NABARD RESEARCH STUDY - 15

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Study on Efficacy of Micro-Irrigation System in Drought Prone Parts of Haryana

Society for Promotion and Conservation of Environment (SPACE), Chandigarh

आर्थिक विश्लेषण एवं अनुसंधान विभाग
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The NABARD Research Study Series has been started to enable wider dissemination of research conducted/sponsored by NABARD on the thrust areas of Agriculture and Rural Development among researchers and stakeholders. *'Study on Efficacy of Micro-Irrigation System in Drought Prone Parts of Haryana'* completed by Society for Promotion and Conservation of the Environment (SPACE), Chandigarh is the fifteenth in the series. The list of studies in the series is given at the end of this report.

Irrigation is essential for increasing the efficiency of input-use, adoption of high-yielding varieties, and improving cropping intensity and yields. The water requirement is bound to increase with the expansion and intensification of agriculture in addition to the increased demand from the industrial and domestic sectors. There is still a wide gap between the created irrigation potential and utilization. Since water is a scarce resource, it is important to conserve and manage it efficiently. Micro-irrigation (MI) is a water management strategy introduced relatively recently in Indian Agriculture. Unlike flood method of irrigation (FMI), micro-irrigation supplies the water at the required interval and in desired quantity at a place where water is demanded using a pipe network, emitters and nozzles. Therefore, MI in principle results in low conveyance and distribution losses leading to higher water use efficiency.

This report is an extensive field based study conducted in three districts of the state of Haryana namely Bhiwani, Mahendergarh and Nuh wherein the efficacy of micro-irrigation system has been explored.

Hope this and other reports we are sharing would make a good reading and help generate debate on issues of policy relevance. Let us know your feedback.

Dr. KJS Satyasai
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President SPACE

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Dr.S.S.Grewal

President SPACE

EXECUTIVE SUMMARY

Water is one of the most important natural resources for sustaining human life on mother earth. However, it has become increasingly scarce worldwide and it is being presumed that more than one-third of the world population would face absolute water scarcity by the year 2025. The worst affected areas would be the arid and semi-arid regions which are already having dense population living below poverty line. Rising demand for urban and industrial water supplies pose a serious threat to irrigated agriculture. However, to achieve the required food and fiber production for ever-increasing population, water is to be used most judiciously. The situation in India is not different and is most critical, where absolute water scarcity is already affecting a substantial population. In order to feed the growing population, we would have to increase farm income substantially. For that the overall agricultural production needs to be increased. One of the key ways to boost overall agricultural production is to implement better soil-water management techniques in arid and semi-arid areas.

Irrigation is essential for increasing the efficiency of input-use, adoption of high-yielding varieties, and improving cropping intensity and yields. The water requirement is bound to increase with the expansion and intensification of agriculture in addition to the increased demand from the industrial and domestic sectors. There is still a wide gap between the created irrigation potential and utilization. Since water is a scarce resource, it is important to conserve and manage it efficiently. The over-exploitation of water has cropped up the problem of depletion in mainland and also rise in water table which has resulted in creation of salinity and water logging problems. The concern of economic efficiency in water-use has remained largely unattended.

One of the water management strategies introduced relatively recently in Indian agriculture is micro-irrigation (MI). Unlike flood method of irrigation (FMI), micro-irrigation supplies the water at the required interval and in desired quantity at a place where water is demanded using a pipe network, emitters and nozzles. Therefore, MI in principle results in low conveyance and distribution losses leading to higher water use efficiency. The net utilization of irrigation water in drip system is 90% and through sprinkler system, it is 82%. In view of the same, micro-irrigation is having paramount importance with brighter future prospects.

In Haryana state, the soil conditions, topography and the climate that are prevailing in the south western part of the state, especially in districts of Bhiwani, Mahendergarh, Rothak, Sirsa and Hisar, have prompted the adoption of sprinkler irrigation. When farmers shift the cropping pattern more in favor of horticultural crops because of their high profitability, the potential area for drip irrigation is s expected to increase significantly in times to come. Further, in many areas where the water table has depleted it has encouraged the farmers to shift the irrigation method from flood to MI.

Micro Irrigation systems are significant not only in water saving but also in efficient energy, labour and fertilizer management for more crop production. These are helpful in uniformity of water application, higher water use efficiency, no land leveling, assured irrigation to the agricultural fields, improving cropping intensity, increasing efficiency through judicious use of irrigation water, saving farm land, appreciating land use and improving socio-economic condition of the farmers. Besides higher water use efficiency, MI has other economic and social benefits too. The field observations show that the MI increases productivity by 20 to 90 % for different crops; reduces weeds, checks soil erosion; and minimizes

cost of cultivation, especially in labor-intensive operations and lower energy use (electricity) for operating irrigation wells due to reduced water consumption.

The water deficit state of Haryana gave a big push to MI, particularly in southern districts where this was most suited due to light textured sandy soils and low rainfall. During the process of implementation in last 20 years, several constraints were noted which were coming in the way of achieving the potential of this technology. Keeping this in view, the National Bank of Agriculture and Rural Development supported a study on the efficacy of micro-irrigation (sprinkler and drip) in drought prone area of Haryana state. Based on the intensive study in three districts namely Bhiwani, Mahendergarh and Nuh through exhaustive consultation of of literature, field observations , interaction with officers and farmers, and pre-designed Performa-based collection of field data from 150 beneficiary farmers, the conclusions have been drawn which are summarized in this report.

The responses of the farmers to the pre-designed questionnaire across six study blocks were almost similar and hence combined and summarized as mentioned below:

a) **The reasons which encouraged farmers to adopt MI. system** included sandy soils requiring more irrigation water; usually farmers have one tube-well which could not cover whole farm, more loss of water in Kacha irrigation channels, more labour cost, more time needed for irrigation and ever-increasing shortage of water.
b) **The effect of these problems on socio-economic conditions of farmers** was due to low crop yield, less farm income, poor status of living, lowering of water table, more cost involved, borrowing of money for routine needs such as health problems, social customs, education of children and daily requirements; farm operations.
c) T**he effect of these problems on agricultural production** included **c**hoice of crops decreased; no fruit/ vegetable/Cotton crops could be raised, low and uncertain production and no market surplus, less use of fertilizer and less crop yields.
d) **The impact of these problems on livestock and farming** included **s**hortage of fodder for livestock, could not keep high yielding animal, low milk production and no milk for sale, could not afford livestock rearing cost.
e) **Problems in case processing** included more time in case processing, completion of documents particularly obtaining land record caused problem, less faith on the honesty of the dealer and dealer did not stick to committed time.
f) **These problems were solved** by getting help to complete the paper from friends, visited department office for help, had detailed discussion with the dealers of the company.

The main problems faced are that the average farmers do not have much knowledge about the procedure and formalities, every work done by dealer and no local service providers, drip and filters blocked very frequently.
How the problems were solved? Most farmers used acid to unblock the filters and drips.
R**easons of dissatisfaction were stated as the m**aterial supplied is sometimes of not good quality, drip system does not work properly, and subsidy often comes late, online system cannot be adopted by ordinary farmers and he do not have full knowledge about this system.
Suggestions for improvement included more involvement of the Department in implementation, early release of subsidy should be ensured, less dependence on company dealers, quality of material should be

ensured, more transparency in dealings and farmer should be made aware of procedure by holding workshops.

Farm level constraints in adoption includes that farmers do not have full knowledge about the quality of materials supplied and drip system is limited to few crops mainly Cotton, Department should organize awareness camps, farmers have to depend on dealers and their dealings lack transparency.

The farmers held that there is no way to sustain agriculture in this drought prone area suffering from an acute shortage of water, low rainfall and sandy soils without water saving through micro-irrigation. It was noted that in case of Bhiwani district covering data of Bahal and Tosham blocks the annual net returns was from all the three components namely flood, sprinkler and drip irrigation. Whereas in case of Mahendergarh district, the main focus remained on flood and sprinkler irrigation and drip system was not adopted because of heavy nature of soils. While in case of Nuh district, the sprinkler system was not adopted by the farmers because of heavy nature of soils and problem of salinity and only flood and drip irrigation were adopted. It was noted that drip irrigation adopted on vegetable crops gave the highest annual net returns in case of both the blocks of Nuh district as shown in Table below:

Table: Annual returns of 25 beneficiary farmers of study blocks from three irrigation systems

District	Block	Annual Net Returns of 25 farmers (lakh Rs)			
		Flood	**Mini Sprinkler**	**Drip**	**Main income source**
Bhiwani	Bahal	39.2	57.6	67.0	Mustard and Cotton
	Tosham	39.4	52.4	61.8	Mustard and Cotton
Mahendergarh	Ateli	30.3	52.7		Mustard and Wheat
	Narnaul	41.5	72.59		Mustard and Wheat
Nuh	Nuh	85.1		174.8	Vegetables + Livestock
	Nagina	127.03		271.05	Vegetables+ Livestock
Labour cost Rs/ acre/year		9000	6000	2000	

The B:C ratio was maximum in Mustard followed by drip irrigated vegetables and sprinkler irrigated Wheat. It was low in case of Cotton due to large number of irrigations required, high cost of picking and expenditure on chemicals and repeated sprays.

The field data collected from number of farmers across three districts comparing the cost of cultivation, gross and net returns from crops irrigated by flood, mini sprinkler and drip irrigation has conclusively proved that financial benefit increase by 60 to 70 percent upon shift from flood to mini sprinkler irrigation and more than 80 to100 percent upon further shift to drip irrigation Such benefits in vegetable crops with drip goes more than 200 percent against flood irrigation.

There is huge saving in labor cost of irrigation. For example, the cost of flood irrigation is Rs 1000 per acre per irrigation; it is around Rs 300 in mini sprinklers and less than Rs 100 in drip irrigation system. The annual irrigation labour cost is around Rs 9000 with flood, around Rs 600 with mini sprinklers and hardly Rs 200 with drip irrigation. Due to time saving in MI, farmers get time to attend other farm operations.

It was interesting to note that the cost of cultivation varied across blocks and districts. For example, in Narnaul area, the cost of cultivation is high since farmers tend to put all inputs required to get better yield levels and their net returns are much higher than Bhiwani.

In case of NUH, the water table is shallow and water is of good quality near the hills where study farmers were located and have opted for drip irrigated Tomato crop and earning profits ranging from Rs 60000 to one lakh/ acre. The economy is sustained by vegetable cultivation.

Though Bajra and Mustard are the main Kharif and Rabi crops but the economy of Bhiwani district is sustained by Mustard and Cotton. Mustard is a wonderful crop requiring less water and less input costs yet provide handsome returns even by one or two irrigations by mini sprinklers.

It is interesting to note that all the micro-irrigation systems may be mini sprinkler or drip system are operational and are fully functional with all the 150 beneficiary farmers contacted during survey. All of them by and large agree that their cases were processed by dealers of the company, but they all participated in planning, and the design was made with their consent and found no problems in installation.

Most farmers are of the view that after handing over the main responsibility to the companies, the department has gone in the background. Most rural farmers with poor education levels fail to understand procedures and formalities and have to depend on the dealers whose hands are not always very clear. This leads to less faith on dealers and an element of less transparency comes in. The departments on the other hand complaint of acute shortage of staff. But they hold that payments are duly made after field verification at site and verification of bills. It is also claimed that now portal system is followed where all the information upwards and downwards flow through net and with these complaints due to delays have reduced. The dealers are clever enough to get no objection/ satisfaction certificate from the farmers so that there is no problem in release of grant.

The officers handling the program and KVK scientists were of the view that small farmers are only to make payment of GST and rest of the system duly installed at farm is free, so farmers are seldom seen making complaints in interactive meetings and workshops. It also came to notice that in order to earn quick profit from the subsidy programs, many companies are marketing various sub-standard components in the market which affect the working condition of the system and creates doubt in the farmer's mind about the functioning of the system. It is to be ensured that only good quality components having the certification of Bureau of Indian Standards (BIS/ISO) are supplied to the farmers. It may be claimed like this but some farmers contest this claim. Lastly, as informed by Sarpanch and farmers of village Tejpur of Ateli block of Narnaul district, all the tube wells in the village has MI system and saturation level has reached. Even in some cases two or three brothers who have separated their land are having separate systems but use the same tube well. Finally, the sum total of discussions was that there is no survival without micro-irrigation system as water table has gone down and availability of water is very low.

CHAPTER 1

INTRODUCTION

1.1 The World Overview

Water is one of the most important natural resources for sustaining human life on mother earth. However, it is becoming increasingly scarce worldwide and by the year 2025 more than one-third of the world population would face absolute water scarcity (Seckler *et al.,* 1998; 1999) The worst affected areas would be the arid and semi-arid regions of Asia, the Middle-East, and sub-Saharan Africa which are already having dense population living below poverty line (Rose Grant *et al.,* 2002).According to a recent estimate (Bhaskar *et al.,* 2017), thirty four countries in the world will be facing water scarcity by 2025 indicating that per capita availability of fresh water supplies will be less than 100 cubic meter/person/ year. Any country with renewable water availability on an annual per capita basis exceeding about 1700 cubic meter will suffer only occasional or local water problems. Below this threshold, there will be periodic or regular water stress. India with 1400 m^3 and China (1700 m^3) will fall in this category in the year 2025 while USA having more than 7000 m^3/person/ year will not face any scarcity. Rising demand for urban and industrial water supplies in the world is bound to pose a serious threat to irrigated agriculture. The allocation of water for agriculture will come down to 50% from the present level of 70%. However, to achieve required food and fiber production with increasing population, water will have to be used most judiciously.

1.2 The Indian Scenario

Early warnings on impending water crisis came from the eminent specialists working in the field of water resources. Seckler *et al.,* (1998) reported that the capacity of countries like India to develop and manage water resources judiciously is likely to be a key determinant for global food security in the 21st century. In India, almost all the easily available and potential means for irrigation have already been tapped. However, the demand for good-quality water for different sectors is growing continuously (Saleth, 1996; Vaidyanathan, 1999).To fulfill the water requirement has become the overall key strategy for managing scarce water resources (Molden *et al.,* 2001). The situation in India is critical and absolute water scarcity is already affecting in many areas covering large population (Amarasinghe *et al.,* 2005, 2007) and much of the water scarcity is due to spatial variation in demand and supply (Narayanmoorthy, 2005).

According to NITI AYOG (2017), the demand for water in India is increasing day-by-day due to two critical reasons. First, owing to the presence of large tracts of arid and semi-arid land, where the surface and sub-surface water resources are highly limited. Second is the spurt in industrial and domestic consumption of water due to a high rate of population growth. Furthermore, over-exploitation is depleting the existing water resources at critical rates, even in areas traditionally known for having abundant irrigation water supply, resulting in irrigation water becoming both scarce and expensive. In order to feed the growing population and to further

increase farm incomes and livelihood of farmers, the overall agricultural production needs to be increased. One of the key ways to boost overall agricultural production is to implement better soil-water management techniques that would provide the arid and semi-arid lands better access to irrigation water, without actually increasing the stress on available water resources. This is feasible only by adopting micro-irrigation techniques.

1.3 Irrigation in India

Bhaskar *et al.,* (2017) held the opinion that India has the second largest net irrigated area in the world after China. Irrigation is the largest water consuming sector accounting for more than 80 % of the total withdrawals. Irrigation so far has covered only about of ok the gross cropped area. Due to increasing scarcity and non-agricultural water requirements, demand-management is receiving special attention. Although a number of demand management strategies in the irrigation sector have been introduced with a view to increase the water use efficiency, however, the net impact of these strategies so far has not been very impressive. The irrigation efficiency under canal irrigation is not more than 40% and for ground water schemes, it is 69% (Vaidyanathan, 1999; Dhawan, 2002).

The net irrigated area in the country was 65 Mha, which was about 42% of the total sown area as in 2012. Although considerable area has been brought under irrigation since independence; there is much scope for its expansion in the future. Irrigation water for agriculture finds competition from domestic use, industrial and hydroelectric projects. At present, the efficiency of the irrigation systems adopted is less than 40 %. As such, 50% of the water release at the project head is lost in transmission of the canal outlet. Additional loss occurs in water courses which is directly proportional to their length and duration of water flow. Considerable scope exists for enhancing the water use efficiency to bring additional area under irrigation. Scientific management of irrigation water is necessary to improve crop productivity and alleviate irrigation related problems such as shortage of irrigation water, water logging and salinity.

Bhaskar *et al.,* (2017) stated that India has to enhance the current irrigation potential of 91 Mha to 160 Mha. But the total water resources estimated are 230 Mhm which will have to cater the need of the non-agricultural uses also. As the country is likely to be water stressed in the coming years, therefore, technologies for water harvesting and storage and precision water application methods need to be adopted. However, to fulfill the additional requirement of irrigation, water harvesting, excess runoff collection, storage and recycling for precision water application by economizing the available amount of irrigation water needs to be adopted. The major problem associated with decreasing amount of fresh water for irrigation is conveyance losses reducing the net utilization of irrigation water to 46% only.

Bhaskar *et al.,* (2017) stressed the need of modern irrigation technologies due to the following reasons:

- The productivity of irrigated land is low compared to its potential.

