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Evaluation Study
on
Integrated Scheme of Micro Irrigation

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PREFACE

The Agriculture sector, the largest user of water in our developing economy, is constantly facing an acute shortage of surface as well as underground water. The availability of water in appropriate quality and quantity is under severe stress with the increasing demand on water from various sectors. The overall development of the agriculture sector will help achieve the intended growth rate in GDP, and therefore needs judicious use of the available water resources. While major and medium irrigation projects have contributed to the development of water resources, conventional methods of irrigation are inefficient and lead to wastage of water. It has been recognized that the use of modern methods like drip and sprinkler irrigation are the ways for the efficient use of surface as well as ground water resources for irrigating the land and thereby increasing the agricultural production of the country. Hence, the scheme on Micro Irrigation (MI), aimed at increasing the area under efficient methods of irrigation by following better soil-water management techniques and providing the arid and semi-arid lands better access to irrigation water without actually increasing the stress on available water resources.

The Ministry of Agriculture, Govt. of India launched the Centrally Sponsored Scheme 'Micro Irrigation ' in January, 2006 with the objective of increasing the coverage of area under micro irrigation in the country for improving crop productivity with efficient use of water resources. Under this scheme subsidy of fifty per cent is given to farmers who install drip or sprinkler systems in their fields with Central Govt. bearing forty percent and state govt. bearing ten percent. The remaining fifty per cent is borne by the beneficiary, either through his/her own resources or soft loan from financial institutions. The scheme has been implemented in almost all the States/Union Territories of the country. Programme Evaluation Organisation, Planning Commission has been entrusted to conduct the evaluation study on this scheme with the objective to access the total area covered under drip and sprinklers method, to examine the extent of the use of marginal and uncultivable lands and thereby the efficiency and adequacy of water use and to find out the impact of the scheme on the farmers at the grass root level. The study covered 33 districts, 66 blocks, 198 villages, 1980 beneficiary farmers spread over 10 major sample states of the country.

The study has revealed that the popularity of Micro Irrigation has been improved remarkably in the states like Rajasthan and Haryana, because of their water scarcity with undulating topography and sandy soils. Rajasthan has recorded the highest

area covered under the sprinkler irrigation system and so also Haryana, which has covered a significant proportion of land under this system of irrigation. The share of drip irrigation system under Micro Irrigation scheme in Andhra Pradesh is the highest, covering 38 per cent area, followed by Maharashtra (28 percent), Gujarat (13 per cent) and Karnataka (12 per cent) if compared to cumulative of area covered under drip in all 10 sample States. These four states have covered more than nine-tenth of the total area across ten states, under drip irrigation system. However, very insignificant proportions of land have been covered under micro irrigation in Chhattisgarh, Odisha, Haryana, Punjab, Rajasthan and Madhya Pradesh. The other details of the study have been explained in different chapters of the report that will be very useful for the implementing Ministry and the policy makers.

The study received continuous support and encouragement from Honourable Deputy Chairman, Planning Commission and Secretary, Planning Commission. The study has been designed by the officers of PEO Headquarters; the field investigation, data collection, tabulation, analysis and drafting of the report have been conducted by Ms. AMS Consulting (P) Ltd., under the supervision of the officers of PEO Headquarters and its field units under my overall guidance. The contribution of all the officers of PEO, subject division of Planning Commission, implementing Ministry and Ms. AMS Consulting (P) Ltd. is gratefully acknowledged.

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New Delhi
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Executive Summary

1. Objectives of the Study

The evaluation of the MI Scheme was undertaken with the following objectives —

1. To estimate the total area covered under drip and sprinkler in selected states since the inception of MI Scheme
2. To estimate the reduction in fertilizer usage, increase in fertilizer use efficiency, and savings in labour, pesticides and energy
3. To assess the extent of the use of marginal and otherwise uncultivable lands and that of saline water
4. To assess the popularity of micro-irrigation systems in terms of their efficiency, adequacy and usage in different states, especially in potential belts/regions having a water deficit (arid & semi-arid areas)
5. To assess the roles played by major stakeholders, like, NCPAH, SMIC, DMIC, IA, TSG, Panchayati Raj Institutions (PRIs) and farmers/ beneficiaries at different levels in planning, implementation and monitoring the scheme under the program
6. To analyze the approach/strategies adopted by the administrative/ implementing machineries for future course of action
7. To study the role played by HRD in imparting training programs, conducting seminars, workshops and exhibitions and demonstrations of MI systems for the officials, farmers, entrepreneurs and other active players involved
8. To identify the major constraints, if any, and to suggest the remedial measures

2. Methodology

The evaluation study of the MI Scheme was carried out in 198 villages from 66 blocks of 33 districts across 10 sample states by gathering quantitative as well as qualitative information through Personal Interviews (PIs) of beneficiary & non-beneficiary households, Focus Group Discussions (FGDs) of the knowledgeable persons in the sampled villages, In-depth Interviews (IDIs) of the various Government stakeholders from the village level up to the State level. Besides, secondary data pertaining to the physical & financial progress of the MI Scheme across the sample states were also analysed.

Sampling of States : Out of the total 15 agro-climatic zones in the country, 8 are such where the area coverage under the MI Scheme is significant. Thus, a total of 10 states falling under these 8 agro-climatic zones were selected as sample for undertaking the current evaluation study of MI Scheme.

Sampling of Districts : The number of sample districts in a State was taken according to the total number of districts in that State. The chosen number of sample districts within a sampled State were then selected in such a manner that the area coverage under the MI scheme during the reference period of study was highest in the 1st, near to the State average in the 2nd, lower than the State average in the 3rd, second-highest in the 4th, and second-lower than the State average in the 5th district.

Sampling of Blocks : From each district, 2 blocks were selected according to the given criterion that the first had the highest area coverage while the second had less than the block-wise average area coverage under the MI Scheme in the district.

Sampling of Villages : From each sampled block, 3 villages were selected in such a manner that the village-wise area coverage under the MI Scheme in that particular block was highest for the first, near to the average for the second and less than the average for the third village.

Sampling of Households : From the list of beneficiaries maintained by the district level implementing agency, a total of 10 beneficiary households were selected at random from every sampled village by giving due weightage to the SC/ST category of the beneficiaries. Further, 5 non-beneficiary households were selected from each of the sampled villages so as that the nature and extent of benefits gained by the beneficiary households could be gauged by comparing with the responses of the non-beneficiary households.

3. Major Findings

The economic analysis of micro irrigation has revealed an important aspect that generalization need to be avoided while formulation strategies and policies pertaining to Micro-irrigation. Although the technique is suitable for all kind of lands, but its adoption varied from region to region, depending upon its natural endowments. The wide variation across the sample States was predominant in three areas/zones, namely, water scarce areas, water scarce areas with undulating topography & sandy soils and water sufficient areas.

Overall, four states (Andhra Pradesh, Gujarat, Karnataka and Maharashtra) belonging to the ‘water scarce areas’ recorded relatively higher area coverage under both the drip and sprinkler irrigation systems than the other sample states. The findings suggest that the

technique was highly acceptable in areas experiencing chronic water deficit and over exploitation of groundwater.

The popularity of the micro-irrigation was very high in Zone II (water scarce areas with undulating topography & sandy soils), where the topography and soil-characteristics restrict the use of conventional irrigation systems. Rajasthan recorded highest area coverage under the sprinkler irrigation system, because of which the overall ranking of the State, in terms of the total area coverage under both drip and sprinkler systems, improved remarkably and stood at the fourth position among the sample states. Haryana, too, has covered a significant proportion (21681 ha) under sprinkler systems, but in the other Micro Irrigation Schemes.

As regards the water sufficient areas, comprising of Punjab, Odisha, Chhattisgarh and Madhya Pradesh, the area coverage under the Scheme was found to be very low. This justifies that adequate availability of irrigation supplies with free or flat rate of electricity tariff impedes the use of modern techniques in these areas.

Regarding proportion of drip irrigation under MI Scheme, Andhra Pradesh stands highest by covering 38% area (cumulative of area covered under drip in all 10 States), followed by Maharashtra (28%), Gujarat (13%) and Karnataka (12%). These 4 States covered more than nine-tenth of the total area across 10 States, under drip irrigation system. Chhattisgarh (0.4%), Odisha (0.7%), Haryana (1%), Punjab (1.3%), Rajasthan (2%) and Madhya Pradesh (4%) emerged as the states covering insignificant proportions under the MI scheme.

Only the states of Punjab and Andhra Pradesh were found to have prepared the five-year Perspective Plans for next 5 years.

Amongst the different models of Implementing Agencies across the ten sample states, it is noteworthy that Andhra Pradesh presents a replicable model in terms of achieving physical and financial targets. The State occupies one-fourth of the total area (cumulative of the ten states) covered under the Micro Irrigation Scheme.

It was disheartening to note that only a miniscule proportion (4%) of beneficiaries availed loan from the bank, almost all of the remaining farmers did not apply for the loan. In most of the cases, farmers were not aware about the availability and processes involved. A significant proportion has availed loan facility only in the states of Gujarat (14%) and Rajasthan (10%),. The district Bikaner of Rajasthan had highest proportion (43%) of the beneficiaries who availed loan, it was followed by Surendranagar, Gujarat (25%).

Amongst the sample states, Gujarat has evolved a replicable model of a multi-stage, multi-level monitoring process. This included a third-party audit of the installed MI systems, an overall appraisal of the performance of the third-party agencies involved in the said audits by the State Agricultural Universities, and an assessment of the quality of the manufactured MI components at the factory sites themselves. Besides, the State has appointed the Agricultural Finance Corporation (AFC) to carry out the concurrent monitoring & evaluation of the scheme.

Overall, hardly one-tenth of the beneficiaries affirmed to have received some training. Excepting Andhra Pradesh, where 61% beneficiaries affirmed to receive training, the other states were found to be lagging behind in this regard.

Only about one-fifth of the beneficiaries recalled that they had received the maintenance manuals. Out of these beneficiaries, only 11% affirmed that they had read and comprehended these manuals.

Only a miniscule proportion of the beneficiaries recalled that they had seen a demonstration farm.

Only 4700 hectares area was found covered under the demonstration farms across all the sample states, of which Andhra Pradesh alone accounted for over four-fifths.

Regarding after-sales & maintenance services, nearly half the beneficiaries were yet to face any problem in their installed systems.

Nearly three-fifths of the beneficiaries who faced a problem were satisfied with the quality of the after-sales & maintenance services received from the registered suppliers. Those not satisfied, cited the lack of quality services as the major reason for their dissatisfaction.

Overall, a little over a quarter of the non-beneficiaries reported to be aware of the scheme, which represents a fair proportion. Among the states, the level of awareness of the scheme was the highest in Maharashtra, followed by that in Rajasthan and Andhra Pradesh, while it was the least in Odisha.

Observation from other farmers' farms had the greatest impact on the awareness regarding the MI scheme as half the beneficiaries and over two-thirds of the non-beneficiaries attributed their awareness to it alone.

Andhra Pradesh and Gujarat were found to have evolved a Special Purpose Vehicle (SPV) each for the implementation of the scheme. It emerged that the creation of SPVs had led to an improved performance in these two states.

The lack of coherence between different departments involved in implementation in the State was found to have adversely affected the outcome of the scheme, as observed in Karnataka and Haryana.

Most of the states have taken efforts to popularize the scheme by increasing the state's share of the subsidy.

The proportion of the total irrigated area among the beneficiaries increased by more than one-tenth following the adoption of the MI systems.

The states of Haryana and Rajasthan, where large proportions of arid and semi-arid areas have saline aquifers, had the highest proportions (about 10%) of beneficiaries affirming the use of saline water for irrigation through their micro irrigation systems.

Overall, an overwhelming majority of the beneficiaries reported their net returns from crops irrigated with MI systems as better in comparison to that earned before adopting the MI systems.

The adoption of micro irrigation systems significantly reduced the farm labour requirements by over a quarter, particularly during the application of irrigation and weeding. Nearly cent-per-cent of the beneficiaries reported a significant reduction in the occurrence of weeds on their farms irrigated with the micro irrigation systems.

Only about one-fourth of the sample beneficiaries were applying fertigation/chemigation to their crops through their MI systems. The proportion of such beneficiaries was the highest (74%) in Maharashtra, followed by Andhra Pradesh (52%) and Gujarat (26%), while no beneficiary farmer was applying fertigation/chemigation in the states of Chhattisgarh, Orissa and Karnataka.

Among the beneficiaries who were applying fertigation/chemigation through MI systems, the consumption rate of fertilizer declined significantly by an overall average of 24% after the adoption of MI systems.

Among those beneficiaries, who were applying insecticides/pesticides with their micro irrigation systems, the average consumption of insecticides/pesticides recorded a decline of 18%.

A substantial reduction in electricity consumption due to micro irrigation was observed among the sample farmers. The average annual savings in energy was higher (370 kWh/ha) for the sample farmers practicing drip irrigation, as compared to the sprinkler irrigation where a reduction of about 198 kWh/ha was observed.

The economic analysis of micro irrigation has revealed that drip & sprinkler methods have generated additional income among the sample farmers. The drip method has proved to be the most efficient mode of irrigation in the water scarce areas, providing additional annual income which was more than one lakh per hectare in case chilly cultivated by sample farmers. Similarly, sprinkler methods provided an additional income of nearly 60, 000 per hectare for the farmers growing garlic.

The rate of return from drip irrigation was observed to be in the range of 48% to 153%. While, the rate of return from sprinkler irrigation varied from 44% to 144%. Understandably, the minimum payback period was found to be less than 1 year and the maximum duration spread over a period of 2 to 3 years in both drip & sprinkler methods.

The study of micro irrigation has revealed a very crucial factor that individuals' skill has an enormous effect over its success, as seen from the case studies of Mr. Shekhar Reddy and Mr. Vinod Kumar.

The returns from intercropping were best seen with the drip method which has brought about significant benefits to the farmers in terms of high annual returns.

4. Major Constraints

Fragmented Landholdings : It is only seldom that a farmer has all his lands in a continuous stretch at a single place. Instead, his landholdings are divided into many smaller fragments which are located at considerable distances from each other. In such cases, the beneficiary farmers are left with no other choice than to install separate MI units for each fragment of land but not without significantly escalating the overall cost of the system. This cost escalation acts as a deterrent for the adoption of such systems by the farmers in almost all the states across the country.

Large Number of Resource Poor Farmers : According to the officials in many states, the proportion of resource poor farmers having marginal landholdings is quite large. Such farmers are usually not adequately equipped to bear the high initial investments for adopting the micro irrigation technologies. On account of such a sizeable chunk of farmers being left out of the ambit of the scheme due to their being unable to afford even their own share of the costs after the subsidies, the adoption of MI systems remains largely limited to those few who have the resources to afford them.

Lack of Awareness regarding water conservation among the farming community : The lack of awareness with regard to the conservation of water among the farming community at large, irrespective of being tribal or non-tribal, has been cited as one of the major

reasons for the moderate level of popularity of MI Scheme in many states, including those of Punjab and Chhattisgarh.

Lack of Proper Forward Planning at the State Level : Across some sample states (Rajasthan, Gujarat, MP, Karnataka, etc.), the officials have cited limited availability of funds, and annual targets being lower than the actual demands for the MI systems, as the major reasons for having a sizeable waiting list of subsidy applicants. Considering that the State as well as Central funds are released as per the targets identified in the Annual Plans forwarded by the implementing agencies, and that the process of fixing of targets for the subsequent years is a subject of the State level implementing agencies, it may be inferred that the planning process in many states does not reflect the actual ground level demand for the MI systems. This not only results in inordinate delays but also in reducing the overall popularity of the scheme.

Mismatch of Timing in the Release of Central & State share of Subsidy Funds : The mismatch of timings in the release of Central and the State shares has also been cited as one of the major constraints that results in delay in the disbursement of subsidies by the district level officials in the states of Punjab, MP and Karnataka.

Lack of Qualified/Trained Field Staff : The lack of qualified and adequately trained field staff has been cited as a major constraint by the official stakeholders in almost all the states. Further, the officials in Odisha have even mentioned that the lack of adequately trained personnel is a critical constraint with System Manufacturers too, which causes delays in the installations of MI systems at the farms of the beneficiaries.

Lack of agronomic support : As the MI scheme focuses on the horticultural crops and other high value cash crops, the lack of agronomical support services to the beneficiaries de-motivates them from adopting the MI systems. However, only a few of the sample states, including Gujarat and Punjab, have provisions for the agronomic support services to be extended to the beneficiary farmers.

Limitation of 5 hectares for subsidy : In the State of Haryana, the proportion of such farmers who have large landholdings and who can easily afford bore-wells/tube-wells is quite high. However, given that the prime focus of the MI scheme is to conserve the underground water resources from being over-exploited, the maximum limit of 5 hectares area for the grant of subsidy leaves out such bigger farmers from the ambit. Thus, it is no surprise that some official stakeholders in the State have explicitly pointed towards this area limit as one of the constraints in the implementation of MI Scheme.

Limited Presence of Suppliers in Some Districts : In Odisha, some districts, like Koraput, Mayurbhanj, Keonjhar etc., do not have adequate presence of the registered suppliers. Consequently, owing to the lack of options in obtaining satisfactory after-sales-service among the beneficiaries, the popularity of MI scheme remains highly constrained in such districts.

Lack of Awareness regarding scheme: Slightly more than one-tenth (12%) of the farmers reported about the lack of awareness about the scheme. The lack of knowledge was reportedly inclusive of the representatives of dealers and the functionaries of the Implementing Agency. This shortcoming was mainly reported by the farmers of Andhra Pradesh (45%), Maharashtra (38%) and Odisha (29%). The proportion of the farmers reporting this shortcoming was alarmingly high in certain districts mainly – district Amarawati of Maharashtra (93%), district Warangal (83%), Kurnool (52%) of Andhra Pradesh and district Angul (67%) and Sonepur, Odisha (46%).

5. Suggestions from Stakeholders

A. Suggestions Forwarded by Officials

Greater Subsidy on Drip: The official stakeholders in the State of Gujarat and Chhattisgarh have suggested that the proportion of subsidy on the purchase of drip irrigation system should be higher as the initial investment on drip is significantly higher than that on the sprinkler irrigation system.

Special Purpose Vehicle (SPV) for Micro Irrigation: The officials from the states of Maharashtra and Karnataka have spelt out the need for a Special Purpose Vehicle (SPV) similar to the one in Gujarat or Andhra Pradesh for catering to the promotion of micro irrigation in their respective states.

Greater Monitoring: The official stakeholders in the State of Karnataka have indicated the need for monitoring by engaging a third-party agency for carrying out inspections of all of the micro irrigation systems installed under the scheme.

Inclusion of Other Cash Crops under MI Scheme: The direct consequences of greater area coverage in the State of Andhra Pradesh are visible in the suggestion forwarded by the APMIP officials. These officials have advocated the inclusion of fodder crops and forest based non-food plantation crops to boost the related sectors.

Additional Funds for IEC : The officials in the State of Chhattisgarh have pointed out towards the need for additional funds for spreading awareness of MI scheme in the State. This can be appreciated in the wake of the non-availability of any earmarked funding in the scheme for the Information, Education and Communication (IEC).

Allowing Subsidy to a Beneficiary Again After 5 Years : The officials in the states of Haryana and Punjab have mentioned that the MI systems being distributed under the scheme do not last for full 10 years, due to which the beneficiaries have to either wait for another couple of years before they get eligible for further round of subsidy or quit using micro irrigation altogether. In view of such a problem, these officials have suggested decreasing the duration for the re-eligibility for subsidy from the present 10 years to 5 years.

Adequate & Timely Allocation of Subsidy Grant: As per the district-level official stakeholders, the insufficient funds allocation as well as the lag between the receipt of the Central and the State funds need to be sorted out in order to allow the smooth implementation of the scheme.

Standardization of uniform rates for MI Systems & Accessories : In many of the states the MI systems of different brands are having different price structures. As such, many officials have pointed out towards the need for a uniform price policy through regular annual price reviews.

Up-scaling Orientation Training on Operations & Maintenance: Majority of the district and block functionaries have suggested for enhanced capacity-building of both the beneficiaries and the official stakeholders on the operation and maintenance of MI systems.

B. Suggestions Forwarded by Beneficiaries

Strengthening of awareness drives, training and establishment of demonstration farms: An overwhelming majority (61%) of beneficiaries strongly demanded for increased awareness, capacity building through training and demonstration. The proportion of farmers demanding for impetus to awareness and capacity building drives was highest in Haryana (84%) and lowest in Odisha (45%), indicating a inevitable need of such programmes all across the country.

Increase in subsidy and or subsidy to be given to the farmers: Considering the high cost of MI System, demand for increase in subsidy was most expected. Nearly one-third (32%) of the beneficiaries put-forward the suggestion of increased subsidy. The Farmers were also suggestive of the subsidy amount to be routed through them for decreasing the dependence on the dealers.

Better Quality Control: A small proportion (4%) of the farmers suggested for exercising the better control on the quality of the components of micro-irrigation systems. The state of Punjab had the highest proportion (15%) of such farmers.

Electric Connection along with System: Another 4% of the beneficiaries suggested that electric connection should be provided with the sanctioning of the MI System for smooth functioning of the scheme. The proportion of farmers for this suggestion was highest in Punjab (18%).

Complete Supply of material: A miniscule proportion (3%) suggested that all the component of the MI System should be supplied. The highest proportion (25%) of such beneficiaries was reported from Andhra Pradesh followed by Odisha (9%). On further probe the farmers of AP were mainly referring to the attachments for fertigation and chemigation, whereas, in case of Odisha it was the components of the MI System. An immediate attention is required on this aspect in Odisha.

6. Recommendations

A. Overarching

- Policies pertaining to micro irrigation cannot be formulated in a generalized manner, considering the varied performance of MI Scheme. Therefore, it is essential to frame strategies and policies which suit the conditions prevailing in that area.
- The compilation of baseline data/feasibility studies and subsequent preparation of 5-year perspective plans should be made mandatory for every State.
- It is advisable that the implementation of the scheme should be taken up by only one department/agency within a State for better results. The success of Special Purpose Vehicle (SPV) for Micro Irrigation in the states of Andhra Pradesh and Gujarat calls for replication in other states.
- A stricter monitoring of the services being offered by the registered suppliers, aimed at ensuring good quality training on operation & maintenance of the MI system and the provision of maintenance manual for the beneficiaries, is strongly recommended. The systematic monitoring mechanism developed by the implementing agency in Gujarat should be studied by other states for apt adoption.
- Research institutes (ICAR & SAU) should be funded for developing suitable models of intercropping, especially for drip irrigation by undertaking an intensive research work.
- In the water scarce areas, the initial efforts rolled by the GoI & State Governments has already popularized micro irrigation, but all out efforts are required to increase technical know-how regarding use of drip irrigation especially fertigation/ chemigation among the beneficiaries, through a strong framework of agriculture extension services.

- Considering the benefits of water soluble fertilizers, a subsidy scheme should be introduced to increase its usage. Possibility of dove tailing with Nutrient Based Subsidy (NBS) Scheme for Fertilizers should be explored.
- In the 'water scarce areas with undulating topography & sandy soils', emphasis should be on providing agronomic support.
- The 'water sufficient areas', covering lowest proportion of area under the Scheme, calls for greater efforts to popularize the techniques, which are to be viewed in this context —
    - ➢ It would be favorable if exemplary performance of skilled farmers, like, Mr. Vinod Kumar are identified by the concerned authorities and provided with public felicitation through awards. Such farmers should be regularly exposed to the other farmers of the surrounding areas.
    - ➢ The number of demonstration farms should be increased, wherein; priority should be given to the progressive farmers with proven technical competence by giving them 100% subsidy for setting up demonstration farms.
    - ➢ A massive drive is required to increase the number of training programmes as also the inclusion of farmers into them. The skilled farmers should be developed as key resource persons, which would allow interaction between the farmers.

B. State Specific

Andhra Pradesh

- ❑ The micro-irrigation was found most popular in Andhra Pradesh in terms of the area coverage. It had high proportion of the farmers, who availed after sale services and were dissatisfied with it. The cause of concern was poor quality of service. Considering a high proportion opting for micro-irrigation, issue needs to be attended by state government so that it does not affect the popularity of the scheme.
- ❑ It was noteworthy that more than two-fifth of the beneficiaries complained of cumbersome application process in the Warangal district. The state government may like to address the problems raised by the farmers.
- ❑ The lack of knowledge on the part of the representatives of the dealers and the functionaries of Implementing Agency was highlighted by the beneficiaries of districts Warangal (83%) and Kurnool (52%). Training Needs Assessment must be required before initiating a capacity building programme.

Gujarat

- The progress of Gujarat in propagating micro-irrigation is praiseworthy. However, the cause of concern was poor quality of service, which was raised by more than one-fourth of beneficiaries of districts Porbandar and Junagarh. Considering a high proportion opting for micro-irrigation, issue needs to be attended by state government at the earliest so that pace of popularity is not hampered.
- The state of Gujarat showed poor performance in providing training, demonstration farm and other capacity building activities. The state government needs to provide concentrated efforts and fresh impetus on this aspect.

Karnataka

- It would be advisable to make only one office as nodal agency for taking up all the projects related to the micro-irrigation. The involvement of 2 departments often leads to slow progress.
- The state is lagging behind grossly on the front of capacity building. No beneficiary remembered to have seen a demonstration farm. Only 2 % of the beneficiaries reported to have received the instruction manual along with the MI System. The state government needs to device a systematic programme for capacity building and a strong vigil and monitoring on supplies.
- A significant proportion complained for poor quality of after sale service, which needs to be looked into by introducing an apt procedure for quality control.

Maharashtra

- The status of training and capacity building is also pathetic in the state of Maharashtra. Only 3 % of the beneficiaries reported to have received the instruction manual along with the MI System.
- Only 2 out of 8 block level beneficiaries affirmed to have received training. Corroborating this fact, a huge proportion (38%) reported for poor knowledge in the part of representatives of dealers and functionaries of the implementing agency. It was noteworthy that this proportion was 93% in the district Amarawati, necessitating and immediate action by state gavernment on this issue.
- An overwhelming majority (87%) in the state was dissatisfied with the after sales service. All the beneficiaries, who were dissatisfied with it, complained for

poor quality of service. An integrated effort need to taken for exercising an effective control on the after sales service.

Rajasthan

- More than two-fifth of the beneficiaries in the Bikaner district reported the cumbersome process of application. Micro-irrigation becomes life line in the areas like Bikaner having undulating topography and sandy soil. Considering the popularity in the area it is imperative that state government immediately address this issue.
- The quality of system and components is basic requirement for promoting the popularity of the scheme. In the district Alwar, more than two-third of the beneficiaries reported for poor quality of components. The large size of proportion immediately necessitates an attention by the state government on the issue.
- In-spite of the fact, that state of Rajasthan has offered a higher subsidy in drip irrigation equipments, the extension of drip irrigation was found lacking in the state. A fresh impetus is needed on this aspect.

Haryana

- It is strongly suggested to make one office as nodal agency for taking up all the projects related to the micro-irrigation. The involvement of 2 departments often leads to confusions and consequent slow progress. The reduced annual budget of the state for Centrally Sponsored Micro-irrigation Scheme, is a burning example in this regard.
- The state of Haryana is offering subsidy up to 90% for promoting drip irrigation in the state, however the desired results are yet to be seen. A change in the strategy may work by introducing demonstration farms. The case studies of Mr. Vinod Kumar and likes may be studied in-depth. Such farmers are needed to be associated for the extension of the MI Scheme. The exposure visits of the progressive farmers to such farms will bring the desired result.

Odisha

- Odisha was found lacking in providing training and capacity building. Only 1 out of six block level functionary was found to have attended any training programme. State government would like to address this issue.
- The officials were complaining regarding non-availability of the suppliers/ dealers leading to exploitation of farmers. Further, a significant proportion of

beneficiaries in the districts Angul (67%) and Sonepur (46%) reported lack of knowledge on the part of the representatives of dealers and the functionaries of the implementing agency. The state government may like to look into the matter.

- Another frequent complaint, which was mainly Odisha specific, was incomplete delivery of system components, this issue was found more prevalent in the districts of Ganjam and Angul . The issue is related to the paucity of dealers. A fresh impetus to the promotion of scheme need to be given for breaking the vicious cycle.

Madhya Pradesh

- The state of Madhya Pradesh was found lacking grossly on the field of providing training and capacity building. Only 1 out of 5 district official has reported to have received any training. None of the beneficiary reported have seen any demonstration farm. Insignificant proportion reported to have received the maintenance manual. Surprisingly, the training programmes run by PFDC were also found comparatively wanting. An immediate attention of the state government is needed on this aspect.
- The proportion of drip irrigation was also much below the desired levels. A dedicated effort on the part of state government is needed to improve the micro-irrigation in general and drip irrigation in particular along with technical support for use of fertigation/chemigation through drip irrigation.

Chhattisgarh

- Like the parent state MP, the state of Chhattisgarh was also found grossly lacking on the issues of training and capacity building. None of the officials in district level and 3 out of 4 at block level received any training. None of the beneficiaries reported to has seen the demonstration farm. An immediate attention of the state government is needed on this area.
- Similar to Madhya Pradesh, the state has performed poorly in promoting the drip irrigation. None of the farmers reported to have used fertigation/chemigation through the Micro-irrigation. A dedicated effort on the part of state government is needed to improve the micro-irrigation in general and drip irrigation in particular along with technical support for use of fertigation/chemigation through drip irrigation.

- The state government may assess the technical competence of the implementing agency to handle the scheme like Micro-irrigation, which needs specialized knowledge base for proper implementation.

Punjab

- The state of Punjab is one of the most blessed states with regard to water endowment. However, the highest irrigation intensity and misuse of ground water resource has brought forward a frightening picture of the future if proper mitigation measures are not taken up right now. The most appropriate answer lies on the promotion of micro-irrigation techniques all across the state. A fresh impetus is required on the part of state government.
- It is understood that in view of abundance of water and free and flat electricity rates, it would be difficult to promote a new technique demanding additional investment. However, the case study of Mr. Vinod Kumar, who represents a water rich area, needs to be studied and publicized. The amount of return he is getting in comparison of other farmers, is an eye opener. The area is in the Haryana, an adjoining state. Such farmers are needed to be involved in promotion programmes. The farmers of the state of Punjab are quite enlightened and proper propagation of ground truth like the case of Mr. Vinod Kumar definitely make the farmers convinced. Exposure visits of progressive farmers to such farms will bring the desired impact sooner than expected.

