sinking funds, etc. There are no cases of defaulters in water charges payments. WUAs look forward to get some financial assistance from Govt. particularly, as they normally don't get any assistance for conversion.

More than 80% beneficiary Farmers give importance to (i)proper O&M of the PINS, (ii)timing of water release – rotation, (iii)judicious water distribution, (iv)proper collection of water charges, (v)dispute solving etc.

6.2.4.2: Water Users Associations (WUAs)

As mentioned above, most of the WUAs of lift schemes were in existence for long time. So the facilitators in their case for formation of WUAs as well taking decision for conversion is obviously the executive body of the society as well the farmers themselves. So also the satisfaction in facilitation is full i.e. 100%. There are around 160 members of each society. There are around 100 farmers located within the command of these schemes but have their other arrangements, so they did not joined the society. In other words, they would have become member of the WUA, in absence of other arrangements.

Office bearers give importance to good relations with the water resources department for getting the water on time. As these are mostly the lift in co-op sector, there is no any question arising once the proper water lifting permission/s are obtained.

The benefits of good lift co-operatives are numerous WUA bearers give highest marks to (i)water on time & proper water distribution within member farmers and over the timespan, (ii)timely communication with the farmers, (iii)enhanced financial condition/position of WUA. Farmers have reported only 3 months during which the less water is available. But we feel that such condition will occur in draught conditions. If federation is formed for all WUAs, it can look into such problems, and pursue the matters with Govt.

6.2.5: Testing Facilities for MIS Components

There are some components which are specifically used in MIS only and not likely to be used in any other systems e.g. drippers, sprinklers, mini sprinklers, lateral tubing and its connectors, fertilizer tanks etc. There are other components which are used in MIS as well in other systems also; e.g. pumps, valves, fertilizer/chemical injection systems etc.

Bureau of Indian Standard (BIS) has issued large no. of specifications for various components. There are also specifications on Design, Installations & Field Evaluations of MIS. While giving approval to the manufacturing companies, it is desired that state Govt. arrange to test MIS products of such companies. We observe that state Govts. have limited testing facilities, and then the Agri. Dptt of such states has to depend on some other units for testing. e.g. [i]for carbon contents in laterals, the AgriDptt depend on Central Institute of Plastics Engineering & Technology(CIPET, GoI), [ii]the pressure compensating drippers are tested at Vasantdada Sugar Institute(VSI), Pune. For non-pressure compensative drippers, variation in discharges becomes an issue of dispute. At the same time, new electronic gadgets/ controls are also coming up in the market, for which there appears no any specifications available. If available, there is no any facility available with the state Govt. to check these products.

We note that at the Intentional Irrigation Technology Centre, Fresno, USA, all components are tested in no. of laboratories within the compound of the Fresno University. These components include dippers, sprinklers, filters, pumps, even electronic gadgets/controls are tested in the same compound. We feel that for Maharashtra, being a leading state in MIS, such comprehensive facilities need to be developed for MIS testing in the state Agricultural Universities.

6.3: Policy Implications

- We feel that, if the financial assistance is made available to the lifts Schemes, they would get converted from PINS+Flow into PINS+MIS rapidly, as the trend is already set by 15 schemes in the state.
- The distribution systems of lift projects will also be converted into PINS+MIS, though not envisaged at the conceptual stages. There is an advantage for lifts, that on the way from pumps to the delivery point, there can be sufficient head available to use MIS by directly hooking up to the rising/pumping main.
- There is a large scope for PINS+MINS for (i)Co-operative lifts, (ii)lifts on Other Govt Projects with lift as distribution System, (iii)Govt. Lift irrigation projects themselves, (iv)individual lifts including lifts on Minor Irrigation Schemes, and in the long run of pipe distribution systems in place of flow irrigations.
- The costs of the drip systems were higher under coop and pvt PINS than the govt norms. Therefore it is suggested that the cost norms for drip irrigation system may be revised so that the farmers can afford the drip irrigation system.
- Extension activities for increasing the awareness about efficient use of water under the MIS, water requirement of the crops as per the crops critical growth stages and season wise are recommended.