- The productivity per unit water is very low.
- Water available for irrigation is becoming scarce day by day.
- Cost for generating water source is ever increasing.
- The predominance of soils with low water retention capacities and very low hydraulic conductivities makes the arid and semi-arid regions an ideal case for light and frequent irrigation through micro-irrigation.
- Micro-irrigation will increase the irrigation area using the existing available water.
- Micro-irrigation with fertigation will further enhance production per unit input in the nutrient poor, shallow and sloppy lands under Cotton (Photo 1.1).

Photo 1.1: Large scale Cotton cultivation in Bhiwani district of Haryana on sandy soils with drip irrigation

CHAPTER-2

MICRO-IRRIGATION AND ITS ROLE IN PROMOTION OF SUSTAINABLE AGRICULTURE IN WATER STRESSED ECOSYSTEMS

Micro-irrigation is a coordinated and controlled water management system where water is made to flow under pressure through a network of pipes of varying diameters, the main-line, the sub-main lines and the lateral lines with appropriately placed emitters along the length of the latter through which water is discharged to the root zone. One of the demand-management strategies introduced relatively recently to manage water consumption in Indian agriculture is micro-irrigation (MI). Unlike flood method of irrigation (FMI), in micro-irrigation water is supplied at the required interval and in the desired quantity at the location where water is required using a pipe network, emitters and nozzles. Therefore, MI in principle should result in low conveyance and distribution losses and lead to higher water use efficiency. The net utilization of irrigation water in drip system is 90% and through sprinkler system, it is 82%. In view of the same, micro-irrigation is having paramount importance with brighter future prospects.

2.1 History of Micro-Irrigation

Based on many historic records, Bhaskar *et al.*(2017) reported that the first work on Micro- Irrigation Systems (MIS) was initiated at Colorado in 1913 and based on studies it was concluded that drip system was too expensive. Later on an important breakthrough was made in Germany in1920 when perforated pipes were used for irrigating the crops. However, in 1930, the peach growers in Australia, pumped water through 5 cm diameter GI pipes laid along the tree rows with water emitting points made on the pipe as small triangular holes. In early 1940, Symcha Blass in early 1940 observed that a tree near a water leaking point exhibited vigorous growth as compared to other trees in the area. This led to the concept of Micro-Irrigation where water is applied in very small amounts as drop by drop. Later on, a remarkable breakthrough was made in the material science, when poly ethylene, a crack resistant and cheaper alternative was accidentally produced in a British laboratory.

Later, Low Density Poly Ethylene (LDPE) gave place to HDPE (High Density Poly Ethylene) and in 1977; LLDPE (Low Lenoir Density Poly Ethylene) was introduced. Thus, micro-irrigation systems really gained the ground with the developments in plastic industry. Later on, the orifice emitters were developed to improve the consistency of "holes drilled into the pipes" and gradually sophisticated water emission small diameter plastic tubes and micro-tubes were developed. Turbulent flow emitters were also developed which are being used at present. Drip irrigation techniques were developed in Israel, Australia, Mexico, New Zealand, South Africa and the USA and are being used for various crops.

2.2 Need for Micro-Irrigation

According to Neeraj *et al.,* 2018**,** the problem of growing groundwater scarcity and persistent ground water resource degradation can only be tackled by two-folds in India. The first is the supply side management practices like water resources development through major, medium and minor irrigation projects. The second is through the demand management by efficient use of the available water. This includes micro-irrigation and other improved water management practices. The micro-irrigation in general and drip irrigation in particular has received considerable attention from policy makers, researchers and economists for its perceived ability to contribute significantly to groundwater and surface water resources development, agricultural productivity, economic growth, and environmental sustainability.

Globally, it's well established that (MI) technologies increase crop yield, save water, improve crop quality, enhance the fertilizer/ chemical application efficiency, conserve energy, reduce labour cost, improve pest management, increase feasibility of irrigating in difficult terrains, improve suitability in problem soils, and improve tolerance to salinity. In MI, supply of optimum quantity of water in the form of tiny streams, fine spray or continuous drops mitigates water loss due to evaporation and on account of seepage and percolation. This further reduces water logging and improves soil health. Consequently, there is an increase in productivity and the quality of produce, thereby leading to a rise in the overall farm incomes. MI technology is promoted primarily for the following reasons: (1) as a means to save water in irrigated agricultural land; (2) as an initiative to increase farmer income and reduce poverty; and (3) to enhance the food and nutritional security of rural households. The substantial dependence on rainfall makes cultivation a high risk and less productive activity, so assured irrigation and *in-situ* moisture conservation encourages farmers to invest more in farming technology and inputs that lead to increase in productivity and farm income.

Further, the rate of return from investment in drip-irrigation is observed to be relatively higher than that of sprinkler irrigation and can be as high as 150%. Understandably, the minimum payback period has been found to be 2 to 3 year in both drip and sprinkler methods. A suitable framework to channelize investment into micro-irrigation in India will generate a beneficial social impact on farmers and positive environmental impact along with a rational financial return for the investor.

2.3 Current Status of MI in India

Out of approximately160 million hectare (mha) of cultivable land in the country, only approximately 65mha (41%) is currently covered under irrigation (for FY 2012). The current area under MI in India is only 8.6mha compared to the potential of 69.5mha. Of the 8.6mha under MI in India, 4.7mha is under sprinkler irrigation (54.64%), while 3.9mha is under drip irrigation (45.4%). States with the largest area under MI include Rajasthan (1.75 mha-20% share), Andhra Pradesh (1.32 mha-15% share), Maharashtra (1.31mha 15% share), Gujarat (1.1 mha-13% share), Karnataka (0.95 mha,-11% share), and Haryana (0.58mha-7% share). These six states cover 81%

of the total area under MI in the country. The adoption pattern of micro-irrigation techniques (drip and sprinkler) in various parts of the country is furnished in table 2.1 and 2.2.

Table 2.1: Area under drip and sprinkler irrigation in India

States	Area (Lakh ha)	
	Drip	**Sprinkler**
Andhra Pradesh	39500	17090
Assam	200	90000*
Bihar	-	160
Gujarat	10000	27740
Haryana	2400	83600
Himachal Pradesh	-	70
Jammu and Kashmir	-	30
Karnataka	50000	41900
Kerala	7500	5800
Madhya Pradesh*	3800	149980
Maharashtra	154000	33120
Orissa	3000	400
Punjab	2000	200
Rajasthan	35000	47850
Tamil Nadu	42000	32130
Uttar Pradesh*	2500	7360
West Bengal	200	120040*
Others	2000	500
Total	**355400**	**658500**

** Madhya Pradesh includes Chattisgarh, and Uttar Pradesh includes Uttaranchal.*
Source: *Ashwini and Singh (2002)*

Table 2.2: State wise area under sprinkler irrigation in India

State	Area (000 ha)	Number of sets installed in VIII plan (000 Nos.)
Assam	90.0	N.A.
Andhra Pradesh	17.1	19.4
Gujarat	27.7	12.9
Haryana	83.6	4.1
Karnataka	41.9	6.5
Kerala	5.8	N.A.
Madhya Pradesh	150.0	16.7
Maharashtra	33.1	18.5
Rajasthan	47.8	29.7
Tamil Nadu	32.1	12.0
Uttar Pradesh	7.4	11.6
West Bengal	120.0	N.A.
Others	1.4	3.2

Source: *INCID (1994).*

2.4 Scope of Micro-Irrigation in India

Studies show that MI has an enormous potential in India, where drip irrigation method (DIM) and sprinkler irrigation method (SIM) can cover about 80 crops (INCID 1994, 1998). DIM is highly suitable for wide spaced crops, but it is also being used for cultivating Oilseeds, Pulses, and Cotton and even for Wheat crop. SIM is mostly suitable for closely grown crops like Cereals, Pulses, Wheat, Sugarcane, Groundnut, Cotton, Vegetables, Fruits, Flowers, Spices and condiments. In the Haryana state, the soil conditions, topography and the climate that are prevailing in the south western part of the state, especially in districts of Bhiwani, Mahindergarh, Rothak, Sirsa and Hisar, have prompted the adoption of sprinkler irrigation. When farmers shift the cropping pattern more in favor of horticultural crops because of their high profitability, the potential area for DIM will increase significantly in future. Similarly, if the depletion in groundwater in different regions aggravates further, it might also encourage the farmers to shift the irrigation method from flood to MI methods. In any case, the potential area for MI is going to increase substantially.

Bhaskar *et al.,* (2017) reported that out of the 250 cropping systems in India, 30 are the most common ones and out of them, several are well fitted under drip and sprinkler irrigation system. There is immense scope for conservation, distribution and on farm utilization of water and attaining higher water use efficiency through micro irrigation system and yields can be maximized significantly with a limited amount of water. Modern irrigation techniques like sprinkler and drip should be promoted where water is scarce and the topographic and soil conditions do not permit conventional methods of irrigation. In dry areas where ground aquifers are saline drip irrigation will be more appropriate to follow.

An increase in the DIM adoption has taken place since the 1980s, mainly as a result of various promotional programs introduced by the Central and State Governments (Narayanamoorthy, 2005). In the state of Haryana, area under DI increased from 812 to 24826 ha and SI from 1864 to 58818 ha between 2006-07 to 2017-18 (NITI AAYOG, 2017).

2.5 Government Sponsored Scheme on MI

Irrigation has been classified as a State subject in the Seventh Schedule of the Indian Constitution and has been given 'Infrastructure' status as per the notification on *Harmonized Master List of Infrastructure Sub-Sectors*, dated 30th March 2017 by the Department of Economic Affairs, Ministry of Finance.

The real thrust on promoting MI adoption in India started with the recommendations of the *Report of the Task Force on Micro Irrigation* in 2004. The report sought to increase the emphasis on MI technology and recommended the Centrally Sponsored Scheme ("CSS"), which was later launched by the Ministry of Agriculture in January, 2006. In 2010, CSS on MI was scaled up to National Mission on Micro Irrigation ("NMMI"), which continued until 2013-14. From 2014, NMMI was subsumed under the National Mission on Sustainable Agriculture ("NMSA") and implemented as- On Farm Water Management ("OFWM") during the FY 2014-

15. From 1st April 2015, the MI component of OFWM has been subsumed under the Pradhan Mantri Krishi Sinchayee Yojana ("PMKSY") which has been implemented as CSS for MI since FY2015-16.

PMKSY has included MI within the scheme as an integral component. The scheme focuses on providing end-to-end solution to the irrigation supply chain issues. The Government of India's manifesto talks about "*Har Khet Ko Paani*" and "Per Drop More Crop." While the infrastructure creation and development for irrigation projects, as mandated to be part of the Command Area Development & Water Management ("CADWM") is covered under the '*Har Khet Ko Paani'* and 'Watershed Development' component. The implementation of bringing area under MI is mandated to be part of the 'Per Drop More Crop' component of this scheme.

2.6 Need and Progress of MI in the Haryana State

According to Sharma and Bansal (2018**)**, the Haryana State, with geographical area of 4.4 mha, is mostly arid or semiarid with limited rain fall ranging from 300mm in the south-west to 1100mm in the north-east. There are no perennial rivers running through the state and about 2/3rd of the area is underlain with brackish water facing problems of rising water table and inadequate natural drainage. About 80% of the cultivable area of the State stands covered by the various canal commands including the lift canal commands, but the actual average annual intensity of canal irrigation in the State is only about 70% (combined for both the crops of Rabi and Kharif) which clearly reflects the limited availability of canal water. Large dependence of the State's agricultural sector on the ground water has led to over exploitation of this source of water and consequently the water table has registered a steep fall in the fresh water belts and rise in saline ground water areas leading to the problems of water logging and soil salinity.

Growing water crisis and need to produce more food per drop of water, requires adoption of water efficient irrigation methods instead of the conventional flood irrigation to increase the field application water use efficiency and to enhance crop productivity. Micro Irrigation systems have matured to their significance not only in water saving but also in efficient energy, labour and fertilizer management system for more crop production. In the areas where canal irrigation is less and farmers largely depend upon rain water & ground water, which is very low and saline with no scope of ground water development, the only solution is creating of Micro Irrigation infrastructure on canal outlets. Where the ground water table is very high with brackish water, there are chances of creating the situation of water logging, which is harmful for soil properties. In these areas, it is essentially required to minimize the flood irrigation by replacing with micro irrigation.

The physical (Table 2.3) and financial (Table 2.4) progress under centrally sponsored scheme-per drop more crops (PMKSY) in Haryana has been tabulated from the year 2006-07 to 2017-18. The districts with prominent blocks, which have been over-exploited regarding use of

water resources, are shown in Table 2.5. The progress of installation of drip and sprinkler along with number of beneficiaries, are shown in Table 2.3

Table2.3: Physical progress of micro-irrigation from 2006-07 to 2017-18 (area in ha)

S. No	Year	Drip	Sprinkler	Total
1	2006-07	812	1864	2676
2	2007-08	1041	6735	7776
3	2008-09	2139	20170	22309
4	2009-10	2468	790	3258
5	2010-11	3900	5254	9154
6	2011-12	2751	5961	8712
7	2012-13	2645	3914	6559
8	2013-14	2504	3860	6364
9	2014-15	1550	1850	3400
10	2015-16	1756	1360	3116
11	2016-17	1158	4624	5782
12	2017-18	2102	2436	4538
	Total	24826	58818	83644

Table2.4: Financial Progress 2006-07 to 2017-18 (Rs. In lakhs)

Sr. No	Year	Available budget	Expenditure	Percentage utilization
1	2006-07	583.69	235.74	40
2	2007-08	1124.36	645.2	57
3	2008-09	2113.62	1891.39	89
4	2009-10	942.42	851.76	90
5	2010-11	2624.10	2594.31	99
6	2011-12	4065.40	4034.09	99
7	2012-13	6648.22	6260.83	94
8	2013-14	6784.58	6189.32	91
9	2014-15	3051.72	3029.07	99
10	2015-16	4416.75	2000.45	45
11	2016-17	8221.23	2083.31	25
12	2017-18	5608.59	2387.86	42
	Total	46184.68	32203.33	70

Source: NITI AAYOG **(**2017)**.** Guidelines on micro- irrigation through public private partnership (Government of India) PPPAU Division a *Draft Concept Note*

Table 2.5: Over exploited and critical blocks in Haryana

S. No	District	Blocks	S. No	District	Blocks
1	**Bhiwani**	1.Badhara 2.Kairu 3.Loharu 4.**Behal 5.Tosham**	8	Kurukshetra	26. Ladwa27.Pehowa 28.Shahabad
2	Fatehabad	6.Tohana	9	Karnal	29. Karnal
3	Gurugram	7. Farukhnagar8.Pataudi 9.Sohna 10.Gurgaon	10	Panipat	30. Bapoli31.Samalkha
4	Kaithal	11. Gulha12.Rajaund	11	Sirsa	32. Rania 33. Ellanabad
5	Palwal	13. Palwal 14. Hassanpur15.Hathin 16.Hodal	12	Faridabad	34. Municipal Corporation of Faridabad 35.Ballabhgarh
6	Yamunanagar	17. Jagadhari18.Mustafabad 19. Radour20.Sadhura	13	Rewari	36. Khol
7	Mahendergarh	21.Nangal Chaudhary 22.**Narnaul** 23. Kanina24.**Ateli**25.Mahendergarh			

Per Drop More Crop (PMKSY) – AAP : 2018-19

Table 2.6 District wise physical summary: Horticultural Crops

S. No	District	Drip		Mini Sprinkler		Total Physical Target	
		Bene. (no.)	**Area (Ha.)**	**Bene. (no.)**	**Area (Ha.)**	**Bene. (no.)**	**Area (Ha.)**
1	Ambala	65	50	103	80	168	130
2	**Bhiwani**	1300	1000	1543	1200	2843	2200
3	Charkhi Dadri	390	300	887	690	1277	990
4	Faridabad	13	10	39	30	52	40
5	Fatehabad	104	80	257	200	361	280
6	Gurugram	195	150	257	200	452	350
7	Hisar	195	150	386	300	581	450
8	Jhajjar	39	30	167	130	206	160
9	Jind	91	70	219	170	310	240
10	Kaithal	65	50	219	170	284	220
11	Karnal	91	70	129	100	220	170
12	Kurukshetra	91	70	103	80	194	150
13	**M. Garh**	195	150	1414	1100	1609	1250
14	**Nuh**	195	150	900	700	1095	850
15	Palwal	130	100	219	170	349	270
16	Panchkula	26	20	39	30	65	50
17	Panipat	65	50	129	100	194	150
18	Rewari	195	150	1029	800	1224	950
19	Rohtak	130	100	129	100	259	200
20	Sirsa	611	470	193	150	804	620
21	Sonepat	104	80	129	100	233	180
22	Yamunanagar	130	100	514	400	644	500
	Total	**4420**	**3400**	**9000**	**7000**	**13420**	**10400**

It may be seen that Bhiwani and Mahendergarh have the maximum number of DI and SI cases and beneficiaries followed by Rewari and Nuh district. The Haryana State Micro Irrigation Committee was formed in the year 2006 to implement Centrally Sponsored Scheme of Micro Irrigation in the state. This is as per the guidelines of Government of India and a notification to this effect was issued by State Government in 2006.