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ABBREVIATIONS

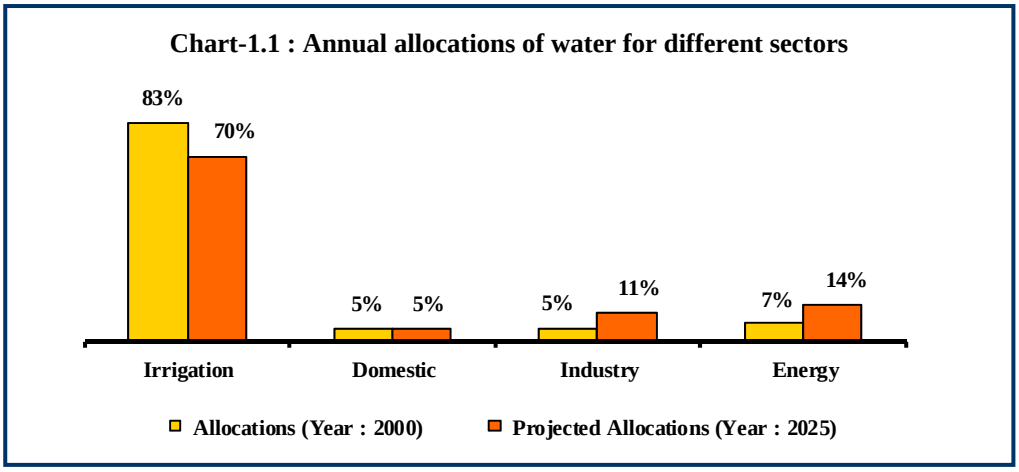
AFC	**:**	Agricultural Finance Corporation
APC	**:**	Agricultural Production Commissioner
APMIP	**:**	Andhra Pradesh Micro Irrigation Project
AAP	**:**	Annul Action Plan
ADH	**:**	Assistant Director Horticulture
BKVY	**:**	Biju Krishak Vikash Yojana
CIPET	**:**	Central Institute of Plastics Engineering & Technology
CRBKVN	**:**	Chhattisgarh Rajya Beej Evam Krishi Vikas Nigam Ltd.
CEO	**:**	Chief Executive Officer
DDPO	**:**	District Development and Panchayat Officer
DAC	**:**	Department of Agriculture & Cooperation
DDH	**:**	Deputy Director of Horticulture
DAP	**:**	District Action Plan
DHO	**:**	District Horticultural Officer
DMIC	**:**	District Micro Irrigation Committee
DPIP	**:**	District Poverty Initiative Project
DRDA	**:**	District Rural Development Agency
DSAO	**:**	District Superintendent Agriculture Officer
DSCO	**:**	Divisional Soil Conservation Officer
FUE	**:**	Fertilizer Use Efficiency
FCD	**:**	Financial Commissioner Development
FGDs	**:**	Focus Group Discussions
GAIC	**:**	Gujarat Agro Industries Corporation Limited
GERI	**:**	Gujarat Engineering Research Institute
GGRC	**:**	Gujarat Green Revolution Company
GIRDA	**:**	Gujarat Industrial Research and Development Agency
GNFC	**:**	Gujarat Narmada Valley Fertilizers Company Limited
GSFC	**:**	Gujarat State Fertilizers and Chemical Limited
GWRDC	**:**	Gujarat Water Resources Development Corporation Ltd.
IA	**:**	Implementing Agency
IDIs	**:**	In-depth Interviews
ICAR	**:**	Indian Council of Agricultural Research
IEC	**:**	Information, Education and Communication

IDE	**:**	International Development Enterprises
KVK	**:**	Krishi Vigyan Kendra
MIAO	**:**	Mandal Irrigation Area Officer
NABARD	**:**	National Bank for Agriculture and Rural Development
NABCONS	**:**	NABARD Consultancy Services
NARP	**:**	National Agricultural Research Project
NCPAH	**:**	National Committee on Plasticulture Applications in Horticulture
NHM	**:**	National Horticulture Mission
NMMI	**:**	National Mission on Micro Irrigation
OHDS	**:**	Odisha Horticultural Development Society
OLIC	**:**	Odisha Lift Irrigation Corporation Limited
OTELP	**:**	Odisha Tribal Empowerment & livelihood Progarmme
PRIs	**:**	Panchayati Raj Institutions
PFDCs	**:**	Precision Farming Development Centers
PEO	**:**	Program Evaluation Organisation
RHEO	**:**	Rural Horticulture Extension Officer
RKVY	**:**	Rashtriya Krishi Vikas Yojana
RIDF	**:**	Rural Infrastructure Development Fund
SPV	**:**	Special Purpose Vehicle
SAU	**:**	State Agricultural University
SMIC	**:**	State Micro Irrigation Committee
TCS	**:**	Tata Consultancy Services
TSG	**:**	Technical Support Group

1. INTRODUCTION

1.1 Background

Water, being a necessity for crop production, is one of the most important natural resources for sustaining human life on earth. However, owing to the presence of large tracts of arid and semi-arid lands, where the surface and sub-surface water resources are highly limited, coupled with the spurt in industrial & domestic consumption of water due to a high rate of population growth, the competition for this limited commodity is increasing day-by-day in the country. Further, the over-exploitation is depleting the existing water resources at critical rates even in areas hitherto known for their having irrigation water in aplenty, resulting in irrigation water becoming both scarce and expensive. Thus, to feed the ever growing population, the agricultural production needs to be boosted by following better soil-water management techniques that could provide the arid and semi-arid lands better access to irrigation water without actually increasing the stress on available water resources.



The allocations of water for the agriculture sector (Chart-1.1) are declining at alarming rates due to its ever increasing demand for the energy, industry and domestic purposes. Much of the available irrigation water in India is applied through the conventional surface irrigation methods, which involve huge conveyance and distribution losses resulting in low overall irrigation efficiencies (35-40%). The poor irrigation efficiency of these systems not only reduce the anticipated outcomes from investments in the water resources sector of the country, but also create environmental problems, like, lowering of water table due to over-exploitation of sub-surface water resources, water-logging and soil salinity, thereby adversely affecting the crop yields.

Micro-irrigation, with drip and micro-sprinklers, enables the frequent application of small amounts of water onto the soil surface very near to the plant root zone in the form of drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line. Thus, owing to its ability of applying water to only a small portion of soil volume resulting in minimal surface evaporation, runoff and deep percolation losses below the crop root zone, micro-irrigation is a far more efficient method having an overall irrigation efficiency of almost 90%.

Dripper

Sprinkler

Apart from saving irrigation water, the micro-irrigation system is beneficial for enhancing the economic returns from crop by increasing the yield as well as yield-quality. This is due to its ability to apply small amounts of irrigation water at frequent intervals that rules out the formation of water-stresses during the critical growth stages of the crops while also enabling the uniform application of precise amounts of nutrients & pesticides along with irrigation water throughout the crop growing season.

Acknowledging its benefits, researchers from across the country have reported that micro-irrigation is the better alternative for irrigating the row crops, mulched crops, orchards, gardens, greenhouses, nurseries and ornamental plantations as against the conventional surface irrigation systems. They found that irrigation with Drip is more suitable for the row-crops, while, that with Sprinkler is better suited for the high density crops. The overall benefits of the micro-irrigation system, as reported by them, are as follows —

- **Enhanced Crop Yield and Quality:** Because of averting the formation of water-stresses during the critical growth stages of the plant owing to frequent applications of the requisite amounts of irrigation water along with nutrients, chemicals, etc.
- **Water Savings:** Conveyance loss is minimal. Evaporation, runoff and deep percolation are reduced as compared to other traditional irrigation systems. A water supply source with limited flow rates such as small water wells or city/rural water can also be used.
- **Energy Savings** : Reduced energy requirements due to pumping of lesser amount of water
- **Reduced Salinity Hazards to Plants** : Because of dilution of soil solution's salt concentration resulting from continuous supply of moisture

- **Weed and Disease Reduction:** Because of limited wetted area, weed growth is inhibited and disease incidences are reduced.
- **Automation of Operations:** Micro-irrigation systems can be automated which reduces the operating labour requirements.
- **Ease of Fertilizer/Chemicals Application:** In addition to irrigation water, fertilizers and chemicals can be applied efficiently through this system.
- **Improved Production on Marginal Lands:** On hilly terrain, micro-irrigation systems can operate with no runoff and without much interference from the wind. The fields need not be levelled.

In spite of the aforementioned benefits, the popularity of these micro-irrigation systems has been limited to only those areas in the country where the farmers are by and large progressive and where the topography and soil-characteristics restrict the use of conventional surface irrigation systems. The growing need for attaining food security by meeting the higher crop water demands through judicious use of available water resources within the country has propelled the planners in the Government to push forward the adoption of micro-irrigation technologies by the farmers from all the 15 agro-climatic zones of the country. Thus, upon the recommendations of the Task Force for promoting the micro-irrigation technologies in the country, the Micro Irrigation Scheme (MI) was launched by the Ministry of Agriculture (GoI) during the VIII Five Year Plan in January, 2006.

The MI Scheme aims at increasing the area under efficient methods of irrigation viz. drip and sprinkler irrigation. Under the scheme, a combined subsidy, of at least 50%, is provided by the Central and State Governments (Central: 40%, State: 10%) on the purchase of micro irrigation systems for a maximum area of 5 hectares, while the remaining cost of those MI systems is borne by the beneficiary, either through his/her own resources or soft loan from the financial institutions. Further, some State governments have supplemented the existing subsidy with additional funds from their own resources in order to reduce the beneficiaries' share of cost and make the scheme more appealing for the SC/ST category of the farmers.

The scheme has two major components — (a) Area Coverage under MI; and (b) Human Resource Development including Demonstrations in the related sector, besides a mechanism for scheme administration and monitoring. For the effective implementation & monitoring of the scheme, a three-tier system has been set up at the national, State & district levels, as described briefly hereunder —

I. National Level

- **National Committee on Plasticulture Applications in Horticulture (NCPAH)**
  The committee provides overall guidance to various stakeholders of the MI Scheme and reviews their physical & financial progress.

- **Executive Committee on MI Scheme**
  The committee oversees all the activities of the MI Scheme, including granting approval to the Action Plans of the states, PFDCs (Precision Farming Development Centers), Projects on Technology Transfer, Sponsored Projects, and making allocations for the various states/components. Further, its mandate includes maintaining smooth functional linkages among the stakeholders at different levels.

- **Technical Support Group (TSG)**
  The committee includes experts from the related fields of agriculture, water management, information technology, etc., to provide monitoring and guidance in technical matters.

II. State Level

- **State Micro Irrigation Committee (SMIC)**
  Under the Chairmanship of the Agriculture Production Commissioner/ Principal Secretary/Secretary Horticulture/Agriculture, its functions include —

  i. Conducting baseline survey and feasibility studies in the State, covering various crops and technologies
  ii. Ensuring smooth implementation of Micro Irrigation scheme in different districts of the State
  iii. Ensuring allocation of State's share of resources required for implementing the Scheme and making it available to the implementing agencies at the district level
  iv. Finalizing and forwarding the consolidated Action Plan of the Districts to Department of Agriculture & Cooperation (DAC)
  v. Circulating the list of registered system manufacturers along with the price list to the District Micro Irrigation Committee and the implementing agency, while also indicating the amount to be borne by the beneficiaries
  vi. Mobilizing the credit requirement of the farmers through the financial institutions
  vii. Facilitating PFDCs in organizing various training and extension programs for farmers, officials, NGOs, entrepreneurs, etc.

III. District Level

- **District Micro Irrigation Committee (DMIC)**

  Headed by the Chief Executive Officer (CEO) of Zila Parishad/District Rural Development Agency (DRDA) or the District Collector, its functions include —

  i. Reviewing the District Action Plan and forwarding it to the SMIC
  ii. Mobilizing the credit requirement of applicant beneficiaries through the financial institutions
  iii. Monitoring and reviewing the physical & financial progress of the MI Scheme
  iv. Reviewing the submission of utilization certificate by the Implementing Agency (IA)

- **Implementing Agency (IA)**

  Under the supervision of DMIC, the primary responsibility of the execution of the scheme lies with an implementing agency (DRDA/ Other Govt. Dept.), specially identified for the purpose.

  During the XI Plan, the MI Scheme was targeted to cover a total area of 28 lakh hectares (13 lakh ha under drip and 15 lakh ha under sprinkler irrigation) out of which 19.47 lakh hectares had been covered up till 2009-10. With the formation of a National Mission on Micro Irrigation in June-2010 there was a strong need to evaluate the level of achievements from the earlier initiatives so that the critical gaps could be identified and duly filled-up for greater success in the future endeavours. Towards this end, the Planning Commission (GoI) aptly decided to conduct a comprehensive evaluation of the MI Scheme for the reference period: *January 2006 – March 2010*.

  AMS Consulting (P) Limited has been assigned to conduct the evaluation study of the MI scheme in 10 sample states — Punjab, Haryana, Rajasthan, Gujrat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Orissa and Chhattisgarh.

1.2 Objectives of the Study

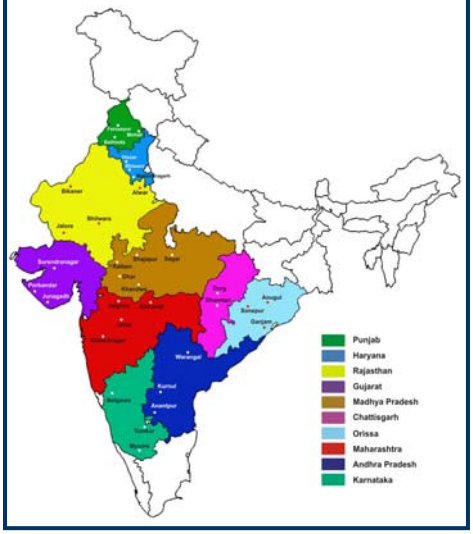
The evaluation of the MI Scheme was undertaken with the following objectives —

1. To estimate the total area covered under drip and sprinkler in selected states since the inception of MI Scheme
2. To estimate the reduction in fertilizer usage, increase in fertilizer use efficiency, and savings in labour, pesticides and energy.
3. To assess the extent of the use of marginal and otherwise uncultivable lands and that of saline water
4. To assess the popularity of micro-irrigation systems in terms of their efficiency, adequacy and usage in different states, especially in potential belts/regions having a water deficit (arid & semi-arid areas)
5. To assess the roles played by major stakeholders, like, NCPAH, SMIC, DMIC, IA, TSG, Panchayati Raj Institutions (PRIs) and farmers/ beneficiaries at different levels in planning, implementation and monitoring of the scheme under the program
6. To analyze the approach/strategies adopted by the administrative/ implementing machineries for future course of action
7. To study the role played by HRD in imparting training programs, conducting seminars, workshops and exhibitions and demonstrations of MI systems for the officials, farmers, entrepreneurs and other active players involved
8. To identify the major constraints, if any, and to suggest the remedial measures

2. METHODOLOGY

The evaluation study entailed gathering quantitative as well as qualitative information by canvassing semi-structured schedules with the beneficiary & non-beneficiary households, village PRI members, government stakeholders at the block, district and State levels, and conducting Focus Group Discussions (FGDs) of the knowledgeable persons in the sampled villages of the 33 districts across 10 sample states (Fig. 2.1). Besides, secondary data pertaining to the physical & financial progress of the MI Scheme was also collected from the official records. The detailed methodology adopted for carrying out the evaluation is presented in the following sections.

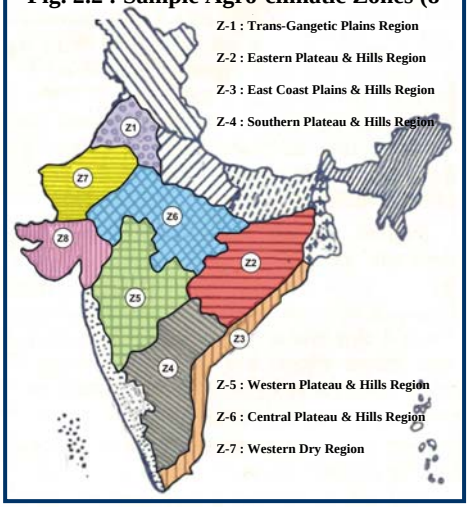
Fig. 2.1 : Study Sample : States &



2.1 Sampling

The evaluation study was carried out in the selected geographical locations duly sampled at the state, district, block and village levels. While, the sampling of the states and districts was carried out by the PEO, that of the blocks, villages and the households was undertaken by AMS. The detailed methodology adopted for the same is as follows—

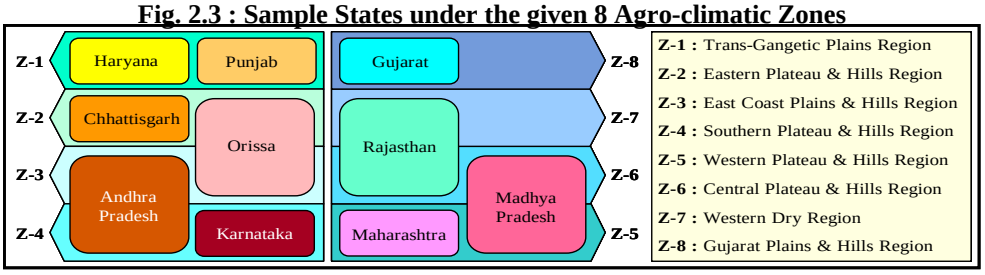
Fig. 2.2 : Sample Agro-climatic Zones (8



2.1a Sampling of States (by PEO)

Based upon the National Agricultural Research Project (NARP-1979) of the Indian Council of Agricultural Research (ICAR), the Indian landmass has been divided into a total of 15 agro-climatic zones on the basis of climate, soil and other related factors. Out of these 15 agro-climatic zones, 8 are such where the area coverage under the MI Scheme is significant (Fig. 2.2). Thus, a total of 10 states falling under these 8 agro-climatic zones were selected as sample by the PEO for undertaking the current evaluation study (Fig. 2.3).

Fig. 2.3 : Sample States under the given 8 Agro-climatic Zones



2.1b Sampling of Districts (by PEO)

As per the ToR, the number of sample districts in a State was selected according to its total number of districts (Table-2.1).

Table-2.1 : Basis for selecting the No. of Districts in a State

Total No.	≤20	21-30	31-40	> 40
Sample No.	2	3	4	5

Further, the criteria adopted for selecting the sample districts within a given State was that the area coverage under the MI Scheme during the reference period of study was highest in the 1st, near to the State average in the 2nd, lower than the State average in the 3rd, second-highest in the 4th, and second-lower than the State average in the 5th district (Fig. 2.4). Thus, overall, a total of 33 districts were selected as sample by the PEO from across the 10 sample states (Table-2.2).

Fig. 2.4 : District Selection Criterion

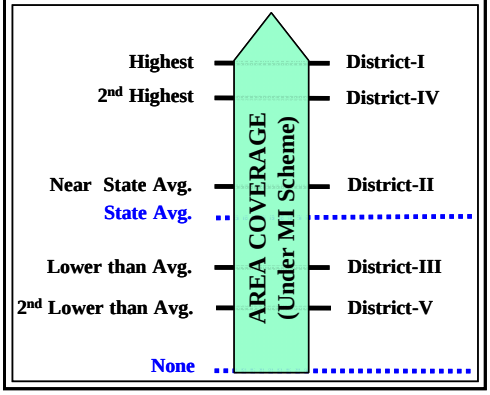


Table-2.2 : State-wise List of Sample Districts

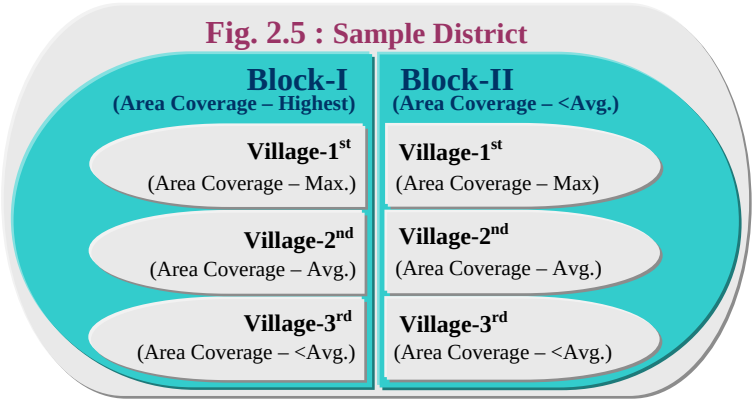
SN	States	Districts				
		1st	2nd	3rd	4th	5th
1.	Haryana	Bhiwani	Mahendragarh	Hissar		
2.	Punjab	Ferozepur	Mohali	Bathinda		
3.	MP	Ratlam	Sagar	Khandwa	Dhar	Shajapur
4.	Chhattisgarh	Durg	Dhamtari			
5.	Andhra Pradesh	Anantpur	Warangal	Kurnul		
6.	Karnataka	Belgaum	Tumkur	Mysore		
7.	Odisha	Ganjam	Anugul	Sonepur		
8.	Maharashtra	Amravati	Jalna	Ahmednagar	Jalgaon	
9.	Gujarat	Junagadh	Surendranagar	Porbandar		
10.	Rajasthan	Jalore	Alwar	Bhilwara	Bikaner	

2.1c Sampling of Blocks

Within a sample district, 2 blocks were sampled according to the given criterion that the first had the highest area coverage and the second had less than the average area coverage under the MI Scheme in the district. Thus, overall, 66 blocks were selected as sample from across the 33 districts of the 10 states.

2.1d Sampling of Villages

Within a sample block, 3 villages were selected as sample by following the criteria (Fig. 2.5) that the village-wise area coverage under the MI Scheme in that particular block was highest for the first, near to the average for the second and less than the average for the third village. Thus, within a sample district, exactly 6 villages were covered for undertaking the current evaluation study.



Overall, the study sample selected for the current study is presented ahead—

Table-2.3 : Study Sample (Nos.)

SN	States	Sample Districts	Sample Blocks	Sample Villages
1.	Haryana	3	6	18
2.	Punjab	3	6	18
3.	MP	5	10	30
4.	Chhattisgarh	2	4	12
5.	Andhra Pradesh	3	6	18
6.	Karnataka	3	6	18
7.	Odisha	3	6	18
8.	Maharashtra	4	8	24
9.	Gujarat	3	6	18
10.	Rajasthan	4	8	24
Total		**33**	**66**	**198**

2.1e Sampling of Households

At the start, all the households who had availed of the benefit under the Micro Irrigation Scheme in the sampled villages were identified from the list of beneficiaries maintained with the district level implementing agency. Out of these, a total of 10 beneficiary households were selected at random from every sampled village by giving due weightage to the SC/ST category of beneficiaries.

Further, 5 households who had not availed of the benefit under the MI Scheme were also selected at random from each of the sampled villages so that the nature and extent of benefits gained by the beneficiary households could be gauged by comparing with the responses of non-beneficiary households.

Thus, overall, the study involved conducting interviews with 1,980 beneficiary households and 990 non-beneficiary households across the 33 sampled districts in 10 states. However, the actual number of beneficiaries selected for the household level interviews was fewer (1614) than originally intended due to their non-availability in sufficient numbers.

2.2 Data Collection

2.2.1 Development of Study Instruments

The relevant primary information was collected by canvassing semi-structured schedules to the sampled households along with other stakeholders from the village level up to the State level and by conducting focus group discussion (FGD) of knowledgeable persons & other stakeholders in every sampled village. Towards this end, the schedules were first developed and duly field-tested for identifying and removing all the logical deficiencies before being finalized in consultation with the Program Evaluation Organisation (PEO) of Planning Commission. Thereafter, the schedules were translated into the local language for enabling better communication with the concerned stakeholders.

Overall, the tools employed for collecting data for the current evaluation study included the following—

Table-2.4 : Data Collection Instruments

SN	Type of Schedule	Data Collection Method
i.	Beneficiary Schedule	Household Interviews
ii.	Non-Beneficiary Schedule	
iii.	FGD Topic Guide	Focus Group Discussions
iv.	State Level Schedule	In-Depth Interviews
v.	PFDC Schedule	
SN	**Type of Schedule**	**Data Collection Method**
vi.	District Level Schedule	

vii.	Block Level Schedule	
viii.	Village Level Schedule	

- *In addition to primary data collection, secondary data related to physical & financial progress of MI Scheme was also collected from the official records.*

2.2.2 Household Level Interviews

The household level information was gathered by canvassing separate sets of semi-structured schedules to the sample beneficiary and non-beneficiary households to gauge the nature and extent of benefits gained by the beneficiaries in comparison to the non-beneficiaries, thereby evaluating the nature of impact of the MI Scheme.

2.2c Focus Group Discussions (FGDs)

Besides eliciting the household level information, qualitative information was gathered from the community members through FGDs in order to tap their perceptions, opinions, attitudes and behaviours regarding the nature of implementation of MI Scheme, particularly with respect to the benefits from the scheme, the potential for its popularity in the region and procedural constraints observed therein. These FGDs were conducted once in every sample village with about 8-10 persons representing beneficiaries, non-beneficiaries, knowledgeable persons, village head persons/PRIs and functionaries of development departments.

2.2d In-depth Interviews (IDIs) with Stakeholders

The information regarding the planning, implementation and monitoring of the MI Scheme at various levels was obtained by conducting the IDIs of different stakeholders who were involved, either directly or indirectly, in its implementation. The officials interviewed during this process included the in-charges of respective state level implementing agencies; the principal investigators of respective PFDCs; the in-charges of district level implementing agencies; the concerned block level officials; and the village PRI members in the 18 sample villages.

2.2e Secondary Data

In addition to the primary data, secondary data in the form of physical & financial progress of the scheme was obtained from the official records at the State, district & block levels so as to gauge the extent of achievements and identify the critical gaps & constraints in the implementation of the MI Scheme.

3. POTENTIAL OF MICRO IRRIGATION

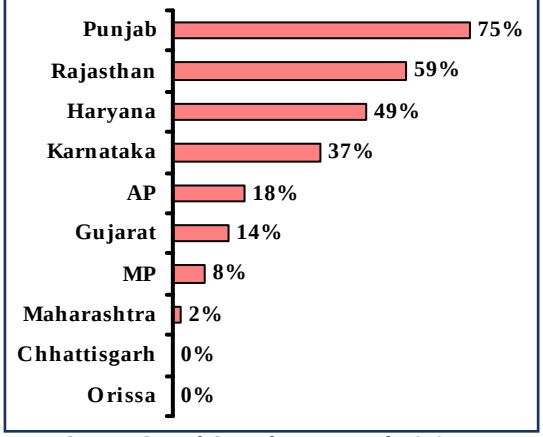
The potential for the adoption of efficient methods of irrigation, such as micro-irrigation with drip and sprinkler, is typically higher in the arid and semi-arid regions, where rainfall is scanty and the cultivated lands are largely irrigated with the underground water resources due to the lack of availability of water from the surface water resources. As such, the potential for the adoption of micro irrigation has a positive correlation with the proportion of net irrigated area (NIA) to net cultivated area (NCA) and over-exploitation of groundwater resources, and a negative correlation with the extent of rainfall (Table-3.1).

Table-3.1 : State-wise Average Annual Normal Rainfall

State	Rainfall (mm)
Karnataka	1761.9
Maharashtra	1470.8
Orissa	1460.5
Chhattisgarh	1290.7
Madhya Pradesh	1062.9
Andhra Pradesh	983.4
Gujarat	725.2
Punjab	635.9
Haryana	562.8
Rajasthan	485.3

Source : *India Meteorological Dept.*

Chart-3.1 : Proportion of Over-exploited Blocks/Talukas/Mandals/Panchayat Samitis



Source: *Central Ground Water Board, 2010-11*

Thus states, like Punjab and Haryana with relatively lower average annual normal rainfall and higher proportion of NIA/NCA (Table-3.2) leading to greater over-exploitation of groundwater resources (Chart-3.1) have a greater potential for the adoption of micro irrigation systems than the other sample states.

Table-3.2 : Proportion of Net Cultivated Area under Irrigation from Different Sources

States	Net Cultivated Area ('000 ha)	Net Irrigated Area ('000 ha)	NIA/ NCA (%)	Irrigated by Surface Water ('000 ha)	Irrigated by Surface Water (%)	Irrigated by Ground Water ('000 ha)	Irrigated by Ground Water (%)
Overall Sample	**108,155**	**38,435**	**36%**	**11,635**	**30%**	**26,800**	**70%**
Punjab	4,193	4,080	97%	1,115	27%	2,965	73%
Haryana	3,685	3,069	83%	1,282	42%	1,787	58%
Madhya Pradesh	15,532	6,891	44%	1,109	16%	5,782	84%
Gujarat	10,685	4,336	41%	835	19%	3,501	81%
Odisha	6,182	2,181	35%	1,411	65%	770	35%
Andhra Pradesh	13,340	4,214	32%	1,445	34%	2,769	66%
Karnataka	19,019	5,850	31%	1,061	33%	2,176	67%
Chhattisgarh	11,697	3,237	28%	870	66%	453	34%
Rajasthan	4,950	1,323	27%	1,424	24%	4,426	76%
Maharashtra	18,763	3,254	17%	1,083	33%	2,171	67%

The same is corroborated from several scientific studies, including that of *Palanisami et. al (2011) (Economic & Political Weekly Supplement, 2011)*, which has reported the following estimates (Table-3.3) of areas across the 10 sample states upon which there is potential for the adoption of micro irrigation systems.

Table-3.3 : State-wise Area having Potential for the Adoption of MI Systems

States	Net Cultivated Area ('000 ha)	Total Potential Area ('000 ha)	Total Potential Area (%)
Punjab	4,193	3,378	81%
Haryana	3,685	2,390	65%
Madhya Pradesh	15,532	6,391	41%
Gujarat	10,685	3,278	31%
Odisha	6,182	219	4%
Andhra Pradesh	13,340	1,117	8%
Karnataka	11,697	1,442	12%
Chhattisgarh	4,950	211	4%
Rajasthan	19,019	5,658	30%
Maharashtra	18,763	2,714	14%
All 10 States	**1,08,155**	**26,798**	**25%**

Further, the potential for the adoption of these MI systems is also dependent upon the nature of cropping pattern and topography in the region. As the pressurized MI systems easily pump water to the most inaccessible parts of the sloping lands, their use becomes highly relevant to the undulating hilly tracts which are usually reliant on the rains for crop cultivation. Thus, their adoption potential is substantially higher in such areas. Besides,

these MI systems are better suited for the horticulture crops and field crops that require lesser amounts of water per irrigation but with higher application frequencies. However, they are not suitable for the crops like, paddy, which are highly water intensive and require standing water.