- There is a lack of awareness about ISO standards, training and testing facility for PINS and MIS. Therefore, there is a scope for providing these facilities for farmers at the block level.
- We observe that some sort of refreshers training etc. need to be arranged at different levels for WUA office-bearers, member farmers etc. Such training should be on co-operative, new technologies in irrigation and agriculture-cultivation, processing, post harvesting issues. There is also a need of a body such as federation, which can put forth the issues faced by these WUAs.
- We feel that for Maharashtra, being a leading state in MIS, comprehensive testing facilities for MIS components need to be developed in the state Agricultural Universities.

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Annexure I

**Comments on draft report
by
Agro-Economic Research Centre,
Sardar Patel University, Vallabh Vidyanagar, Anand, Gujarat**

"Working of Pressurized Irrigation Network Systems (PINS) in Maharashtra State"

- | | | |
|-----------|---|--|
| 1. | Title of report | "Working of Pressurized Irrigation Network Systems (PINS) in Maharashtra State" |
| 2. | Date of receipt of the Draft report | April 03, 2017 |
| 3. | Date of dispatch of the comments | April 12, 2017 |
| 4. | Comments on the Objectives of the study | The authors have satisfied the objectives of the study |
| 5. | Comments on the methodology | The sampling and methodology used is as suggested and accepted. |
| 6. | Comments on analysis, organization, presentation etc. | <p>i. Please place tables on same page (not broken).
Mention source of data outside the table. The units of measurement should be placed above the table below its title.</p> <p>ii. More relevant reviews of literature may be included.</p> <p>iii. Pages 39 - 42: Table 2.22 has been assigned to three tables. Please rectify table numbers in all subsequent tables in 2nd Chapter.</p> <p>iv. Page 46: Assign table number and title. Please rectify table numbers in all subsequent tables in 3rd Chapter.</p> <p>vi. Page 50: The 3rd and 4th columns in Table 3.1 may be deleted.</p> <p>vii. Page 100. Rectify table no in the text (it is Table 4.28, not 4.29).</p> <p>viii. Please add the list of tables, figures, just after the Content Page</p> <p>ix. Table 4.24a: rows 4 and 7 may be deleted since there is no area mentioned. Also please check the area of non-beneficiary farmers. Since the area under soyabean alone is 18.2 acre per hh, the total kharif area cannot be less (9.11), so also GCA. The per hh area under Soybean (Intercrop Tur) seems very high. Please check.</p> <p>x. Also please verify the reporting of area in Tables</p> |

4.24c and 4.25c. In all the tables related to cropping pattern, the area needs to be reported in acre per household. It seems that the total area under the crop has been reported, which is difficult to make the comparative analysis.

xi. pp-100: The extent of water saving can be reported from Table 4.11.

xii. Table 5.1: Please verify if the data is reported per WUA or not. It should be per WUA.

xiii. Table 5.3: In last column, please report the average area per WUA also.

xiv. Typographical errors at some places need to be corrected, as mentioned in the text. All other aspects as suggested within the text are to be addressed.

7. References:

All important references have been used in the study. However, few of them are missing which needs to be checked and corrected, as mentioned in the text.

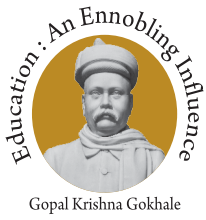
8. General remarks:

The standard of the report is good.

Some useful policy recommendations have also been made.

At some places, authors may include graphs, figures and photographs taken during the field survey to make the report more vivacious. The list of tables and figures need to be added in content page. Please include some abbreviations such as DIRD, WRIS, and WWC in the list of abbreviations.

9. Overall view on acceptability of report: The report is acceptable after incorporating the suggested changes.



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