The Horticulture Department Haryana issued notification on 14th June, 2006 giving the Composition of Implementation Agency**.** The District Horticulture Mission was made the implementation unit and charged with the responsibility to formulate Action Plans for their District, Forward Action Plans to Ministry of Agriculture through District Micro Irrigation Committee (DMIC)/State Micro-irrigation Committee(SMIC), receive funds directly from the Ministry of Agriculture through DMIC/SMIC, disburse the assistance to the beneficiaries, furnish Utilization Certificate and Monthly Progress Report to Ministry of Agriculture through DMIC/SMIC.

2.7 Advantages of MI System

By applying Micro-irrigation we minimize the cost of cultivation, weed problems, soil erosion and increase water use efficiency as well as electricity use efficiency, besides reducing the overexploitation of groundwater. Among advanced micro-irrigation (MI) techniques, drip and sprinklers are gaining special attention. Drip irrigation (DIM) and sprinkler irrigation (SIM) methods have distinct characteristics in parameters such as flow rate, pressure requirement, wetted area and mobility (Kulkarni, 2005), but they have the potential of significantly increasing water use efficiency. While DIM supplies water directly to the root zone through a network of pipes and emitters, SIM sprinkles water, similar to rainfall, into the air through nozzles which subsequently breaks into small water drops and fall on the field surface. DIM has little or no water losses through conveyance (INCID, 1994; Narayanamoorthy, 1996, 1997; Dhawan, 2002), and the on-farm irrigation efficiency of a properly designed and managed drip irrigation system can be as high as 90 %, compared with 35 to 40 % efficiency in surface method of irrigation (INCID, 1994). However, SIM has relatively less water saving (up to 70 % efficiency), since it supplies water over the entire field of the crop (INCID, 1998; Kulkarni, 2005).

The advantages of micro-irrigation are summarized as under:

- Saving of ample irrigation water
- Low water application rate
- Uniformity of water application around the plant
- Precision placement of water
- Efficient fertilizer and chemical application
- Better control of root zone environment
- Significant yield enhancement
- Improved quality of the farm produce

- Improved disease control
- Discourages weed growth
- Saving of power due to lesser use of electricity
- Reduced labour cost
- Being light in weight, the system can be shifted without any problem
- It can be used on undulating topography
- It can be put to use during night also
- Covers more land area uniformly and also the crop canopy
- Develops suitable micro climate for sowing of crop and better plant growth
- Improve conveyance and application efficiency on coarse textured and shallow soils
- Low discharges may be used
- Applicable on undulating and steep terrain without need for land forming (Gravity head may be used to pressurize the system)
- Reduced labour requirement
- Enable uniform application of water

2.8 Limitation of Micro-Irrigation

In spite of having many economic and other advantages, the growth of area under micro-irrigation has not so far been appreciable compared to the total potential. High capital investments depending upon the nature of crops and the material to be used, little or no cost of surface irrigation supplies; free electricity for pumping groundwater have been the important impediments for faster adoption of MI techniques. The main issues and concerns are flagged as under:

- Sprinkler irrigation has generally been promoted through subsidy schemes and not as an on-farm water and land management strategy. The design aspect is ignored so as to reduce the cost.
- In order to earn quick profit from the subsidy programs, many companies are marketing various sub-standard components in the market which affect the working condition of the system and create enormous doubt in the farmer's mind about the functioning of the system. It is to be ensured that only good quality components having the certification of Bureau of Indian Standards (BIS/ISO) are supplied to the farmers.
- Efforts should be made to manufacture improved sprinkler systems through joint ventures, with the condition that the imported components and technology would be transferred to indigenous manufacture within a period of 2 years. This would help reduce the cost of the system and increase the adoption of micro-irrigation at a large scale.
- One of the major reasons for the slow growth of micro-irrigation in India is the high initial investment. There is a need to look into the technological options, of which crop geometry modification is the most important one. Instead of adopting traditional spacing, adoption of paired row planting has been found to reduce the cost of the system by 40 % in many

crops including Tomato, Brinjal, Okra, etc. Therefore, micro-irrigation system should be tailor-made, i.e., planned and designed based on location specific parameters.

- It is understood from the field studies that capital cost required to install drip irrigation is relatively high. Because of this reason, considerable percentage of farmers have expressed that they are unable to adopt this technology for low- value crops. If drip system is made available at a low cost, area under drip irrigation can be increased at a faster rate. By recognizing drip industry as an infrastructure industry as well as announcing tax holiday for specific time periods to all those drips set industries which produce genuine drip materials, the competition can be increased to ultimately bring down the cost of the system.
- The rate of subsidy provided through government schemes is fixed uniformly for both water-intensive as well as less water-intensive crops. This needs to be restructured.
- Organizing frequent demonstrations at farmers' fields is equally important.

In view of the above constraints in implementation of the MI program at the field level, there was a need of a detailed study on the efficacy of MI system in rain-fed parts of the Haryana state.

CHAPTER-3

OBJECTIVES AND METHODOLOGY ADOPTED

3.1 Background

Haryana is a small but one of the progressive states of India. Though overall growth rate is impressive, the agricultural growth rate is constrained by number of problems. The central districts have most productive irrigated lands under paddy-Wheat system. The over exploitation of ground water, soil fertility depletion and several soil health problems have imposed limitation on farm productivity and net returns. Because of availability of ground water, fruit and vegetable cultivation is being promoted to diversify agriculture. This region is grain bowl of the state and has the facility of canal irrigation. The problem of salinity, alkalinity and water logging limits farm growth in several pockets. The southern belt is most problematic mostly due to brackish water, ground water availability, and sandy nature of soils, low rainfall and lack of canal irrigation network. The southern districts of Dadri, Mahendergarh at Narnaul, Rewari, Bhiwani, Part of Jind and Nuh/Mewat suffer from water availability problems and need most efficient use of limited water.

The State Government through the Department of Agriculture and Horticulture is promoting micro-irrigation in these areas. Efforts are being made to promote the concept of more crops per drop. Government is providing subsidy on micro-irrigation schemes. However, there are several constraints on the acceptability of this program which is associated with the implementation of the program, equipment supply and repairs and inherent defects in the model at small farm level. These problems needed a detailed study particularly in southern districts so that suitable financial, administrative and policy issues are flagged and remedial measures are taken to facilitate the promotion of this flagship program.

The DARE National Bank of Agriculture and Rural Development (NABARD), awarded this study on **efficacy of micro irrigation system (drip and sprinkler) in rain-fed parts of Haryana** to the Society for Promotion and Conservation of Environment (SPACE), a Chandigarh based group of agricultural professionals.

3.2 Objectives of the Study

- Comprehensive review of water scarcity problem with particular reference to Haryana.
- Compilation of data of previous projects, critical analysis, outcome and lessons of experience.
- Stakeholder consultation at State, District, Block and Village level including relevant research institutions.
- Comprehensive interaction with farmers, their perceptions of the problem, and impact on livelihoods.
- The impact of past projects on production levels and productivity.

- Post project sustainability issues and concerns.
- Emerging best agricultural practices for micro-irrigation.
- Assess the cost benefit analysis of micro irrigation system.
- Documenting the best agricultural practices of micro-irrigation possible for replication.

3.3 Methodology

There are six districts of Haryana which have sandy soils, scarcity of water and crops raised under drought prone conditions. Sprinkler and drip irrigation has been promoted in these districts due to their suitability to the conditions of this region. In the present study three districts were selected out of six for impact evaluation of micro-irrigation system . These are Nuh, Mohinder Garh at Narnaul and Bhiwani which are spread across this belt (Table 3.3).

Table 3.1: The Agro-ecological Zone of Haryana state

Zone	Number of Districts	Name of Districts	% Area
I	8	Panchkula, Ambala, Yamunanagar, Kurukshetra, Karnal, Kaithal, Panipat, Sonepat	32
II	7	Sirsa, Fatehabad, Hissar, Jind, Rohtak, Faridabad, and Palwal	39
III	6	**Bhiwani, Mahendergarh**, Rewari, Jhajjar, Gurgaon and **Mewat**	29

As per plan, two blocks from each district were selected having maximum area under M.I. and from each block 5 villages were randomly selected and from each village five beneficiary farmers were identified and information through pre-designed proforma (Annexure-1) was collected from these farmers. In order to start the study, the local resource persons were selected who would interact with farmers and fill the formats. However, the training of the resource persons was necessary to make them understand the project concept and how to select the farmers and how to fill up the forms. In view of the above, a resource person's interaction and training program was planned on 14.07.2020 first at Narnaul and then at Chahal Kalan Village of Bahal block of Bhiwani district.

A detailed review of available literature on micro-irrigation has been carried out with particular reference to Haryana. Focused group discussions have been held in every district to illicit the views of the community about the MI program. Similar meetings have been held at district and state level with the stake holders. The data on the progress, details of implementation arrangements and constraints experienced was collected at the district and state level. A draft report has been compiled for review at the DARE, NABARD and comments shall be incorporated in the final report.

The list of selected districts, blocks and villages is given below in Table 3.2.

Table 3.2: Detail of districts, blocks and villages selected for the study

S.No	Name of district	Name of Block	Name of villages
1	Bhiwani	Bahal	ShazmanPur
			Sirsi
			Baran
			Nunshar
			Chahar Kalan
		Tosham	Alampur
			Hassan
			Sandwa
			Sahkwala
			Isherwall
2	Mahendergarh	Ateli	Bhilwara
			Bihali
			Bochariya
			Tajpur
			Tigra
		Narnaul	Kunjpura
			Neerpur
			Patikara
			Shapur-II
			Sobhapur
3	Nuh	Nuh	Badka
			Badwa
			KhodBasai
			Korali
			Sadai
		Nagina	Ghagas
			Ghumat Bihari
			Kansali
			Notky
			Shahapur

Format for study

As per plan, 150 beneficiary farmers, fifty per district were interviewed and information was compiled in a pre-tested format. The copy of the format is given as Annexure-I. The map of Haryana and districts selected is given below (Figure 3.1).

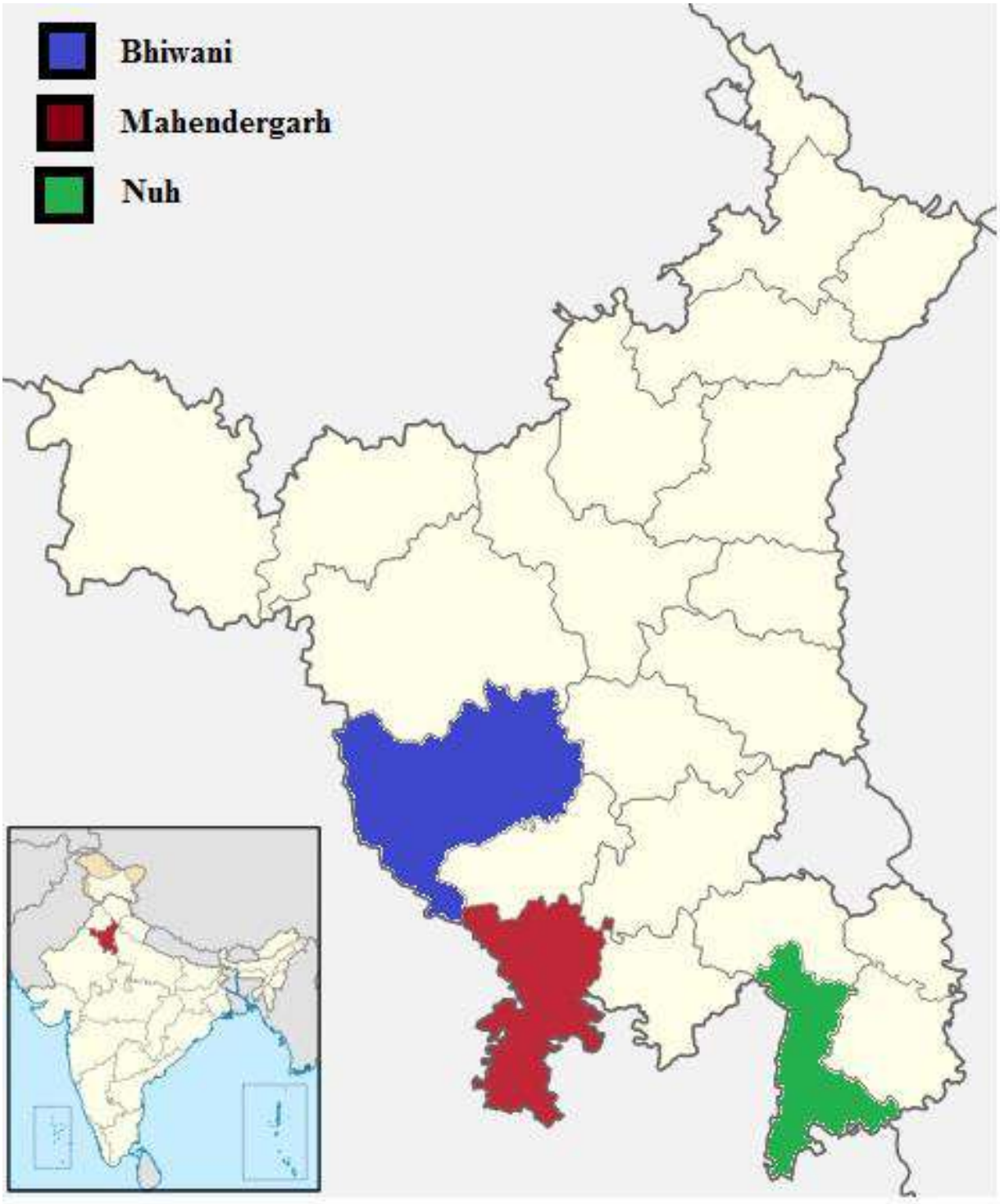

Figure 3.1: Map of districts selected for the MI study

The data collected from 150 farmers in the survey formats was put in Excel Sheet and from the Excel Sheet data was converted to the Word Format tables for all the blocks and conclusions briefly mentioned at the end of each table.

CHAPTER-4

REVIEW OF LITERATURE

As a result of intensive agriculture development in the Haryana state, groundwater has depleted to a great extent with nearly 60% of the total blocks falling in the category of over-exploited and critical zones. In the study districts of Bhiwani and Mahendergarh, five blocks each were under over-exploited and critical category. Micro-irrigation system was advocated as an effective measure to improve irrigation efficiency thus reducing pressure on fragile groundwater system in arid and semiarid regions (Arya *et al.*, 1999; IWMI, 2006; K Palanisami *et al.*, 2011; Chauhan *et al.*, 2007; Khan and Gupta, 2007; Kumar and Narayanmoorthy, 2005).

As groundwater was found to be the key factor defining agricultural land use, a research study was taken up by Mamta *et al*., 2012 to understand groundwater use dynamics and to analyze the potential of micro-irrigation system (sprinkler and drip) as a means to improve on-farm water use efficiency and the factors limiting their wide scale adoption in the Mewat district of Haryana. The main highlights of the study are worth reporting and are as follows:

1. With low mean annual rainfall of 594 mm, water is a scarce resource and its availability is critical to meet the needs for potable supply and for agriculture use. Except 20 villages of Nuh and Nagina block where agriculture is almost entirely rain-fed, the groundwater is the lifeline of agriculture for rest of villages of Mewat.
2. The groundwater in about 55% area of the district is moderate to highly saline. On account of high salt load in nearly 75% area of the Nuh and Nagina blocks; groundwater is unfit for drinking and for irrigating crops. Only in Taoru block and a stretch of 1-1.5 km wide all along Aravalli foot hills, the salinity level of groundwater is low, less than 2 millimohs/cm^2, and groundwater is suitable for potable and irrigation purposes. Beyond 1.5 km from the hills, the salinity is very high such that it is unfit for any purpose.
3. The trend of groundwater exploitation has accelerated with shift in cropping pattern from traditional to more water intensive crops e.g. Paddy and Vegetables over the past ten years. In a span of 34 years (1984-2008), groundwater depth in the district has declined by 4.80 m and the rate of decline is on the rise with greater withdrawal of groundwater than recharge.
4. Sprinklers have spread over the past 15 years in Mewat especially in the Taoru block and in the villages along the foothills of Aravalli having good groundwater quality. Sprinkler system is being used roughly in 17% of total area under irrigation in the Taoru block. The adoption is more in undulating areas in comparison with the flat areas because of more easiness of irrigation and reduction in wastage of irrigation water.
5. Sprinkler system was found 63 % more efficient than the flood irrigation system (Table 4.1) as the water requirement per irrigation is quite less than that of the flood irrigation.