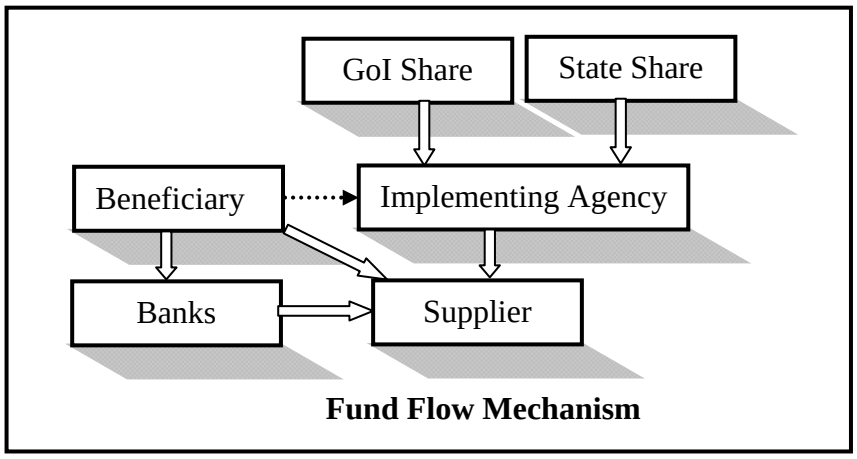
4. MICRO IRRIGATION SCHEME

Being implemented under the overall guidance of the National Committee on Plasticulture Applications in Horticulture (NCPAH), Ministry of Agriculture, Govt. of India, the centrally sponsored scheme of micro irrigation aims at increasing the area under efficient methods of irrigation viz. drip and sprinkler irrigation systems.

Under the scheme, a combined subsidy, of at least 50%, is provided by the Central and State Governments (Central: 40%, State: 10%) on the purchase of micro irrigation systems for a maximum area of 5 hectares, while the remaining cost is borne by the beneficiary, either through his/her own resources or a soft loan from the financial institutions. Further, some State governments supplemented the subsidy with additional funds from their own resources in order to reduce the beneficiaries' share of the cost and make the scheme more appealing for the poorly endowed farmers, especially for those belonging to the SC, ST and marginal categories. Therefore, it would be imperative to study the flow of funds, differential subsidy pattern between drip & sprinkler and ratio of subsidy between GoI and State Government during the Scheme period.

4.1 Flow of Funds

As per the guidelines of the Centrally Sponsored Micro Irrigation Scheme, the Government of India (GoI) directly releases the funds to the State Level Implementing Agency (IA) on the basis of the approved Annual Action Plan. Further, the State share of subsidy is released to the IA, as depicted ahead —



Fund Flow Mechanism

The process of subsidy disbursement is usually routed thorough the beneficiary and the State Level Implementing Agency. The beneficiary's share of contribution is paid to the manufacturer/supplier; who issues a receipt to the farmer in duplicate for the amount received. In case the farmer avails bank loan, the concerned bank would pay the beneficiary's sanctioned amount to the supplier by crossed cheque. Subsequent to the satisfactory installation of the MI system, the IA furnishes the balance amount of the system through the crossed cheque to the supplier directly or through the beneficiary. In case of direct payment to supplier, a certificate of successful installation is obtained from the beneficiary.

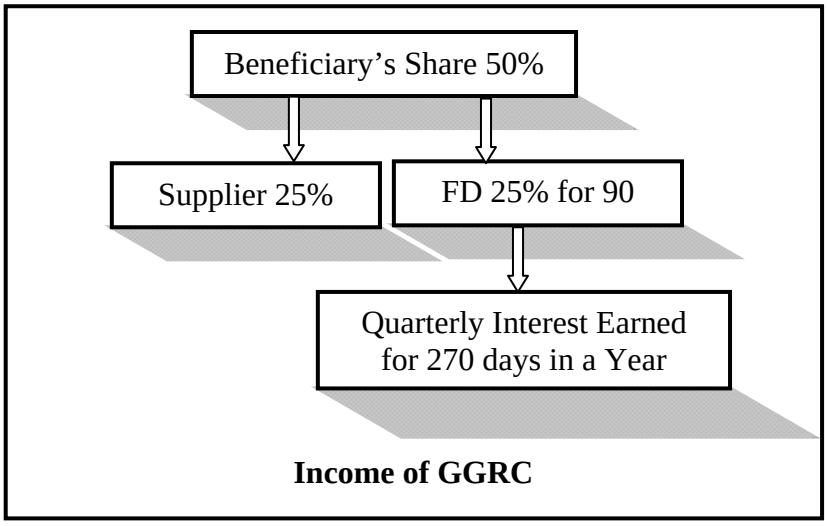
By and large, most of the States have adopted the general procedure of flow of funds under the MI Scheme, excepting a few States. Out of all the 10 States studied so far, only the implementing agency (Department of Horticulture) in Karnataka follows a very distinct pattern of subsidy disbursement. It was reported that the implementing agency releases the GoI and State Share of subsidy directly to the beneficiary's account through ECS/RTGS.

Whereas in some States, the beneficiary pays his share of the cost of the system directly to the IA, which in turn releases the subsidy amount to the supplier, as per the terms of payment. This process has been suitably exploited by the States of Andhra Pradesh and Gujarat. The implementing agencies in both the states, that is, APMIP and GGRC, respectively, follow similar procedures for collecting farmer's share of the cost of the MI system, as represented by dotted line in the illustration.

Gujarat Model: In Gujarat, the farmer deposits his share (50%) of the cost of the MI system to the GGRC, which in turn releases half of it to the supplier as a mobilization amount. The GGRC deposits the remaining half of the farmer's share in a bank, as fixed deposits for a term of 90 days. Subsequent to the installation of the system, verification is conducted by a third party monitoring agency. Once the farmer provides a certificate confirming successful installation of system, GGRC releases 70% amount to the supplier. The balance (5%) amount is held by GGRC as a guarantee to ensure that the supplier provides after sales service.

The GGRC has innovatively exploited the potential of income generation, which has been camouflaged within this procedure (earlier suppliers were beneficiaries in most of the cases). It may be unveiled from the fact provided by the Officials of the Company, that GGRC collects an amount of about Rs 1 Crore every day from the beneficiary's contribution. As apparent from the following illustration, half of the beneficiary's share, that is, Rs 50 lakh is deposited by GGRC as fixed deposit for 3 months. The Company generates its revenue from the interest earned by the fixed deposits. Thus, the income

obtained in the form of interest amount sustains Gujarat Green Revolution Company to a large extent.



Income of GGRC

Subsidy Structure

The MI Scheme provided for the disbursement of 40% subsidy by the Central Government and another 10% subsidy by the concerned State governments to the farmers for meeting their expenses incurred on the purchase of MI systems during the reference period of this study. However, with a view to broadening the scope and coverage of the scheme according to local conditions, many states supplemented the specified subsidy structure with funds from their own resources. Thus, while the SC/ST and general categories of farmers in Andhra Pradesh were provided subsidies up to 100% and 90%, respectively, all the categories of farmers in Haryana were provided subsidies of 90% on drip irrigation through the department of horticulture.

Further, in Punjab, the total subsidy available to the farmers was 75% for both drip and sprinkler as against the specified 50% on account of the state government supplementing its 10% share of subsidy with another 25% from the NABARD-Rural Infrastructure Development Fund (RIDF). Besides, the government of Punjab also appended the subsidy for the demonstration farms with another 10% from its own resources thereby taking it to 85%. Likewise, subsidies were enhanced by the state governments in MP (for small & marginal farmers), Odisha, Maharashtra (for SC/STs only), Gujarat (for SC/STs only), and Rajasthan. The overall subsidy structure that existed during the reference period of study (2006-2010) in different states is as follows—

Table-4.1 : Subsidy Structure in Sample States

States	Type of Beneficiary	Subsidy (%)		
		Drip	Sprinkler	Demonstration
Punjab	All	75	75	90
Haryana	All	90	50 (Agri. Deptt)	75
Madhya Pradesh	All	50	50	75
Gujarat	Gen/SC	50	50	100
	ST	75	75	100
Odisha	All	70	70	75
Andhra Pradesh	Gen	60-90	60-90	75
	SC/ST	100	100	
Karnataka	All	50	50	75
Chhattisgarh	All	50	50	75
Rajasthan	All	70	50	75
Maharashtra	Gen	50	50	-
	SC/ST	60	60	-

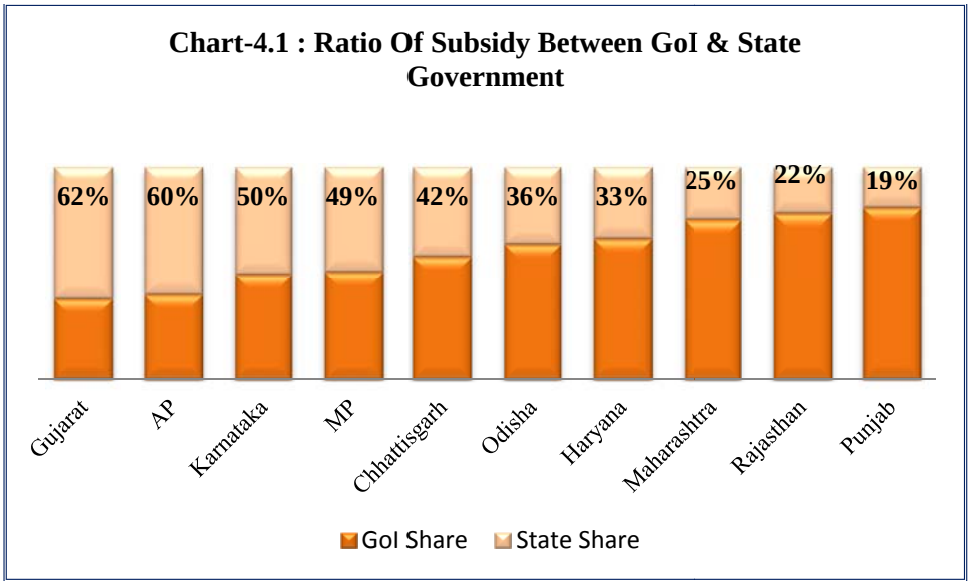
☛ *Data up to March, 2010*

Difference in Subsidy between Drip and Sprinkler

It is clearly evident from Table 4.1, that out of the ten sample states, only the States of Haryana and Rajasthan have provided an additional subsidy in case of drip irrigation to promote its usage. In Haryana, the subsidy available for purchasing drip systems is 90%, which is shared in the ratio of 40:50 by the GoI and the State Government, respectively. Similarly, the State government in Rajasthan has taken an initiative to provide 20% additional subsidy for the purchase of drip system of irrigation under the MI Scheme.

Ratio of Subsidy between GoI and State Government based on Fund Allocation

As per the guidelines of the Micro Irrigation Scheme, out of the Governmental assistance, 80% share (40% of unit cost of system) would be met by the Government of India (GoI) and the balance 20% (10% of unit cost of system) would be met by the participating State Government. Based on the annual grants released and expenditure incurred by both the Central and State Governments under the MI Scheme, it was observed that out of the ten sample states, Gujarat and Andhra Pradesh have evolved an exceptional pattern of assistance. The State's share in both these states was as high as 62% and 60%, respectively, during the study period (2006-10). While in Karnataka and Madhya Pradesh, the State Government has contributed about 50% of the total cost of the MI System, as evident from the chart given ahead —



The scheme has two major components — (a) area coverage under micro irrigation; and (b) transfer of technology through training & capacity building, seminars, workshops, exhibitions, publicity campaigns and demonstrations of micro irrigation systems, besides having a mechanism for the scheme's administration and monitoring.

4.2 Modality of Implementation

Meticulous planning and effective monitoring besides a robust implementation network are the critical factors for the success of any scheme. The analysis of the aforesaid three components pertaining to the implementation of MI scheme across the 10 sample states have been presented in the sections ahead.

4.2.1 Planning

The success of any initiative depends on an effective planning. Carefully drawn plans not only ensure realization of the objectives of any government scheme, but they also ascertain the maximum utilization of project inputs by minimizing cost overruns and delays in implementation.

The guideline for the centrally sponsored micro irrigation scheme stipulates that the implementing agency shall submit an Annual Action Plan (AAP) for every district to the National Committee on Plasticulture Applications in Horticulture (NCPAH) through the DMIC and SMIC in the prescribed format. The format of the AAP has 3 sections, as detailed ahead—

- **Section-A :** Under this section, the implementing agency is required to furnish the physical targets in terms of the number of beneficiaries and area to be covered and the financial requirements including the Govt. of India and State Government shares.
- **Section-B :** This section requires furnishing of details such as land use, climate, soil-type, crop-wise cultivated area, sources of irrigation, etc., which describe the status of the overall environment for promoting micro irrigation in the district.
- **Section-C :** This section includes the block-wise details of area covered under drip/sprinkler systems, the area proposed to be covered in the ensuing financial year and the financial requirements including the Govt. of India and State Govt. shares.

Further, the SMIC is required to conduct baseline survey and feasibility studies in different parts of the State, covering various crops and technologies in order to be able to formulate a long term plan for the State.

The comparison of the forward planning status in the sample states yielded that each one of them had conducted the baseline survey and feasibility studies (Table-4.2). Based on these baseline surveys and feasibility studies, only two states — Punjab and Andhra Pradesh had projected long term plans from which the AAPs had been prepared. The remaining states were found to be preparing their AAPs based on the number of applications received and the expenditure made during the previous year.

Table-4.2 : Forward Planning Status in Sample States

States	Baseline or Feasibility Studies	AAP based on perspective plan	AAP based on previous year's expenditure and number of applicants
Punjab	✓	✓ (5-year perspective plan)	-
Haryana	✓	×	✓
Madhya Pradesh	✓	×	✓
Gujarat	✓	×	✓
Odisha	✓	×	✓
Andhra Pradesh	✓	✓ (5-year perspective plan)	-
Karnataka	✓	×	✓
Chhattisgarh	✓	×	✓
Rajasthan	✓	×	✓
Maharashtra	✓	×	✓

Role of Stakeholders in Planning : The entire process of planning for the implementation of MI scheme emanates around the preparation of the AAPs, which are prepared by the implementing agency at the district level and forwarded to the NCPAH through the DMIC and SMIC for their approval.

In the states of Punjab and Rajasthan, the PFDCs were found to assist the district level implementing agencies in the preparation of AAPs. However, the PFDCs played no significant role in planning in the remaining eight states. As regards the technical support group (TSG), it largely has no role in planning on account of being non-functional in most of the states, except Odisha and Gujarat, where it has been reported to be assisting in the preparation of State plans and the establishment of benchmark data. Nevertheless, the Horticulture Officer at the State level office of the Horticulture Department in Karnataka informed that the TSG is slated to be formed soon in the State.

However, the PRIs have been found to be playing no role in planning in any of the states.

4.2.2 Implementation

The actual implementation of MI scheme entails the distribution of subsidy to the beneficiaries after due approval of their applications. As such, the entire process of implementation starts with IEC/BCC of the potential beneficiary farmers followed by their communicating their intention for the adoption of micro irrigation systems with a registered supplier. Thereafter, the supplier conducts preliminary survey to ascertain the assured availability of irrigation water and obtain necessary data pertaining to the design of a suitable micro-irrigation system along with preparing an estimate of all the costs associated with the same. Following this, the supplier files an application with the district level implementing agency on behalf of the applicant.

After the scrutiny and approval of subsidy application, the district level implementing agency issues work order to the concerned supplier. The supplier then installs the MI system into the beneficiary's field, provides brief orientation training on the operation & maintenance of the installed system, and hands over the user manual after charging for the beneficiary's share of the cost of installed MI system. The installed MI system is then verified by the implementing agency officials themselves in almost all of the states. However, in Gujarat, this verification is carried out by an external agency appointed for the purpose at the behest of the implementing agency. The MI system, so installed by the distributor/supplier, is automatically covered for free after-sales-service for the next 3 years. The beneficiary then pays his share of cost either through cash or through loan, for which, he has to file a separate application with a nationalized bank along with the application for subsidy.

After obtaining the beneficiary's share of cost, or an installment of the cost as mutually agreed upon, the distributor/supplier obtains a satisfaction certificate from the beneficiary

if the beneficiary deems it to be working to his full satisfaction. He then submits it with the district level implementation agency for approval and subsequent release of payment of the subsidy amount.

Implementation Structure

Prior to the launch of the Centrally Sponsored Scheme (CSS) on MI in 2005-06, some states, like Andhra Pradesh and Karnataka, were having their own versions of MI schemes. However, the extent of subsidies granted under those schemes were low as well as highly variable across the states due to which their intended impact was not being realized. The implementation of MI as a CSS provided the much needed impetus to increase the area coverage under the micro irrigation systems in almost all the states, with Madhya Pradesh recording an increase of nearly 800%, Punjab of nearly 300% and Odisha of about 150% during the period 2006-08 (NCPAH, 2009).

Over the years, different states have implemented the CSS-MI under different structural models ranging from Special Purpose Vehicles (SPVs) in Andhra Pradesh (APMIP) and Gujarat (GGRC) to State government departments in the other states (Table-4.3). In Andhra Pradesh, the MI Scheme is implemented by the Andhra Pradesh Micro Irrigation Project (APMIP), an autonomous SPV created within the Horticultural Department, while in Gujarat it is implemented by the Gujarat Green Revolution Company Limited (GGRC), a SPV promoted by the Gujarat State Fertilizers and Chemicals Limited, Gujarat Narmada Valley Fertilizers Company Limited and Gujarat Agro Industries Corporation Limited. Further, in Odisha it is implemented by the Odisha Horticulture Development Society (OHDS), which is registered under the Societies Registration Act, 1860. Besides, the implementation of MI scheme in the other sample states is through some or the other state government departments, as presented in matrix ahead—

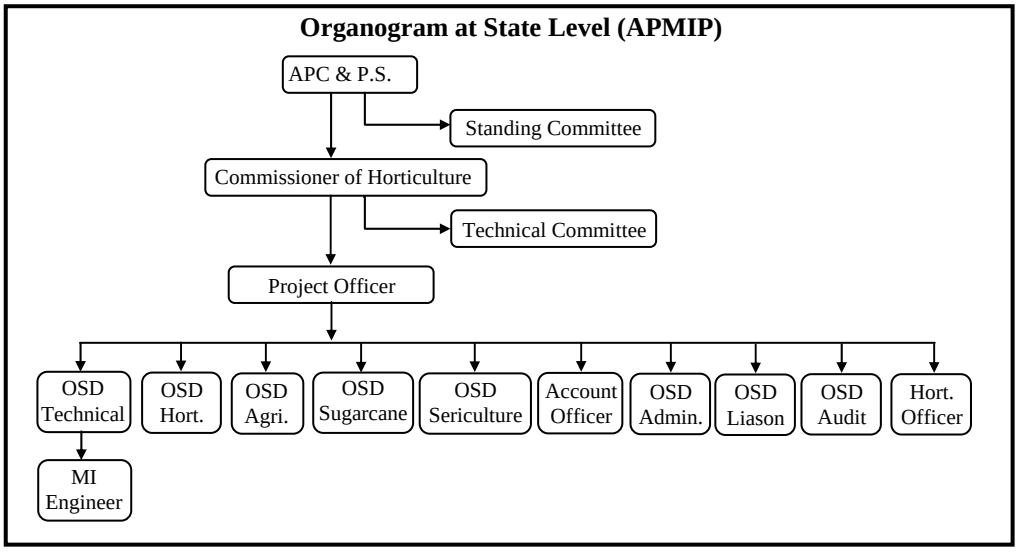
Table-4.3 : State-wise Implementation Structure of MI Scheme

SN	State	Implementing Agency	
		Name	Type
1.	Punjab	Dept. of Soil & Water Conservation	Govt. Department
2.	Haryana	Dept. of Horticulture	Govt. Departments
		Dept. of Agriculture	
3.	Madhya Pradesh	Dept. of Horticulture	Govt. Department
4.	Gujarat	Gujarat Green Revolution Company (GGRC)	Registered under Companies Act, 1956
5.	Odisha	Odisha Horticultural Development Society (OHDS)	Registered under Societies Registration Act, 1860

Table-4.3 : State-wise Implementation Structure of MI Scheme

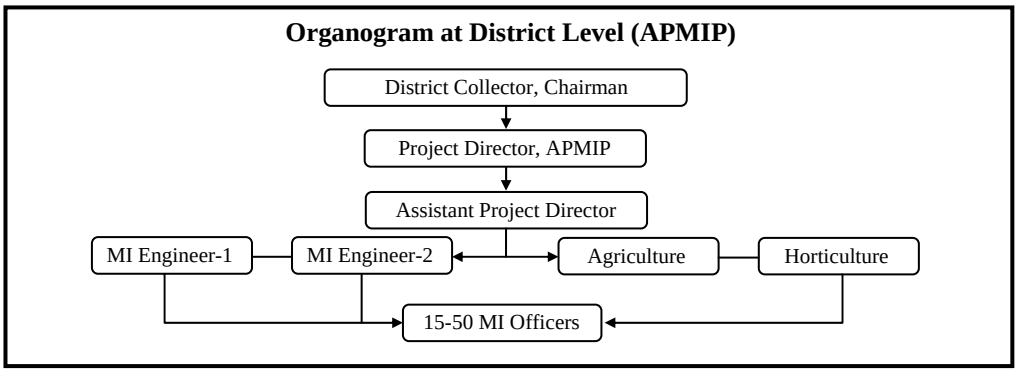
SN	State	Implementing Agency	
		Name	Type
6.	Andhra Pradesh	APMIP	SPV - An autonomous unit within Horticultural Dept.
7.	Karnataka	Dept. of Agriculture	Govt. Departments
		Dept. of Horticulture	
8.	Chhattisgarh	Chhattisgarh Rajya Beej Evam Krishi Vikas Nigam Ltd.	Registered under Companies Act, 1956
9.	Rajasthan	Dept. of Horticulture	Govt. Department
10.	Maharashtra	Dept. of Agriculture	Govt. Department

Andhra Pradesh: The Andhra Pradesh Micro Irrigation Project (APMIP), an autonomous unit formed as a Special Purpose Vehicle (SPV) within the Department of Horticulture, is the implementing agency for MI scheme in the State. At the State level the project, headed by a Project Officer, functions under the direct supervision of SMIC whose members include the Agricultural Production Commissioner and the Special Chief Secretary. Further, a Technical Committee, comprising of technical experts from different fields, supports the Project Officer in the implementation of the project.



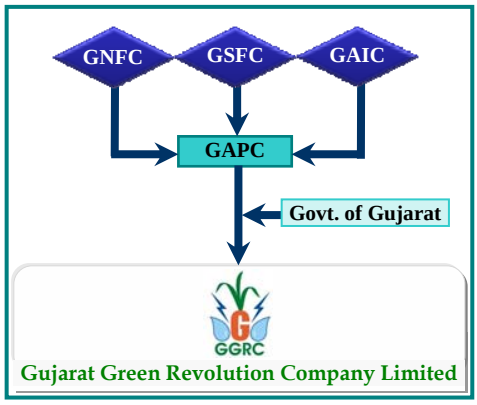
At the district level, APMIP is implemented through the Project Directors under the chairmanship of District Collector, while the technical support is provided by two agricultural engineers. Further, the agronomic services are rendered through two Micro Irrigation Coordinators who are from the core agricultural background. Further down at

the block (Mandal) level, the project is implemented by 15-50 Area Officers who provide a reasonable reach to the farmers.



Besides, the registered suppliers deploy a team comprising of a district coordinator and two technical officers along with sufficient number of field staff in every district. Additionally, for rendering effective after-sales-service, the suppliers depute several technical teams in each of the districts in the State.

Gujarat: The MI Scheme in the State is implemented in corporate style by Gujarat Green Revolution Company Limited (GGRC), a Special Purpose Vehicle (SPV) promoted by Gujarat State Fertilizers & Chemicals Limited (GSFC), Gujarat Narmada Valley Fertilizers Company Limited (GNFC) and Gujarat Agro Industries Corporation Limited (GAIC). GGRC has been mandated to implement the MI Scheme centrally in the entire State through its own field staff, under the supervision of the State Micro Irrigation Committee (SMIC) at the State level and the District Micro Irrigation Committee (DMIC) at the district level. The SMIC meetings are held at least once in a year for approving the Annual Action Plans (AAP), though the DMICs are largely non-functional.



For the necessary technical support GGRC has a full-fledged technical and services department that acts as the Technical Support Group (TSG) for the company. This department prepares and submits the AAPs, MIS unit cost review, MI component price review and services to various stakeholders, including the MI system suppliers and farmers. For the additional technical and research back-up, the SMIC is assisted by a Precision

Farming Development Center (PFDC), which is located at the premises of Gujarat Agricultural University (GAU), Navsari.

Odisha: In Odisha, the Directorate of Horticulture is the implementing agency for the MI scheme, which is supported by the TSG and functions under the supervision of the SMIC. Altogether 25 members from Agriculture and allied sectors constitute the body of SMIC.

At the District level, the DMIC comprising of about 16-17 members, functions under the chairmanship of District Collector with members/representatives from concerned Departments, namely, Agriculture, Horticulture, Rural Development, Irrigation and Water Resources, Growers' Association, *Krishi Vigyan Kendras* (KVKs) and local Lead Banks which are responsible for implementing the MI scheme in the district. The Deputy Director Horticulture is the convener of the DMIC. Every year the DMIC participates in the preparation of AAPs with due support from the block level officials. Based on the potential of the district, the crop coverage, availability of water resources and presence of registered system manufacturers, the action plans are prepared and forwarded to the Directorate at the state headquarter. The DMIC usually meets quarterly and as per urgency to implement the project, undertaking necessary responsibilities at the district level.

The chairperson of TSG is the Joint Director of Horticulture, while the Assistant Agricultural Engineer is the member secretary. The other members include the Principal Investigator of PFDC, representatives of the Directorate of Water Management and that of the registered micro irrigation system manufacturers.

Chhattisgarh: The MI Scheme in the State is implemented by the Chhattisgarh Rajya Beej Evam Krishi Vikas Nigam Limited, which has been formed under the Companies Act 1956. The agency works under the supervision of SMIC at the State level and DMICs at the district level.

Punjab: The MI Scheme in Punjab is implemented by the Department of Soil & Water Conservation under active guidance & supervision of the State Micro Irrigation Committee (SMIC) and of the District Micro Irrigation Committees (DMICs) at the district level.

Headed by the Chief Executive Officer of the Zila Parishad, the DMIC's members include the representatives of the line departments, like, Agriculture, Horticulture, Irrigation, DDPO, KVK, NABARD, etc. The Divisional Soil Conservation Officer (DSCO) is the member secretary who maintains the DMIC bank account for receiving & disbursing the

Government of India (GoI) Grant and also acts as the Implementing Agency (IA) at the district level.

Haryana: In Haryana, the MI Scheme is implemented simultaneously by two government departments, namely, Departments of Horticulture and Agriculture, under the chairmanship of Financial Commissioner & Principal Secretary, Agriculture. While the Department of Horticulture distributes subsidy on micro sprinklers and drippers for the horticulture crops, the Department of Agriculture distributes subsidy on sprinklers for the agriculture crops. The DMICs are headed by the Chief Executive Officers of the Zila Parishad in the districts. The District Horticultural Officer (DHO) is the Member Secretary who maintains the DMIC bank account for receiving & disbursing the GoI Grant and also acts as the Implementing Agency (IA) at the district level.

Karnataka: In the State, the MI scheme is implemented simultaneously by two departments – Department of Horticulture & Department of Agriculture under the supervision of the State Micro Irrigation Committee (SMIC) and of the District Micro Irrigation Committees (DMICs) at the district level. Headed by the Additional Chief Secretary-cum-Development Commissioner, the SMIC is duly represented by the members of PFDC, State Agricultural Universities (SAUs), Lead Banks, Growers Association, Irrigation Association of India, Ground Water Board and Directorates of Agriculture and Horticulture. Besides, the SMIC also has representation from the NCPAH, Ministry of Agriculture, Govt. of India, and the PRIs.

In the states of Karnataka and Haryana, the MI Scheme is simultaneously managed by two different departments (Dept. of Horticulture & Dept. of Agriculture). In Haryana, the situation often led to confusion among the beneficiaries with regard to the subsidy structure on the two types of MI systems—drip & sprinkler.

Maharashtra: The MI scheme is implemented by the Directorate of Agriculture under the supervision of the State Micro Irrigation Committee (SMIC), chaired by the Principal Secretary, Agriculture, at the State level. Further, the DMIC provides the requisite support in implementation of the scheme at the district level.

The members of SMIC include the Secretary—Water Resources department, Secretary—Rural Development, representatives of NCPAH and PFDC, four research directors of the State Agriculture Universities (SAUs), lead bank representatives, farmers group representatives of the state government, while the Directors of Horticulture and

Agriculture are its member secretaries. Further, the DMIC is headed by the District Collector, while the Chief Executive Officer of the Zila Parishad is its co-chairman. Other members of the committee include Project Director of DRDA and the representatives of progressive farmers' committee, Krishi Vigyan Kendras (KVKs) and lead banks. The District Superintendent Agriculture Officer (DSAO) is the member secretary of the DMIC.

Rajasthan: In Rajasthan, the MI Scheme is implemented by the Department of Horticulture, under active guidance & supervision of the SMIC at the State level and of the DMICs at the district level. The technical support & research back-up is provided by the PFDC, which is headed by a Principal Investigator.

Madhya Pradesh: The MI Scheme in Madhya Pradesh is implemented by the Department of Horticulture & Farm Forestry, which is headed by the Assistant Director of Horticulture. The department operates under the overall guidance of the SMIC at the State level and that of the DMIC at the district level.

The members of the DMICs include the representatives of the line departments, like, Agriculture, Horticulture, Irrigation, DDPO, KVK, NABARD, etc. Further, the RHEO and the Garden Superintendent are also involved in the processing of the subsidy applications.

Among the different models of implementation across the ten sample states, it is noteworthy that Andhra Pradesh is a leading model in terms of achieving the physical and financial targets which other states may follow. The State occupies one-fourth of the cumulative area, covered under the Micro Irrigation Scheme across the 10 sample states, whereas it covers nearly two-fifths of the total area under the drip system of irrigation.

Role of stakeholders in Implementation:

Regarding the implementation of the MI Scheme, the stakeholders including the NCPAH, implementing agencies, PFDCs, SMICs, DMICs, TSGs, beneficiaries, PRIs and the manufacturers each play a vital role. While the NCPAH is the nodal agency for implementing the scheme in the entire country, the implementing agencies implement it at the State level under the supervision of SMICs and at the district level under the supervision of DMICs. At the block level, the officials of the implementing agencies are closest to the farmers, which makes them better off in playing a relatively more important role than their higher ups at the district and the State levels.

The implementing agency is assisted by the TSGs for the technical inputs and the PFDCs for the transfer of technology among the stakeholders by way of arranging training programmes, conducting research activities and organizing farm demonstrations.

The PRIs were reported to be having a definite role in the implementation of the scheme in four out of the ten sample states. In Madhya Pradesh and Chhattisgarh, the PRI members were reported to be involved in the verification of beneficiary applicants by way of attesting their documents. In Odisha and Maharashtra, the district officials reported that the PRI members were involved in creating awareness about the MI scheme and in motivating the farmers in adopting the MI systems. However in the remaining states, the PRIs were reported to have played no role in the implementation of the scheme.