Table 4.1: Efficiency of sprinkler system over flood irrigation in Wheat crop in sandy soils

Parameter	Flood Irrigation	Sprinkler Irrigation
Number of Irrigation	7	7
Time (hrs) per irrigation per acre (considering electricity for 6 hrs per day)	24	9
Total Time (hrs.)	168	63
Pump Capacity (HP)	10	10
Discharge (m3/hr) from 10 HP (2 inch pipe)	15.14	15.14
***Volume of water applied (m3)/irrigation/acre**	364	136
Total volume for entire season (m3)/acre	2548	952
Conveyance losses/irrigation	20%	0
****Irrigation depth (cm)/irrigation**	7.3	3.5
*****Savings on water usage for entire season (%)**	63.15%	

6. Drip System: It was found that drip method of irrigation is not so popular in this region. Thus, very few farmers in few villages are using this method. Meoli is one of the village in the district where drip system has been in use for the past 6 years for Vegetable crops. Drip system resulted in water saving up to 89%. Drip system was quite successful in case of Tomatoes as it resulted in 50percent increase in yield. Drip system resulted in 25% less nitrogenous fertilizers and 50% less pesticides in comparison with the traditional flood irrigation method. Drip system was largely being used in Vegetables which require good quality water that is restricted largely to the foothills of Aravali. As the system is comparatively more sophisticated than sprinkler, it demands greater care in operation and management.

Summary of Research Results on Micro-irrigation

The research and development work carried out at different Agricultural Universities, CAR Institutes, Agricultural Research Farms and farmers' fields during the past few years was summarized by Bhaskar *et al.* (2017) and main highlights are given below:

- Micro irrigation has given very high (>90%) irrigation efficiency with significant improvement in yield and quality of Cotton, Vegetables and Horticultural crops.
- Majority of the area (55.40 %) covered under micro irrigation is in Horticultural crops, while7 % is under field crops.
- Yield improvement due to micro irrigation has been reported up to 35-50% in Cotton, 5-10%, in castor, 15-42% in groundnut and 20-26% in potato. The yield improvement in principle crops is to the tune of 30-105%.
- Climatic water requirement of Cotton varies from 650 - 1000 mm in Cotton growing states.
- Irrigation through DS was found superior to flood, alternate furrow irrigation, irrigation in each furrow and sprinkler irrigation with higher water saving and quality improvement.
- Field experiments conducted at different research centers indicated that through drip irrigation, higher fertilizer use efficiency in Cotton is possible.

- Irrigation through drip is a better alternative for Cotton on uneven, undulating topography with or without saline/ sodic water.
- Drip requires less gross water (31 %), with high water application efficiency (69 %), water distribution efficiency (17 %) and water storage efficiency ratio (83 %) over sprinkler and open furrow irrigation.
- Through fertigation, 30-50 % fertilizer can be saved in drip with higher yield (27%) and higher water saving (53 %).
- Highest coefficient of uniformity in moisture distribution (98.2%) due to drip irrigation at the land surface was recorded.
- With the use of drip, farmer can get Rs 2000 /ha more and about Rs 50,000 more for the same quantity of water used as in the surface method.
- The yield target of 2.0-2.5 t/ha under irrigation through drip can be achieved by sowing of Cotton 20-25 days over the monsoon sowing.
- The life span of drip is estimated to be 1 0-15 years by taking all due care in handling the system costing Rs 30,000-50,000 per ha.
- The area under micro-irrigation is increasing over the years in the country, mainly due to its suitability in water saving and better water use efficiency. At present, about 6.7 lakh ha area is under sprinkler and 3.5 lakh ha under drip in the country.
- Response of Cotton to drip varies under different soil and agro-climatic conditions. Under conditions of ample availability of irrigation water and in non-problematic conditions, the yield response may be poor though considerable saving in irrigation water can be achieved.
- Under conditions of good quality irrigation water, but with enough land availability, drip may be a boon to bring more area under irrigation and improve the overall economy of the farmers with the same quantity of water used as in the surface method.
- In salt affected soils, availability of either good or moderately saline water, drip can be most profitably used both for increasing Cotton productivity and maintaining soil health. Fertigation through drip can save 40-50 % of fertilizer requirement.
- Under high water table conditions with poor quality underground water, irrigating through drip to maintain shallow and restricted root zone is a better proposition than the surface irrigation.

Micro-irrigation, i.e. sprinkler and drip methods have been used with the aim of minimizing water use and enhancing water use efficiency of Rice. In the state of Haryana, 57314 ha area was covered under MI as in March31, 2015 which was only 16.3 percent of net crop sown area (Mandal *et al.*, 2019).

The adoption of micro-irrigation projects has resulted in water saving, yield and income enhancement at the farm level. However, the overall impression is that they are capital-intensive and suited to large farms. In this context, a study was undertaken by Palanisami *et al.*, 2011, in nine states, mainly to examine the actual area covered compared to the potential area and to

understand the adoption level of MI as well as to analyze the cost and returns under different farm categories. According to them, the micro-irrigation technologies such as drip and sprinkler are the key interventions in water saving and improving crop productivity. Evidence shows that up to 40 to 80% of water can be saved and water use efficiency (WUE) can be enhanced up to 100% in a properly designed and managed MI system compared to 30-40% under conventional practice (INCID, 1994; Sivanappan, 1994 cited in Suresh Kumar, 2008).

Drip has a potential of around 12 million ha under Cotton, Sugar cane, Fruits and Vegetables, Spices and condiments; and some pulse crops like Red Gram, etc (Table 4.2).

Table 4.2: Potential and actual area under MI in different states (area in '000 ha) in 2010

State	Drip			Sprinkler			Total		
	P	A	%	P	A	%	P	A	%
Andhra Pradesh	730	363.07	49.74	387	200.95	51.93	1117	564.02	50.49
Bihar	142	0.16	0.11	1708	0.21	0.01	1850	0.37	0.02
Chhattisgarh	22	3.65	16.58	189	59.27	31.36	211	62.92	29.82
Goa	10	0.76	7.62	1	0.33	33.20	11	1.09	9.95
Gujarat	1599	169.69	10.61	1679	136.28	8.12	3278	305.97	9.33
Haryana	398	7.14	1.79	1992	518.37	26.02	2390	525.50	21.99
Himachal Pradesh	14	0.12	0.83	101	0.58	0.58	115	0.70	0.61
Jharkhand	43	0.13	0.31	114	0.37	0.32	157	0.50	0.32
Karnataka	745	177.33	23.80	697	228.62	32.80	1442	405.95	28.15
Kerala	179	14.12	7.89	35	2.52	7.19	214	16.64	7.77
Madhya Pradesh	1376	20.43	1.48	5015	117.69	2.35	6391	138.12	2.16
Maharashtra	1116	482.34	43.22	1598	214.67	13.43	2714	697.02	25.68
Nagaland	11	0.00	0.00	42	3.96	9.43	53	3.96	7.48
Orissa	157	3.63	2.31	62	23.47	37.85	219	27.10	12.37
Punjab	559	11.73	2.10	2819	10.51	0.37	3378	22.24	0.66
Rajasthan	727	17.00	2.34	4931	706.81	14.33	5658	723.82	12.79
Tamil Nadu	544	131.34	24.14	158	27.19	17.21	702	158.52	22.58
Uttar Pradesh	2207	10.68	0.48	8582	10.59	0.12	10789	21.26	0.20
West Bengal	952	0.15	0.02	280	150.03	53.58	1232	150.18	12.19
Others	128	15.00	11.72	188	30.00	15.96	316	45.00	14.24
Total	11659	1428.46	12.25	30578	2442.41	7.99	42237	3870.86	9.16

P = Potential, A = Actual area

Source: Raman (2010) and India stat (2010)

The percentage of actual area against the potential estimated in different states varied between nil in Nagaland to 49.74% in Andhra Pradesh, 43.22% in Maharashtra and 24.14% in Tamil Nadu.

In case of sprinkler irrigation, the percentage of actual area against the potential estimated was as low as 0.01% in Bihar and as high as 51.93% in Andhra Pradesh. Compared to the potential of 42.23 million ha in the country, the present area under MI accounts for 3.87 million ha (1.42 million ha under drip and 2.44 million ha under sprinkler) which is about 9.16%. The results indicated that only about 9% of the MI potential is covered in the country. They suggested reduction in capital cost, provision of technical support for operation after installation, relaxation

of farm size limitation in providing subsidies and the establishment of a single state level agency for implementation of the MI program.

Namara (2005) further suggested that the successful adoption of MI requires, in addition to technical and economic efficiency, two additional preconditions, viz, technical knowledge about the technologies and accessibility of technologies through institutional support systems.

Economics of MI System

Lauch *et al.,* (2004) reported that the surface irrigation system has many drawbacks such as wastage of water in delivery, difficulty in maintaining uniformity of irrigation, soil erosion and limitation of irrigating undulated lands. To overcome these problems specifically to reduce wastage of water, SI and DI have been suggested. Keeping in view the importance of efficient irrigation methods to increase the productivity of per unit irrigation water, a study was conducted by Luhach *et al.,* (2004) to assess the economic impact of sprinkler and drip irrigation in Haryana. The results of the study are summarized as under.

1. In Haryana, SI is practiced on about 85000 hectares of land. SI is water-efficient and was introduced in the canal irrigated areas of southern Haryana. Sprinkler system of irrigation saves water and can irrigate much more area than surface irrigation. It also eliminates the needs for channels and land leveling. This method is particularly suited on sandy soils that have a high infiltration rate. Small streams of irrigation water can be used efficiently and sprinkler distributes water uniformly.
2. Drip irrigation was introduced during the early 1970s in India. In Haryana, area under DI is about 2135 ha at present.
3. The investment in sprinkler irrigation was quite remunerative. The benefit: cost ratio (1:1.97), NPV (Rs 7970) and IRR (17%) indicated that it was worth to invest in sprinkler irrigation. In case of DI also, the benefit: cost ratio, NPV and IRR were much higher than the furrow irrigation method.
4. The SI and DI techniques are water-saving, cost effective and efficient in comparison to surface irrigation through flooding or furrow system. The higher values of NPV, IRR, and BC ratio indicate better economic viability of these systems. The results have indicated considerable savings in water from SI and DI methods. The SI has also been found to reduce operational costs as well as labour requirements. It has been suggested that it is worth to invest in the SI and DI systems.

Micro-irrigation in Paddy

Neeraj *et al.*, (2018) reported the experiences of Installation of Community Based Solar/Grid Powered Micro Irrigation Infrastructure in existing canal commands in various districts of Haryana. Their paper mainly discusses the experimental results of the above said Pilot Project. Irrigation was done in one acre demonstration plot of Rice crop through conventional flooding and in two acres with micro irrigation systems. They professed that:

1. The future of Rice production which consumes a lion's share of water (85%) used in irrigated agriculture will depend heavily on developing and adopting technologies and practices which will use less water with highest use efficiency. Rice is cultivated usually in a puddle condition with large volumes of water and grown in standing water resulting in heavy loss of water.

2. The Rice yield increased by 11.65 % in drip irrigation along with 42.03% saving of water. The drip system has been found more profitable than flood irrigation due to higher yield, higher net return (Rs.83486 per ha) in comparison to flood irrigation (Rs.73414 per ha). The drip irrigation produced 13.71% more net income than flood irrigation method. It was proved that for cultivating Rice in water-limited condition and following drip irrigation system it has been possible to sustain the productivity.
3. They elaborated the following challenges in the successful adoption of MI technology.

   - Reduce the high release of greenhouse gases (CH_4 and CO_2) due to Rice flood irrigation.
   - Reduce leaching of nitrogen rich irrigation water which causes ground water pollution.
   - Use DI for combined application of water, fertilizer, pesticide and weedicides to check weeds without manual labour.
   - Reduce absorption of heavy metals from the soil and their accumulation in the seed under anaerobic condition. Design a drip system wherein Rice could be grown in all types of soil and topographies.

Roopal Suhag (2016) provided an overview of Ground Water in India

1. Out of 1123 BCM/year usable water in India, the share of surface water and groundwater is 690 and 433 BCM/year respectively. Setting aside 35 BCM for natural discharge, the net annual ground water availability for the entire country is 398 BCM.
2. The overall contribution of rainfall to the country's annual ground water resource is 68% and the share of other resources, such as canal seepage, return flow from irrigation, recharge from tanks, ponds and water conservation structures taken together is 32%. Due to the increasing population in the country, the national per capita annual availability of water has decreased from 1,816 cubic metre to 1,544 cubic metre in 2011.
3. The groundwater is available at a lower level in the northwestern region of the country. There are other significant pockets across the country where the depth of the water level is more than 10 meter. This implies that one has to dig deeper to reach the water table in these regions. When the ground water level crosses 10 meter, sophisticated equipment is required to extract it.

4. The level of ground water development is very high in the states of Delhi, Haryana, Punjab and Rajasthan where ground water development is more than 100%. This implies that in these states, the annual groundwater consumption is more than annual groundwater recharge. Experts believe that India is fast moving towards a crisis of ground water overuse and contamination.
5. 89% of ground water extracted is used in the irrigation sector, making it the highest category user in the country. This is followed by ground water for domestic use which is 9% of the extracted groundwater. Industrial use of ground water is 2%. 50% of urban water requirements and 85% of rural domestic water requirements are also fulfilled by ground water.
6. The dependence of irrigation on ground water increased with the onset of the Green Revolution, which depended on intensive use of inputs such as water and fertilizers to boost farm production. Incentives such as credit for irrigation equipment and subsidies for electricity supply have further worsened the situation. Low power tariffs have led to excessive water usage, leading to a sharp fall in water tables.
7. In the states of Punjab, Haryana and Rajasthan, ground water levels are fast depleting due to excessive exploitation for agriculture use. To improve the situation, the solutions may include, (i) on-farm water management techniques and adoption of improved irrigation methods, (ii) implementation of 'Master Plan for Artificial Recharge to Ground Water', and (iii) revamping agricultural power pricing structure, as flat rate of electricity adversely affects the use of ground water, a well-defined policy on ground water extraction should also be framed to ensure long-term sustainability.

MICRO IRRIGATION – A Centrally Sponsored Mission: Guidelines by Horticulture Department Haryana

The guidelines states that the conventional irrigation has caused problems of rise in water table resulting in problem of water logging and salinity which reduced the productivity of crops. In such a situation refined methods of irrigation like sprinkler and drip irrigation were promoted under a centrally sponsored scheme. The brochure of the department lists the following benefits of drip irrigation.

Benefits of Drip Irrigation

- The optimum combination of nutrients, air and water in the root zone results in better production and quality of crops.
- The MI is suitable for uneven, undulating lands and sandy soils.
- It is possible to irrigate almost all crops through Micro-Irrigation.
- Nutrients, insecticides and pesticides can be applied through this system.
- Less labour cost in the construction of irrigation channels.
- Proper placement of water results in less weed problem.
- Every plant receives water as per its requirement.

- More area can be irrigated with less amount of water.
- Total 90% subsidy, 40% by Centre and 50% by State Government.
- All categories of farmers are included and subsidy limited to 5 hectare area.
- Benefit of purchasing equipment at market rate from any of the approved companies.
- Free service for three years after the supply of material.
- In addition to extension services, provision for awareness generation through seminars, workshops about water management.
- Provision of preparing cost estimates by the approved company.
- Provision of proper warranty and user manual for proper operation and maintenance of the system

Release of Subsidy

- Beneficiary farmer submits application along with cost estimate to the concerned Horticulture Development Officer.
- The District Horticulture Development Officer sanctions the project and informs the concerned farmer.
- Farmer credits the farmer share to the company.
- The installed system by the farmer is inspected by a team constituted at the district level.
- After the satisfaction of the farmer and the inspecting team, the district horticulture development officer through the farmer release subsidy to the company supplier.

- As per the Horticulture Department Haryana, there is saving of water through Drip irrigation to the extent of 20 to 30 percent in fruit crops and 40 to 60% in Vegetable crops. The increase in crop production also varies from 20 to 40% with drip irrigation.
- The amount of subsidy is worked out on the basis of spacing of laterals and area covered. This increases with decrease in spacing of laterals and increase in area both for wider (mostly Fruits) and narrow spacing (Vegetable) geometry of crops.
- In case of Micro and Mini sprinklers – the estimated cost and amount of subsidy is worked out on the basis of area and spacing. The spacing of 5x5m is taken for micro and 10x10m for mini sprinklers. For example, for one hectare area, the estimated cost for micro and mini sprinkler is Rs.58932 and 85212 and respective amount of subsidy is Rs.53039 and Rs.76691.
- There is a separate provision of drip / fogging system in poly and net houses.
- In a poly-house of 504 and 100 sq.m. The cost is Rs.63250/- and Rs.24150 and subsidy is Rs.56925 and Rs.21735, respectively.
- In case of net house of the same size, the cost is Rs.51750 and Rs.20700 and subsidy amount is Rs.46575 and Rs.18630, respectively.
- A list of 19 companies approved by the Department is available and phone number of district horticulture officers is available on a department brochure.

CHAPTER-5

AN OVERVIEW OF SPRINKLER AND DRIP IRRIGATION IN HARYANA STATE

Entry of Micro-Irrigation in the Haryana State

Haryana probably is the first state in the country to introduce the sprinkler method of irrigation. Keeping in view the topography, limited water resources and type of soil, the system of sprinkle irrigation was started in early seventies in the south western parts of the state. However, efforts were made to introduce this method of irrigation in the entire state but the success could only be achieved in the south western area (mainly Bhiwani, Mohindargarh, Rewari, Jhajjar Districts), where there are undulating sandy type of lands and mostly basin irrigation was followed which was very labour intensive and there was also huge loss of water.

In 1974, 25 sets were given for demonstration only to those farmers who were having tube wells and tried on Rabi crops (mainly Wheat & Mustard).Later on, it was also demonstrated in Kharif season (on millets i.e. Bajra). Next year, the number the sets was increased to 57 farmers and then further distributed to 128 in 1976. By the end of the 1980, it was introduced to 2023 farmers. During this time, a scheme of providing subsidy on sprinkler sets was also started by the state Government. By that time, the farmers were also convinced with its usefulness and thus, demand was generated at the farmer's level. In the beginning, main manufactures were M/s Premier Irrigation, M/s Jindal Irrigation and M/s Mahavir OK Irrigation etc. The system firstly was only Aluminum based. Later on, more players of the trade joined. After seeing the success of the scheme, many central teams visited the state and the scheme was also adopted by the Central Government Ministry of Agriculture and Co-Operation, Department of Agriculture, New Delhi. The subsidy cost was divided on 50:50basis.

Setting up of State Level Committee

For smooth functioning of the scheme, Haryana state notified a State Level Committee under the Chairmanship of the State Agriculture Minister, where all the concerned departments were made members. This committee decided the unit rates of irrigation sets of different firms and subsidy rates and the procedure to be followed in the implementation of the scheme. Simultaneously, the State Government roped in the then Agricultural Refinance Corporation (ARC), now NABARD, Land Development Co-operative banks and other Commercial banks to extend loan facilities to those farmers who were willing to install the sprinkler sets and also installing tube wells. However, the Department of Agriculture (Soil Conservation Section) and manufacturing firms played a pro-active role in popularizing this technology of irrigation among the farmers.

In order to ascertain the impact and usefulness of the scheme, this committee also took up decision to evaluate the impact of this technology. So, number of studies were got conducted from the independent wings of the Department (statistical) and also by a separate Department of Economic and Statistics. All these studies revealed that the scheme was very useful to the farmers where water is scarce, land is undulating and soil is sandy in nature. Studies also showed that it

has not only increased the area under irrigation, enhanced the yield of crops but also saved the water and no expenditure is needed to do land leveling. It also came out that there is labour saving in irrigating the fields as compared with the traditional methods of irrigation and water application was more uniform and thus there was increased water use efficiency, these studies further strengthened the program and by the end of 1990, 19681 more sets were installed which covered additional area under irrigation.

Micro-irrigation in Canal Command Areas

With the success of this system, irrigation department also came up with an idea of implementing big size sprinkler sets on various canal commands, covering100 hectares each. This was started in Bhiwani, Hissar, Rewari, Fatahbad, Jhajjar, Sirsa districts of the state. For this, pressure pumps and filters were installed with nozzles of high volume. But after working for few years, it could not be sustained for longer period and ultimately scheme of bigger size sprinkler system failed due to lack of maintenance, clogging of the system and other problems of distribution of water. But during use, this system also saved more water and additional area was brought under irrigation. These all were of aluminum pipe sprinkler sets. However, later on these pipes were used for carrying water in other state projects.

Canal Command Area Agency also came up with a scheme of installing sprinkler sets on individual farmers on different commands, but in the field, officers of Agriculture Department (Soil Conservation Wing) implemented the scheme. The unit cost and pattern of subsidy remained same as per the decision taken by the state level committee. In this way, the funds were further supplemented.

Role of Manufacturing Firms

Keeping the increasing demand in view, many manufacturing firms opened their outlets even in small towns through dealer's network. At present, the role of the department is not in initial stages as all farmers apply on a portal started by the department along with submission of all documents needed. In fact, all this facilitation work is done by the representative of the firm like taking all papers from the farmer, land records, soil/water testing, if needed, type of sets, design as per field and tube well location, number of pipes needed, nozzles required and other accessories and bill of cost etc. All the details are loaded on the portal. Almost entire work is done by the firms distributing the sets through their dealers at different places. On portal, the action is taken by head office like sanction of estimate and design, allotment of funds and the entire information is then sent back to firm, farmer and field officers. After system installation, the verification of set based on bills is done by the department man after visiting the field and thereafter, money is transferred to the account of farmers.

In case of all this promotional work, the Department of Agriculture (Soil Conservation Section) and manufacturing firms play a pro-active role in popularizing this technology of MI among the farmers. Meanwhile, there is an acute shortage of staff in the field. Similarly, there is

also an acute shortage of staff in soil testing laboratories. The information of soil testing is very scanty. For example, one sample is taken on 25 acres (10ha) land in un-irrigated areas and two samples on irrigated lands. Almost same procedure is followed by the Horticulture Department in case of drip irrigation where the subsidy amount is almost 100 percent. With the increase in demand, some malpractices of supplying less material, poor quality of pipes and nozzles came into the notice of the department and the same were addressed which improved the implementation of the program. With the start of portal scheme, there are fewer loopholes for corruption. Once it was also reported that some farmers gave sprinkler sets in the marriage of their daughters.

Earlier, the aluminum based sprinkler sets were being installed, but in the mid-eighties High Density Poly Ethylene (HDPE), plastic system was also approved by the Committee and many new companies joined. These plastic systems were found to be lighter and cheaper and State Government allowed subsidy on both the systems and the choice of the system was left to the farmers to purchase any type and from any approved firm. However, the working life is more in aluminum based system as compared to the HDPE. During field visit, one of the farmers of Jojju kalan village (Bhiwani) told that he purchased one aluminum set from M/s Premier Irrigation Ltd in early eighties and it is still working. During 2019-20, 11 new firms were approved to supply Aluminum and HDPE based system in addition to 58 firms already registered with the Department. Department also fixed the rates of pipes and accessories to be charged of different sizes.

During mid-eighties, drip irrigation system was also started mainly on widely spaced horticultural crops. However, later on it was adopted on Sugarcane mostly by the various sugar mills and other crops and much later on Cotton crop also. The program of sprinkler irrigation was also made part of Oilseed mission & on Cotton Mission by Government of India. When the Rashatarya Krishi Yojna (RKY) was started by the Govt. of India Department of Agriculture, Ministry of Agriculture and Co-operation, the subsidy scheme on sprinkler system was made its part, because many central schemes were merged into it. But the MI program among the farmers became very popular between 1990 and 2000 and more than 27000 additional sets were provided to the farmers. The subsidy amount provided to the farmers was more that Rs 3400 Lakh up to March, 2000.

Implementation Arrangements

The work on micro irrigation was implemented under Pradhan Mantri Krishi Sinchai Yojana (PMKSY) started in 2017. In the department of agriculture Haryana, there are four components i.e. (i) Accelerated Irrigation Benefit Program (AIBP), (ii) Har khet ko Panni, (iii) Watershed Development and (iv) Per Drop More Crop. This scheme is being coordinated at Central Level by the Department of Agriculture and Farmers Welfare. However, now there is a move to transfer the whole program to Jalshakti Ministry (Water Resources). Under PMKSY, there is a National Steering Committee under the Chairmanship of the Prime Minister and there

is a National Executive Committee under the Chairmanship of Vice-Chairman Niti Aayog New Delhi.

As per the PMKSY, in the States, State Level Sanctioning Committee is chaired by Chief Secretary Haryana and Inter Departmental working group under the Chairmanship of Agriculture Secretary (Additional Chief Secretary) of the State. Further, at the District Level, Implementation Committee under the Chairmanship of Deputy Commissioner is constituted where District Irrigation plans are prepared, discussed and finalized. As per the Govt. of India guideline, 55% subsidy is given to small & marginal farmers and for others it is 45% with a share of 60:40 between State and Central Government. However, State Government has increased the subsidy amount up to 85% to all formers for sprinkler/mini sprinkler and drips irrigation sets in 53 critical blocks of the State. Most of the south western Haryana blocks and other over exploited blocks of the State falling in very dark zones have been covered. In this way, all potential area where micro irrigation is popular have been taken care of but for other areas, subsidy is given at the rate of 60% and 70% for general category and small/marginal farmers respectively. At present, almost entire cost is borne by the department and farmer has only to bear the GST charges applicable on the sprinkler set. All the subsidy amounts are disbursed to the farmers on Direct Benefit Transfer (DBT) basis.

Cost of HDPE varies from Rs. 17843 to Rs. 47204 for one hectare to five hectares for 75 mm size and for 90 mm sizes but it would be more in case of Aluminum based system. Similarly, rates of different items of drip irrigation such as main, sub mains, emitters, filters/sand separator etc. are also fixed. Drip irrigation system is being looked after by the officers of Horticultural Department. Now the drip irrigation system is increasingly used on the Cotton, Sugarcane crops. Fertigation is also very easy with drip irrigation system. Now there is more adoption of mini sprinkles on most of the crops. Their area of spread (diameter) is less as compared to sprinkles. Up to March, 2020, beginning from start of the scheme, 150477 sets with total subsidy amount of Rs. 24997.43 Lakh has been setup so far. During the last thirteen years (starting from2006 to 2019), area benefitted under mini sprinklers and drip irrigation is 107950 hectares.

As stated above, unit cost is fixed and department is providing subsidy on the bases of actual cost as per the bill and whichever is less. Subsidy on sprinkler set is fixed at present on both aluminum based and HDPE based but the cost of aluminum set is much more. There is a major problem of late release of subsidy due to non-release of the subsidy amount by state government (Finance Department) in time and some time as late as March but demand of farmers is generated in October/November at the time of sowing of the crop. In that case, the cost till subsidy amount made available by the Government is borne by the firm/dealer.

Joint Use of Tube-Wells by Farmers

Now there is almost saturation in many areas of the state as far as installation of Sprinkler set is concerned, but due to fragmentation of holdings, especially among brothers, the tube well

is common among them (brothers), so the other brother(s) also want to have a separate set, so he or she purchase another one and use the same tube well for his sprinklers. In this way, one tube well has more than one set (even 3 or 4) and all of them use the water of the same tube well. Hence, there is a practice of use of tube wells jointly. They also use them in a supplementary and complementary way. For this, they have mutual agreement and can have double lines. It was learnt that almost all tube wells have been covered with MI.

Convergence between Horticulture and Agriculture Departments

Earlier subsidy cost on drip irrigation was born by the Horticultural Department as it was being installed on either Vegetable or Fruit crops. Now with the use of drip irrigation on other field crops like Cotton and Sugarcane etc. any of the two departments can give subsidy on drip irrigation mainly on Cotton or Sugarcane. But it has been ensured that farmer claim subsidy on drip irrigation from one source only. Subsidy on the horticulture crops is credited directly to the supplying firm but on the other hand, Agricultural Department credit subsidy directly to the farmer in his account. This all is done on line but copies are also kept for records and audit etc.

It is also learnt that many farmers are using both sprinkler/mini sprinklers and drip irrigation especially where Cotton is grown. Only part of the area is diverted from traditional crops to Vegetables and Fruits though the benefits are much more in Vegetable growing but that needs much more care and sometime marketing risks are problems.

Benefits of MI as Perceived by the Beneficiary Farmers

During discussions with the farmers, it was found that benefits in monetary term are very significant. For example, the farmers of Mahendergarh stated that the cost of flood irrigation is Rs 25000 per acre/year, while it reduces to Rs.14000, Rs 6000 and Rs 2000 after adopting sprinkler, mini sprinkler and drip irrigation respectively. However, in case of Loharu (Bhiwani) these all costs are relatively much less. In term of time, it is 12 hours for flood irrigation, 6 hours in sprinkler while only 2 hours in drip system. In this way, farmers time of supervision is reduced which can be utilized for other purposes. One very special benefit of sprinklers in case of Cotton is that white flies are washed with jets of water and there is less incidence of its pest damage.

The farmers of different areas narrated different benefits of the MI irrigated crops depending upon specific conditions operating in that particular area. In case we take cost of cultivation calculated by scientists (agriculture economics) of Haryana Agricultural University Hissar, it is different because they take into consideration other costs also such as rental value of land, risk factor, management cost etc. which are generally not taken into account by the farmers, In that way, benefits are further reduced over per unit area. There is a difference in gross cost of cultivation and net income what farmers of Biran and Sagban villages of Tosham Block of Bhiwani told and what KVK scientists of Bhiwani has worked out. In case we take up the data of KVK then the overall benefits are reduced to a large extent as they have loaded the cost with land rent, bank loan interest and management costs.

Transparency

Though with the introduction of technology (portal/ direct transfer of money in account) some loop holes have been plugged but due to lack of education on the part of farmers, he or she has to depend on firm`s representative and many intricacies are not clear to him. Although departments claim that trainings are organized in the villages but that does not solve the problem. Subsidy amount should be made available before sowing of crops so that farmer is not dependent on the dealer / firm. Though with the start of portal system, the role of field officers is very much limited in the beginning but the final payment is made after field verification of sets which take time and it should be made mandatory that inspection shall be done in 10 to 15 days otherwise it would be deemed to be verified. Such issues on transparency were discussed at various levels with the concerned officers and their versions are incorporated in the main report of the project.

CHAPTER - 6

ANALYSIS OF DATA COLLECTED THROUGH PRE-TESTED FORMATS

Out of 4.42-million-hectare geographical area of the Haryana state, 80 percent is under cultivation and out of which 84 percent or 2.936 mha is irrigated- 45.3 percent by canals and 54.2 percent by tube wells and 62 percent area is laid under poor-quality water. The conventional irrigation has caused problems of rise in water table resulting in problem of water logging and salinity which reduced the productivity of crops. In such a situation, refined methods of irrigation like sprinkler and drip irrigation were promoted under a centrally sponsored scheme. Under the centrally sponsored micro-irrigation scheme, the area under sprinkler irrigation increased from 1864 to 58814 ha and under drip irrigation from 812 to 24832 ha between 2006-07 and 2017-18. So, has increased the expenditure under micro-irrigation from Rs 235.74 lakh to 32203.33 lakh in this period **(**NITI AAYOG, 2017**).**

There are six districts of Haryana which have sandy soils, scarcity of water and crops raised under drought prone conditions. Sprinkler and drip irrigation has been promoted in these districts due to their suitability to the conditions of this region. In the present study, three districts were selected out of six for efficacy of Micro-irrigation in the rain-fed areas of Haryana. These are Nuh, Mohinder Garh at Narnaul and Bhiwani which are spread across this belt. As per plan, two blocks from each district were selected having maximum area under M.I. and from each block 5 villages were randomly selected and from each village, five beneficiary farmers were identified and information through pre-designed Performa was collected from these farmers. The results of the data collected from 150 beneficiary farmers are presented in this part of the report.

Farmers Responses to Pre- Designed Questionnaire

The responses across six study blocks were almost similar and hence combined for all the three districts and are presented as under.

a) What was your problem that made you to think about M.I. SI/DI system?

- In sandy soils, more irrigation was required.
- One tube-well could not cover whole farm and only 3-4 acres were covered.
- More loss of water in Kacha irrigation channels
- More labour cost and more time needed for irrigation.
- Ever increasing shortage of water

b) What was the effect of these problems on rural life and normal living?

- Low crop yield, less farm income, poor status of living
- More use of water, lowering of water table, more cost involved
- Low return, borrowed money, no money for health, education and housing
- Land leveling was needed that added to the cost of cultivation
- More cost involved in farm operations

c) What was the effect of these problems on agricultural production?

- Choice of crop decreased and no Fruit/ Vegetable crops could be raised.
- Low and uncertain production and no market surplus
- Could not raise commercial crops like Cotton
- Less agriculture production and no market surplus
- Less use of fertilizer and less crop yields

d) What kind of impact were these problems had on livestock and farming?

- Shortage of fodder for livestock
- Could not keep high yielding animal
- Low milk production and no milk for sale
- Livestock rearing cost could not be afforded

e) What were the problems in case processing?

- Took more time in case processing
- Completion of documents particularly obtaining land record caused problem
- Less faith on the honesty of the dealer
- Dealer did not stick to committed time

f) How those problems were solved?

- Got help to complete the paper from friends who earlier got the projects
- Visited department office to sort out the problem
- The field staff of the department provided help and support
- Had a detailed discussion with the dealers of the company

g) If not satisfied with services then what were the problems?

- Drip and filters are blocked very frequently
- Every work done by dealer and no local service providers
- Average farmers do not have much knowledge about the procedure and formalities.

h) How the problems were solved?

- Used acid to unblock the filters and drips

i) What are the reasons of dissatisfaction?

- Material supplied is sometimes of not good quality
- Drip system is not working properly
- Subsidy often comes late and sometimes not released same year
- Online system cannot be adopted by ordinary farmers
- Ordinary farmer do not have knowledge about this system

j) What are your suggestions for improvement?

- More involvement of the Department in implementation
- Early release of subsidy should be ensured.
- Less dependence on company dealers
- Quality of material should be ensured.
- There is a need of more transparency.

- Farmer should be made aware of procedure by workshops.

k) Farm level constraints in adoption

- Farmers do not have more knowledge about water saving techniques.
- High cost of drip system - poor farmers unable to share cost
- Farmers do not have full knowledge about the quality of materials supplied
- Drip system use is limited to few crops mainly Cotton
- Department should organize awareness camps in the field for the benefit of farmers
- Farmers have to depend on dealers and their dealings lack transparency.
- As of now, only GST is to be paid and rest installation is free, so farmers generally do not complain.