Beneficiaries' Perspective: When beneficiaries were probed regarding the problems faced by them in applying for the subsidy under the scheme, an overwhelming majority (87%) informed that they did not face any problem as the dealers managed everything. However, about 8 % respondents were not happy with this scenario and they felt that there were chances of illiterate farmers getting exploited by the dealers. Some of them also felt that the application form was complicated, which again led to dependency on the dealers and officials. This problem was highlighted by the farmers of 4 states explicitly – Maharashtra (40%), Andhra Pradesh (13%), Odisha (5%) and Rajasthan (1%). Alarmingly, more than nine-tenth (95%) of the farmers raised this issue in Amarawati district of Maharashtra. About 5% beneficiaries felt that the process of application was cumbersome and that it required lots of running around. This constraint was brought forth by the farmers of 3 states, namely – Andhra Pradesh (24%), Rajasthan (16%) and Maharashtra (2%). It was noteworthy that nearly three-fifth (59%) and two-fifth (43%) of farmers in Warangal (Andhra Pradesh) and Bikaner (Rajasthan), respectively reported about this problem. A small proportion (1.7% overall), mainly in Punjab (22%), reported the inconvenient location of the dealer's establishment, especially in the districts of Mohali (31%) and Bhatinda (32%).

It was disheartening to note that only a miniscule proportion (4%) of beneficiaries availed loan from a bank, whereas the remaining farmers did not even apply for a bank loan. In most of the cases, farmers were not aware about the availability and processes involved. A significant proportion availed loan facility only in the states of Gujarat (14%) and Rajasthan (10%),. The district Bikaner in Rajasthan had the highest proportion (43%) of the beneficiaries who had availed loan followed by district Surendranagar in Gujarat (25%). None of the farmers reported any problem in availing loan in the state of Gujarat, whereas

the case was different in the state of Rajasthan in general and in district Bikaner in particular. More than two-fifth (43%) of the beneficiaries felt that the process involved was highly time-consuming and that it also entailed lots of running around. A small proportion (3%) reported regarding demands for a bribe. Such a complaint was only reported by the farmers of Bikaner, where 2 out of 21 beneficiaries, who had availed loan, complained regarding the demand for a bribe. Incidentally, loan facility was availed only in the district Bikaner amongst the 4 sample districts of Rajasthan.

4. 3 Monitoring

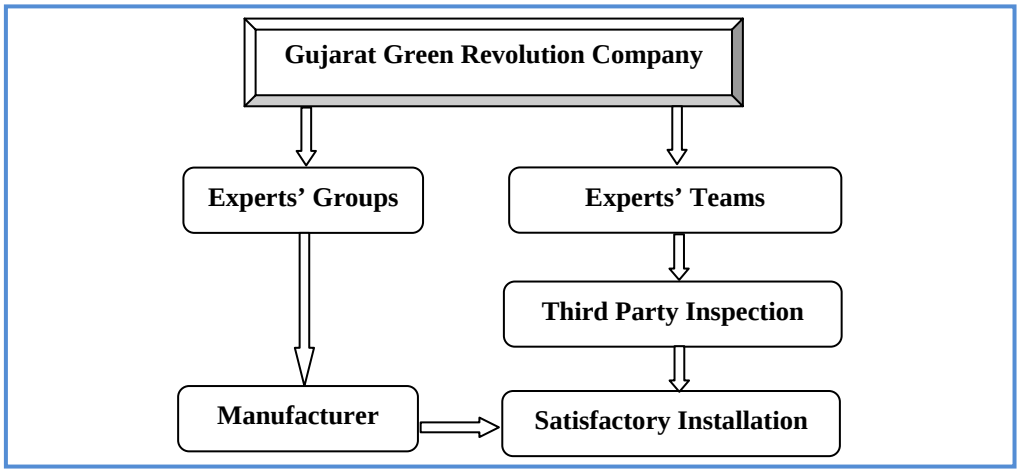
Regular monitoring is a key to successful implementation of any development program. Monitoring is a continuous assessment of the functioning of the project activities in the context of the implementation schedule, use of project inputs and the design expectations.

In the course of evaluation of schemes, such as the MI scheme, monitoring becomes a twofold process, as given ahead —

- Monitoring during installation and subsequent verification.
- Post installation monitoring to ensure smooth running of MI System.

With the exception of Gujarat, the functionaries of the implementing agencies themselves verify the successful installation of the systems for the release of subsidy. In Gujarat, the implementing agency has evolved a unique system of monitoring that has been integrated into an online system. Instead of conducting the verification through its own functionaries, GGRC was found to have appointed seven Third Party Inspection Agencies (TPIAs) for carrying out the third-party verification of the MI systems installed on the farmers' fields. The third-party audits conducted by the TPIAs were further subjected to appraisal from Agriculture Universities specially appointed for the purpose.

Further, Gujarat has evolved an innovative system whereby the quality of the manufactured MI components are monitored at the factory sites themselves by agencies, such as, Central Institute of Plastics Engineering & Technology (CIPET), Gujarat Engineering Research Institute (GERI) and Gujarat Industrial Research and Development Agency (GIRDA). Once superior quality products conforming to the required specifications are produced by the manufacturers, the performance of the MI systems gets enhanced. Furthermore, the State has also appointed the Agricultural Finance Corporation (AFC) to carry out concurrent monitoring & evaluation of the scheme. The entire monitoring mechanism in place in the State of Gujarat is depicted in the diagram presented ahead—



The monitoring & evaluation of the MI scheme in other states was found to have been carried out by other specialized agencies. In Madhya Pradesh and Chhattisgarh, for instance, CIPET undertook the exercise whereas NABCONS (a wholly owned subsidiary of NABARD) conducted the same in Punjab and Haryana.

The details regarding the agencies involved in monitoring across the 10 sample states are presented in the matrix ahead—

Table-4.4 : State-wise Monitoring Agencies

States	Internal Agencies for Monitoring	External Agencies for Monitoring
Punjab	Block Level Functionaries of Implementing Agency	NABCONS
Haryana	Block Level Functionaries of Implementing Agency	NABCONS
Madhya Pradesh	Block Level Functionaries of Implementing Agency	CIPET
Gujarat	Functionaries of Implementing Agency	• TPIAs • SAUs
Odisha	Block Level Functionaries of Implementing Agency	None
Andhra Pradesh	Block Level Functionaries of Implementing Agency	None
Karnataka	Block Level Functionaries of Implementing Agency	None
Chhattisgarh	Block Level Functionaries of Implementing Agency	CIPET
Rajasthan	Block Level Functionaries of Implementing Agency	None
Maharashtra	Block Level Functionaries of Implementing Agency	None

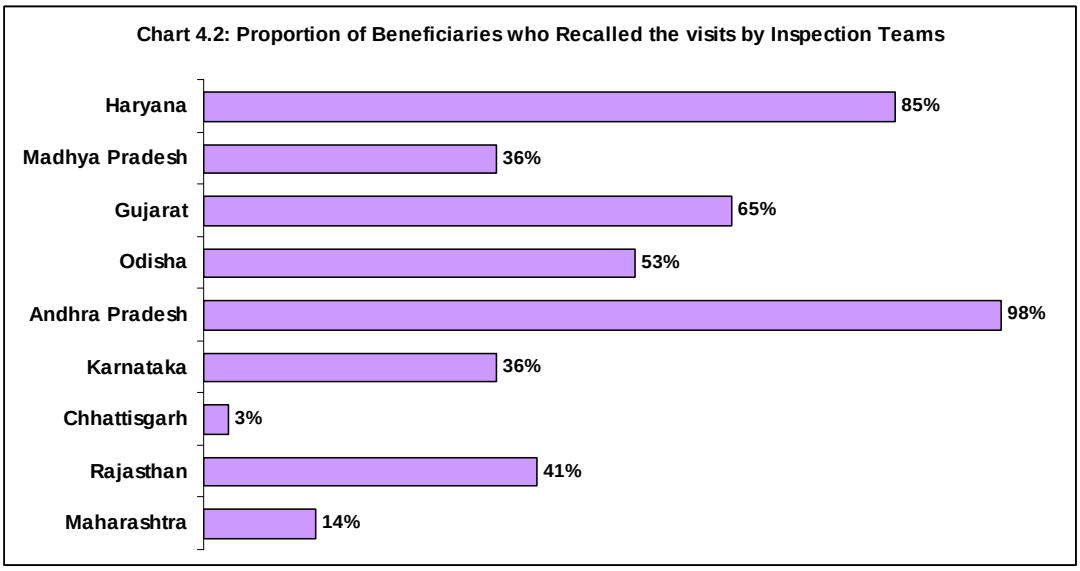
The unique multi-stage monitoring model in Gujarat that targets not only the verification of the successful installation of MI systems but also the quality of the components at the very factory-sites of the registered manufacturers is commendable to be replicated by the other states.

Role of various Government stakeholders

The guidelines for the MI scheme call for regular surveillance by the inspection teams comprising of officials from NCPAH/ PFDC, CIPET, Irrigation Association of India (IAI) and Bureau of Indian Standards (BIS). These teams are mandated to draw samples periodically from the field on a random basis within a period of three years from the date of installation of the MI systems for the purpose of conducting the inspection.

In view of the above, the beneficiaries were asked whether the officials from the aforesaid agencies/organizations had visited their farms for inspection. Overall, nearly three-fifth (57%) of the beneficiaries reported to be aware of such inspections/monitoring visits across the 10 sample states. Further, the proportion of beneficiaries who successfully recalled these visits having been undertaken for the purpose of verification ranged from 36% in Madhya Pradesh to 98% in Andhra Pradesh. Chhattisgarh stood out as only 3% of the beneficiaries interviewed in the State could recall such as visit.

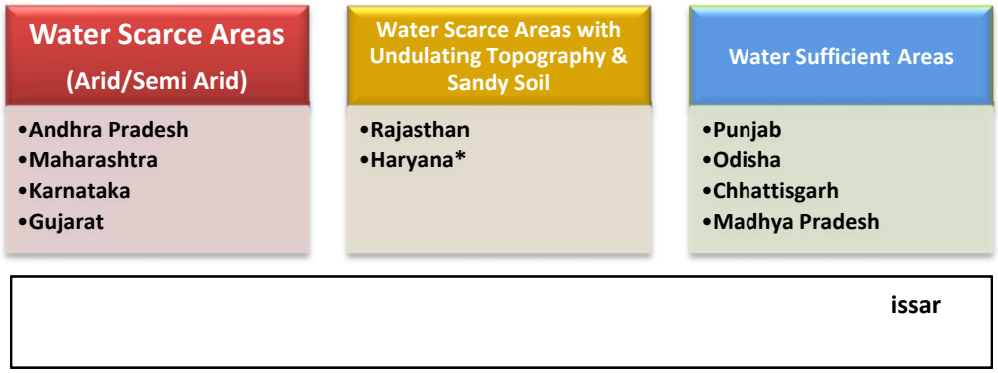
The state-wise comparison of the proportions of beneficiaries recalling such visits by inspection teams is presented in the chart given ahead—



4.4 Area Coverage under the MI Scheme

The drip and sprinkler method of irrigation helps to save water and improves the yield of crops. Besides, it also delivers many other economic and social benefits to the society. The technique can be adopted in all kind of lands, which is not generally possible through flood irrigation method. It is not only suitable for those areas that are presently under cultivation, but it can also be operated efficiently in undulating terrain, hilly areas, barren land and areas which have shallow soils. Although the technique is suitable for all kind of lands, but, the acceptance generally differs from region to region, depending upon its natural endowments. As a result, the economic returns from micro irrigation cannot be generalised, owing to the diverse topography, soil characteristics, hydro-geological and climatological settings across the Country. Accordingly, the sample states have been classified into different categories to study the benefits under varying regions.

Categorization of Sample States: By and large the sample States have been classified into the following three categories or zones, as shown in the illustration given ahead**. It is important to note that the classification of States has been done by identifying the maximum number of the sample districts within a State, which aptly represents one of the 3 categories.**



The first zone has been termed as, *'water scarce areas,'* which include the sample States of Andhra Pradesh, Maharashtra, Karnataka and Gujarat. While the States of Rajasthan and Haryana fall under the second zone of *'water scarce areas with undulating topography & sandy soils'*. Lastly, the remaining four States (Punjab, Odisha, Chhattisgarh and Madhya Pradesh) have been grouped as the *'water sufficient areas'*.

Zone I: Water Scarce Areas

The 'water scarce areas', as the name suggests, are the regions experiencing chronic water deficit. These areas typically represent the arid or semi arid type of climate, which is characterized by extreme temperatures exceeding 45^0 C during summers coupled with lesser & erratic annual rainfall. Further, overexploitation of ground water in these areas has resulted in depletion of water resources. The sample States of Andhra Pradesh, Gujarat, Karnataka and Maharashtra, have been grouped together, as maximum number of the sample districts in each of these States represents the characteristics of arid/semi arid areas. In such water scarce areas, the drip method provides the most efficient way to conserve irrigation water. Micro irrigation helps in mitigating the impact of water scarcity and maximizing output. Acknowledging its benefits, the farmers have started adopting the drip method in the States of Andhra Pradesh, Maharashtra, Karnataka and Gujarat.

Zone II: Water Scarce Areas with Undulating Topography and Sandy Soils

The sample districts of Rajasthan and Haryana typically represent the areas which are characterized by an undulating topography and sandy soils, besides being water deficit. Accordingly, the two States have been grouped together, since the economics of micro irrigation in these areas is completely different. The popularity of the micro-irrigation systems is very high where the topography and soil-characteristics restrict the use of conventional surface irrigation systems (flooding). In areas, such as Bikaner and similar districts of Rajasthan and the bordering districts of Haryana (Mahendragarh, Hissar and Bhiwani), conventional method of irrigation is not viable due to the undulating topography and sandy soil (having very high porosity and permeability) in the region. Incidentally, all these areas also represent the sample districts selected for the study. There is a huge potential of micro irrigation in these areas, being the only mode for irrigation. The Government has already taken initiatives to promote the use of micro irrigation in such areas, thereby, setting off a snowball effect over its adoption. As a result, the farmers are willingly adopting these techniques and would continue irrespective of any promotion. Hence, subsidy on micro irrigation in such States would only expedite the adoption of sprinkler and drip systems. The potential and popularity of micro irrigation in districts such as Bikaner, is entirely different and needs to be studied individually.

Zone III: Water Sufficient States

Micro irrigation has received considerable attention among the farmers for its perceived ability to contribute significantly to agricultural productivity, economic growth, and environmental sustainability. However, the technique is not very popular in the States

which have adequate availability of irrigation supplies. Although the use of micro irrigation in these areas has led to an increase in the agricultural yield, there are various reasons for the slow progress of adoption of this new technology. One of the main deterrent factors for low adoption of micro irrigation is it's the capital-intensive nature. Micro-irrigation technology requires fixed investment that varies from Rs. 16,700 to Rs. 57,600 per hectare depending upon the nature of crops (wide or narrow spaced). Since the Indian farmers have been getting water for low cost from the public irrigation system and also from well irrigation (because of free and flat-rate electricity tariff), there is less incentive to them to adopt this capital-intensive technology unless it is necessary. Under such mode of pricing, the farmer would be reluctant to shell out money on this high-priced water saving technique. In such areas micro irrigation needs to be promoted through aggressive campaigning, including regular and frequent visits to fields of the farmers of the same or adjoining districts, who are practicing the technique successfully. Another major constraint is poor extension services offered by concerned authorities. Micro irrigation system involves sophisticated technologies, and their operation and maintenance is not very simple. Since the farmers are not well conversant with the operation and maintenance, they are not able to achieve the desired results with micro irrigation.

As per the MI scheme guidelines, the states have been divided into three categories— A, B & C. States where more than 10,000 hectares had been brought under drip irrigation up till 1.4.2004 would come under category 'A'. All the States except those covered under Category 'A' and those falling in the Himalayan belt would come under Category 'B'. All the North Eastern States, Sikkim, Himachal Pradesh, Jammu & Kashmir, Uttaranchal and Darjeeling district of West Bengal would come under Category 'C'.

Out of the 10 sample states, Andhra Pradesh, Gujarat, Karnataka and Maharashtra fall under the category 'A', incidentally all the states belong to water scarce area (Zone I) while the remaining six states (Rajasthan, Haryana, M adhya Pradesh, Odisha, Punjab & Chhattisgarh) belong to category 'B'. The details of area covered under the MI scheme during the study period April-2006 to March-2010 are as shown in Table-4.5—

Table-4.5 : Area Coverage under MI Scheme (Area in '000 ha)

States	Drip	Sprinkler	Total
All 10 States	**937.0**	**1041.9**	**1978.9**
Andhra Pradesh	360.2	128.4	488.6
Maharashtra	260.8	144.0	404.8
Karnataka	108.7	224.5	333.2
Rajasthan	19.1	295.5	314.6

Table-4.5 : Area Coverage under MI Scheme (Area in '000 ha)

States	Drip	Sprinkler	Total
Gujarat	118.5	87.5	206.0
Chhattisgarh	3.6	90.1	93.7
Madhya Pradesh	38.9	40.2	79.1
Haryana*	8.7	19.7	28.4
Odisha	6.4	10.7	17.1
Punjab	12.1	1.3	13.4
** Haryana has a high area coverage under other Micro Irrigation Schemes*			

Overall, four states (Andhra Pradesh, Gujarat, Karnataka and Maharashtra) belonging to the water scarce areas (Zone I), recorded relatively higher area coverage under both the drip and sprinkler irrigation systems than the other sample states. The figures suggest that the technique of micro irrigation is highly acceptable where the scarcity of water is acute and exploitation of groundwater is very high.

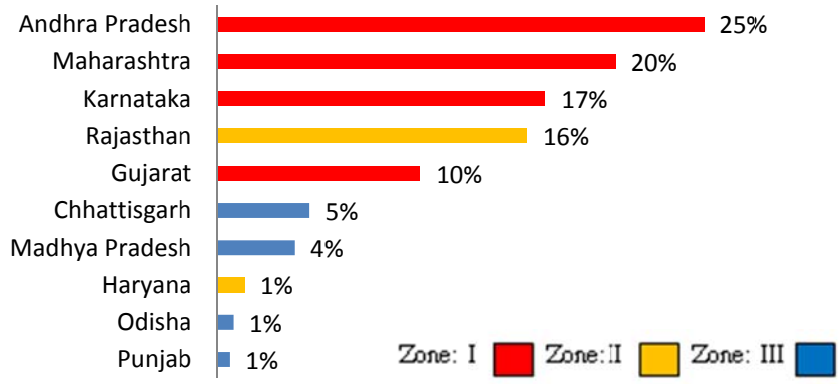
Rajasthan and Harayana fall under the Zone II as their sample districts are characterized by water scarcity with undulating topography & sandy soils. As mentioned earlier, micro irrigation is very popular in the areas where conventional method of irrigation is not viable due to the undulating topography and sandy soil. Therefore, Rajasthan recorded highest area coverage under the sprinkler irrigation system. As a result, the total area coverage under both drip and sprinkler systems improved remarkably and stood at the fourth position among all the sample states (table 4.5). Although Haryana has covered only 28396 ha during the Scheme period, it has performed well under other Micro Irrigation Schemes by covering an area of 21681 ha under sprinkler irrigation. Accordingly Haryana has been grouped under the Zone II, owing to its sample districts (Bhiwani, Mahendragarh & Hissar) representing undulating characteristics with sandy soils and water scarcity.

As regards the Zone III, comprising of Punjab, Odisha, Chhattisgarh and Madhya Pradesh, the area coverage under the Scheme was found to be very low. This justifies that the use of modern techniques in the water sufficient areas is yet to gain momentum.

The four sample states, namely, Andhra Pradesh, Maharashtra, Karnataka and Gujarat states have covered a whopping 72% of the cumulative area under the MI scheme across the 10 sample states (Chart-4.3). Rajasthan has covered a significant proportion (16%) of the total area under the Scheme. As apparent from the chart given ahead, Haryana has covered only a marginal proportion of area under the MI Scheme, but the State has performed well under the other MI Schemes. The remaining sample states (Chhattisgarh,

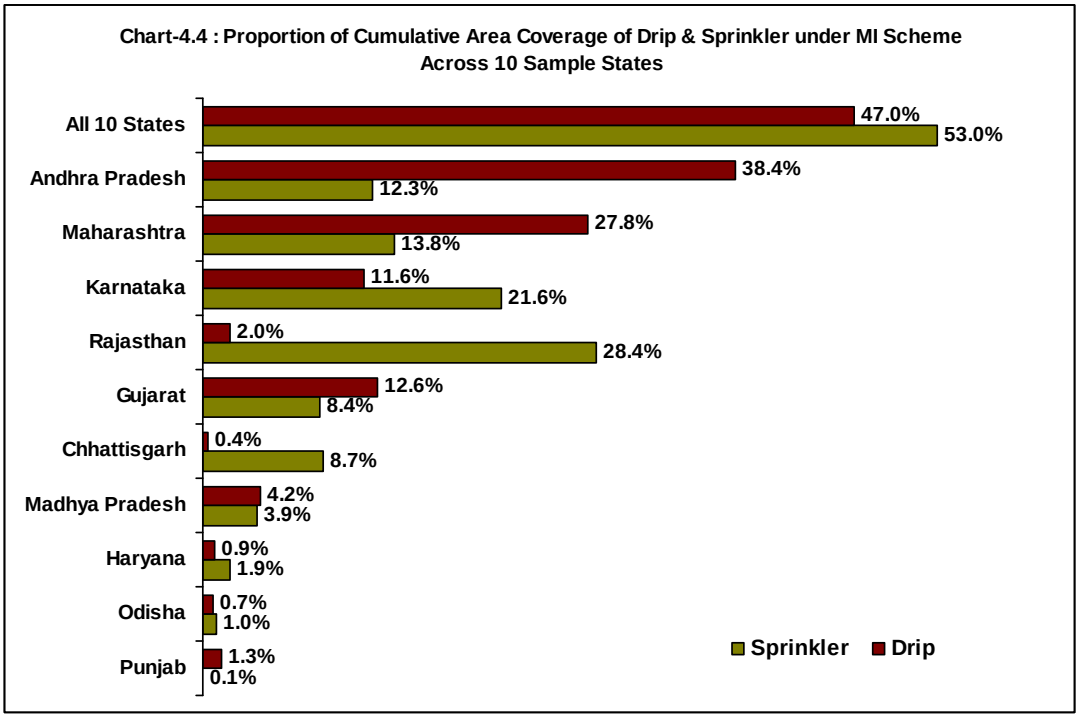
Madhya Pradesh, Odisha and Punjab) have covered only a minor proportion of the cumulative area.

Chart-4.3 : **Proportion of Cumulative Area Coverage under MI Scheme Across 10 Sample States**



It is amply evident from the above chart that the adoption of micro irrigation is understandably higher in the water scarce areas (Zone I), followed by the undulating & sandy soils areas (Zone II) wherein these methods are the only mode of irrigation.

Regarding proportion of drip irrigation under MI Scheme, Andhra Pradesh stands highest by covering 38% area (cumulative of area covered under drip in all 10 States), followed by Maharashtra (28%), Gujarat (13%) and Karnataka (12%). These four States have covered more than nine-tenth of the total area across 10 States, under drip irrigation system. The States of Chhattisgarh (0.4%), Odisha (0.7%) and Punjab (1.3%) emerged as the states covering the lowest proportions under the MI scheme, as seen from the chart 4.4 given below.



Though Rajasthan has covered a significant proportion (28% of the total area covered under sprinkler in all 10 States) of agricultural land under sprinkler system, it has covered an insignificant proportion (2%) of area under drip system.

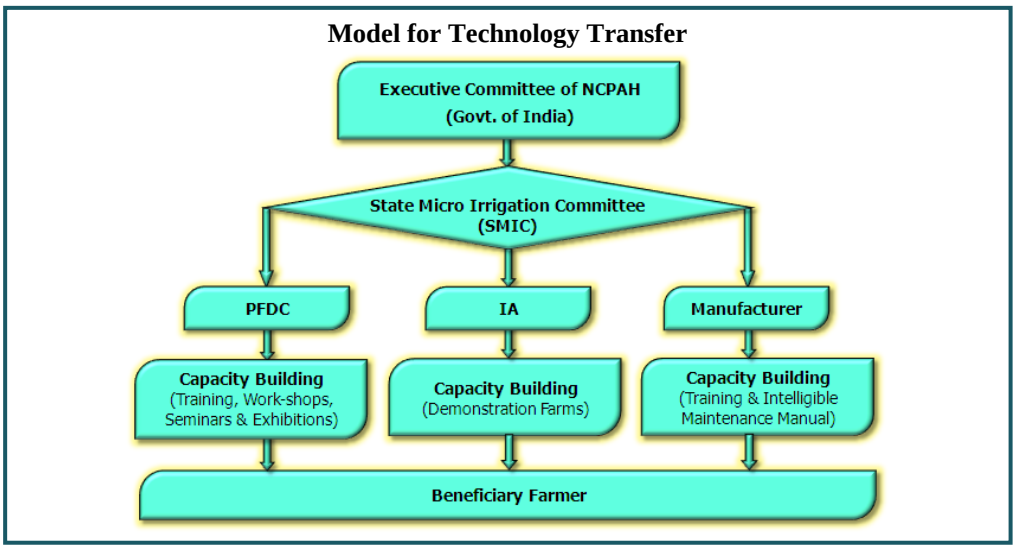
Contrary to the MI Scheme which envisages over 60% of area coverage under the highly efficient drip systems, coverage of nearly 50% was observed among the 10 sample states, during the Scheme period. Thus, there is a need to revisit the planning & implementation strategies under the MI scheme for effecting greater area coverage under the drip irrigation system.

4.5 Transfer of Technology

Transfer of technology is the term used to describe the processes by which technical knowhow is transferred from the entities or organizations which have either created it or possessed it to ones who intend to use it. In the context of MI scheme, the technical knowhow of the micro irrigation technology has to be transferred to the ultimate users, i.e., the potential beneficiaries or the beneficiaries themselves, with a three-pronged objective —

- Awareness generation leading to the adoption of MI systems
- Enabling farmers to operate MI systems smoothly & systematically
- Building capacities of the farmers for preventive maintenance of the MI systems

For achieving the said transfer of technology, the scheme guidelines provide for a three-tier approach as presented ahead—



Under the present model, while awareness generation is carried out by the functionaries of the implementing agencies at various levels, capacity building is undertaken by the PFDCs and the registered distributors/suppliers. The PFDCs mainly undertake the capacity building of the officials, farmers, entrepreneurs and other active players involved in micro irrigation through NCPAH supported project-based trainings, while the manufacturers/ suppliers build the basic understanding of the beneficiaries regarding the operation & maintenance of MI systems through orientation trainings.

A. Awareness Generation

The guidelines of the scheme provide for strong HRD inputs for the farmers, field functionaries and other stake holders across different levels. The guidelines also mandate the conduct of publicity campaigns, seminars and workshops at extensive locations to develop skills and improve awareness among the farmers regarding importance of water conservation and the utilities of the MI systems. The findings of the study were consistent with these provisions.

The study revealed that awareness of the MI scheme among the beneficiaries and non-beneficiaries alike, resulted from various sources, such as, village camps, newspapers, TV, exhibitions/fairs, interpersonal communications from government officials/implementing agency functionaries/PRIs and even observation from other farmers' farms. However, it was observation from other farmers' farms that had the greatest impact as half of the

beneficiaries and over two-thirds (69%) of the non-beneficiaries across the 10 sample states attributed their awareness to it alone (Table-4.6).

Table-4.6 : Major Sources of Awareness of MI scheme

Particulars	Non-Beneficiaries (Aware of MI Scheme)	Beneficiaries
No. of Respondents	272	1614
% Observed in other Farmers' Fields	69%	50%
% Officials/ IA Functionaries/PRIs	21%	34%
% Distributors/Suppliers	13%	11%
% Newspaper/TV/Village Camps/exhibitions/fairs	3%	7%

Thus, the farmers get best convinced of the usefulness of the MI systems when they observe their operation on others' farms. However, the implementing agencies seem to have stopped short of taking a cue from here and set up demonstration farms in sufficient numbers, as evident from the fact that only a trivial proportion (4%) of the beneficiaries reported having seen any demonstration farm in their vicinities (Table-4.7). The highest proportion of such beneficiaries who reported having knowledge of the demonstration farms was in the states of Andhra Pradesh (14%) and Maharashtra (13%), while in the other states the beneficiaries were found to be hardly aware.

Table-4.7 : Awareness of Demonstration Farms among Beneficiaries

States	Total No. of Beneficiaries	Beneficiaries Aware of Demonstration Farms
Overall Sample	**1614**	**4%**
Punjab	120	3%
Haryana	124	0%
Madhya Pradesh	232	0%
Gujarat	179	0%
Odisha	58	2%
Andhra Pradesh	174	14%
Karnataka	162	0%
Chhattisgarh	110	0%
Rajasthan	215	0%
Maharashtra	240	13%

Further, as part of the awareness generation exercise for promoting the concept of micro irrigation among the farmers and the official stakeholders, the PFDCs across the ten sample states organized altogether 6 National and 123 regional/district level seminars and workshops during the study period (Table-4.8).

At the National level, Gujarat emerged as the leading State having conducted two seminars/workshops during the study period. As regards the regional/district level campaigns, the states of Andhra Pradesh, Maharashtra and Karnataka were found to have

organized a sizeable number of campaigns during the same period. Madhya Pradesh and Orissa almost followed suit with slightly fewer campaigns.

Table-4.8 : Number of Seminars/Workshops organized by PFDC

States	National Level (Nos.)	Regional/District Level (Nos.)
All 10 States	**6**	**123**
Punjab	0	6
Haryana	0	9
Madhya Pradesh	1	14
Gujarat	2	0
Odisha	0	15
Andhra Pradesh	0	28
Karnataka	1	22
Chhattisgarh	1	2
Rajasthan	0	4
Maharashtra	1	23

B. Training / Capacity Building

Human Resources Development through training programmes for officials, farmers, entrepreneurs and other active players involved in micro irrigation is an important element of the MI scheme. These training programmes are coordinated in project mode by the Horticulture Division, Department of Agriculture & Cooperation (DAC) with the involvement of NCPAH and organized through PFDCs, SAUs, ICAR Institutes and the registered manufacturers. Besides these trainings, the registered distributors/suppliers of the MI systems are required to impart basic orientation training for the beneficiary farmers so as to enable them to operate & maintain their MI systems.

As stated earlier, the PFDC is mandated to organize training programmes for disseminating the precision farming technology to the official stakeholders and farmers in order to facilitate its adoption by the end users. Accordingly, the PFDCs in the sample states were found to have conducted a total of 684 training programmes, with Karnataka and Gujarat having

Table-4.9 : Number of Training Programs organized by PFDC

States	Nos.
All 10 States	**684**
Punjab	23
Haryana	49
Madhya Pradesh	24
Gujarat	112
Odisha	60
Andhra Pradesh	78
Karnataka	162
Chhattisgarh	80
Rajasthan	88
Maharashtra	8

organized significantly higher number of these programmes than the other states (Table-4.9).