6.1 ANALYSIS OF DATA OF BHIWANI DISTRICT

6.1.1 Block Bahal – Total Number of Farmers 25

1. **Basic information about the respondent farmers:** All the farmers were of general category. The population was well spread in all the categories of farmers. The water table depth varies from 106 to 270m which is very deep. The water availability is inadequate and water quality is poor. None of the farmers got their soil tested.
2. **History of irrigation systems operation in the project area:** The tube well irrigation came in the project area around 1978-79. After a gap of fifteen years, the sprinklers were introduced around 1995-96. This was followed by drip irrigation around in 2010-11 and mini sprinklers in 2015-16. It is interesting to note that all the MI systems were operational and kept in fully functional condition by the farmers. It is apparent that without MI systems, the farming in this area is simply not possible.
3. **History of implementation of Micro-Irrigation Projects:** The farmers applied for MI systems around 2014-15 onwards. They were given full information about the project procedure and details. The farmer's case was sanctioned in the same year of application. As regards the amount of loan and subsidy, the farmers had no information and this data was taken from records. Farmers reported some problems in processing the cases like late sanction and over dependence on dealers who compromised on transparency.
4. **Planning of the MI projects:** The projects were planned either by the dealers of the company or by the staff of the department. All the farmers participated in the planning of the project and the design was made with their consent. Almost all farmers were satisfied with the services of the department. It appears that everything went well at the planning stage.
5. **Impact of the project on ground water:** By and large there was rise of 2 to 5m in water table after the monsoon rains as less numbers of irrigations were applied. However, the correctness of information is not sure because there was no mechanism to record the ground water level. Farmers generally reported that ground water level has gone down by 10 to 15 m in last ten years because of the installation of more and more tube wells in spite of considerable saving in irrigation water by MI systems. There is good quality water in

upper layers but as the water table goes down, the quality of water deteriorates. Extraction of water from deeper layers and less recharge due to low rainfall is leading to water quality problems.

6. **Labor and financial saving in irrigation operations with the MI system:** The farmers clearly reported substantial savings in labour cost upon shifting from flood irrigation to sprinkler and further on to drip irrigation. One acre irrigation takes 12, 7 and 2-3 hours in case of flood, sprinkler and drip irrigation. The respective cost of one acre irrigation is Rs 4000, Rs 2800 and only Rs 1200. The money saved is Rs 1200 per acre over flood irrigation to sprinkler and Rs 1600 from sprinkler to drip irrigation. The domestic labour cost per year was Rs 9000, Rs 6000 and Rs 2000 with flood, sprinkler and drip irrigation. Accordingly, the yearly monetary saving over flood irrigation was Rs 3000 with sprinklers and Rs 4000 further from sprinkler to drip irrigation.
7. **Summary of the cost of cultivation, gross and net returns from three irrigation systems:** There was progressive increase in total net returns of 25 farmers from flood to mini sprinkler and then to drip irrigation (Figure 6.1).

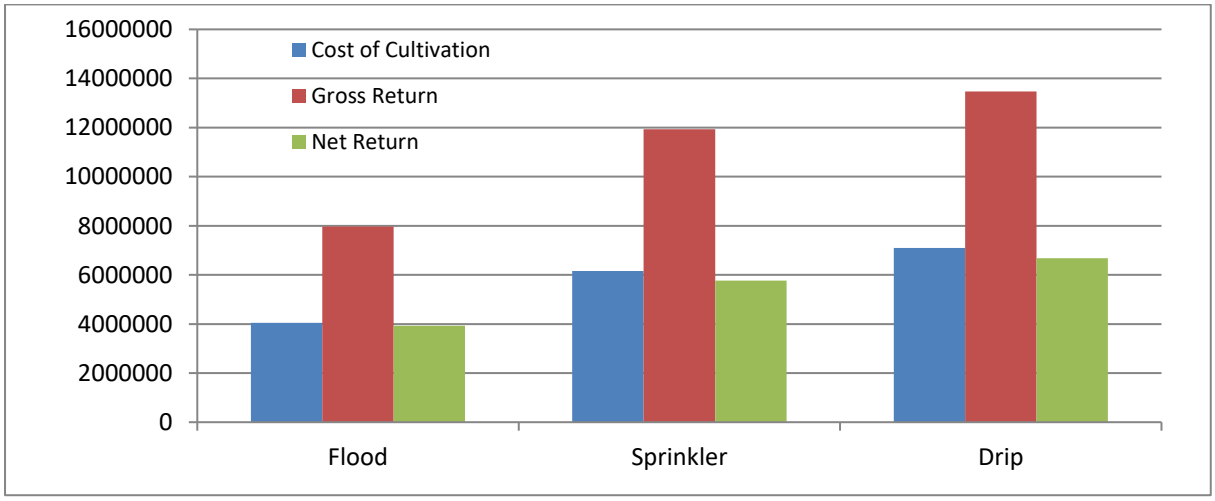

Figure 6.1: Cost incurred under flood, sprinkler and drip irrigation systems

8. Gross returns and cost of cultivation per acre is given in Table 6.1. This data was used to work out net returns of each farmer given at SN 7

Table 6.1: Gross return and cost of cultivation of different crops

Name of crop	Bajra SP		MustardSP		Cotton SP		Cotton DP		Wheat SP	
Crop particular	GR	CC	GR	CC	GR	CC	GR	CC	GR	CC
Total	451000	303300	841900	354640	1084500	526890	1206000	568190	930430	425680
Mean	18792	12638	35079	14777	45188	26345	50250	25827	38768	17737
BC Ratio		1.49		2.37		1.71		1.94		2.18

GR = Gross Return, CC = Cost of Cultivation;

8. Pearl millet, Mustard and Wheat were sprinkler irrigated and Cotton was sprinkler irrigated only up to boll formation in one case and complete drip irrigated in second case. Mustard with low in put cost, good yield and market price gave the highest benefit cost ratio. Relatively high cost of irrigations and labour in picking reduced its gross returns. Wheat is sold at support price and Wheat straw fetch good price which provide good benefit cost ratio.
9. **Status of livestock with farmers before and after the adoption of MI system:** The numbers of Buffalo **increased from 55 to 69 after the MI project but number of cows decreased from 23 to 11.** There was thus 25 percent increase in number of buffaloes after the project but 50 percent reduction in case of cows. As such, there was no income to farmers from the livestock component as all the milk was used at home.
10. **Annual income of farmers from different sources:** The annual income of a family was primarily from agriculture and it was Rs 157100, 230607 and 267859 with flood, sprinkler and drip irrigation, respectively (Figure 6.2) which was 46.8 and 70.5 percent higher in sprinkler and drip irrigation, respectively over flood irrigation. Only one farmer got income of Rs 12000 from fruit plants raised with drip irrigation. There was no income from livestock component also.

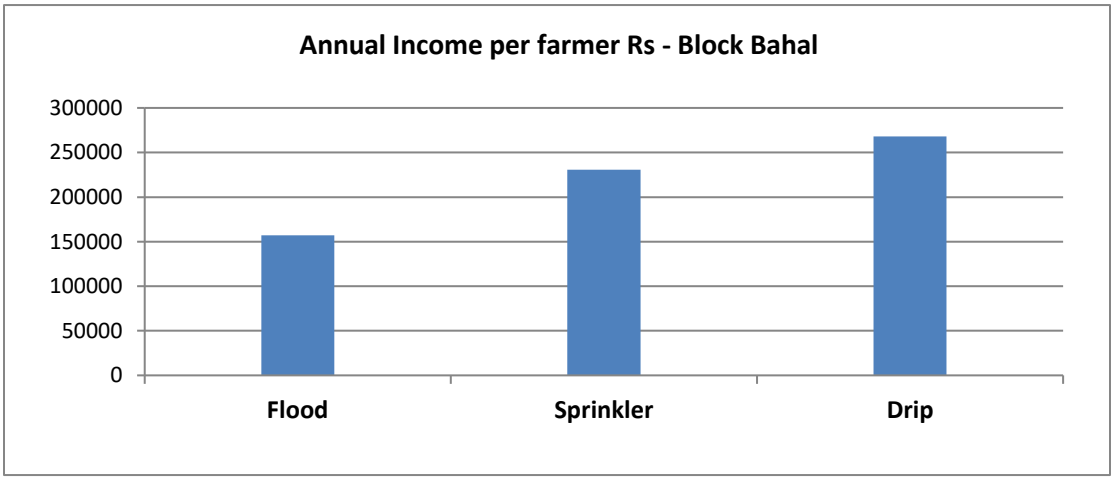

Figure 6.2: Comparison of annual income per farmer under flood, sprinkler and drip irrigations

6.1.2 Block Tosham District Bhiwani – Total Number of Farmers = 25

1. **Basic Information of the respondent farmers:** Except one, all other farmers were of general category. The farmers are well spread in small, marginal and large category. In Alampur and Sandwan village, the water table is 45 to 70 and 70 to 90m respectively but in other villages, it is almost 100m and above. It is strange that none of the farmers got their soil tested. The irrigation water availability is generally inadequate and water quality is poor.

2. **History of M.I system operations in the project villages:** The history of MI system operations started with installation of tube wells from 1975 onwards and this was followed by the entry of large size sprinklers in 1982-83 onwards. The mini sprinklers and drip system came at the same time around 2011-12 but expanded from 2016-17. It is pertinent to note that all the systems are in operation and kept fully functional by the farmers. It appears that this MI system has become a dire necessity for sustainable farming in this area.
3. **Implementation of Micro-Irrigation Projects:** The implementation of M.I Projects started in Tosham block around 2010-11 but farmers were not given full information about the procedure, policies and financial details. Farmers started applying from 2010-11 onwards and even as late as 2019-20. The cases were sanctioned in the same year of application. The amount sanctioned and subsidy was credited in the account of the farmers as noted from the records of the department. Most farmers did not face any problem in the sanction of their cases.
4. **Details about planning of the projects:** The cases were planned either by the Department Staff (A.I) or by the dealers of the company. All farmers participated in planning and their cases were planned with their consent and there was no problem in installation. About the satisfaction of the farmers about services by the dealers, there is a mixed response. Some farmers are not satisfied with the services provided by the dealers mainly because of lack in transparency.
5. **Post-project impacts:** There is always some rise in water table in post monsoon period both before and after the MI projects. This is mainly because of less extraction during rainy season as some irrigation is skipped. No more tube wells are being installed now in the villages as saturation level has reached. Farmers admit that water extraction is much less with MI system but number of bore wells increased to lower the water table. The good quality water in upper layers is almost exhausted. More the farmers go deep, bad quality water comes. The ground water recharge has been low due to low rainfall in the last couple of years
6. **Financial saving in irrigation operations:** The hours to irrigate one acre decreased from 10-12 hours to 7-8 from flood to sprinkler irrigation and further decreased to only 3 hours with drip irrigation. The cost incurred under drip was lowest as compared to flood and sprinkler irrigation (Figure 6.3). Similarly, there was saving of money from Rs1000 to 1500 with sprinkler and from Rs 1500 to 2000 on shift to drip irrigation. There was substantial reduction in labour cost per acre per year which is around Rs 9000, 6000 and only 2000 with FI, SI and DI, respectively. The yearly savings in labour cost over flood irrigation is thus Rs 3000 with sprinkler and Rs 4000 with drip irrigation per year.

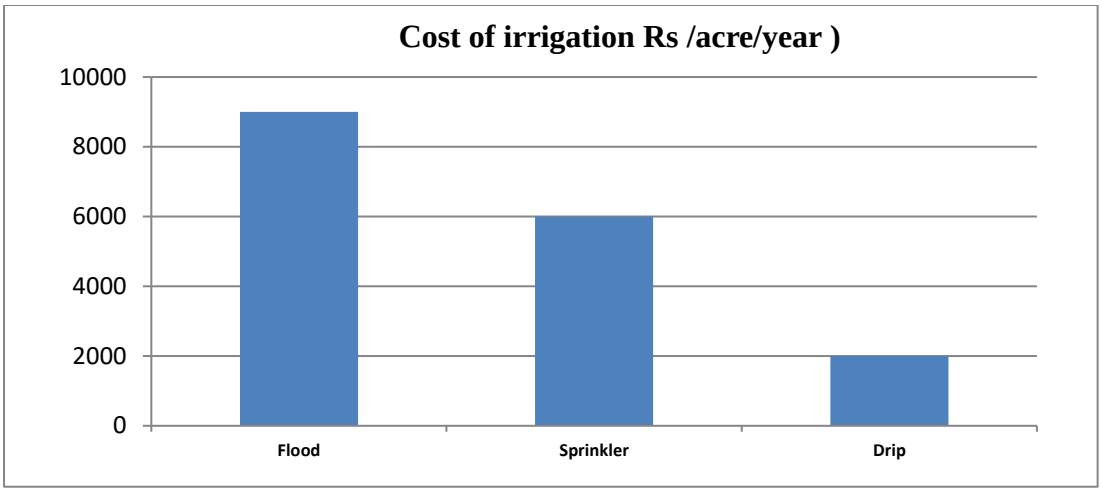

Figure 6.3: Cost of irrigation under different methods of irrigation

7. **Cost of cultivation, gross and net returns to farmers from three irrigation systems:** The total cost of cultivation, gross return and net return of 25 farmers from Flood irrigation was Rs.3580092, Rs.7566750 & Rs.3986878 and Rs.5211177, Rs.1310250 and Rs.5265453 with Sprinkler irrigation and Rs.5965200, Rs.12070040 and Rs.6154840 with Drip irrigation thus registering net income of Rs.159475, Rs.210618 and Rs.246194 per farmer from these three systems (Figure 6.4).The adoption of sprinkler system has resulted in substantial savings to the farmers and the adoption of drip has further added to the income.

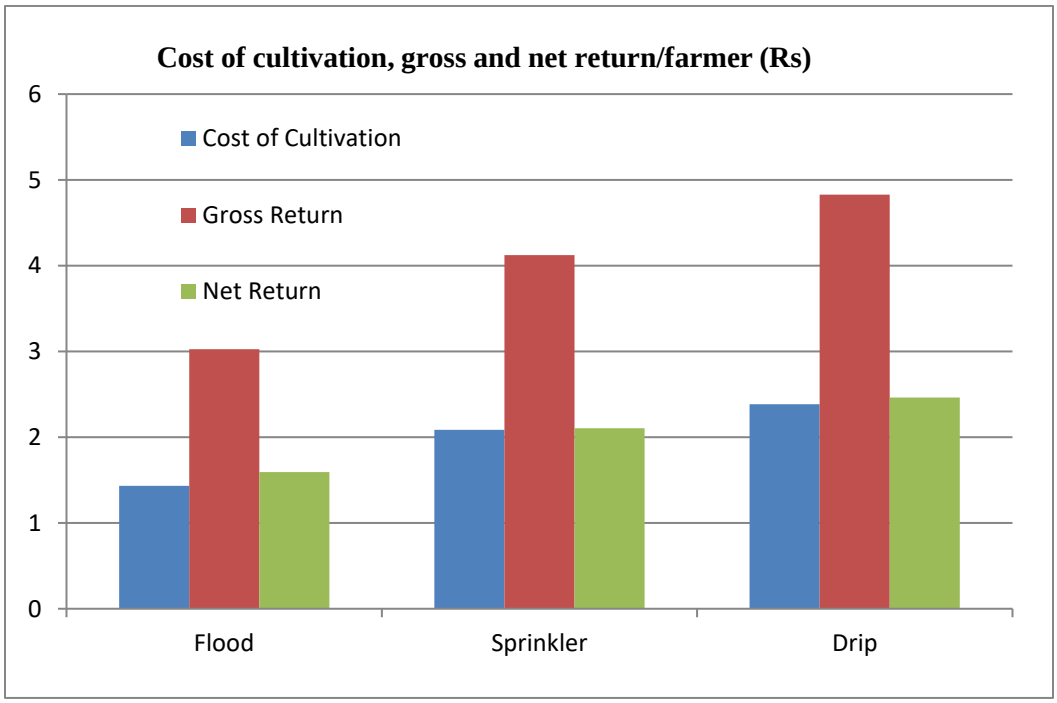

Figure 6.4: Economy under different methods of irrigation

8. **Gross returns and cost of cultivation of different crops in project area (Rs per acre)- data used in table no 6.2**

Table 6.2 Cost of cultivation and gross return of different crops under different modes of irrigation

Crops	BajraSP		Mustard SP		Cotton SP		Cotton DP		Wheat SP	
Particulars	GR	CC	GR	CC	GR	CC	GR	CC	GR	CC
Mean	**18600**	**11375**	**33496**	**12801**	**41508**	**24858**	**46029**	**24774**	**39760**	**18853**
BC Ratio		**1.63**		**2.62**		**1.67**		**1.86**		**2.11**

GR = Gross Return, CC = Cost of

The Wheat and Mustard provides the highest B:C ratio and returns per acre. More number of irrigations, labour cost on picking and pesticide sprays increases the cost of cultivation and hence less net returns from Cotton. Water use economy and low cost of drip irrigation is prompting farmers to opt for Cotton.

9. **Impact of Project on Livestock Population**: The number of animal mostly buffalo decreased from 109 to 37 after the adoption of MI system. The educated men and women find it difficult to rear animal. Shortage of fodder, no milk collection centers and milk plants in the area are the other reasons attributed by the farmers.
10. **Change in Annual Income of farmers with MI system:** There was no income of the farmers from orchards or livestock. Milk was used for home consumption. However, there was clear increase in agricultural income of 25 farmers from Rs 3939948 with flood to Rs 5243948 with Sprinkler and to Rs 6184560 (Figure 6.5) with Drip irrigation thereby registering an increase of 33 and 57 percent over flood irrigation.

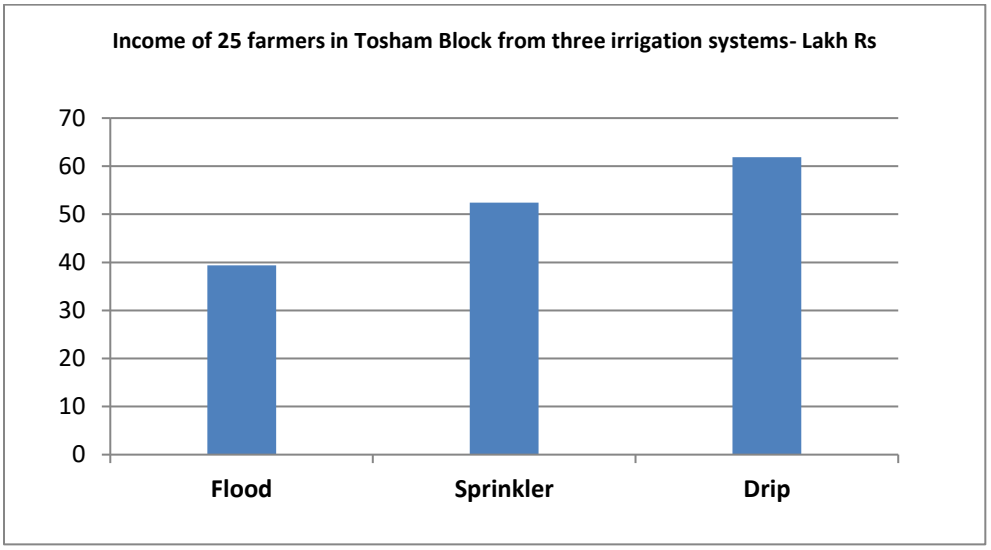

Figure 6.5: Total income of 25 farmers who used different methods of irrigation

6.2 Mahendergarh District

6.2.1 Block Ateli –Total Number of Farmers = 25

1. **Basic Information of the respondent farmers:** Most of beneficiary farmers of Ateli block are of OBC category and 54 percent of them are small and 46 percent are medium farmers and none is large farmer and this is unlike Bhiwani district. The water table depth varies from 100 to 215m and water availability is by and large inadequate but is generally of good quality. Here more than 50 percent farmers have done soil testing which was not there in Bhiwani area.
2. **History of irrigation operations in the project area:** The tube well irrigation in this area started around 1980 and all farmers were covered by 1985. However, the mini sprinkler and drip irrigation started around 2012 and is continued till now. It is interesting to note that all the MI systems were in operation and fully functional. It thus, appears that without MI system farming in this area is simply not possible and farmers keep the systems in operation all the time.
3. **Implementation of micro-irrigation projects:** The drip and mini sprinkler irrigation started around 2012 onwards. The farmers were given full information about the project. Their cases were sanctioned in the same year of application. The total sanctioned amount and subsidy data were taken from office records. The farmers did not face any problem in getting their cases sanctioned.
4. **Planning of the project:** The projects were planned by the company dealers and all farmers participated in the planning and design was made with the consent of the farmers. These farmers did not face any problem during installation and they were satisfied with the services provided by the department.
5. **Post project impacts:** There was always rise in ground water table after the monsoon season both before and after the project. This was because during rainy season, less numbers of irrigations were applied and hence less extraction and resulting in rise in water table. There is saving of water with MI but at the same time more numbers of bore wells have come up and thus caused drop in ground water level.
6. **Financial saving in irrigation operations:** There has been four to five hours of time saving to irrigate one acre of land with mini sprinklers over flood irrigation. As a result, there was saving in labour cost varying from Rs 1200 to Rs 2000/ acre. The yearly domestic labour cost decreased from Rs 9000/ acre to Rs 6000 to 6500/acre and thus money saved per acre was around Rs 3000.
7. **Summary table of cost of cultivation and net returns from flood and sprinkler irrigation:** Strange that there is no drip irrigation projects in Ateli block except one. The B: C ratio in flood and sprinkler irrigation was 2.21 and 2.93 (Table 6.3).

Table 6.3: Cost of cultivation, gross and net returns and B:C ratio of two irrigation Systems

Irrigation system	Flood Irrigation (Before Project)			Sprinkler Irrigation (After Project)		
Particular	CC	GR	NR	CC	GR	NR
TOTAL	2476673	5480072	3003399	2631357	7705875	5074518
B:C Ratio			2.21			2.93

CC = Cost of cultivation, GR = Gross return, NR = Net return

As compared to flood irrigation, the cost of cultivation decreased with mini sprinklers in those cases where land area irrigated remained the same. However, it increased when more area was brought under irrigation after mini sprinkler irrigation came. The fact remains that there was substantial increase in farm income after the mini sprinkler system was introduced (Figure 6.6).

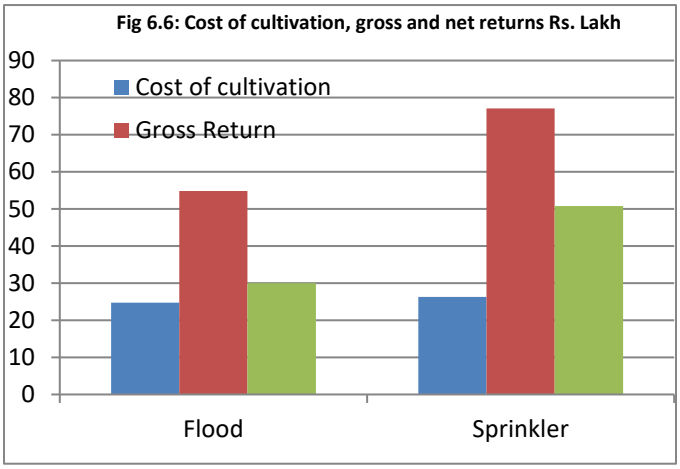

Figure 6.6: Cost of cultivation, gross and net return under flood and sprinkler irrigation

8. **Gross returns and cost of cultivation per acre-basic data used in cost/return tables:** It was observed from the data that Mustard crop provides the maximum BC ratio followed by Wheat crop. The cost of cultivation in Cotton is relatively high due to large number of irrigations and picking charges and pesticide sprays and hence its BC ratio is relatively low (Table 6.4).

Table 6.4: Gross returns, cost of cultivation and B:C ratio of different crops.

	Bajra		Mustard		Cotton SP		Cotton DP		Wheat	
Particulars	**GR**	**CC**	**GR**	**CC**	**GR**	**CC**	**GR**	**CC**	**GR**	**CC**
MEAN	**23539**	**9445**	**43719**	**12028**	**45060**	**21180**	**46200**	**25850**	**46071**	**15975**
BC Ratio		**2.49**		**3.63**		**2.13**		**1.79**		**2.88**

CC = Cost of cultivation, GR = Gross return

9. **Impact of the MI project on livestock population:** The farmers are not keeping livestock in sufficient numbers i.e. only 15 animal by 25 farmers before and 10 after the project. There was no impact of the MI project on livestock population of the project area. In fact, some farmers removed livestock. There is no income from livestock component. Educated families are not interested in animal rearing and there are no milk collection centers.

10. **Annual income of farmers from flood and micro irrigation:** The overall total family income of 25 farmers was Rs.3003399 under flood irrigation and Rs.5217538 under micro irrigation thereby registering an increase of 57.56%. There was no additional income from livestock or fruit plants.

6.2.2 Block Narnaul – Total Number of Farmers = 25

1. **Basic Information of the respondent farmers (**Type of Farmer: up to 5 acre = SF, 5-10 = MF and above 10 = LF): All the 25 sample farmers belong to OBC category. More than 40% are small, another 40 percent are medium and the rest are large farmers. The water table is very deep and varies from 130 to 300m and it is in adequate and quality is generally good but medium at few farms.
2. **History of M.I system operations in project area**: The tube well irrigation in project area started around 1968 and bigger sprinklers got introduced around 2007-08. However, the mini sprinklers and drip irrigation came around 2017-18. It is interesting to note that all the irrigation system are operational and fully functional indicating that these have become an absolute necessity for sustain agriculture in this area.
3. **Details about implementation of micro-irrigation projects:** The ordinary sprinkler started in these villages around 2008. The farmers agree that they were given complete information about the project at the stage of application. Most of them started applying around 2016-17 and their cases were sanctioned in the same year. The data about the amount sanctioned and subsidy credited was noted from the records of the department. It varied depending upon category of farmer. They faced no problem in getting their cases sanctioned.
4. **Planning of the project:** All the planning was done by the dealer of the company but farmers participated in the planning and design was made with their consent. None of them faced any problem in installation and they are satisfied with the services provided.
5. **Post Project impacts on ground water table:** In case of submersible motors, there is no precise indication of the ground water table. Generally, when water table goes down, more pipes are added to increase the depth of extraction. At that time motors are taken out, depth to water table comes to be known. As such, there was rise in ground water level after the monsoon season both before and after the project. This is mainly because less irrigation is applied during rainy season resulting in less extraction and hence rise in water level. As such, the water table went down as more numbers of bore wells were installed.
6. **Financial saving in irrigation operations**: It took 12 to 14 hours to irrigate one acre of land with flood irrigation but only 8 to 9 hours with sprinkler, 6 hours with mini sprinkler and only two hour with drip system. The labour cost for watering one acre was Rs 4000-4500, 2800-3500, 1250 and 350 with flood, sprinkler, mini and drip respectively. Accordingly, the money saved per acre varied from Rs 1000 to 1500, 2250 and 4150 in case of SP, Mini and DP irrigation. The annual labour cost per year varied from Rs 8000 to 8500, 6000 to 7000, 4000 and Rs 2000 with flood, SP, Mini and DP irrigations system.

The annual saving varied from Rs 1500 to 3000, 4000 and 6000 to 7000 in case of SP, Mini and DP system of irrigation. It is quite evident these modern irrigation systems resulted in lot of labour saving to beneficiary farmers.

7. **Summary table of cost of cultivation, gross and net returns of farmers in three irrigation systems:** There was overall increase in net returns per farmer from Rs 166393 to 408809 i.e. by 146 % with mini sprinkler irrigation over flood irrigation. Though cost of cultivation increased in case of farmers who increased area under sprinkler irrigation due to saving in water but even then there was substantial increase in net returns. The benefits of MI systems have been clearly brought out by this data. It is pertinent to note that drip irrigation could not become common in Narnaul area.
8. **Cost of cultivation (CC) and gross returns (GR) per acre of common crops (Rs):** The benefit cost ratio of sprinkler irrigated Mustard is highest followed by drip irrigated Brinjal crop. The B:C ratio of Cotton is low because of higher cost of cultivation which include more irrigation, picking and pesticide spray costs(Table 6.5).

Table 6.5: Gross returns, cost of cultivation and B:C ratio of different crops with irrigation systems

	Bajra SP		Mustard SP		Cotton SP		Brinjal DP		Wheat SP	
Particulars	**GR**	**CC**	**GR**	**CC**	**GR**	**CC**	**GR**	**CC**	**GR**	**CC**
MEAN	24909	8828	43724	10556	38138	20720	254000	82220	46162	15856
BC Ratio		2.82		4.14		1.84		3.08		2.91

CC = Cost of cultivation, GR = Gross return SP and DP stand for sprinkler and drip, respectively

9. **Impact of MI projects on livestock population:** There were only 24 buffalo and 2 cows with 25 farmers before the project and the same decreased to 10 buffalo and 2 cows after the MI project indicating no interest of farmers in livestock rearing.
10. **Annual income of beneficiary farmers from three different sources (Rs):** There was no income of farmers from livestock and horticulture but combined income of 25 farmers from agriculture increased substantially by Mini sprinkler irrigation from Rs 4159826 in flood to Rs 7259185 under sprinkler registering an increase of 57.3 percent.

6.3 District NUH

6.3.1 Block Nuh – Total Number of Farmers = 25

1. **Basic information of the respondent farmers:** All the farmers belong to OBC category and more than 60% are small farmers and rest is medium and large farmers. The water table is quite shallow and varies from 3 to 10m, 10 to 20 and more than 20 in few cases depending upon distance from the Aravali Hills. Area is irrigated by bore wells. Only 20% farmers got the soil tested. The water availability is in adequate but it is of good quality as the study villages are located in the foot of Aravali hills.

2. **History of M.I system operations in the project area:** The tube well irrigation in this area started around 1968 and got expanded up to 1975. It is interesting to note that both sprinkler and mini sprinkler are not popular in this area. This is contrasting to Narnaul where Mini Sprinkler was most popular and in Bhiwani all three were common. The drip irrigation started from 2007-08 and continued to expand up to 2019-20. All the drip systems are in operating condition and are fully functional. It appears that drip has become very popular with these farmers mainly because of vegetable cultivation.
3. **Implementation of micro-irrigation projects in the project area:** The drip irrigation system started in 2007 in these villages and more expansion was seen around 2012 and further expansion very recently from 2018 to 2020. The cases were submitted in different years but the fact remains that all the cases were sanctioned in the same year. Most farmers faced problems in sanction which were mainly created by the dealers of the company. The farmers have no knowledge about the amount sanctioned and subsidy given because this detail remained up to the level of dealers and farmer paid only his share of cost.
4. **Planning of the project:** It is interesting to note that all the cases were planned by the dealer of the company and all farmers participated in the planning and the design was prepared with their consent. They did not face any problem in installation. Yet the farmers are not satisfied with the services of the department due to very little back up support and made farmers to depend solely on dealers and whose dealings were not fair.
5. **Post Project impacts on water table:** The water table depth was highly variable in these villages. In some cases, it was just 2 to 3 meter indicating nearly waterlogged conditions. But in some cases, it was up to 30m deep. The fact remains that there was rise in water table at variable rate after the rainy season both before and after the project. It is understandable because less numbers of irrigations were applied in the rainy season leading to less extraction and hence rise in water table. All farmers perceived that water table has gone down even after drip irrigation simply because numbers of tube wells have gone up.
6. **Financial saving in irrigation operations:** The time to irrigate on acre of land is 8 to 12 hours with flood irrigation but only 2 hours with DP used in case of vegetable crops. The labour cost of one acre of land per irrigation varies from Rs 400 to 500 in case of flood irrigation but Rs20 to 50 in case of DP irrigation. The money saved per acre per irrigation accordingly is from Rs 175 to 479 with DP. The annual savings per acre varies from Rs 2625 to 3353 with DP. The data above clearly depicts the substantial saving in labour, energy and money on the adoption of drip irrigation.
7. **Cost of cultivation and gross return per acre of different crops:** The costs of cultivation of crops have consistently decreased after the adoption of the MI system whereas the gross returns have consistently increased. The farmers have stopped the cultivation of paddy crop. The BC ratio was highest in case of mustered followed by drip irrigated vegetable crop (Table 6.6).

Table 6.6: Cost of cultivation and gross return of different crops before and after MI system

Crop	Bajra				Fodder				Paddy			
	CC		GR		CC		GR		CC		GR	
	Before M.I. Flood	After M.I. SP	Before M.I Flood	After M.I. Sp	Before M.I. Flood	After M.I. Sp	Before M.I. Flood	After M.I. Sp	Before M.I. Flood	After M.I. Sp	Before M.I. Flood	After M.I. Sp
MEAN	**9545**	**9132**	**16000**	**19000**	**6000**	**5000**	**10000**	**12500**	**25500**		**42000**	
BC			**1.67**	**2.08**			**1.66**	**2.5**			**1.65**	

CC = Cost of cultivation, GR = Gross return

Crop	Wheat				Mustard				Tomato (Veg.)			
	CC		GR		CC		GR		CC		GR	
	Before M.I. Flood	After M.I. Sprinkler	Before M.I. Flood	After M.I. Sprinkler	Before M.I. Flood	After M.I. Sprinkler	Before M.I. Flood	After M.I. Sprinkler	Before M.I. Flood	After M.I. Drip	Before M.I. Flood	After M.I. Drip
MEAN	**20200**	**15700**	**32668**	**36800**	**13280**	**12198**	**37700**	**37700**	**110650**	**98150**	**180000**	**231360**
BC			**1.61**	**2.34**			**2.84**	**3.09**			**1.63**	**2.36**

CC = Cost of cultivation, GR = Gross return

8. **Summary table of cost of cultivation, gross and net returns and benefit: cost ratio:** After the adoption of micro irrigation system, there was increase in the cost of cultivation basically because more area was brought under micro-irrigation. However, there was increase in the gross return per farmer from Rs.6.80 to 12.75 Lakh and simultaneously the net return also increased from Rs.3.22 to 7.55 lakh thereby proving the economic viability of the micro irrigation system. The overall BC ration also increased from 1.90 to 2.45 after the adoption of the micro irrigation system.