In order to have an assessment of the efficacy of such training programmes in terms of coverage, both the official stakeholders and the beneficiaries were asked to affirm whether or not they had received the trainings. The study revealed that nearly three-fifth of the official stakeholders both at the district and block levels had actually received the trainings (Table-4.10). In this regard, Rajasthan, Andhra Pradesh and Haryana fared much better than their counterparts. However, the number of official stakeholders affirming their participation in training was comparatively lesser in the states of Chhattisgarh, Madhya Pradesh and Karnataka. In Gujarat, there were no official stakeholders at the district and block levels involved in implementation and the scheme was being implemented centrally from the State making use of the advanced information technologies.

Table-4.10 : District & Block Level Official Stakeholders Affirming Receipt of Trainings

States	District Level		Block Level	
	Total Number of Functionaries	Nos. Received Training	Total Number of Functionaries	Nos. Received Training
Overall	**33**	**19 (58%)**	**66**	**39 (59%)**
Punjab	3	2	6	4
Haryana	3	3	6	5
Madhya Pradesh	5	1	10	6
Gujarat	0	0	0	0
Odisha	3	3	6	1
Andhra Pradesh	3	2	6	6
Karnataka	6	2	12	6
Chhattisgarh	2	0	4	1
Rajasthan	4	4	8	8
Maharashtra	4	2	8	2

As regards the extent of such trainings received by the beneficiaries, hardly one-tenth (8.5%) reported in the affirmative (Table-4.11). However, Andhra Pradesh stood out as an exception where a significantly greater proportion (62%) of the beneficiaries reported having received such a training in the State of Andhra Pradesh.

Table-4.11 : Beneficiaries attended MI Trainings

States	Total No. of Beneficiaries	Proportion of Beneficiaries Trained
Overall	**1614**	**8.5%**
Punjab	120	7.5%
Haryana	124	3.2%
Madhya Pradesh	232	0%
Gujarat	179	0%
Odisha	58	22.4%
Andhra Pradesh	174	61.5%
Karnataka	162	0%
Chhattisgarh	110	0.9%
Rajasthan	215	0%
Maharashtra	240	1.3%

The coverage of nearly three-fifth of the official stakeholders in its training programmes is an effort on part of the PFDCs that deserves to be applauded. However, the inclusion of only 9% beneficiary farmers in these programmes calls for greater efforts to increase their participation.

Orientation Training

The guidelines of the Scheme provide for the registered distributors/suppliers of the MI systems to orient the beneficiaries regarding the basic operational procedures and maintenance protocols post-installation of the systems. However, the study revealed that, overall, only less than two-fifth of the beneficiaries had received such an orientation.

Table-4.12 : Proportion of Beneficiaries Affirming Receipt of Orientation Training

States	Total No. of Beneficiaries	Proportion Affirming
Overall Sample	**1614**	**37%**
Punjab	120	63%
Haryana	124	56%
Madhya Pradesh	232	23%
Gujarat	179	22%
Odisha	58	71%
Andhra Pradesh	174	59%
Karnataka	162	30%
Chhattisgarh	110	17%
Rajasthan	215	56%
Maharashtra	240	12%

User Manual

The MI scheme stipulates for the distribution of a lucid user manual, describing the operation & maintenance procedures, to the beneficiaries at the time of installation of MI systems on their farms.

- **Major aspects dealt with in User Manual—**
  - Sand filter backwash to be done five minutes prior to operating the system
  - Regular cleaning of sand and screen filter
  - Flushing of mains/sub-mains and laterals after every round of fertigation
  - Flushing of mains/sub-mains, laterals and filters to be compulsorily carried out for at least two hours in a week even after harvesting
  - Operating the system only at the prescribed pressure

The study revealed that, overall, only 17% of the beneficiaries had received the user manual (Chart-4.4). Such a low proportion of beneficiaries having received the user manual could be attributed to the fact that the entire monitoring of the implementation of MI scheme was actually limited to physical verification of the installed MI systems under the scheme. Little was found to have been attempted on part of the registered suppliers, including the provision of a user manual, other than providing and installing the MI systems, in the absence of a robust monitoring mechanism in place. Andhra Pradesh fared relatively better on this count considering that more than half of the beneficiaries in the State were in the receipt of the manual.

Out of the beneficiaries who had received the user manual, more than two-thirds (70%) had reportedly read and attempted to understand the manual. Further, out of the proportion which had read the manual, nearly two-thirds (65%) again had comprehended it.

Table-4.13 : Beneficiaries Affirming Receipt & Comprehension of the User Manual

Sample States	Total No. of Respondents	Respondents in Receipt of User Manual		
		Proportion	Respondents in Receipt of User Manual in Local Language	Respondents Having Read & Comprehended User Manual
Overall	**1614**	**17%**	**70%**	**65%**
Punjab	120	8%	60%	80%
Haryana	124	5%	17%	67%
MP	232	10%	79%	79%
Gujarat	179	20%	91%	91%

Table-4.13 : Beneficiaries Affirming Receipt & Comprehension of the User Manual

Sample States	Total No. of Respondents	Respondents in Receipt of User Manual		
		Proportion	Respondents in Receipt of User Manual in Local Language	Respondents Having Read & Comprehended User Manual
Odisha	58	29%	100%	100%
AP	174	55%	86%	66%
Karnataka	162	2%	25%	75%
Chhattisgarh	110	13%	21%	21%
Rajasthan	215	29%	47%	47%
Maharashtra	240	3%	0%	17%

The situation wherein hardly one-tenth of the beneficiaries across the ten sample states affirmed receiving the basic training on micro irrigation and over three-fifths reported receiving no orientation training from their respective distributors/suppliers, calls for greater attention to these training programmes so as to increase their frequencies and enhance the participation of beneficiaries in them for facilitating an effective transfer of technology to the end users of the MI systems.

5. OPERATION & MAINTENANCE

The maintenance of the installed MI systems is the key to success for the MI scheme. To ensure the optimal performance and sustained usage of the MI systems, it is imperative that the beneficiaries in possession of the MI systems get effective after-sale repair & maintenance services from the suppliers.

5.1 After-sales Service

The after-sales service of MI systems plays an important role in their repair & maintenance that keeps them in working condition up to their intended life period. Thus, besides the warranty on the installed MI components, the MI scheme guidelines stipulate for the provision of free after-sales service of at least three years to the beneficiaries by the respective distributors/suppliers.

Interestingly, about a half of the beneficiaries reported having faced no operating problem in their MI systems since installation till the time of interview (Table-5.1). The finding that the beneficiaries were yet to face any problem even after the lapse of quite a few years since the installation indicates largely the good quality of the installed MI systems.

Table-5.1 : Beneficiaries Yet to Face Any Problem

States	Total No. of Beneficiaries	Proportion
Overall Sample	**1614**	**49%**
Punjab	120	38%
Haryana	124	36%
Madhya Pradesh	232	66%
Gujarat	179	58%
Odisha	58	50%
Andhra Pradesh	174	40%
Karnataka	162	90%
Chhattisgarh	110	75%
Rajasthan	215	17%
Maharashtra	240	36%

However, a majority (56%) of those who faced problems while operating the MI systems and availed the repair & maintenance services reported having been largely satisfied with the overall quality of the services. Karnataka, Orissa and Maharashtra were found to be performing poorly on the scale of satisfaction as far as the quality of the after-sales services received from the registered suppliers were concerned (Table-5.2).

Table-5.2 : Extent of Satisfaction with After-sales & Maintenance Services among Beneficiaries

States	Beneficiaries Who Availed After-sales Service	Satisfied	
		Nos.	(%)
Overall	**826**	**462**	**56%**
Punjab	74	55	74%
Haryana	81	64	79%
Madhya Pradesh	79	76	96%
Gujarat	75	65	87%
Odisha	31	1	3%
Andhra Pradesh	106	45	42%
Karnataka	16	0	0
Chhattisgarh	29	25	86%
Rajasthan	182	111	61%
Maharashtra	153	20	13%

When probed further, the beneficiaries who reported being dissatisfied with the quality of the after-sales & maintenance services offered by the registered suppliers of the MI systems cited the lack of quality services as the major reason for their dissatisfaction (Table-5.3).

Table-5.3 : Reasons for Dissatisfaction with After-sales & Maintenance Services

States	Beneficiaries Dissatisfied (No.)	Poor Services (%)	Service Center too far (%)	Miscellaneous (%)
Overall	**364**	**88%**	**8%**	**4%**
Punjab	19	79%	5%	16%
Haryana	17	71%	29%	-
Madhya Pradesh	3	67%	-	33%
Gujarat	10	90%	-	10%
Odisha	30	90%	10%	-
Andhra Pradesh	61	93%	2%	5%
Karnataka	16	31%	69%	-
Chhattisgarh	4	75%	-	25%
Rajasthan	71	80%	10%	10%
Maharashtra	133	100%	-	-

The proportion of beneficiaries who emerged as being dissatisfied with the quality of after-sales services offered by the registered suppliers of the MI systems was more than two-fifths across the ten sample states. Even this proportion is too large to be ignored and merits attention of the concerned authorities, especially those involved in the monitoring of the scheme. It was felt that the states needed to adopt special measures aimed at ensuring quality after-sales services from the registered suppliers on a sustained basis.

6. IMPACT OF THE SCHEME

The MI Scheme focuses on promoting the use of MI systems in all the potential areas of the country. However, regardless of its benefits reported by researchers from various quarters, the rate of adoption of MI systems among the farmers depends directly upon the nature and extent of benefits being recorded by the beneficiary farmers on their own farms. As such, the current study sought to gauge the extent of such benefits among the beneficiary farmers from across the 10 sample states.

The findings from the study corroborates the research outcomes as beneficiaries have reported gaining benefits like, water savings, reduced labour requirements, savings in electricity/fertilizers/pesticides, enhanced crop yield and yield quality, higher net returns, and more importantly an overall increase in the proportion of net irrigated area from the use of micro irrigation systems. The detailed findings regarding each of these benefits are presented sequentially in the following sections.

6.1 Increase in Proportion of Irrigated Lands

In addition to promoting the use of micro irrigation systems for better soil, water & land management, the major objective of the MI Scheme is to increase the proportion of irrigated lands among the beneficiaries in the arid and semi-arid regions. Accordingly, the present survey sought to ascertain the extent of such an increase in the proportion of irrigated lands among the beneficiaries.

The survey has revealed that the proportion of total irrigated areas among the beneficiary farmers has increased by more than one-tenth (10.8%) after adopting the MI systems (Table-6.1). Such an increase in total irrigated area was due to the adoption of MI systems for enabling cultivating on the rainfed and marginal/uncultivable lands.

Table-6.1 : Change in Proportion of Irrigated Lands among the Beneficiaries

SN	Irrigation Method	Proportion of Total Land under the given Irrigation Method		
		Before MI Installation	After MI Installation	Increase (+) / Decrease (-)
1.	Drip	-	19.8%	19.8%
2.	Sprinkler	-	30.3%	30.3%
3.	Conventional	80.7%	41.4%	-39.3%
Total Irrigated Land		**80.7%**	**91.5%**	**10.8%**

6.2 Extent of the Use of Marginal/Uncultivable Lands

Marginal lands are such which altogether are not barren but do not allow crop cultivation with full profitability. They have several limitations which in aggregate cause irreversible degradation after sustained cropping upon them in the absence of proper soil water and land management techniques. They typically encompass mountains and tropical and sub-tropical lowlands or plateaux with low, unstable rainfall or higher rainfall areas in intensive use relative to use-capability under existing population densities, traditional technologies and institutional structures. In most cases, in absence of external inputs, they have reached or exceeded the threshold limits to maintenance or enhancement of agricultural performance. They are characterized by poor soil fertility (nutrient deficiencies, acidity, salinity, poor moisture holding capacity, etc.), inaccessibility (poor communications, immobility with all its social and economic implications), fragility (low input absorptive capacity, high input-output ratios, limited capacity to withstand disturbance, vulnerable to irreversible damage), and heterogeneity (physically and culturally diverse with site-specific constraints and opportunities which restrict applicability of general technological or institutional measures to remove constraints or exploit opportunities). [***Source**: FAO (1997). Report of the Study on CGIAR Research priorities for Marginal Lands*]

The highly water-efficient micro irrigation systems with their unique ability of applying water and nutrients in controlled amounts lead to an increase in the proportion of irrigated area, which, in turn, enables crop cultivation even on the marginal and otherwise uncultivable lands. As such, the adoption of micro irrigation systems by the scheme's beneficiaries was expected to enable cultivation on their marginal & uncultivable lands.

The findings from the study fulfilled the aforesaid expectation from the use of micro irrigation systems, as the proportion of marginal & uncultivable lands of the beneficiaries across the 10 sample states indeed decreased by 2.6% (Table-6.2).

Table-6.2 : Decrease in Proportion of Marginal Lands among the Beneficiaries

SN	Type of Land	Before MI System Installation	After MI System Installation	Increase
1.	Irrigated	80.7%	91.5%	10.8%
2.	Rainfed	13.8%	5.6%	-8.2%
3.	Marginal & Uncultivable	5.5%	2.9%	-2.6%
Total Land		**100.0%**	**100.0%**	**-**

6.3 Extent of the Use of Saline Water for Irrigation

Irrigation, which has the ability to not only increase the food production for unit area of land but also to stabilise productions with minimum probability of crop failures, plays a major role by contributing around 50% to the world's total agricultural output (*Wolf and Hubener, 1999*). However, irrigation with saline water through the conventional methods causes accumulation of salts in soil profile, reduced availability of water to plants, poor to delayed germination and slow vegetative growth rate. Thus, the salinization and depletion of limited freshwater resources due to the absence of effective drainage system and poor water management practices coupled with the ever increasing and competing demands of water from the other sectors puts severe constraints in the way of expansion of irrigation. As such, the issue of proper management of the available water resources is all the more relevant.

In India, saline underground water resources are present in almost all the north-western states (Rajasthan, Haryana, Punjab, Uttar Pradesh, Gujarat, Maharashtra, Andhra Pradesh and Karnataka) having arid and semi-arid regions and the coastal states including part of Andhra Pradesh, Orissa and West Bengal. However, the problem is especially severe in the arid parts of Rajasthan, Gujarat, Haryana and parts of Punjab, where the salinity level of underground water sources is relatively higher. At some places in Rajasthan and Gujarat, the ground water salinity is so high that well water is directly used for salt manufacturing by solar evaporation method.

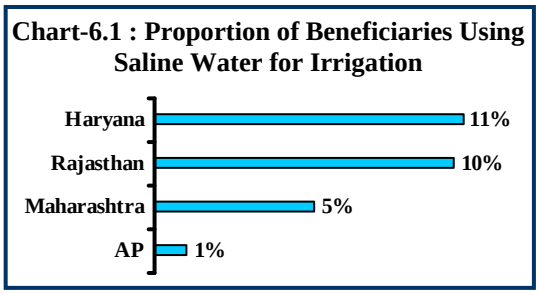
Inland salinity is caused in the absence of effective drainage system and poor water management practices resulting in gradual rise of ground water levels, while the coastal salinity results from the over-exploitation of groundwater resources leading to intrusion of brackish seawater into the underground water sources. In areas affected with this problem, reluctance on the part of the farmers to use saline water for irrigation only adds to the salinity and water-logging problems.

When saline water is applied through the conventional methods of irrigation, like flooding, a good proportion of water evaporates-off leaving behind salts on to the topsoil and the crop root zone. This decreases the porosity of soil which reduces the oxygen supply to the plant roots thereby impeding vegetation on such lands. However, with the use of micro-irrigation systems (drip/sprinkler) the saline water is able to be applied frequently in lesser amounts, due to which the evaporation losses of irrigation water are very less which prevents the accumulation of salts and keeps their concentration well below the harmful limit in crop root zone. Thus, at places where the freshwater resources are limited, alternative non-conventional water resources, like saline water aquifers, may be exploited

to feed the expansion drive for irrigation. In this context, the scientific use of saline water in conjunction with adaptable water use technologies has been advocated as an excellent proxy for irrigation through the fresh water resources by many research scientists and organisations, like, World Bank 1986, FAO 1992, Rhoades 1998, etc.

With the launch of MI scheme in the country, it was expected that the use of micro irrigation systems will push up the usage of saline water for irrigation. With this thought, the beneficiary farmers were asked to affirm as to whether or not they are using saline water for irrigation. As expected, a number of beneficiaries have affirmed using saline water for irrigation with their MI systems in states affected with the problem of groundwater salinity. Among those who have affirmed, the use of sprinkler has been reported by a whopping 94% while the remaining few (4%) have reported using drip irrigation system.

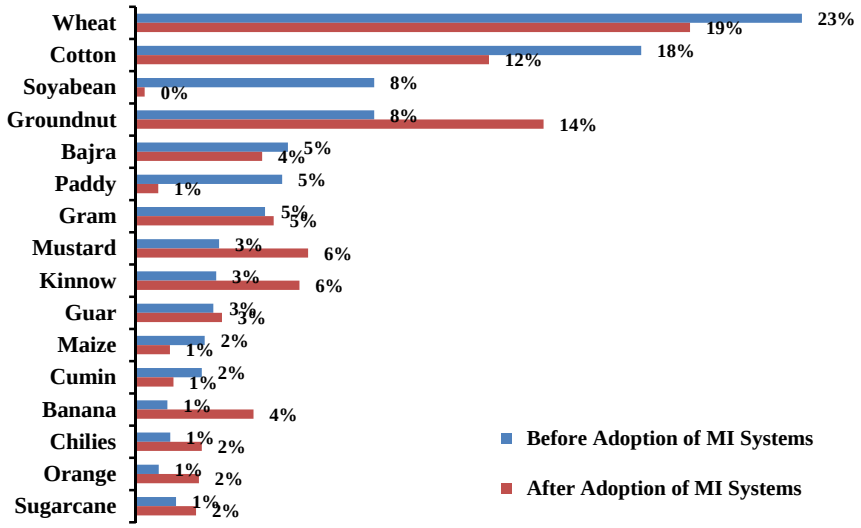
The states of Haryana and Rajasthan, where large proportions of arid and semi-arid areas have saline aquifers, have the highest proportions of beneficiaries affirming the use of saline water for irrigation through their micro irrigation systems (Chart-6.1). However, surprisingly, none of the beneficiary farmers in the State of Gujarat have affirmed using saline water for irrigation, though the State has the highest proportion (6%) of talukas/blocks that have been notified as having saline aquifers in comparison to the other states. In such states, where the beneficiaries are hesitant to use saline water for irrigation, the MI systems do not render advantages to their full potential. Thus, focused awareness campaigns on the use of poor quality brackish/saline groundwater through the involvement of scientists/technical experts may be advocated for enabling better utilization of saline water in such states.



6.4 Changes in Cropping Pattern

The survey of the cropping pattern has revealed that the major crops irrigated with the MI systems among the beneficiaries are wheat and groundnut followed by cotton, mustard, kinnow, gram, bajra, banana, guar, chillies, orange, sugarcane, etc. (Chart-6.2).

Chart-6.2 : Proportion of Cultivated Area under Major Crops among Beneficiaries



Apart from cultivating the aforementioned major crops, the beneficiaries have also been found to be growing some horticultural crops like pomegranate, aonla, carrot, red sandal, raddish, cumin, rachko, melon, mulberry, beetroot, sapota, which they were not cultivating prior to adopting the MI systems. However, such crops are being grown by them on significantly lesser area as compared to that under the major crops.

As one of the implicit objectives of the MI scheme is to bring about a change in the water-intensive cropping patterns with that of other high value cash crops requiring less irrigation water through the micro-irrigation systems, it was thought as worthwhile to ascertain the extent of such a change among the sample beneficiaries. Accordingly, the survey has revealed that among the major crops, the cropping pattern indeed shifted towards that of other high value crops, as the areas under soybean, cotton, paddy, wheat, maize, cumin, bajra, etc., registered a decline, while, that under the crops like, groundnut, mustard, banana, kinnow, orange, chillies, sugarcane, gram, guar, etc., increased (Table-6.3).

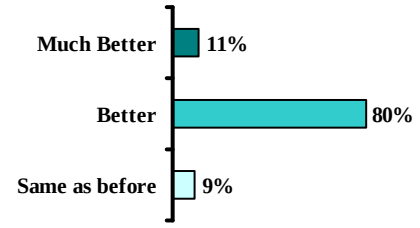
Table-6.3 : Change in Proportion of Area under Major Crops among Beneficiaries

I. Cultivated Area Increased			II. Cultivated Area Decreased		
SN	**Major Crops**	**Increase in Area (%)**	**SN**	**Major Crops**	**Decrease in Area (%)**
1.	Groundnut	6.0%	1.	Soybean	8.0%
2.	Mustard	3.1%	2.	Cotton	5.3%
3.	Banana	3.0%	3.	Paddy	4.3%
4.	Kinnow	2.9%	4.	Wheat	3.9%
5.	Orange	1.4%	5.	Maize	1.2%
6.	Chilies	1.0%	6.	Cumin	1.0%
7.	Sugarcane	0.6%	7.	Bajra	0.9%

6.5 Increase in Net Returns

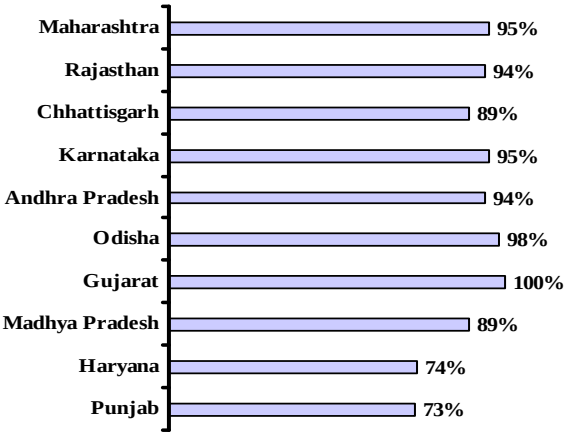
The household level interviews have revealed that the net returns from the crops irrigated with the micro irrigation systems were significantly higher than those earned from crops irrigated with conventional methods. This is evident from the fact that, overall, more than nine-tenths (91%) of the beneficiaries have reported their net returns from crops irrigated with MI systems as better or much better in comparison to those earned before adopting the MI systems (Chart-6.3).

Chart-6.3 : Proportion of Beneficiaries reporting relative change in Net Returns



The same was visible from the responses of beneficiaries of almost all the states, except those of Punjab and Haryana, where relatively smaller (three-quarters) proportions of beneficiaries reported such increments in their net returns from crops irrigated with the micro irrigation systems (Chart-6.4).

Chart-6.4 : % Beneficiaries reporting Net Returns as '*Better*' or '*Much Better*'



The increased net returns among the beneficiary farmers resulted from a number of advantages provided by their micro irrigation systems, which primarily included the improvements in yield (Table-6.4) and yield-quality (Chart-6.5) besides the savings in labour requirements, fertilizer application, insecticides/pesticides application, electrical energy consumption, etc.

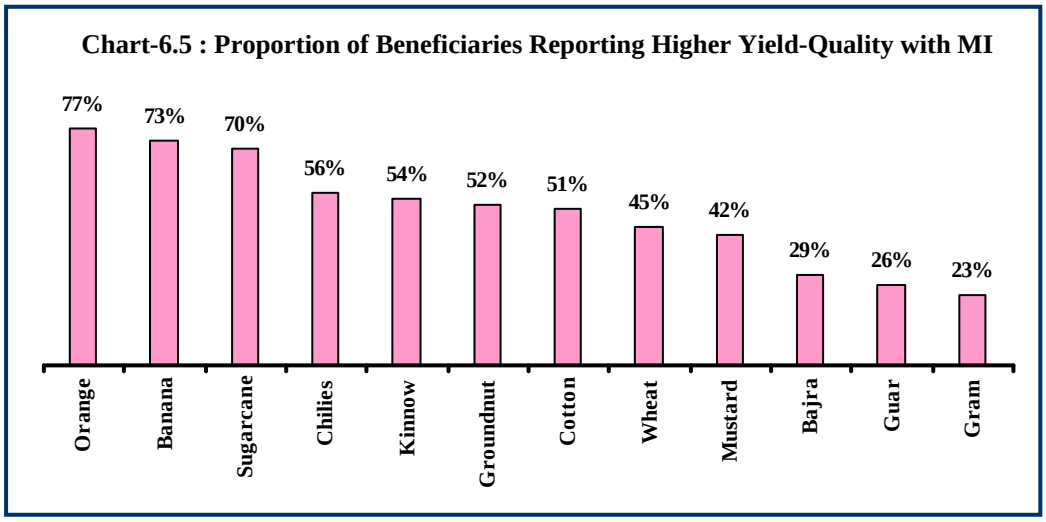
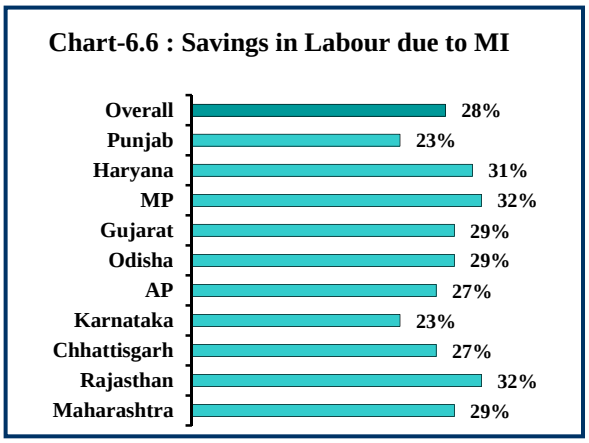


Table-6.4 : Increase in Average Yield of Major Crops due to MI

SN	Crop	Yield (kg/ha)		Increase in Yield (%)
		Without MI	With MI	
1.	Orange	25,233	31,472	25%
2.	Groundnut	1,492	1,850	24%
3.	Sugarcane	47,854	58,790	23%
4.	Banana	40,525	49,086	21%
5.	Mustard	1,404	1,693	21%
6.	Chilies	2,048	2,446	19%
7.	Bajra	1,766	2,107	19%
8.	Kinnow	21,467	25,508	19%
9.	Guar	625	733	17%
10.	Wheat	3,137	3,667	17%
11.	Cotton	2,231	2,583	16%
12.	Gram	1,066	1,190	12%

6.6 Savings in Labour

The adoption of micro irrigation systems significantly reduced the farm labour requirements by over a quarter (28%), particularly during the application of irrigation and weeding (Chart-6.6). Incidentally, almost all (98%) of the beneficiaries have reported a significant reduction in the occurrence of weeds on



their farms irrigated with the micro irrigation systems. Thus, the said extent of labour saving was possible because of minimal human intervention required during irrigations through the drip/sprinkler systems and lesser weed growth resulting from the lower wetted area.

6.7 Savings in Energy

The conventional irrigation systems mainly involve lifting underground water through the tube-wells that consume a considerable amount of electrical energy. The micro irrigation systems, too, are driven by electrical pumps, but consume much lesser electrical energy due to the reduced hours of pumping. However, the energy savings from the MI systems are possible only when they are operated for pumping the requisite amount of irrigation water into the field. In case where the MI system is used for longer than the recommended duration, the additional water percolates deep into the water table and goes waste, while it also pushes up the electrical consumption.

The power savings vary according to different irrigation systems, crop types and crop geometry. According to one estimate (*Task Force Report published by the Ministry of Agriculture, Govt. of India*), the savings in average annual electrical energy consumption is 324 kWh/ha with drip and 116 kWh/ha with sprinkler irrigation systems, with the assumption that these MI systems are operated for the recommended durations only (Table-6.5).

Table-6.5 : Savings in Electrical Energy with Drip/Sprinkler Irrigation Systems

SN	Crop Type	Average Annual Consumption (kWh/ha)			Average Annual Savings (kWh/ha)
		Conventional	Drip	Sprinkler	
i.	Crops suitable for drip irrigation	2408	2084	-	324
ii.	Crops suitable for sprinkler irrigation	926	-	810	116

☛ *Source: Task Force Report, Ministry of Agriculture, Govt. of India*

An attempt was made to study the savings in electricity consumption on account of using micro irrigation. The data collected from the sample farmers was analyzed for both drip and sprinkler methods, for various crops. Savings in energy due to drip methods were found to be higher than sprinkler method. The adoption of drip irrigation has effectively reduced the

Table-6.6 : Savings in Electrical Energy with Drip Irrigation

SN	Crop Type	Average Annual Savings (kWh/ha)
i.	Potato	581.9
ii.	Cotton	503.7
iii.	Turmeric	207.6
iv	Chilly	185.0
Average (kWh/ha)		**369.5**

energy requirements for the sample farmers, as evident from the table 6.6. On an average, the maximum energy savings was observed in potato (582 kWh/ha), while the minimum being in Chilly (185 kWh/ha). Thus, the drip method which utilizes lesser water has resulted in savings of electrical energy due to reduction in the time of operating of the pump. On the whole, the average savings in electricity was found to be 370 kWh/ha for the sample farmers practicing drip irrigation.

Regarding energy savings from sprinkler irrigation, the maximum was observed in peanut (290 kWh/ha), followed by coriander (261 kWh/ha). The minimum energy savings was observed in case of masoor (51 kWh/ha), as shown in the table given alongside. Overall, the average annual savings in electricity was about 198 kWh/ha from sprinkler irrigation. Therefore, substantial reduction in electricity consumption was observed with micro irrigation techniques, especially with the drip methods.

Table-6.7 : Savings in Electrical Energy with Sprinkler Irrigation

SN	Crop Type	Average Annual Savings (kWh/ha)
i.	Peanut	290.3
ii.	Coriander	261.8
iii.	Mustard	197.6
iv	Gram	189.8
v.	Masoor	50.7
Average (kWh/ha)		**198.0**

Further, during the household-level interviews, more than nine-tenths of the sample beneficiaries (94% having drip; 91% having sprinkler) across the 10 sample states have affirmed having reduction in their electrical consumption after the adoption of MI systems. Thus, using the estimates mentioned in Table-6.5, the average annual savings in electricity consumption comes out to 395 MU (Mega Electrical Units) among all the beneficiary farmers, from across the 10 sample states, who received subsidized MI systems under the MI Scheme during the reference period of this study (Table-6.6).

Table-6.8 : Estimated Annual Savings in Electrical Energy among All Beneficiaries

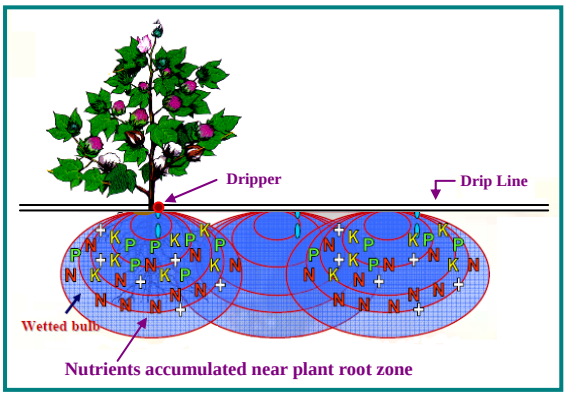
SN	Type of MI System	Total Area Coverage ('000ha)	Beneficiaries Affirming Reduction in Electricity		Annual Savings in Electrical Energy	
			Proportion (%)	Area ('000ha)	Average (kWh/ha)	Total (MU*)
i.	Drip	937	94%	880.8	324	285
ii.	Sprinkler	1041.9	91%	948.1	116	110
Overall						**395**

**** 1 MU (Mega Electrical Unit) = 10^6 kWh***

6.8 Reduction in Fertilizer Usage

Soil fertility depletion is a cause of concern for Indian agriculture. The organic carbon content of most Indian soils is very low and nitrogen deficiency is universal. Most of the soils are low to medium in phosphorus and potassium, and sulphur deficiencies have developed over time. There exists a gap of about 10 million tonnes of nutrients (NPK) between the removal of nutrients by crops and their addition through fertilizers. The use of plant nutrients per hectare is relatively low and imbalanced, and this is one of the major reasons for low crop yields in India (FAO, 2005).

In order to feed the ever-growing population, the farmers are faced with the challenge to increase crop yields by making further use of the available resources, including fertilizers. However, the rampant use of fertilizers along with intensive irrigation leeches the nutrients into the underground water-table causing pollution of the underground water resources.



The micro irrigation systems' ability (particularly that of drip) to place small amounts of nutrients directly into the plant root zone not only minimizes nutrient losses but also allows rapid uptake of nutrients by the plants. This in-turn helps in increasing the crop yield on one side and prevents the pollution of precious water resources on the other. Further, the precise application and uniform distribution of fertilizers allows the application of nutrients as per the plant requirements which ultimately saves fertilizers to the tune of 25-30%.

A. Usage Status of MI Systems for Fertigation/Chemigation

Survey has revealed that, overall, only about one-fourth (23%) of the sample beneficiaries are applying fertigation/chemigation to their crops through their MI systems. This was due to higher price of the water soluble fertilizers, used in micro irrigation. In addition, there is no provision of subsidy on these fertilisers, though these fertilizers are used in smaller quantities but application of water soluble fertilizer requires greater skills and knowledge in comparison to conventional fertilizers. The proportion of beneficiaries applying fertigation is highest (74%) in Maharashtra, followed by Andhra Pradesh (52%) and Gujarat (26%), while no beneficiary farmer has been found to be applying fertigation/ chemigation in the states of Orissa and Karnataka (Chart-6.7). Water soluble fertilizers have multifarious

advantages as compared to conventional fertilizers, in terms of nutrient uptake, enhancement of yield and quality of crops. Considering these benefits, a subsidy scheme should be introduced to increase its usage. Possibility of dove tailing with Nutrient Based Subsidy (NBS) Scheme for Fertilizers should be explored.

Further, more than nine-tenth (91%) of the beneficiaries who are applying fertigation/chemigation to their crops are doing so through drip irrigation systems. This is probably because drip irrigation system allows better application of fertilizers and pesticides/ insecticides near to the plant root zone as compared to the micro-sprinkler irrigation systems.

B. Reduction in Fertilizer Usage

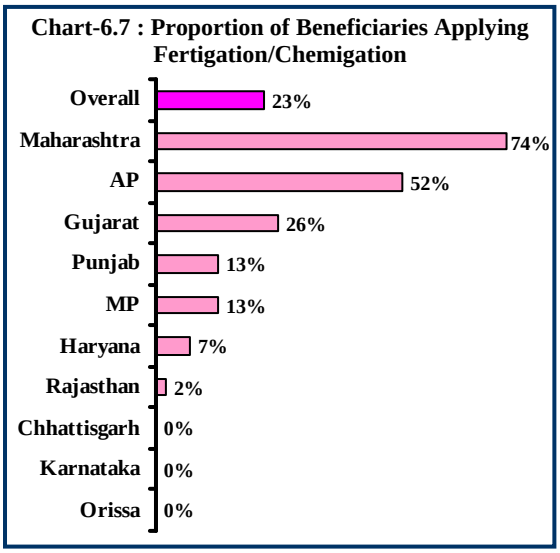
Among the beneficiaries who are applying fertigation/chemigation through their MI systems, the consumption rate of total fertilizer (N+P2O5+K2O) declined significantly by an overall average of 24% after the adoption of MI systems (Table-6.9).

Table-6.9 : Reduction in Fertilizer Consumption from the Use of MI Systems

SN	Sample States	No. of Beneficiaries applying Fertigation	Avg. Fertilizer Usage (kg/ha)		Reduction in Fertilizer Consumption (%)
			Without MI	With MI	
Overall		**371**	**189.9**	**144.6**	**24%**
1.	Maharashtra	177	191.0	147.7	23%
2.	AP	90	222.1	167.3	25%
3.	Gujarat	46	138.0	101.0	27%
4.	MP	29	124.4	97.9	21%
5.	Punjab	15	302.4	232.5	23%
6.	Haryana	9	204.0	150.0	26%
7.	Rajasthan	4	54.1	45.3	16%

6.9 Increase in Fertilizer Use Efficiency

The agronomic definition of '*Fertilizer Use Efficiency*' (FUE) refers to the ratio of crop yield (kg/ha) per unit quantity (kg/ha) of fertilizer applied. It improves both with increase in yield and with reduction in fertilizer consumption rate [*Maslaris N., S. Helen and S. Asterios. 2002. Fertilizer use efficiency of sugarbeet in Greece, Paper No. 972, Symposium No. 14, 17th WCSS, 14-21 August, 2002, Thailand*].



Among the one-fourth (23%) beneficiaries who were applying fertigation with their MI systems, the significant increase in crop yields from the use of micro irrigation systems coupled with the decrease in fertilizer consumption rate significantly increased the fertilizer use efficiencies up to 39-65% for different crops. The improvement in fertilizer use efficiencies of some of the major crops grown by such beneficiaries are presented in Table-6.10.

Table-6.10 : Improvement in Fertilizer Use Efficiency (FUE)

SN	Major Crops	FUE [Yield (kg/ha) ÷ Fertilizer Qty (kg/ha)]		Increase in FUE (%)
		Without MI	With MI	
1.	Banana	124.0	204.0	65%
2.	Orange	140.0	225.0	61%
3.	Chilly	12.8	20.4	59%
4.	Kinnow	85.8	136.6	59%
5.	Cotton	13.5	19.9	47%
6.	Sugarcane	250.5	348.0	39%

6.10 Savings in Insecticides/Pesticides

Insecticides/pesticides protect the crops from the hazardous attacks of insects/pests and as such, are a great boon for the farmers in enhancing their crop yields and quality that fetch them higher returns. However, when traces of these chemicals enter into the edible portions of crops in quantities more than the permissible limits the crops become toxic and

pose a threat to human health. As such, their application in the recommended dosage is always a challenge before the farmers.

The micro irrigation systems' ability to apply the requisite amounts of insecticides/ pesticides through calibrated mechanisms allow for their application in recommended quantities, which prevents their wasteful use and also saves the crops from getting toxic.

The survey has revealed that among those few beneficiaries from across the 10 sample states who are applying insecticides/pesticides with their micro irrigation systems, the average consumption of insecticides/pesticides recorded a decline of 18%.

6.11 Economic Impact of Micro-irrigation

The adoption of micro irrigation has brought about significant benefits to the farmers, as discussed in the previous section. Above all, it has generated additional income from the farms, which has directly contributed towards improvement in livelihoods of the farmers. Therefore, micro irrigation achieves paramount importance being the most suitable water saving technique, besides enhancing the economic returns from crops. However, the technology of micro irrigation involves a significant amount of capital investment, depending upon the nature of crops (wide or narrow spaced) to be cultivated. Keeping in mind the significance of drip and sprinkler methods in the sustainable use of irrigation water, it is imperative to carry out a comprehensive analysis of its benefits in monetary terms.

Economics of Micro Irrigation

It would be apt to reiterate that although the micro-irrigation is suitable for all kind of lands, the return generally differs from region to region, depending upon its natural endowments. Considering the diverse topography, soil characteristics, etc across the Country, the sample states were classified into three different categories to study the benefits under varying regions. The first category of, 'water scarce areas,' includes the sample States of Andhra Pradesh, Maharashtra, Karnataka and Gujarat. While the States of Rajasthan and Haryana fall under the second category of 'water scarce areas with undulating topography & sandy soils'. Lastly, the remaining four States (Punjab, Odisha, Chhattisgarh and Madhya Pradesh) were grouped as the 'water sufficient areas'. Keeping in mind the three areas, the economic benefits of micro irrigation has been evaluated by undertaking a comparative study of drip & sprinkler methods over traditional irrigation practices.

Water Scarce Areas

In water scarce areas, the drip method provides the most efficient way to conserve irrigation water. Acknowledging its benefits, the farmers have started adopting micro irrigation (particularly the drip method) in the States of Andhra Pradesh, Maharashtra, Karnataka and Gujarat. The comparative performance of drip methods and conventional methods has been done by studying the returns from a water scarce area, as discussed ahead.

Drip Irrigation: Unlike flood irrigation method, drip method supplies water directly to the root zone of the crop, instead of irrigating the entire land. This inhibits water loss occurring through evaporation and infiltration. The drip method was found to have significant crop productivity benefits and improvement in the quality of yields. This method is considered to be highly suitable for row crops. The on-farm irrigation efficiency of properly designed and managed drip irrigation system is estimated to be about 90 percent. Moreover, drip method calls for special skills in order to suitably exploit the technique for gaining maximum returns. Keeping in mind the literacy levels of Indian farmers specially the small & marginal farmers, the returns from micro irrigation was observed to be highly diverse. The economics of drip was worked out for the crops cultivated during a year on an area of 1 hectare. Four crops, such as, chilly, turmeric, bitter gourd and cotton were selected for understanding the benefit of micro irrigation in comparison to the conventional method. The criterion for selection of crops was made on the basis of maximum usage of drip technique among these four crops, in the water scarce area selected for the study. The table 6.11 exhibits the benefit obtained from cultivating chilly, turmeric, bitter gourd and cotton with drip irrigation —

Table-6.11 : Economics of Crops Cultivated Through Drip (Cost in Rs. per ha)

Details	Total Input* (Rs. per ha)	Total yield (Quintal/ha)	Rate per Quintal	Total Income (per ha)	Total Savings (per ha)	Additional Benefit by MI (per ha)
CHILLY						
MI	188991	84	6000	504000	315009	121183
Conventional	166174	60	6000	360000	193826	
TURMERIC						
MI	103476	84	4000	336000	232524	109405
Conventional	104881	57	4000	228000	123119	
BITTER GOURD						
MI	212800	400	1000	400000	187200	79500
Conventional	192300	300	1000	300000	107700	
COTTON						
MI	101740	41	4000	164000	62260	25835
Conventional	103575	35	4000	140000	36425	

**Input costs include expenditure over Human Resource, Leveling, Seeds, Irrigation, Fertilizer, Pesticide, etc*

Chilly: As depicted in the above table , the highest additional benefit of Rs. 1.21 lakh per hectare was observed in case chilly, being irrigated through drip methods. Micro irrigation has led to higher sales realization of approximately Rs. 5.04 lakh per hectare, as against Rs. 3.60 lakh per hectare with conventional methods.

Turmeric: A significant increase of 27 quintals per hectare was observed in the yield of turmeric with the drip method among the sample farmers, resulting in an additional benefit of Rs 1.09 lakh. As evident from the table 6.11, drip method of irrigation has proved to be highly rewarding in enhancing the yields from turmeric.

Bitter Gourd: the economics of bitter gourd was also worked out to assess the profitability of cultivating through drip systems. On comparing the two methods of irrigation, it was observed that drip irrigation yields about 100 quintals per hectare of additional bitter gourd, which was otherwise 300 quintals per hectare through conventional methods. There has been a considerable increase in the returns with micro irrigation as compared to the conventional methods which was approximately Rs. 0.79 lakh per hectare.

However, the analysis of the crops discussed above does not present a complete picture of the total additional increase in the annual income due to micro irrigation. In most of the cases the farmers were cultivating two crops with the same set of drip system, thereby, investing only once over the capital cost. In view of this, the annual returns from farm level data cannot be computed solely on the basis of returns from one crop. Therefore, it would be worthwhile to assess the additional annual income from micro irrigation by studying the returns from the total number of crops cultivated with the same investment.

Cost Benefit Analysis

As mentioned earlier, micro irrigation is a capital intensive technology which requires a fixed investment for installing the system. Since the technique involves a capital cost, the need for undertaking a cost-benefit analysis is considered to be inevitable. Apart from evaluating the benefit cost ratio, rate of return and payback period of the system was also worked out. The area of sample farmers was studied and analyzed for comparison of crops cultivated with micro irrigation and conventional method.

Benefit-Cost Ratio under Drip Irrigation

A benefit-cost ratio is defined as the value of a project against the money that will be spent in doing the project in the overall assessment of a cost-benefit analysis. This ratio provides a value of benefits and costs that are represented by actual rupees spent and gained. All

benefits and costs are expressed using discounted present values. Since the drip system entails an investment, it would be pertinent to assess its profitability in term of benefit-cost ratio. It was observed that the benefit-cost ratio was higher for drip irrigation as compared to conventional methods across all the sample farmers. The ratio worked out to be as high as 2.90 and 2.14, respectively, for a farmer cultivating turmeric, cotton and corn (Refer to Annexe No. 1, page ii). These results corroborate the fact that drip irrigation is far better than the conventional methods, providing higher income from additional yields.

Rate of Return and Payback Period under Drip Irrigation

The major benefit derived by the farmer through micro irrigation was the increase in productivity of crops, resulting in a significant rise in the annual income. In order to evaluate the economic feasibility of drip irrigation in terms of rate of return and payback period, it is essential to take into account the annual additional benefits obtained from different crops being cultivated with the same equipment. (Refer to Annexure No. 1). The rate of return due to drip irrigation was worked out using the capital cost of the system, annualized expenses towards the system (including interest and depreciation at the rate of 10%, each and repair & maintenance levied at 2%) and the additional crop income that will occur during the year due to MI system in the farm. Based on the information gathered from different farmers, the annual additional benefits with micro irrigation have been worked out.

The rate of return from drip irrigation varied to a large extent. It was found to be exceeding 100% mark in majority (5 out of 8 farmers) of these cases, while for the rest of farmers it was in the range of 48% to 71%. Understandably, the payback period was higher in the cases where the rate of return dipped below 70%. The minimum payback period was found to be within a period of 1 year for majority of the farmers, while the maximum duration extended up to 2-3 years for a few farmers (3 out of 8 farmers).

Impact of Subsidy: the impact of subsidy can be gauged from the rate of return and payback periods. Due to the provision of subsidy, the rate of return will be more than double while the payback periods, would become almost half as the investment on the system reduces.

Role of Individual Farmer: the study and analysis of micro irrigation has revealed a very crucial factor that individuals' skill has an enormous effect over its success. In techniques like micro irrigation involving technological interventions, the economics is largely affected by the competency and skills of the farmer. Significant returns from micro irrigation are possible only if the farmer makes a judicious selection of crops along with observance of

Standard Operating Procedures. The variation observed in the rate of return corroborates the fact that the benefits from such techniques depends on the competency of the farmer to a large extent. For instance, a farmer (Annexe No. 1, page i) gained an exorbitant additional income of Rs. 2.45 lakh by cultivating a single crop (chilly) which was not even half in case of the returns from the same crop cultivated by different farmers (Annexe No. 1, page iv & v).

Further, the study has outlined an important aspect of the drip irrigation that it not only improves the yield and quality of agricultural produce, but it has facilitated intercropping which has brought about significant benefits to the farmers. Therefore, there is an enormous potential for income generation, which has been successfully exploited by some of the competent farmers. The statement may be ascertained with the case study of a skilled farmer in the village Gullapalli of district Nalgonda (Andhra Pradesh) who has been gaining stupendous benefits with drip irrigation, particularly due to intercropping.

Case Study — Mr. Shekhar Reddy

Village Gullapalli, District Nalgonda (Andhra Pradesh)

Mr. Shekhar Reddy has a total landholding of 3.24 hectares out of which about 2.83 hectares was irrigated through drip method. Out of the total area irrigated with drip, he had claimed the subsidy only on 0.81ha, while incurring an expenditure on nearly 80% area (2.02 ha) through his own resources. He has installed the drip system of irrigation for cultivating chilly, tomato and marigold (grown as an intercrop). The economics of micro irrigation were worked out for these crops cultivated on one ha of land, for comparison of micro and conventional irrigation. On comparing the two systems, it was observed that the yield from micro irrigation was far better than the conventional methods. A considerable increase in the productivity of both, chilly and tomato was noticed with drip irrigation. As a result, both these crops have provided an additional income of Rs. 2.50 lakh per hectare. Most importantly, intercropping of marigold through drip irrigation has contributed to an added income of Rs 3.60 lakh, leading to a significant increase in the annual returns. As evident from the table 6.12, an annual income of Rs.8.40 lakh was obtained by the farmer, which would otherwise have been only Rs.4.17 lakh through conventional method. Thus, Mr. Reddy was generating immense profits by adopting the drip methods, which was to the tune of Rs. 4.23 lakh per hectare.

Table-6.12 : Comparison of Returns from Micro-irrigation and Conventional Irrigation					
Crop	Rate Rs. Per Quintal	Return Rs. per Ha			
		MI		Conventional	
		Quintals per Ha	Rs. Per Ha	Quintals per Ha	Rs. Per Ha
Chilly	1000	625	625000	500	500000
Tomato	500	750	375000	500	250000
Marigold (Inter-crop)	800	450	360000	0	0
Total Sale Value from 1 Hectare Area			**1360000**		**750000**
Total Expenditure on 1 Hectare Area			**520250**		**333250**
Total Annual Return from 1 Hectare Area			**839750**		**416750**
Annual Additional Return due to use of Drip			**423000**		

The case study reflects that if a farmer understands the revenue related benefits of micro irrigation, he would not even need subsidy for purchasing the systems. This implies that greater efforts are needed to make the farmers well conversant with the benefits of micro irrigation. The case study is an example of the farmer's competency which has enabled production of maximum yields with MI. The profits earned with this technique have helped in justifying the high capital investment the farmer has made. With such skilled farming, investment in micro irrigation appears to be economically viable, even without availing subsidy. The payback period would be within a year for installing the drip system worth Rs. 1.00 lakh, approximately

Sprinkler Irrigation: Under sprinkler method of irrigation water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. Sprinkler irrigation is adaptable to any farmable slope, whether uniform or undulating and they are best suited to sandy soils with high infiltration rates. In order to determine the benefit of micro irrigation in comparison to the conventional method, five crops were studied and analyzed. The following table exhibits the benefit obtained from cultivating garlic, gram, masoor, coriander and mustard with sprinkler irrigation.

Table-6.13 : Economics Of Crops Cultivated Through Sprinkler (Avg. Cost in Rs. per ha)						
Details	**Total Input (Rs.)**	**Total yield (Quintal/ha)**	**Rate (per Quintal)**	**Total Income (per ha)**	**Total Savings (per ha)**	**Additional Benefit by MI (per ha)**
GARLIC						
MI	83192	69	3500	241500	158308	59256
Conventional	86448	53	3500	185500	99052	
GRAM						
MI	39168	20	4000	80000	40832	22163
Conventional	41331	15	4000	60000	18669	
MASOOR						
MI	27608	15	4000	60000	32392	9907
Conventional	29515	13	4000	52000	22485	
CORIANDER						
MI	37906	15	5000	75000	37094	18528
Conventional	41434	12	5000	60000	18566	
MUSTARD						
MI	25358	18	3100	55800	30442	9981
Conventional	26039	15	3100	46500	20461	

Garlic: The table given above clearly shows that the productivity of garlic was significantly higher under the sprinkler method of irrigation, when compared to conventional methods. Irrigation with the former method has provided an additional income of Rs. 60, 000, approximately. The adoption of micro irrigation has led to higher sales realization of approximately Rs. 2.41 lakh per hectare, as against Rs. 1.85 lakh per hectare with conventional methods.

Gram: The comparative performance of the two methods of irrigation indicates a substantial increase of 5 quintals per hectare in the yield of gram with the sprinkler method, resulting in an additional benefit of Rs 22, 163.

Coriander: the economics of coriander was also worked out to assess the profitability of cultivating through sprinkler systems. On comparing the two methods of irrigation, it was observed that sprinkler irrigation yields about 15 quintals per hectare of coriander, which was otherwise 12 quintals per hectare through conventional methods. There has been a considerable increase in the returns with micro irrigation as compared to the conventional methods which was approximately Rs. 18,528 per hectare. As evident from the table 6.13, sprinkler method of irrigation has proved to be highly rewarding in enhancing the yields from garlic, gram, masoor, coriander and mustard.

Benefit-Cost Ratio under Sprinkler Irrigation

As the sprinkler system also involve an initial investment, it is essential to study the cost and benefits under this method of irrigation. It was observed that the benefit-cost ratio

was higher for sprinkler irrigation as compared to conventional methods across the sample farmers. The ratio worked out to be as high as 3.63 and 3.09, respectively, for a farmer cultivating garlic, coriander and gram (Refer to Annexe No. 2, page xiii). The benefit-cost ratio was greater than one among all sample farmers, indicating that investment in sprinkler was economically viable.

Rate of Return and Payback Period under Sprinkler Irrigation

Apart from working out the economics for the five crops, the rate of return and payback period was also studied for the sprinkler method. The economic viability of the sprinkler system has been studied by considering the same parameters (as in drip method), such as the capital cost of the system, annualized expenses towards the system (including interest and depreciation at the rate of 10%, each and repair & maintenance levied at 2%) and the additional crop income that will occur during the year due to MI system in the farm (Refer to Annexure No.2). The annual additional benefits with micro irrigation have been worked out on the basis of information provided by the sample farmers. The financial viability of sprinkler irrigation was also found to be impressive. The rate of return from sprinkler irrigation was observed to be in the range of 44% to 144%. While the minimum payback period was found to be less than 1 year and the maximum duration spread over a period of 2 to 3 years.

Water Scarce Areas with Undulating Topography and Sandy Soils

As mentioned earlier, that the sample districts of Rajasthan and Haryana typically represent the areas that are marked by an undulating topography and sandy soils, besides being water deficit. Accordingly, the two States have been grouped together, since the economics of micro irrigation in these areas is completely different. In areas, such as Bikaner and similar districts of Rajasthan and the bordering districts of Haryana (Mahendragarh, Hissar and Bhiwani), conventional method of irrigation is not viable due to the undulating topography and sandy soil (having very high porosity and permeability) in the region. Therefore, there is a huge potential of micro irrigation in these areas, being the only mode for irrigation.

The potential and popularity of micro irrigation in districts such as Bikaner, is entirely different and needs to be analysed differently.

Bikaner is one of desert district situated in the North-West of Rajasthan. Irrigation was impossible through conventional methods (flooding) due to the uneven topography and presence of sandy loam soil causing water losses due to high infiltration rates. The farmers were largely dependent on rainfall for irrigation purposes. However, micro-irrigation technique provided solution to this intrinsic problem of the district. Consequently, popularity of sprinkler systems has picked-up during last decade. With the introduction of Centrally Sponsored Micro Irrigation Scheme in the year 2006, the scenario of irrigation in the district has experienced a complete metamorphosis. For such water scarce and unfriendly to irrigation environments, the technique of micro-irrigation has been very successful in cultivation of crops which were earlier not at all feasible in the district through conventional methods. As a result, micro irrigation in such areas has provided a surplus income to the farmers, who were otherwise not able to able to produce any crops other than Jowar. In other words the entire benefit from micro irrigation materializes out to be the income of the farmer, as shown in the table 6.14. It was observed that the adoption of modern technique has led to the production of high value cash crops such as groundnut, guar, gram, wheat, etc, which has given an advantage over the farm agriculture produce and income of farmers.

Irrigation via sprinkler system, Village Akkasar, Bikaner showing undulating physiography along with exposure of sandy soil

Table-6.14 : Returns from Micro-irrigation

Crops	Total Input (Rs. per ha)	Total yield (Quintal/ha)	Rate per Quintal/ha	Total Income	Total Savings
Groundnut	56500	40	5000	200000	143500
Gram	39100	24	3200	76800	37700
Wheat	42000	40	1600	64000	22000
Guar	38400	20	8000	160000	121600

The district of Bikaner has experienced a considerable increase in the yield of crops during the last decade (1999-2010), as evident from the table given ahead —

Table-6.15 : Area (ha) under Crops in Bikaner District										
Year-wise	Wheat	Jowar	**Gram**	**Ground nut**	Barley	Moong	Moth	Cotton	**Guar**	**Gross Sown Area of Major Crops**
1999-00	70628	513	**78371**	**18083**	360	458	162445	35878	**150418**	**517154**
2006-07	52898	529	125791	46251	2086	1275	274661	-	-	**503491**
2010-11	79123	574	**163767**	**85189**	3353	5792	324991	514	**876113**	**1539416**
Source: Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Ministry of Agriculture, GoI										

As reflected from the table given above, the gross sown area under the major crops exhibits an exorbitant increase over the years. The area under guar was recorded to be approximately 6 times higher than in the year 1999-00, while for groundnut the increase in the sown area was nearly five times more as compared to last decade.

Such boom in the agriculture sector of the district has brought about financial stability amongst the farmers, who were otherwise forced to migrate to other areas for better opportunities. The success of micro irrigation in the district can be witnessed through the number of farmers (48844) who have adopted the sprinkler system for irrigating purposes in the district. Each of these farmers owns a pair of sprinkler set, which costs them approximately Rs 1 lakh. The tube wells consist of motors with 45 HP to 75 HP, which enables 35 to 60 sprinklers to operate collectively. During the period 2006-13, as many as 17895 farmers have received subsidy on sprinkler system, whereas 1037 farmers were given financial assistance over drip systems.

The increase in the number of micro irrigation systems and the enormous potential of this technique in the district has drawn in many manufacturers/dealers, who have started opening up their factories, show rooms and service centres. As a result of increased competition in the market, there has been aggressive promotion of micro irrigation, through advertisements as seen from the illustration given alongside.

Advertisement of sprinkler manufacturing company

The dealers have played a pivotal role in the growth of micro irrigation with their efforts in facilitating loans to the farmers. During the evaluation of centrally sponsored micro irrigation scheme (2006-10), out of the total beneficiaries (49) interviewed in Bikaner

district, a significant proportion (43%) of them had availed loan from the banks for paying their share of expenditure for MI system. This figure (43%) was recorded as the highest for any of the districts across all the 10 states selected for the study, contrary to an insignificant proportion (4%) of overall beneficiaries (cumulative of all 10 states) who received the loan.

Water Sufficient Areas

The technique is not very popular in the areas which have adequate availability of irrigation supplies due to various reasons. One of the main deterrent factors for slow adoption of micro irrigation is it's the capital-intensive nature. Since the Indian farmers have been getting water for low cost from the public irrigation system and also from well irrigation (because of free and flat-rate electricity tariff), there is less incentive to them to adopt this capital-intensive technology unless it is necessary. Another major constraint is poor extension services offered by concerned authorities. Micro irrigation system involves sophisticated technologies, and their operation and maintenance is not very simple. Since the farmers are not well conversant with the operation and maintenance, they are not able to achieve the desired results with micro irrigation in absence of guidance & technical support services.

Despite all these issues, it is reasserted that the skill of the farmer plays a vital role in exploiting the technique of micro irrigation, leading to phenomenal results. Even in the water sufficient areas, there were some competent farmers who had adopted these techniques and were successfully gaining significant benefits with the same. Although the proportion of such farmers is less than 10%, but the potential of micro irrigation in these areas is highly appreciable. The extent of such benefits arising of out expertise of the farmer may be studied through the case study of Mr. Vinod Kumar, a farmer in village Kewalgarhi (Panipat).

Case Study — Mr. Vinod Kumar

Village Kewalgarhi, District Panipat (Haryana)

Mr. Kumar has a total landholding of 18 acres, out of which approximately 16 acres of land is irrigated through micro irrigation for the last three years. Mr. Kumar has installed both, sprinkler and drip systems for cultivating a variety of horticulture crops, such as, bitter gourd, cauliflower, brinjal, tomatoes, cucumber and peas. From April till December, vegetables such as, bitter gourd, cauliflower and cucumber were being cultivated. Bitter gourd and cauliflower were being simultaneously cultivated by Mr. Kumar through intercropping. Mr. Kumar informed that he applied fertigation to the crops through the drip irrigation system. Further, he reported that the drip method yields better quality of farm produce than through conventional methods, only if proper Standard Operating Procedures (SOPs) were followed under micro irrigation.

Bitter Gourd being cultivated through drip

About one hectare of plot was studied and analyzed for comparison of micro and conventional irrigation. The economics of micro irrigation were worked out for the crops cultivated during a year between April to March. If appropriate crops are selected along with intercropping, the results of farming through micro irrigation would be far higher than the conventional methods, as seen from table 6.16 given ahead. An additional income of Rs. 1 lakh per hectare was found in case of bitter gourd, cultivated through micro irrigation. Further, intercropping of cauliflower coupled with added yield of bitter gourd has led to higher sales realization in micro irrigation (Rs. 8.50 lakh), whereas in case of conventional methods it was Rs 6.45 lakh. This has resulted in a considerable increase in the annual returns to Rs. 4.87 lakhs per hectare, which was about 1.5 times higher than the conventional methods (Rs. 2.60 lakhs per hectare). Therefore, one could conclude that if proper crop selection is made along with observance of SOPs, the payback period of drip & sprinkler systems, would be within a year for system which is not more than Rs 1 lakh. A crucial aspect of micro irrigation is that it requires owner's supervision for the carrying out timely and accurate course of actions involved in the irrigation, such as duration & quantity of water supply, quantity of fertilizers applied, etc. A minor negligence in the procedure can adversely affect the quality of the crops. Therefore to ensure good quality of produce, proper technical know-how coupled with regular supervision is required at the fields.

Table-6.16 : Comparison of Returns from Micro-irrigation and Conventional Irrigation				
Inputs			**Cost Rs. per Ha**	
			MI	**Conventional**
Leveling/Bed Preparation			5000	2000
Seeds			8000	8000
Irrigation/Electricity			3600	3600
Human Resource			117000	150000
Fertigation*			25000	15000
Insecticides/Pesticides			12000	13000
Fungicides			12000	13000
Transportation			180000	180000
Total			**362600**	**384600**
Output				
Produce	**Quintals per Ha**	**Rate Rs. Per Quintal**	**Return Rs. per Ha**	
			MI	**Conventional**
Bitter Gourd	400	1000	400000	300000
Cauliflower	70	1500	105000	-
Cucumber	150	1000	150000	150000
Pea	60	1000	195000	195000
Total Sale Value from 1 Hectare Area			**850000**	**645000**
Total Annual Return from 1 Hectare Area			**487400**	**260400**
** There is no subsidy on the fertilizers used in drip irrigation system*				

Importance of Inter-cropping: It would be necessary to recapitulate that the drip irrigation not only improves the yield and quality of agricultural produce, but facilitates intercropping which has provided significant benefits over the farm produce. As discussed above in the case study, intercropping of cauliflower has resulted in an additional income of Rs. 1.05 lakh due to drip irrigation. This has contributed immensely over the annual returns, generating significantly higher profits.

Such benefit of drip irrigation has been reaffirmed by a farmer in the State of Andhra Pradesh, where drip irrigation has facilitated intercropping of cocoa between rows of coconut trees, leading to sustainable farming of coconut fields. In one acre of land about 60 coconut trees were planted, along with intercropping of 200 cocoa plants. As a result the farmer gained an additional income of Rs. 30,000 per acre due to intercropping. Because of drip system it has been possible to plant both these crops together, which would not have been viable through conventional methods, since there is a wide difference in water requirement of these crops.

Thus, the economic analysis has unfolded the enormous potential of micro irrigation as a result of intercropping, which calls for an intensive research work to facilitate large scale adoption of these methods.

Recognizing the varied performance of Micro Irrigation Scheme in the three different areas, it is certain that policies pertaining to micro irrigation cannot be formulated in a generalized manner. The findings suggest that the adoption of micro irrigation across the 10 sample states is largely affected by the area in which it is practiced. Therefore, it is essential to frame policies/strategies which suit the conditions prevailing in each of the three areas. In the '*water scarce areas',* the farmers have received considerable attention about the benefits of micro irrigation, but the technical knowledge about its operation, particularly fertigation/ chemigation is still a cause of concern among these farmers. This necessitates a strong framework of agriculture extension services, to provide guidance and technical support to the farmers. Likewise, in the '*water scarce areas with undulating topography & sandy soils',* emphasis should be on providing agronomic support. Further, in the '*water sufficient areas',* covering lowest proportion of area under the Scheme, calls for greater efforts to popularize the techniques. Although efforts have been made to promote micro irrigation by subsidizing the system, but the need of the hour is to demonstrate exemplary benefits of micro irrigation among the farmers. In view of this, it would be favorable if certain skilled farmers like Mr. Vinod Kumar, are identified by the concerned authorities and provided with public felicitation through awards. Further, such progressive farmers should be given 100% subsidy for setting up demonstration farms. Developing them as key resource persons would allow interaction between the farmers, resulting in spread of knowledge about micro irrigation. These strategies would help in creating awareness regarding the benefits of micro irrigation and would foster its adoption across the farmers.

7. POPULARITY OF MI SCHEME

Popularity of any object in a given geographical area is a relative term which is defined by the extent of its demand in proportion to its usage potential. As such, the popularity of MI systems across the 10 sample states has been estimated in terms of the total area coverage under these systems as against the total area under the regions where these systems have a high potential for adoption due to their higher efficiency and adequacy in comparison to the conventional irrigation systems (Table-7.1).

Against their potential for adoption across the sample states, the MI systems were installed under a number of schemes, including the MI scheme. Out of the 10 sample states, the micro irrigation systems, drip and sprinkler combined, emerged as being the most popular in the State of Andhra Pradesh (50.5%) and the least in the State of Punjab (0.7%). When examined separately, Andhra Pradesh still came out to be the top ranker in terms of the extent of adoption of both drip and sprinkler systems. As against this, the states of Madhya Pradesh, Haryana, Punjab, Odisha and Rajasthan figured at the bottom for drip exhibiting a range of only 1.5% to 2.3% of the actual coverage area against the potential. For sprinkler, the states of Punjab and Madhya Pradesh represented the bottom of the ladder of popularity as the range of the actual coverage area against the potential varied from 0.4% to 2.3% in these states.

Table-7.1 : Potential and Actual Area under MI in Sample States (Area in '000 ha)

States	Drip			Sprinkler			Total		
	Potential	Actual	(%)	Potential	Actual	(%)	Potential	Actual	(%)
Punjab	559	11.7	2.1%	2819	10.5	0.4%	3378	22.2	0.7%
Haryana	398	7.2	1.8%	1992	518.3	26.0%	2390	525.5	22.0%
Madhya Pradesh	1376	20.4	1.5%	5015	117.7	2.3%	6391	138.1	2.2%
Gujarat	1599	169.7	10.6%	1679	136.3	8.1%	3278	306.0	9.3%
Odisha	157	3.6	2.3%	62	23.5	37.9%	219	27.1	12.4%
Andhra Pradesh	730	363.1	49.7%	387	201.0	51.9%	1117	564.1	50.5%
Karnataka	745	177.3	23.8%	697	228.6	32.8%	1442	405.9	28.2%
Chhattisgarh	22	3.7	16.6%	189	59.3	31.4%	211	63.0	29.8%
Rajasthan	727	17.0	2.3%	4931	706.8	14.3%	5658	723.8	12.8%
Maharashtra	1116	482.3	43.2%	1598	214.6	13.4%	2714	696.9	25.7%
All 10 States	**7429**	**1256.0**	**16.90%**	**19369**	**2216.6**	**11.40%**	**26798**	**3472.6**	**13.0%**

Source: http://www.epw.in/review-agriculture/spread-and-economics-micro-irrigation-india-evidence-nine-states.html

The results of the current evaluation study corroborated the findings discussed in the foregone paragraph. Understandably, Andhra Pradesh surfaced as the lead State among all sample states in terms of having the maximum number of beneficiaries under the MI scheme and consequently made headway to reach the pinnacle of implementation occupying the largest area coverage.

Besides the popularity of micro irrigation systems, the popularity of the MI scheme across the 10 sample states was assessed by estimating the extent of awareness regarding the scheme in the farming community, represented by the non-beneficiaries of the scheme. Overall, a little over a quarter (28%) of the non-beneficiaries reported to be aware of the scheme, which represents a fair proportion. Among the states, the level of awareness of the scheme was the highest in Maharashtra, followed by that in Rajasthan and Andhra Pradesh, while it was the least in Odisha.

Table-7.2 : Awareness of MI Scheme among Non-beneficiaries

States	Total No. of Respondents	Aware (%)
Overall	**987**	**28%**
Punjab	90	12%
Haryana	91	17%
Madhya Pradesh	150	16%
Gujarat	90	28%
Odisha	90	9%
Andhra Pradesh	87	38%
Karnataka	90	23%
Chhattisgarh	60	12%
Rajasthan	120	42%
Maharashtra	119	69%

7.1 Factors Affecting Popularity of MI Scheme

There could be several factors affecting the popularity of any Government welfare scheme similar to the MI scheme. Out of the factors which emerged as exercising the most profound influence on popularity, the following three merit special attention —

a) Structure and disposition of the implementing agencies
b) Proactive role played by the State governments
c) Quality of services provided by the registered suppliers of the MI system

i. Structure and disposition of the implementing agencies

The study reflects that there should be a dedicated agency adept at adopting innovative approaches for the implementation of the scheme. Contrary to the finding, only in Andhra Pradesh and Gujarat, were the Special Purpose Vehicles (SPVs) found operational for undertaking the aforesaid implementation. GGRC in Gujarat and APMIP in Andhra Pradesh were SPVs with unique strengths. GGRC harnessed the prowess of IT innovations and

APMIP utilized the wide network of its functionaries so as to reach closest to the potential beneficiaries for achieving an optimal level of implementation.

Andhra Pradesh has surged ahead of Gujarat as it has effectively put across the technology of micro irrigation among its farmers by conducting maximum number of training programmes and seminars, besides enabling the coverage of the largest area under the scheme. The GGRC has though evolved excellent policy frameworks, yet it has not been able to translate that proportionately into the field, probably because of the absence of an extensive network of its functionaries.

Regarding the disposition of the implementing agency, the study revealed an interesting situation in the states of Karnataka and Haryana, where the MI scheme was found being implemented by two different departments — Agriculture and Horticulture. Needless to say, the reporting hierarchies were different across these two departments, and as such, these departments were found to have adopted different subsidy structures for two types of the MI systems— drip and sprinkler. For instance, all the categories of farmers in Haryana were provided subsidies of 90% on drip through the departments of horticulture and agriculture. However, the subsidy on sprinkler was to the tune of 50% through the department of agriculture and 90% through the department of horticulture. Though such a difference might not be without any rationale, yet it would be desirable to have a uniform subsidy structure under the scheme to avoid any confusion among the potential beneficiaries, thereby preventing the popularity of the scheme from being diminished.

ii. Proactive role of the State

On comparing the pattern of assistance in different states, it is noteworthy to comment that some of the sample states have taken extra efforts to popularize the scheme. The additional subsidy pattern in the sample states can be seen from the table given ahead —

Table-7.3 : Additional Subsidy provided by States under MI Scheme

States	Type of Beneficiary	State Share	States' Additional Share	Beneficiary's Share
Punjab	All Farmers	35%	25%	25%
Haryana	All Farmers - Horticulture Dept. (in case of Drip only)	50%	40%	10%
Madhya Pradesh	Small & Marginal Farmers - SC/ST	30%	20%	30%
	Small & Marginal Farmers - General	20%	10%	40%
Chhattisgarh	Small & Marginal Farmers - SC/ST	30%	20%	30%
	Small & Marginal Farmers - General	20%	10%	40%

Table-7.3 : Additional Subsidy provided by States under MI Scheme				
States	**Type of Beneficiary**	**State Share**	**States' Additional Share**	**Beneficiary's Share**
Karnataka	Small & Marginal Farmers	40%	30%	20%
Odisha	All Farmers	30%	20%	30%
Maharashtra	Only to SC/ST	20%	10%	40%
Gujarat	Only ST	35%	25%	25%
Rajasthan	All Farmers (in case of Drip only)	30%	20%	30%
Andhra Pradesh	SC/ST Farmers (up to Rs. 1 Lakh)	60%	50%	0%
	Small & Marginal Farmers (up to Rs. 1 Lakh)*	50%	40%	10%
	Medium Farmers (up to Rs. 1 Lakh)*	35%	25%	25%
	Big Farmers (up to Rs. 1 Lakh)*	20%	10%	40%

***Andhra Pradesh — State specific criterion for Farmer Category**

- SC/ST Small & Marginal Farmers (up to 5 acres dry/ 2.5acres wet)
- Small & Marginal Farmers other than SC(up to 5 acres dry/ 2.5acres wet)
- Medium Farmers (above 5 acres dry/ 2.5acres wet up to 10 acres dry/ 5 acres wet)
- Big Farmers (above10 acres dry/ 5 acres wet)

In Andhra Pradesh, the SC/ST farmers belonging to marginal & small category are provided with 100% subsidy, which is shared in the ratio of 40:60 by the Central and the State government, respectively. In case of small and marginal farmers, other than those belonging to SC/ST, the proportion of subsidy is 90% and it is shared in the ratio of 40:50 between the Central and State Governments. In case of medium and big farmers, the total amount of subsidy is 75% and 60%, respectively.

In Gujarat state, the total subsidy available for purchasing drip and sprinkler irrigation systems in the State is 50% for the general and SC categories of the farmers, 75% for the farmers belonging to ST and 100% for setting up the demonstration farms for all categories of farmers. A provision has been made by the State Government to enhance subsidy for the ST category of farmers and for those setting up the demonstration farms with a view to broadening the scope and coverage of the scheme based on the local conditions. Further, in contrast to the scheme's guidelines, which permit the release of subsidy only for a maximum area of 5 hectares, the beneficiary farmers in the State are provided subsidy even on lands which are greater than 5 hectares. This subsidy is borne entirely by the State Government from its own resources.

In the states of Madhya Pradesh and Chhattisgarh, the Government, in its endeavour to promote adoption of MI Scheme by farmers, has taken an initiative to provide 20% additional subsidy to the small and marginal farmers belonging to the SC/ST categories and 10% to the general category with landholdings up to 2 ha. Moreover, in Karnataka, an assistance of 80% is provided under drip and sprinkler system for the landholdings up to 2 ha.

To promote drip irrigation the State government in Rajasthan has taken an initiative to provide 20% additional subsidy for the purchase of drip system of irrigation under the MI Scheme. In Haryana, the subsidy available for purchasing MI systems in the State is 90% for the horticulture crops.

In Punjab, the total amount of subsidy made available to the beneficiary farmers is 75%, as the State Government has supplemented the 10% subsidy with another 25% from NABARD - Rural Infrastructure Development Fund (RIDF), thereby taking its share to 35% as against the Central Government's share of 40%.

The upper limit on coverage area for being eligible for subsidy was 5 ha across most of the states, while it was 2 ha for drip and 1 ha for sprinkler in Andhra Pradesh for state's additional subsidy, 2 ha for both drip and sprinkler in Karnataka, and none in Gujarat. Further, the lower limit on coverage area was found to have been the same (0.4 ha) as prescribed in the micro irrigation scheme guidelines across all the states barring Andhra Pradesh and Karnataka. In Karnataka, the State government has reduced the lower area limits to 0.2 ha both for drip and sprinkler.

Further, for generating awareness on the efficacy of micro-irrigation technology through the establishment of demonstration farms, the State Government has appended the subsidy of 75% with another 10% from its own resources, thereby taking the total proportion of subsidy to 85%.

Realizing the importance for economic use of water for irrigation, these states have taken initiatives to promote the Scheme. In addition to undertaking the above roles, the SMIC in Madhya Pradesh has taken special initiatives for the convergence of the MI scheme with other development programs, like, District Poverty Initiative Project (DPIP), etc., under which entire beneficiary share is met from the State Government resources.

Besides, with the formation of National Mission on Micro Irrigation (NMMI), the GoI has increased its own share of subsidy to 50%, from the year 2010-11 onwards, for the small & marginal farmers who own less than 2 ha of agricultural lands.

iii. Quality of services provided by the registered suppliers of the MI system

Although it is more than six years since the scheme has been implemented, yet nearly half the beneficiaries have reported facing no problem in the operation & maintenance of the installed MI systems till the time of collection of data. The remaining half of the beneficiaries, who faced a problem with regard to the installed systems, nearly three-fifth (56%) emerged as being satisfied with the services received from the registered suppliers of the MI systems. It is therefore amply clear that the states have taken due care to ensure quality services from the suppliers thereby aiding the popularity of micro irrigation systems in general and MI scheme in particular.

8. Major Constraints and Suggestions from Official Stakeholders

8.1 Major Constraints

A) Functionaries of Implementing Agency

During the in-depth interviews, the official stakeholders and the beneficiary farmers have reported facing a number of constraints that hamper the smooth implementation of the MI scheme. The major constraints faced by the official stakeholders at different levels of the scheme implementation are as follows—

1. Fragmented Landholdings

It is only seldom that a farmer has all his lands in a continuous stretch at a single place. Instead, his landholdings are divided into many smaller fragments which are located at considerable distances from each other. In such cases, the beneficiary farmers are left with no other choice than to install separate MI units for each fragment of land but not without significantly escalating the overall cost of the system. This cost escalation acts as a deterrent for the adoption of such systems by the farmers in almost all the states across the country.

2. Large Number of Resource Poor Farmers

According to the officials in many states, the proportion of resource poor farmers having marginal landholdings is quite large. Such farmers are usually not adequately equipped to bear the high initial investments for adopting the micro irrigation technologies. On account of such a sizeable chunk of farmers being left out of the ambit of the scheme due to their being unable to afford even their own share of the costs after the subsidies, the adoption of MI systems remains largely limited to those few who have the resources to afford them.

3. Lack of Awareness regarding water conservation among the farming community

The lack of awareness with regard to the conservation of water among the farming community at large, irrespective of being tribal or non-tribal, has been cited as one of the major reasons for the moderate level of popularity of MI Scheme in many states, including those of Punjab and Chhattisgarh.

4. Lack of Proper Forward Planning at the State Level

Across some sample states (Rajasthan, Gujarat, MP, Karnataka, etc.), the officials have cited limited availability of funds, and annual targets being lower than the actual demands for the MI systems, as the major reasons for having a sizeable waiting list of subsidy applicants. Considering that the State as well as Central funds are released as per the targets identified in the Annual Plans forwarded by the implementing agencies, and that the process of fixing of targets for the subsequent years is a subject of the State level implementing agencies, it may be inferred that the planning process in many states does not reflect the actual ground level demand for the MI systems. This not only results in inordinate delays but also in reducing the overall popularity of the scheme.

5. Mismatch of Timing in the Release of Central & State share of Subsidy Funds

The mismatch of timings in the release of Central and the State shares has also been cited as one of the major constraints that results in delay in the disbursement of subsidies by the district level officials in the states of Punjab, MP and Karnataka.

6. Lack of Qualified/Trained Field Staff

The lack of qualified and adequately trained field staff has been cited as a major constraint by the official stakeholders in almost all the states. Further, the officials in Odisha have even mentioned that the lack of adequately trained personnel is a critical constraint with System Manufacturers too, which causes delays in the installations of MI systems at the farms of the beneficiaries.

7. Lack of agronomic support

As the MI scheme focuses on the horticultural crops and other high value cash crops, the lack of agronomical support services to the beneficiaries de-motivates them from adopting the MI systems. However, only a few of the sample states, including Gujarat and Punjab, have provisions for the agronomic support services to be extended to the beneficiary farmers.

Apart from those discussed above, the official stakeholders have also cited other State specific constraints, like—

- **Limitation of 5 hectares for subsidy**

In the State of Haryana, the proportion of such farmers who have large landholdings and who can easily afford bore-wells/tube-wells is quite high. However, given that the prime focus of the MI scheme is to conserve the underground water resources

from being over-exploited, the maximum limit of 5 hectares area for the grant of subsidy leaves out such bigger farmers from the ambit. Thus, it is no surprise that some official stakeholders in the State have explicitly pointed towards this area limit as one of the constraints in the implementation of MI Scheme.

- **Limited Presence of Suppliers in Some Districts**

In Odisha, some districts, like Koraput, Mayurbhanj, Keonjhar etc., do not have adequate presence of the registered suppliers. Consequently, owing to the lack of options in obtaining satisfactory after-sales-service among the beneficiaries, the popularity of MI scheme remains highly constrained in such districts. According to the Assistant Agricultural Engineer at the Directorate of Horticulture in Odisha—

> *"……In such districts, the MI Scheme is at the mercy of the sole manufacturer….."*

B) Beneficiaries' Perspective

Besides the officials, the beneficiaries were also asked regarding major constraints or shortcomings of the centrally sponsored micro irrigation scheme. Their views regarding the same are summarised below —

- More than half (56%) of the beneficiaries did not report any constraint or shortcoming in the scheme.
- About one-eighth (13%) reported regarding the poor quality of parts like pipe, nozzle, washer, etc. The highest proportion (40%) of beneficiaries with complaints of quality was found in the state of Rajasthan followed by Gujarat (20%), Punjab (15%), MP (12%), Chhattisgarh (11%) and Haryana (8%). The proportion of farmers with complaint regarding quality was reportedly less in the other states. However, district Alwar of Rajasthan presented an extreme scenario in this regard, where, more than two-third (70%) beneficiaries reported for poor quality of system components.
- Slightly more than one-tenth (12%) of the farmers reported about the lack of awareness about the scheme. The lack of knowledge was reportedly inclusive of the representatives of dealers and the functionaries of the Implementing Agency. This shortcoming was mainly reported by the farmers of Andhra Pradesh (45%), Maharashtra (38%) and Odisha (29%). The proportion of the farmers reporting this shortcoming was alarmingly high in certain districts, namely – district Amarawati of Maharashtra (93%), district Warangal (83%) & Kurnool (52%) of Andhra Pradesh and district Angul (67%) & Sonepur (46%) of Odisha.

- Expectedly more than one-tenth (11%) of the beneficiaries reported about high cost of micro-irrigation systems or less amount of subsidy.
- A small proportion (4%) of farmers reported their displeasure on high dependency on dealers or the officials of the implementing agency. This shortcoming was having significant proportion in Maharashtra (38%) and Odisha (7%).

8.2 Suggestions for improving the Micro-irrigation Scheme

A) Functionaries of the Implementing Agency

The successful running of any scheme necessitates concurrent monitoring and midterm corrections. To elicit suggestions for bringing about an overall improvement in the implementation of MI scheme, the official stakeholders were thoroughly probed. During these in-depth interviews, the suggestions forwarded by the State, district and block level official stakeholders were as follows—

- **Greater Subsidy on Drip:** The official stakeholders in the State of Gujarat and Chhattisgarh have suggested that the proportion of subsidy on the purchase of drip irrigation system should be higher as the initial investment on drip is significantly higher than that on the sprinkler irrigation system.

- **Special Purpose Vehicle (SPV) for Micro Irrigation:** The officials from the states of Maharashtra and Karnataka have spelt out the need for a Special Purpose Vehicle (SPV) similar to the one in Gujarat or Andhra Pradesh for catering to the promotion of micro irrigation in their respective states.

- **Greater Monitoring:** The official stakeholders in the State of Karnataka have indicated the need for monitoring by engaging a third-party agency for carrying out inspections of all of the micro irrigation systems installed under the scheme.

- **Inclusion of Other Cash Crops under MI Scheme**: The direct consequences of greater area coverage in the State of Andhra Pradesh are visible in the suggestion forwarded by the APMIP officials. These officials have advocated the inclusion of fodder crops and forest based non-food plantation crops to boost the related sectors.

- **Additional Funds for IEC :** The officials in the State of Chhattisgarh have pointed out towards the need for additional funds for spreading awareness of MI scheme in the State. This can be appreciated in the wake of the non-availability of any earmarked funding in the scheme for the Information, Education and Communication (IEC).

- **Allowing Subsidy to a Beneficiary Again After 5 Years :** The officials in the states of Haryana and Punjab have mentioned that the MI systems being distributed under the scheme do not last for full 10 years, due to which the beneficiaries have to either wait for another couple of years before they get eligible for further round of subsidy or quit using micro irrigation altogether. In view of such a problem, these officials have suggested decreasing the duration for the re-eligibility for subsidy from the present 10 years to 5 years.

- **Adequate & Timely Allocation of Subsidy Grant:** As per the district-level official stakeholders, the insufficient funds allocation as well as the lag between the receipt of the Central and the State funds need to be sorted out in order to allow the smooth implementation of the scheme.

- **Standardization of uniform rates for MI Systems & Accessories :** In many of the states the MI systems of different brands are having different price structures. As such, many officials have pointed out towards the need for a uniform price policy through regular annual price reviews.

- **Up-scaling Orientation Training on Operations & Maintenance:** Majority of the district and block functionaries have suggested for enhanced capacity-building of both the beneficiaries and the official stakeholders on the operation and maintenance of MI systems.

  Apart from these suggestions forwarded by the official stakeholders, some have also been suggested by the beneficiaries. The suggestions from such beneficiaries are as follows—

- **Awareness Generation on MI Scheme and Technology :** About a half (48%) of the beneficiaries have suggested that there should be a greater emphasis on the awareness generation component of the scheme.

- **Provision for Additional Subsidy:** Subsidy being an incentive and a motivational factor for a large proportion of resource poor and marginal farmers, over a

quarter (29%) of the beneficiaries have suggested a revision in the minimum subsidy structure from the present 50% to at least 90%.

- **Provision of a Comprehensive Training for Operation & Maintenance of MI Systems :** Currently, the onus for providing orientation training lies with the registered suppliers. However, often a brief orientation training session fails to adequately equip the beneficiaries with proper information on all the aspects of the operation & maintenance of MI systems. Thus, over one-tenth (13.1%) of them have pointed out towards the need for a comprehensive training to be imparted by the registered suppliers covering all aspects of operating and maintenance of the micro irrigation systems. In this regard, they have specifically mentioned that such trainings should be provided through trained individuals.

- **Improvement in Quality of Pipes of the MI systems:** Frequent damage of the pipes is experienced by farmers, mainly due to weather vagaries as piped networks are often exposed to scorching sunlight & precipitation and excess physical stress arising out of extra water pressure inside them. As a remedy to the aforementioned problem, around 5.4% of the respondents demanded supply of better quality pipes under the scheme. These farmers also suggested that a shift to the sub-surface installations could be thought of as an alternative to the currently used system.

- **Providing Free Electricity Connection:** Benefits under the scheme are achievable only with an assured supply of electricity that is required to draw water from the tanks/wells. However, in its absence during the critical growth stages, yield as well as yield-quality takes a beating. As such, few beneficiaries have suggested the provision of free electricity connection within the scheme.

B) Beneficiaries' Perspective

The farmers' perspective and suggestions are most important for the successful running of the scheme and necessitates in-depth consideration. The important suggestions gathered from the beneficiaries are presented ahead —

- **Strengthening of awareness drives, training and establishment of demonstration farms:** An overwhelming majority (61%) of beneficiaries strongly demanded increased awareness and capacity building through training and demonstration. The proportion of farmers demanding for impetus to awareness

and capacity building drives was highest in Haryana (84%) and lowest in Odisha (45%), indicating a inevitable need of such programmes all across the country.

- **Increase in subsidy and or subsidy to be given to the farmers:** Considering the high cost of MI System, demand for increase in subsidy was most expected. Nearly one-third (32%) of the beneficiaries put forward the suggestion of increased subsidy. The farmers were also suggestive of the subsidy amount to be routed through them for decreasing the dependence on the dealers.
- **Better Quality Control:** A small proportion (4%) of the farmers suggested for exercising better control on the quality of the components of the micro-irrigation systems. The state of Punjab had the highest proportion (15%) of such farmers.
- **Electric Connection along with MI System:** Another 4% of the beneficiaries suggested that electric connection should be provided with the sanctioning of the MI System for smooth functioning of the scheme. The proportion of farmers for this suggestion was highest in Punjab (18%).
- **Complete Supply of material:** A miniscule proportion (3%) suggested that all the components of the MI System should be supplied. The highest proportion (25%) of such beneficiaries was reported from Andhra Pradesh followed by Odisha (9%). On further probe, the farmers of AP were found to be mainly referring to the attachments for fertigation and chemigation, whereas, in case of Odisha, it was the components of the MI System. An immediate attention is required on this aspect in Odisha.

9. KEY FINDINGS & RECOMMENDATIONS

The various initiatives taken by the Central Government and the State Governments regarding the use of micro irrigation in Horticulture and Agriculture have shown positive results and benefited a large number of farmers in many ways. Nonetheless, there are certain gaps that need to be addressed in order to bring about further improvements. The findings and recommendations derived from the study are to be viewed in this context.

9.1 Key Findings

- The economic analysis of micro irrigation has revealed an important aspect that generalization need to be avoided while formulation strategies and policies pertaining to Micro-irrigation. Although the technique is suitable for all kind of lands, but its adoption varied from region to region, depending upon its natural endowments. The wide variation across the sample States was predominant in three areas/zones, namely, water scarce areas, water scarce areas with undulating topography & sandy soils and water sufficient areas. **The classification of States was done by identifying the maximum number of the sample districts within a State, which aptly represents one of the 3 zones.**

- Overall, four states (Andhra Pradesh, Gujarat, Karnataka and Maharashtra) belonging to the 'water scarce areas' recorded relatively higher area coverage under both the drip and sprinkler irrigation systems than the other sample states. The findings suggest that the technique was highly acceptable in areas experiencing chronic water deficit and over exploitation of groundwater.

- The popularity of the micro-irrigation was very high in Zone II (water scarce areas with undulating topography & sandy soils), where the topography and soil-characteristics restrict the use of conventional irrigation systems. Rajasthan recorded highest area coverage under the sprinkler irrigation system, because of which the overall ranking of the State, in terms of the total area coverage under both drip and sprinkler systems, improved remarkably and stood at the fourth position among the sample states. Haryana, too, has covered a significant proportion (21681 ha) under sprinkler systems, but in the other Micro Irrigation Schemes. Therefore, looking at the combined performance of

Haryana across all MI Schemes, the overall ranking shows marked increase in areas coverage.

- As regards the water sufficient areas, comprising of Punjab, Odisha, Chhattisgarh and Madhya Pradesh, the area coverage under the Scheme was found to be very low. This justifies that adequate availability of irrigation supplies with free or flat rate of electricity tariff impedes the use of modern techniques in these areas.

- Regarding proportion of drip irrigation under MI Scheme, Andhra Pradesh stands highest by covering 38% area (cumulative of area covered under drip in all 10 States), followed by Maharashtra (28%), Gujarat (13%) and Karnataka (12%). These 4 States covered more than nine-tenth of the total area across 10 States, under drip irrigation system. Chhattisgarh (0.4%), Odisha (0.7%), Haryana (1%), Punjab (1.3%), Rajasthan (2%) and Madhya Pradesh (4%) emerged as the states covering insignificant proportions under the MI scheme.

- Only the states of Punjab and Andhra Pradesh were found to have prepared the five-year Perspective Plans for next 5 years.

- Amongst the different models of Implementing Agencies across the ten sample states, it is noteworthy that Andhra Pradesh presents a replicable model in terms of achieving physical and financial targets. The State occupies one-fourth of the total area (cumulative of the ten states) covered under the Micro Irrigation Scheme.

- Amongst the sample states, Gujarat has evolved a replicable model of a multi-stage, multi-level monitoring process. This included a third-party audit of the installed MI systems, an overall appraisal of the performance of the third-party agencies involved in the said audits by the State Agricultural Universities, and an assessment of the quality of the manufactured MI components at the factory sites themselves. Besides, the State has appointed the Agricultural Finance Corporation (AFC) to carry out the concurrent monitoring & evaluation of the scheme.

- Overall, hardly one-tenth of the beneficiaries affirmed to have received some training. Excepting Andhra Pradesh, where 61% beneficiaries affirmed to receive training, the other states were found to be lagging behind in this regard.

- Only about one-fifth of the beneficiaries recalled that they had received the maintenance manuals. Out of these beneficiaries, only 11% affirmed that they had read and comprehended these manuals.

- Only a miniscule proportion of the beneficiaries recalled that they had seen a demonstration farm.

- Only 4700 hectares area was found covered under the demonstration farms across all the sample states, of which Andhra Pradesh alone accounted for over four-fifths.

- Regarding after-sales & maintenance services, nearly half the beneficiaries were yet to face any problem in their installed systems.

- Nearly three-fifths of the beneficiaries who faced a problem were satisfied with the quality of the after-sales & maintenance services received from the registered suppliers. Those not satisfied, cited the lack of quality services as the major reason for their dissatisfaction.

- Overall, a little over a quarter of the non-beneficiaries reported to be aware of the scheme, which represents a fair proportion. Among the states, the level of awareness of the scheme was the highest in Maharashtra, followed by that in Rajasthan and Andhra Pradesh, while it was the least in Odisha.

- Observation from other farmers' farms had the greatest impact on the awareness regarding the MI scheme as half the beneficiaries and over two-thirds of the non-beneficiaries attributed their awareness to it alone.

- Andhra Pradesh and Gujarat were found to have evolved a Special Purpose Vehicle (SPV) each for the implementation of the scheme. It emerged that the creation of SPVs had led to an improved performance in these two states.

- The lack of coherence between different departments involved in implementation in the State was found to have adversely affected the outcome of the scheme, as observed in Karnataka and Haryana.

- Most of the states have taken efforts to popularize the scheme by increasing the state's share of the subsidy.

- The proportion of the total irrigated area among the beneficiaries increased by more than one-tenth following the adoption of the MI systems

- The states of Haryana and Rajasthan, where large proportions of arid and semi-arid areas have saline aquifers, had the highest proportions (about 10%) of beneficiaries affirming the use of saline water for irrigation through their micro irrigation systems.

- Overall, an overwhelming majority of the beneficiaries reported their net returns from crops irrigated with MI systems as better in comparison to that earned before adopting the MI systems.

- The adoption of micro irrigation systems significantly reduced the farm labour requirements by over a quarter, particularly during the application of irrigation and weeding. Nearly cent-per-cent of the beneficiaries reported a significant reduction in the occurrence of weeds on their farms irrigated with the micro irrigation systems.

- Only about one-fourth of the sample beneficiaries were applying fertigation/chemigation to their crops through their MI systems. The proportion of such beneficiaries was the highest (74%) in Maharashtra, followed by Andhra Pradesh (52%) and Gujarat (26%), while no beneficiary farmer was applying fertigation/chemigation in the states of Chhattisgarh, Orissa and Karnataka.

- Among the beneficiaries who were applying fertigation/chemigation through MI systems, the consumption rate of fertilizer declined significantly by an overall average of 24% after the adoption of MI systems.

- Among those beneficiaries, who were applying insecticides/pesticides with their micro irrigation systems, the average consumption of insecticides/pesticides recorded a decline of 18%.

- A substantial reduction in electricity consumption was observed among the sample farmers practicing micro irrigation techniques, especially with the drip methods. On an average, annual savings in electricity was found to be 370 kWh/ha for the sample farmers practicing drip irrigation. Whereas, reduction in electricity consumption was about 198 kWh/ha from sprinkler irrigation.

- The economic analysis of micro irrigation has revealed that drip & sprinkler methods have generated additional income among the sample farmers. The drip method has proved to be the most efficient mode of irrigation in the water scarce areas, providing additional annual income which was more than one lakh per hectare in case chilly cultivated by sample farmers. Similarly, sprinkler methods provided an additional income of nearly 60, 000 per hectare for the farmers growing garlic.

- The rate of return from drip irrigation was observed to be in the range of 48% to 153%. While, the rate of return from sprinkler irrigation varied from 44% to 144%. Understandably, the minimum payback period was found to be less than 1 year and the maximum duration spread over a period of 2 to 3 years in both drip & sprinkler methods.

- The study of micro irrigation has revealed a very crucial factor that individuals' skill has an enormous effect over its success, as seen from the case studies of Mr. Shekhar Reddy and Mr. Vinod Kumar.

- The returns from intercropping were best seen with the drip method which has brought about significant benefits to the farmers in terms of high annual returns.

9.2 Recommendations

A) Overarching

- Recognizing the varied performance of Micro Irrigation Scheme in the three different areas, it is certain that policies pertaining to micro irrigation cannot be formulated in a generalized manner. Therefore, it is essential to frame strategies and policies which suit the conditions prevailing in that area.

- The compilation of baseline data/feasibility studies and subsequent preparation of 5-year perspective plans should be made mandatory for every State.

- It is advisable that the implementation of the scheme should be taken up by only one department/agency within a State for better results. The success of Special Purpose Vehicle (SPV) for Micro Irrigation in the states of Andhra Pradesh and Gujarat calls for replication in other states.

- A stricter monitoring of the services being offered by the registered suppliers, aimed at ensuring good quality training on operation & maintenance of the MI

system and the provision of maintenance manual for the beneficiaries, is strongly recommended. The systematic monitoring mechanism developed by the implementing agency in Gujarat should be studied by other states for apt adoption.

- Research institutes (ICAR & SAU) should be funded for developing suitable models of intercropping, especially for drip irrigation by undertaking an intensive research work.
- In the water scarce areas, the initial efforts rolled by the GoI & State Governments has already popularized micro irrigation, but all out efforts are required to increase technical know-how regarding use of drip irrigation especially fertigation/chemigation among the beneficiaries, through a strong framework of agriculture extension services.
- Considering the benefits of water soluble fertilizers, a subsidy scheme should be introduced to increase its usage. Possibility of dove tailing with Nutrient Based Subsidy (NBS) Scheme for Fertilizers should be explored.
- In the '*water scarce areas with undulating topography & sandy soils',* emphasis should be on providing agronomic support.
- The '*water sufficient areas',* covering lowest proportion of area under the Scheme, calls for greater efforts to popularize the techniques, which are to be viewed in this context —
  - It would be favorable if exemplary benefits of skilled farmers, like, Mr. Vinod Kumar are identified by the concerned authorities and provided with public felicitation through awards. Such farmers should be regularly exposed to the other farmers of the surrounding areas.
  - The number of demonstration farms should be increased, wherein, priority should be given to the progressive farmers with proven technical competence by giving them 100% subsidy for setting up demonstration farms.
  - A massive drive is required to increase the number of training programmes as also the inclusion of farmers into them. The skilled farmers should be developed as key resource persons, which would allow interaction between the farmers.

A) State Specific

During the in-depth interviews with the official stakeholders and the beneficiary farmers, certain state or district specific issues emerged. Accordingly, the recommendations in such cases may not be applicable all across the country. Therefore, such issues were analysed separately as summarised ahead —

Andhra Pradesh

- The micro-irrigation was found to be most popular in Andhra Pradesh in terms of the area coverage. It had high proportion of the farmers, who had availed the after sales service and were dissatisfied with it. The cause of concern was poor quality of service. Considering a high proportion of the farmers opting for micro-irrigation in the State, issue needs to be attended by the State Government so that it does not affect the popularity of the scheme.
- It was noteworthy that more than two-fifth of the beneficiaries complained of cumbersome application process in the Warangal district. The State Government may like to address the problems raised by the farmers.
- The lack of knowledge on the part of the representatives of the dealers and the functionaries of Implementing Agency was highlighted by the beneficiaries of districts Warangal (83%) and Kurnool (52%). Training Needs Assessment must be required before initiating a capacity building programme.

Gujarat

- The progress of Gujarat in propagating micro-irrigation is praiseworthy. However, the cause of concern was poor quality of service, which was raised by more than one-fourth of the beneficiaries of districts Porbandar and Junagarh. Considering a high proportion of the farmers opting for micro-irrigation in the State, issue needs to be attended by the State Government at the earliest so that degree of popularity is not hampered.
- The State of Gujarat showed poor performance in providing trainings, demonstration farms and other capacity building activities. The State Government needs to undertake concerted efforts and give fresh impetus to this aspect.

Karnataka

- It would be advisable to make only one office as nodal agency for taking up all the projects related to micro-irrigation. The involvement of two departments often leads to slow progress.
- The State is lagging behind grossly on the front of capacity building. No beneficiary remembered to have seen a demonstration farm. Only 2 % of the beneficiaries reported to have received the instruction manual along with the MI System. The State Government needs to devise a systematic programme for capacity building and exercise a strong vigil and monitoring on the supplies.
- A significant proportion of the beneficiary farmers complained of poor quality after sale service. The issue needs to be looked into by introducing an apt procedure for the quality control.

Maharashtra

- The status of training & capacity building is also pathetic in the State of Maharashtra. Only 3 % of the beneficiaries reported to have received the instruction manual along with the MI System.
- Only 2 out of 8 block level beneficiaries affirmed to have received training. Corroborating this fact, a huge proportion (38%) reported for poor knowledge on the part of representatives of dealers and the functionaries of the implementing agency. It was noteworthy that this proportion was 93% in district Amarawati, necessitating an immediate action by State Government in this regard.
- An overwhelming majority (87%) in the State was dissatisfied with the after sales service. All the beneficiaries, who were dissatisfied with it, complained of poor quality of service. Obviously, an integrated effort was needed to exercise an effective control over the quality of the after sales service.

Rajasthan

- More than two-fifth of the beneficiaries in the Bikaner district reported the cumbersome process of application for the scheme. Micro-irrigation becomes a lifeline in areas like Bikaner which has undulating topography and sandy soil. Considering the popularity in the area, it is imperative that State Government immediately addresses this issue.
- The quality of system and the components is the basic requirement for promoting the popularity of the scheme. In district Alwar, more than two-third

of the beneficiaries reported for poor quality of the components. This immediately necessitates an attention by the State Government.

- In-spite of the fact that State of Rajasthan has offered a higher subsidy on drip irrigation equipment, the extension of drip irrigation was found to be lacking in the State. A fresh impetus is needed on this aspect.

Haryana

- It is strongly suggested to make one office as nodal agency for taking up all the projects related to micro-irrigation. The involvement of 2 departments often leads to confusion and consequent slow progress. The reduced annual budget of the State for Centrally Sponsored Micro-irrigation Scheme is a burning example in this regard.
- The State of Haryana is offering subsidy up to 90% for promoting drip irrigation in the State. However, the desired results are yet to be achieved. A change in the strategy may work by introducing demonstration farms. The case studies of Mr. Vinod Kumar and the likes may be studied in depth. Such farmers are needed to be associated for the extension of the MI Scheme. The exposure visits of the progressive farmers to such farms might bring in the desired results.

Odisha

- Odisha was found lacking in providing training & capacity building. Only 1 out of six block level functionaries was found to have attended any training programme. State Government may like to address this issue.
- The officials were complaining regarding the non-availability of suppliers/ dealers leading to exploitation of farmers. Further, a significant proportion of the beneficiaries in the districts Angul (67%) and Sonepur (46%) reported lack of knowledge on part of the representatives of dealers and the functionaries of the implementing agency. The State Government may like to look into the matter.
- Another frequent complaint, which was mainly Odisha specific, was about incomplete delivery of the system components. This issue was found relatively more prevalent in the districts of Ganjam and Angul. The issue is related to the paucity of dealers. A fresh impetus to the promotion of scheme was needed for breaking this vicious cycle.

Madhya Pradesh

- The State of Madhya Pradesh was found lacking grossly in terms of providing training and capacity building support. Only 1 out of 5 district official reported to have received any training. Again, none of the beneficiaries reported to have seen any demonstration farm and only insignificant proportion reported to have received the maintenance manual. Surprisingly, the training programmes run by PFDC were also found comparatively wanting. An immediate attention of the State Government is needed on this aspect.
- The proportion of drip irrigation was also much below the desired level. A dedicated effort on part of the State Government is needed to improve the micro-irrigation in general and drip irrigation in particular along with technical support for use of fertigation/chemigation through drip irrigation.

Chhattisgarh

- Like the parent State MP, the State of Chhattisgarh was also found grossly lacking on the issues of training & capacity building. None of the officials at the district level and 3 out of 4 of them at the block level reported having received any training. Further, none of the beneficiaries reported to have seen the demonstration farm. An immediate attention on part of the State Government is needed in this regard.
- Similar to Madhya Pradesh, the State has performed poorly in promoting drip irrigation. None of the farmers reported to have used fertigation/chemigation through the Micro-irrigation. A dedicated effort on part of State Government is needed to improve the micro-irrigation in general and drip irrigation in particular along with technical support for use of fertigation/chemigation through drip irrigation.
- The State Government may assess the technical competence of the implementing agency to handle the scheme like Micro-irrigation, which needs specialized knowledge base for proper implementation.

Punjab

- The State of Punjab is one of the most blessed states with regard to water endowment. However, the highest irrigation intensity and misuse of ground water resource have brought forward a frightening picture of the future if proper mitigation measures are not taken up right now. The most appropriate answer lies in the promotion of micro-irrigation techniques all across the State. A fresh initiative on part of the State government is therefore required.
- It is understood that in view of abundance of water and free & flat electricity tariff, it would be difficult to promote a new technique demanding additional investment. However, the case study of Mr. Vinod Kumar, who represents a water rich area, needs to be understood and publicized. The amount of return he is getting as compared to other farmers is an eye- opener. The area is in Haryana, an adjoining State. Such farmers are needed to be involved in the promotion programmes. The farmers of the State of Punjab are quite enlightened and proper propagation of the ground realities like the ones involving Mr. Vinod Kumar would certainly make farmers better convinced. Further, exposure visits of progressive farmers to such farms will bring in the desired impact sooner than expected.

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COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Chilly (Annexe No. 1)

Mr. P. Sampat Rao (Village Rangapuram, District Warangal, AP)

Returns from Micro-irrigation (Field Area 1.6 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	106626	136700
Irrigation/Electricity	360	360
Pesticides/Insecticides	20000	20000
Fertilizer	19400	24800
Seeds	12000	12000
Other costs	70000	40000
Total	**228386**	**233860**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**160000**	
Depreciation @ 10%	16000	
Interest @ 10%	16000	
Repair & Maintenance @ 2%	3200	
Total Annual Expenses towards MI System	**35200**	
Total Annual Expenditure	**263586**	**233860**
Output	**MI**	**Conventional**
Chilly		
Yield	120	80
Rate	6000	6000
Income in Rupees	720000	480000
Savings (Income-Input)	491614	246140
Additional Benefit due to MI	245474	
Rate of Return %	153	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	2.73	2.05

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Turmeric, Cotton & Corn (Annexe No. 1)

Mr. Addepeer Anna (Village Shyampeth, District Warangal, AP)

Returns from Micro-irrigation (Field Area 2.8 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	83772	107400
Irrigation/Electricity	320	320
Pesticides/Insecticides	17000	17000
Fertilizer	34950	34950
Seeds	14600	14600
Other costs	31240	22240
Total	**181882**	**196510**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	138000	
Depreciation @ 10%	13800	
Interest @ 10%	13800	
Repair & Maintenance @ 2%	2760	
Total Annual Expenses towards MI System	30360	
Total Annual Expenditure	**212242**	**196510**
Output	**MI**	**Conventional**
Turmeric		
Yield	75	60
Rate	4000	4000
Income in Rupees	300000	240000
Cotton		
Yield	55	27
Rate	4000	4000
Income in Rupees	220000	108000
Corn		
Yield	80	60
Rate	1200	1200
Income in Rupees	96000	72000
Total Income from 3 Crops	616000	420000
Savings (Income-Input)	403758	223490
Additional Benefit due to MI	180268	
Rate of Return %	131	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	2.90	2.14

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Chilly & Cotton (Annexe No. 1)

Mr. Shripati Shankraiyya (Village Laxmipuram, District Warangal, AP)

Returns from Micro-irrigation (Field Area 0.8 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	53207	69100
Irrigation/Electricity	240	240
Pesticides/Insecticides	11500	11500
Fertilizer	12600	13800
Seeds	4000	4000
Other costs	19000	15000
Total	**100547**	**113640**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	47233	
Depreciation @ 10%	4723	
Interest @ 10%	4723	
Repair & Maintenance @ 2%	945	
Total Annual Expenses towards MI System	10391	
Total Annual Expenditure	**110938**	**113640**
Output	**MI**	**Conventional**
Chilly		
Yield	38	30
Rate	6000	6000
Income in Rupees	228000	180000
Cotton		
Yield	20	18
Rate	4000	4000
Income in Rupees	80000	72000
Total Income from 2 Crops	308000	252000
Savings (Income-Input)	197062	138360
Additional Benefit due to MI	58702	
Rate of Return %	124	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	2.78	2.22

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Chilly (Annexe No. 1)

Mr. Ramesh Amudalapalli (Village Laxmipuram, District Warangal, AP)

Returns from Micro-irrigation (Field Area 1.2 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	101350	131350
Irrigation/Electricity	240	240
Pesticides/Insecticides	12000	12500
Fertilizer	16800	17400
Seeds	9000	9000
Other costs	50000	40000
Total	**189390**	**210490**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**115191**	
Depreciation @ 10%	11519	
Interest @ 10%	11519	
Repair & Maintenance @ 2%	2304	
Total Annual Expenses towards MI System	**25342**	
Total Annual Expenditure	**214732**	**210490**
Output	**MI**	**Conventional**
Chilly		
Yield	100	80
Rate	6000	6000
Income in Rupees	600000	480000
Savings (Income-Input)	385268	269510
Additional Benefit due to MI	115758	
Rate of Return %	100	
Pay Back period in Years	1 year	
Gross Benefit-Cost Ratio	2.79	2.28

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Chilly (Annexe No. 1)

Mr. P. N.Venkat Rao (Village Laxmipuram, District Warangal, AP)

Returns from Micro-irrigation (Field Area 1.2 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	118989	152550
Irrigation/Electricity	240	240
Pesticides/Insecticides	18000	18000
Fertilizer	15000	15000
Seeds	9000	9000
Other costs	50000	37500
Total	**211229**	**232290**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**65380**	
Depreciation @ 10%	6538	
Interest @ 10%	6538	
Repair & Maintenance @ 2%	1308	
Total Annual Expenses towards MI System	**14384**	
Total Annual Expenditure	**225613**	**232290**
Output	**MI**	**Conventional**
Chilly		
Yield	90	75
Rate	6000	6000
Income in Rupees	540000	450000
Savings (Income-Input)	314387	217710
Additional Benefit due to MI	96677	
Rate of Return %	148	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	2.39	1.94

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Chilly & Cotton (Annexe No. 1)

Mr. P. Satish Rao (Village Laxmipuram, District Warangal, AP)

Returns from Micro-irrigation (Field Area 1.2 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	78848	102400
Irrigation/Electricity	240	240
Pesticides/Insecticides	9000	9000
Fertilizer	15000	15000
Seeds	6000	6000
Other costs	25500	18500
Total	**134588**	**151140**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	125000	
Depreciation @ 10%	12500	
Interest @ 10%	12500	
Repair & Maintenance @ 2%	2500	
Total Annual Expenses towards MI System	27500	
Total Annual Expenditure	**162088**	**151140**
Output	**MI**	**Conventional**
Chilly		
Yield	51	37
Rate	6000	6000
Income in Rupees	306000	222000
Cotton		
Yield	22	18
Rate	4000	4000
Income in Rupees	88000	72000
Total Income from 2Crops	394000	294000
Savings (Income-Input)	231912	142860
Additional Benefit due to MI	89052	
Rate of Return %	71	
Pay Back period in Years	1 to 2 Years	
Gross Benefit-Cost Ratio	2.43	1.95

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Turmeric & Cotton (Annexe No. 1)

Mr. Jangali Saraya (Village Taharpur, District Warangal, AP)

Returns from Micro-irrigation (Field Area 1.0 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	27200	36400
Irrigation/Electricity	240	240
Pesticides/Insecticides	10800	10800
Fertilizer	10470	10470
Seeds	8250	8250
Other costs	15000	9000
Total	**71960**	**75160**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	100000	
Depreciation @ 10%	10000	
Interest @ 10%	10000	
Repair & Maintenance @ 2%	2000	
Total Annual Expenses towards MI System	22000	
Total Annual Expenditure	**93960**	**75160**
Output	**MI**	**Conventional**
Turmeric		
Yield	35	20
Rate	4000	4000
Income in Rupees	140000	80000
Cotton		
Yield	15	9
Rate	4000	4000
Income in Rupees	60000	36000
Total Income from 2 Crops	200000	116000
Savings (Income-Input)	106040	40840
Additional Benefit due to MI	65200	
Rate of Return %	65	
Pay Back period in Years	1 to 2 Years	
Gross Benefit-Cost Ratio	2.13	1.54

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER DRIP IRRIGATION

Chilly & Cotton (Annexe No. 1)

Mr. Ramakrishna (Village Rangapuram, District Warangal, AP)

Returns from Micro-irrigation (Field Area 1.6 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	122847	155700
Irrigation/Electricity	360	360
Pesticides/Insecticides	10000	10000
Fertilizer	18800	20000
Seeds	8000	8000
Other costs	25000	20000
Total	**185007**	**214060**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	150000	
Depreciation @ 10%	15000	
Interest @ 10%	15000	
Repair & Maintenance @ 2%	3000	
Total Annual Expenses towards MI System	33000	
Total Annual Expenditure	**218007**	**214060**
Output	**MI**	**Conventional**
Chilly		
Yield	50	40
Rate	6000	6000
Income in Rupees	300000	240000
Cotton		
Yield	32	28
Rate	4000	4000
Income in Rupees	128000	112000
Total Income from 2 Crops	428000	352000
Savings (Income-Input)	209993	137940
Additional Benefit due to MI	72053	
Rate of Return %	48	
Pay Back period in Years	2 to 3 Years	
Gross Benefit-Cost Ratio	1.96	1.64

**Other Costs include expenditure on thrashing, drying etc*

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Garlic (Annexe No. 2)

Mr. Kailash Chandra (Village Panwari, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 0.4 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	10062	12900
Irrigation/Electricity	2500	2500
Pesticides/Insecticides	1000	1000
Fertilizer	3370	3370
Seeds	40000	40000
Other costs	1200	1400
Total	**58132**	**61170**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**18000**	
Depreciation @ 10%	1800	
Interest @ 10%	1800	
Repair & Maintenance @ 2%	360	
Total Annual Expenses towards MI System	**3960**	
Total Annual Expenditure	**62092**	**61170**
Output	**MI**	**Conventional**
Garlic		
Yield	28	21
Rate	3500	3500
Income in Rupees	98000	73500
Savings (Income-Input)	35908	12330
Additional Benefit due to MI	23578	
Rate of Return %	131	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	1.58	1.20

**Other Costs include expenditure on thrashing*

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Onion & Potato (Annexe No. 2)

Mr. Laxmi Narayan (Village Panwari, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 5.0 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	81928	106400
Irrigation/Electricity	3000	3000
Pesticides/Insecticides	10000	10000
Fertilizer	18510	18510
Seeds	46000	46000
Total	**159438**	**183910**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**150000**	
Depreciation @ 10%	15000	
Interest @ 10%	15000	
Repair & Maintenance @ 2%	3000	
Total Annual Expenses towards MI System	**33000**	
Total Annual Expenditure	**192438**	**183910**
Output	**MI**	**Conventional**
Onion		
Yield	700	600
Rate	500	500
Income in Rupees	350000	300000
Potato		
Yield	580	500
Rate	600	600
Income in Rupees	348000	300000
Income from 2 Crops in Rupees	698000	600000
Savings (Income-Input)	505562	416090
Additional Benefit due to MI	89472	
Rate of Return %	60	
Pay Back period in Years	1 to 2 years	
Cost-Benefit Ratio	3.63	3.26

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Gram, Peanut & Masoor (Annexe No. 2)

Mr. Rodi Lal (Village Dharola, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 2.4 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	22446	29150
Irrigation/Electricity	3600	3600
Pesticides/Insecticides	3000	3000
Fertilizer	10800	10800
Seeds	8080	8080
Other costs	3400	3400
Total	**51326**	**58030**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**18000**	
Depreciation @ 10%	1800	
Interest @ 10%	1800	
Repair & Maintenance @ 2%	360	
Total Annual Expenses towards MI System	**3960**	
Total Annual Expenditure	**55286**	**58030**
Output	**MI**	**Conventional**
Gram		
Yield	11	8
Rate	4000	4000
Income in Rupees	44000	32000
Peanut		
Yield	7	6
Rate	4000	4000
Income in Rupees	28000	24000
Masoor		
Yield	11	10
Rate	4000	4000
Income in Rupees	44000	40000
Income from 3 Crops in Rupees	116000	96000
Savings (Income-Input)	60714	37970
Additional Benefit due to MI	22744	
Rate of Return %	126	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	2.10	1.65

**Other Costs include expenditure on thrashing*

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Coriander, Gram & Masoor (Annexe No. 2)

Mr. Chattar Singh (Village Dharola, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 1.6 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	13572	17400
Irrigation/Electricity	3600	3600
Pesticides/Insecticides	1875	1875
Fertilizer	5600	5600
Seeds	3200	3200
Other costs	2270	2270
Total	**30117**	**33945**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**18000**	
Depreciation @ 10%	1800	
Interest @ 10%	1800	
Repair & Maintenance @ 2%	360	
Total Annual Expenses towards MI System	**3960**	
Total Annual Expenditure	**34077**	**33945**
Output	**MI**	**Conventional**
Coriander		
Yield	7.5	7.5
Rate	5000	5000
Income in Rupees	37500	37500
Gram		
Yield	10	8
Rate	4000	4000
Income in Rupees	40000	32000
Masoor		
Yield	3	3
Rate	4000	4000
Income in Rupees	12000	12000
Income from 3 Crops in Rupees	89500	81500
Savings (Income-Input)	55423	47555
Additional Benefit due to MI	7868	
Rate of Return %	44	
Pay Back period in Years	2 to 3 year	
Gross Benefit-Cost Ratio	2.63	2.40

**Other Costs include expenditure on thrashing*

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Garlic, Coriander & Gram (Annexe No. 2)

Mr. Rakesh Singh (Village Pankhedi, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 1.6 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	21450	27500
Irrigation/Electricity	5000	5000
Pesticides/Insecticides	6040	6040
Fertilizer	9120	9120
Seeds	8430	8430
Other costs	1750	1750
Total	**51790**	**57840**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**28800**	
Depreciation @ 10%	2880	
Interest @ 10%	2880	
Repair & Maintenance @ 2%	576	
Total Annual Expenses towards MI System	**6336**	
Total Annual Expenditure	**58126**	**57840**
Output	**MI**	**Conventional**
Garlic		
Yield	34	30
Rate	3500	3500
Income in Rupees	119000	105000
Coriander		
Yield	12	10
Rate	5000	5000
Income in Rupees	60000	50000
Gram		
Yield	8	6
Rate	4000	4000
Income in Rupees	32000	24000
Income from 3 Crops in Rupees	211000	179000
Savings (Income-Input)	152874	121160
Additional Benefit due to MI	31714	
Rate of Return %	110	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	3.63	3.09

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Gram & Masoor (Annexe No. 2)

Mr. Kanta Prasad (Village Pankhedi, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 1.2 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	15015	19250
Irrigation/Electricity	1380	3312
Pesticides/Insecticides	3500	3500
Fertilizer	6210	6210
Seeds	10575	10575
Other costs	3900	3900
Total	**40580**	**46747**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**21600**	
Depreciation @ 10%	2160	
Interest @ 10%	2160	
Repair & Maintenance @ 2%	432	
Total Annual Expenses towards MI System	**4752**	
Total Annual Expenditure	**45332**	**46747**
Output	**MI**	**Conventional**
Gram		
Yield	12	9
Rate	4000	4000
Income in Rupees	48000	36000
Masoor		
Yield	12	9
Rate	4000	4000
Income in Rupees	48000	36000
Income from 2 Crops in Rupees	96000	72000
Savings (Income-Input)	50668	25253
Additional Benefit due to MI	25415	
Rate of Return %	118	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	2.12	1.54

**Other Costs include expenditure on thrashing*

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Coriander & Gram (Annexe No. 2)

Mr. Ram Karan (Village Fanti, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 3.2 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	32984	43400
Irrigation/Electricity	14400	14400
Pesticides/Insecticides	16000	16000
Fertilizer	46760	46760
Seeds	11500	11500
Other costs	6350	6350
Total	**127994**	**138410**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**51840**	
Depreciation @ 10%	5184	
Interest @ 10%	5184	
Repair & Maintenance @ 2%	1037	
Total Annual Expenses towards MI System	**11405**	
Total Annual Expenditure	**139399**	**138410**
Output	**MI**	**Conventional**
Coriander		
Yield	18	16
Rate	5000	5000
Income in Rupees	90000	80000
Gram		
Yield	40	30
Rate	4000	4000
Income in Rupees	160000	120000
Income from 2 Crops in Rupees	250000	200000
Savings (Income-Input)	110601	61590
Additional Benefit due to MI	49011	
Rate of Return %	95	
Pay Back period in Years	1 to 2 years	
Gross Benefit-Cost Ratio	1.79	1.44

**Other Costs include expenditure on thrashing*

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Mustard & Gram (Annexe No. 2)

Mr. Rameshwar (Village Dharola, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 1.8 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	27105	34750
Irrigation/Electricity	11200	11200
Pesticides/Insecticides	2100	2100
Fertilizer	8187	8187
Seeds	3800	3800
Other costs	6100	6100
Total	**58492**	**66137**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**18000**	
Depreciation @ 10%	1800	
Interest @ 10%	1800	
Repair & Maintenance @ 2%	360	
Total Annual Expenses towards MI System	**3960**	
Total Annual Expenditure	**62452**	**66137**
Output	**MI**	**Conventional**
Mustard		
Yield	20	18
Rate	3100	3100
Income in Rupees	62000	55800
Gram		
Yield	14	10
Rate	4000	4000
Income in Rupees	56000	40000
Income from 2 Crops in Rupees	118000	95800
Savings (Income-Input)	55548	29663
Additional Benefit due to MI	25885	
Rate of Return %	144	
Pay Back period in Years	>1 year	
Gross Benefit-Cost Ratio	1.89	1.45

**Other Costs include expenditure on thrashing*

COST BENEFIT ANALYSIS UNDER SPRINKLER IRRIGATION

Coriander, Gram, Masoor & Garlic (Annexe No. 2)

Mr. Ram Narayan (Village Dharola, District Shajapur, MP)

Returns from Micro-irrigation (Field Area 2.8 ha) in Rupees		
Agricultural Input Cost	**MI**	**Conventional**
Human Resource	33852	43400
Irrigation/Electricity	14400	14400
Pesticides/Insecticides	16000	16000
Fertilizer	46760	46760
Seeds	11500	11500
Other costs	6350	6350
Total	**128862**	**138410**
Expenditure towards MI System	**MI**	**Conventional**
Cost of MI System	**48900**	
Depreciation @ 10%	4890	
Interest @ 10%	4890	
Repair & Maintenance @ 2%	978	
Total Annual Expenses towards MI System	**10758**	
Total Annual Expenditure	**139620**	**138410**
Output	**MI**	**Conventional**
Coriander		
Yield	12	9
Rate	5000	5000
Income in Rupees	60000	45000
Gram		
Yield	15	12
Rate	4000	4000
Income in Rupees	60000	48000
Masoor		
Yield	12	10
Rate	4000	4000
Income in Rupees	48000	40000
Garlic		
Yield	35	25
Rate	3500	3500
Income in Rupees	122500	87500
Income from 4 Crops in Rupees	290500	220500
Savings (Income-Input)	150880	82090
Additional Benefit due to MI	68790	
Rate of Return %	141	
Pay Back period in Years	> 1 year	
Gross Benefit-Cost Ratio	2.08	1.59

**Other Costs include expenditure on thrashing*