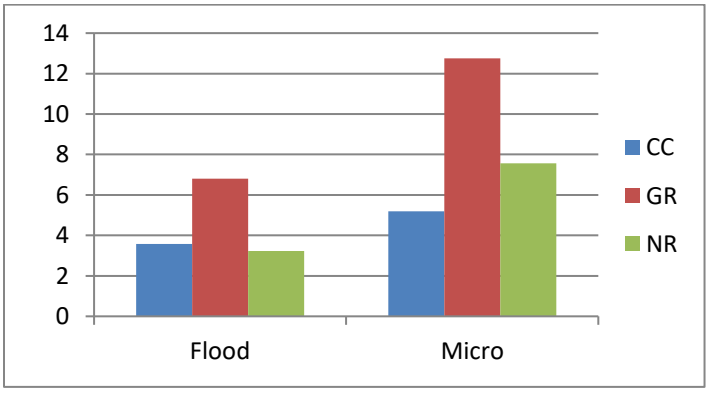

Figure 6.7: Income under different irrigation methods

Status and income from fruit crops to the farmers before and after the MI system: Five farmers raised 875 fruit plants over an area of 2.3 acres in 2017 under drip system and two of them earned an income of Rs 24000.

9. **Livestock status and income to farmers before and after MI project:** Every farmer kept one or two buffalo before the project and total number with 25 farmers was 38 and net income of those who sold milk was Rs 165600. This increased to 66 buffalo after MI system and income from milk increased to Rs 986400. Better breed of buffalo were introduced. The number of cows decreased from five to two.
10. **Annual income of farmers from flood and micro irrigation:** The total agriculture income in case of flood irrigation was Rs.80.67 lakh which increase to Rs.161.19 lakh thereby registering an increase of 49.80%. Similarly incase of livestock component there was increase from Rs.2.32 lakh to Rs.10.94 Lakh thereby registering an increase of 371% (Table 6.7).

Table 6.7: Annual income of farmers before and after micro irrigation

Particulars	Flood Before					Micro Irrigation (Drip + Sprinkler)				
	Agri	Orchd	Livestock	Wage	Total	Agri	Orcd	Livestock	Wage	Total
TOTAL	**8067125**		**232200**	**214500**	**8513825**	**16197158**	**24000**	**1094400**	**168000**	**17483558**
Average	322685		33171	71500	340553	647886	12000	66456	84000	699342

6.3.2 Block Nagina – Total Number of Farmers = 25

1. **Basic information of the respondent farmers:** All the respondent farmers belong to OBC category and sample population is almost equally divided into small, medium and large category. The sample farmers belong to Muslim community sharing similar social and cultural traditions.
2. **Land ownership and groundwater details:** The depth to water table is more than 20m in all the 25 cases. Fifty percent farmers have got soil tested. The entire area is tube well irrigated but the availability of water is inadequate in all cases. The quality of ground water is variable and range from average to poor as per the location of the villages and location of farm. Those which are located close to the hills have good quality water. The quality deteriorates as the farms go away from the hills. The runoff from the Aravali hills is the main source of good quality water.
3. **History of irrigation sources in the project area:** The tube well irrigation in the project area came around 1968 and quickly got expanded. There are no sprinklers in this area except three cases and drip irrigation has become most common. It started in 2008 in one village but gradually expanded. It is interesting to note that all the MI systems even the older ones are in operation and fully functional. It appears that this DS has become very popular and farmers are keeping the systems as integral part of the farm operational system.
4. **Implementation of micro-irrigation projects in selected villages:** The drip system started in 2008 in some villages and most farmers installed it by 2012. The beneficiary farmers were given full information about the project. Their cases were sanctioned in the same year in which these were applied. They do not have any information about amount sanctioned and subsidy given since they totally depended on the dealer of the company.

They remember to have given their cost share to the dealer. There was mixed reaction to the problem faced in the approval of cases. Majority of them say no, some do not want to comment and some said yes.

5. **Planning of the project:** The project was planned by the dealer of the company and they participated in the planning and the design was made with their consent. Moreover, these farmers did not face any problem during installation of the system. Yet many of them are not satisfied with the services of the department because they were left at the mercy of dealers and farmers had no faith on them.
6. **Post project impacts:** It is clear from the data that there was 2 to 4m rise in water table after the monsoon period both before and after the project. This is understandable as during the rainy season less irrigation were applied and there was less extraction of ground water and hence rise in level. However, in the post project period, the water table went down both before and after monsoon. It was reported by the farmers that after noticing the benefits of the drip system many more farmers installed tube wells and more the tube wells means more ground water extraction resulting in lowering of water table. All farmers agree to this impact on ground water.
7. **Financial saving in irrigation operations:** The time to irrigate one acre varies from 8 to 20 hours in flood irrigation, 5 to 6 hours in SP and only 2 hours in drip. Accordingly, the labour cost/acre is Rs 500 to 800 in flood, Rs 100 to 200 in SP but only Rs 25 to 100 in drip irrigation. The money thus saved is Rs 250 to 400/acre/irrigation in SP and Rs375 to 750 in DP. The domestic labour cost varied from Rs 2800 to Rs 5600/ year in flood irrigation depending upon the size of the farm. However, in case of SP and DP, such a cost was only Rs 700 to 1400 and Rs175 to Rs700 respectively. The annual saving in irrigation cost/acre over flood irrigation varied from Rs1750 to Rs 2800 in SP and Rs 2275 to Rs 5250 in case of DP. It is evident that the MI systems resulted in substantial saving in labour cost of the farmer.
8. **Livestock status with farmers before and after MI projects and effect on annual income:** The combined livestock numbers before the MI project was 48 both buffaloes and cows which increased to 58 buffaloes and 7 cows. Similarly, the total income from livestock increased from Rs.7.56 lakh to Rs.11.68 lakh registering an increase of 64.72 %. This is also due to improvement in breed of livestock.
9. **Summary table of annual ancome with flood and MI systems:** The main increase has come from Tomato cultivation with drip irrigation system. The net income of 25 farmers was Rs.127.03 lakh in case of flood irrigation which increased to Rs.271.05 lakh under drip irrigation registering an increase of 44.25 percent. The BC Ratio was 1.79, 2.35 and 2.41 under flood, sprinkler and drip irrigation (Table 6.8).

Table 6.8: Summary table of annual income with flood and MI system

Particulars	Flood			Sprinkler			Drip		
	Agri	Livestk	Total	Agri	Livestk	Total	Agri	Livestk	Total
TOTAL	**11996950**	**706500**	**12703450**	**1099402**	**226800**	**1326202**	**25874161**	**1231200**	**27105361**
MEAN	**479878**	**37184**	**508138**	**219880**	**113400**	**265240**	**1034966**	**72424**	**1084214**

10. Summary table of annual net returns of 25 farmers of each block across districts

It was noted that in case of Bhiwani district covering data of Bahal and Tosham blocks the annual net returns was from all the three components namely flood, sprinkler and drip irrigation (Table 6.9).

Table 6.9 Annual net returns gained by farmers of different districts under different mode of irrigation

District	Block	Annual Net Returns of 25 farmers(lakh Rs.)			
		Flood	**Mini Sprinkler**	**Drip**	**Main Source**
Bhiwani	Bahal	39.2	57.6	67.0	Cotton
	Tosham	39.4	52.4	61.8	Cotton
M. Garh	Ateli	30.3	52.7		
	Narnaul	41.5	72.59		
Nuh	Nuh	85.1		174.8	Vegetables + Livestock
	Nagina	127.03		271.05	Vegetables + Livestock
Labour cost Rs/ acre/year		9000	6000	2000	

In case of Mahendergarh district the main focus remained on flood and sprinkler irrigation and drip system was not adopted because of heavy nature of soils. While in case of Nuh district, the sprinkler system was not adopted by the farmers and only flood and drip irrigation were adopted. The sprinkler irrigation couldn't become possible because of heavy nature of soils and problem of salinity.

It may be noted that drip irrigation adopted on Vegetable crops gave the highest annual net returns in case of both the blocks of Nuh district. The net returns both under flood and mini sprinklers were better in Narnaul block of Mahendergarh district than blocks of Bhiwani district.

CHAPTER-7

DISCUSSIONS WITH THE OFFICERS AND SCIENTISTS OF PROJECT AREA

7.1 Points emerged out of discussion with the Additional Director Agriculture (Soil Conservation)

On 16.09.2020, we had discussion with Dr. Anil Rana Additional Director (Soil Conservation) Farmers Welfare and Agricultural Department Haryana in his office. Along with him Sh.Kuldeep Gautam, Sh.Chet Ram Head Draftsman and Sh. Gourav Technical Assistant were present. Following points emerged:

- Now state Government has notified to constitute a "Micro-Irrigation Authority and in future all micro irrigation schemes (drip, sprinkler and mini-sprinkler) will be looked after by them. System of transfer from Agriculture and Horticulture is under process.
- Separate Portals of sprinkler / drip / mini-sprinklers are being maintained by both Agriculture and Horticulture separately.
- There is Government order to draw the subsidy of drip irrigation on all field crops by the Agricultural Department while on Vegetables and Fruit Crops by the Horticultural Department.
- Now subsidy is being disbursed immediately and there is no time lag as it used to be earlier.
- Now the subsidy is availed through the HDFC Bank where subsidy amount is deposited by opening a virtual bank account and farmer need not to give advance cheque to the dealer / suppliers of the set. This virtual account is opened in the name of the farmer to whom the set is supplied.
- All dealers / company supplying sprinkler / drip / mini sprinklers are registered by the Agriculture Department only and the same will be applied to Horticultural Department.
- There are complaints that drip sets on Vegetable crops are being given more than the area under Vegetables in these districts. So, the Government has ordered the Girdawari of each plot in the state where subsidy was given.

Photo7.1: Meeting with Additional Director Agriculture at Chandigarh

District Bhiwani

7.2 Discussions with Sh. Mahavir Sangwan, Technical Expert District Administration, Bhiwani on 03.09.2020

Mr. Sangwan has worked in this area since last 40 years in different capacities and also belongs to this area. We discussed the issues concerning sprinkler / mini-sprinkler / drip irrigation system with him. The summary of discussion is given as under.

- Sprinkler in this area was introduced in 1976 and they themselves purchased one set of aluminum- based from M/s Premier Irrigation Ltd. in 1981 and it is still working.
- Subsidy on different sprinkler system went on changing from time to time, first it was 25% of the cost, and then fixed at Rs.4000/set and now it is almost 85%.
- There is no after sale service of the sets as it used to be in the earlier time. Previously, the company representative used to visit villages to check the working of the sets. Now it is stopped resulting into many sets went out of order.
- At present, there is not proper supply of material and there is no quality check by anybody. The samples of the sets should be taken by the district level committee to check the quality of material and action be taken if found of poor quality. Now samples can only be taken by the HQ which they seldom visit.
- There is no system of addressing the grievances of farmers and for this there should be a toll free number and it should be properly followed. It has to be at district level.
- Pipe and other material of the system should be purchased from any dealer / companies with proper ISI marked and not only from the registered supplier which they exploit the farmers.
- Checking / verification of material at site as per bill should be within a specific time otherwise delay brings more malpractices.
- There could be a cluster approach for an area of say 500 – 1000 hectares which can be given to one or two companies (specified) to supply the material and do its proper maintenance if required.
- For Cotton crop, drip is very useful and it is the only cash crop for this area in Kharif. However, in Rabi season Mustard is the cash crop.
- Cotton is very suitable to the climate during its growth and up to maturity.
- Mini sprinklers are more in demand as compared to sprinkler system due to its easy handling and can be operated on low pressure.
- Sprinklers are not found suitable at the time of flowering as due to its more pressure pollens are washed away which affects the yield of crops.
- Due to a provision of 85% subsidy to the farmers on drip / sprinkler / mini sprinkler it is almost free to farmers. Therefore, farmer does not bother whether he is getting full material (as claimed in the bill) or its quality and it give rise to short supply of material and also to poor quality of the material he is getting. So, there should be an element of

cost sharing, may be 25% on the part of farmers so that he can show some concern to look after it and also its quality.

- Cost of drip set is Rs.41630 plus 50% fitting charges, which comes to Rs.37154/- as 85% subsidy amount.
- Hand written bills are raised many a time, these should be printed with proper bill no. (With a copy with supplier / dealer) so that it can be verified.
- There is multi dealer ship with many dealers and they can supply material of any company but on the other hand he may not be having material of that particular company in his stock.

7.3 Interaction with Scientists of Krishi Vigyan Kendra Bhiwani on 04.09.2020

It was considered necessary to ascertain the view of scientists of KVK Bhiwan because they remain in contact with farmers during different training programs and workshops. Four scientists were available i.e. District Extension Specialist Agricultural Economics, Horticulture, Agronomy and Agricultural Engineering. The Horticulture scientist was new and shared the list of some progressive Fruit growers and informed that area under Horticulture is limited but one Kinnow grower could get net income of Rs one lakh per year. The agriculture engineering specialist informed that the KVK provides trainings in energy saving, maintenance and efficient management of drip and sprinkler system. Generally, farmers report good income from MI and there is huge labour and water saving.

Photo 7.2: Meeting with Scientists of KVK Bhiwani on 3.9.2020

The main discussion revolved around cost of cultivation of different MI irrigated crops and their net returns. The economics scientist shared the format in which he is collecting data.

Some details of the cost of cultivation as per HAU norms are given below:

a) Cost of cultivation is divided into material and labour and labour is further divided into human, draught (bullocks), farm machinery (tractor hours).
   We are taking total cost of tillage, including preparatory and inter-culture etc.
b) The cost of laser leveling has been taken but once the field is laser leveled, it is used for 2 to 3 crop years. Moreover, drip / sprinklers are used on uneven sloping lands. Laser leveling would be required for basin / flood irrigation. We are not taking the cost of laser leveling in the total cost of cultivation.
c) He has taken green manuring in Kharif but we have not seen any crop raised for green manuring in our project villages.
d) Cost of sowing + ridging has been kept separate but in our case cost of ridging is not taken separately.
e) Cost of FYM taken separately.
f) In cost of fertilizers, cost of growth promoters is added which no farmer has used.
g) Interest on working capital @4.5% has been taken.
h) Under variable cost, additional costs have been loaded
   i. Transportation cost
   ii. Rental value of land
   iii. Management and risk charges @ 20%

- Taking g + h over other costs makes farming an unviable proposition
- The gross returns would be very negligible. However, in few publications of HAU on economic analysis, these variable costs have not been included.
- As per HAU (Economist Bhiwani), the economics is as under

Table 7.1 Economics of cultivation of different crops under MI method of irrigation (Rs. per acre)

Crops	Gross Income	Cost of Cultivation	Net Income
Bajra	26800	15635	11185
Wheat	38800	28000	11500
Mustard	45850	20000	23850
Cotton	55000	33816	22686

7.4 Discussion with the Divisional Soil Conservation Officer and District Horticulture Officer Bhiwani on 4.9.2020

The Divisional Soil Conservation Officer is the main controlling officer of the MI program on behalf of the Department of Agriculture Haryana. After fixing appointment we met him in his office where the HDO also joined (Photo 7.3). The DSCO briefed us about the detail of the MI program, achievements so far and its large number of benefits for this water starved district. We raised some implementation issues which farmers brought to our notice during meetings. Dr. Mukesh Yadav informed that most of the problems related to implementation have been solved

ever since the department started the portal system of submission of documents, sanction of cases and release of payment. The Department Officers verify the installation, get certificate of satisfaction from the farmer and then and only then the subsidy is released. Dr. Yadav informed that the department is facing extreme shortage of staff including the soil testing laboratories. The farmer is given a choice to select any of the company for processing the case and installation in the field. Some discrepancies were noted after receiving complaints from farmers and proper action was taken upon enquiry. He felt that since farmer is to pay nominal charges of GST in drip irrigation and rest of the cost is free to him, so if the system operates properly the farmer remains satisfied. He assured all help and assistance in the fair conduct of this useful study and assured that the recommendations of the study conducted by NABARD would be faithfully followed.

Photo 7.3: Discussion with the DSCO and DHO Bhiwani

The HDO informed that the area under Fruit and Vegetable crops is limited because there is not much water for large number of irrigations to vegetable crops. In case of Fruit plants, the gestation period is four to five years and ordinary farmers have no capacity for long wait to get returns. He however, informed that some progressive farmers have earned net income of more than one lakh per acre from Kinnow plantation. There is very high saving of water in drip irrigation and labour cost on irrigation is very nominal He informed that the MI procedure is same in both the departments except that horticulture department credit the subsidy in the account of dealer who has installed the system and got verification from the department and no objection to payment from the farmers. He laid stress on proper care of the equipment for its longer life.

District Mahendergarh

7.5 Interaction with Deputy Director Agriculture and his officers on 04.09.2020 at Narnaul

In this discussion, the following officers participated:

- Dr. Jaswinder Singh Deputy Director Agriculture, Narnaul

- Sh. Harpal Singh Sub-Divisional Officer Agriculture (9466817660)
- Sh. Mandeep Singh District Horticulture Officer (9996788076)
- Sh. Sanjay Yadav Quality Control Inspector (9812573027)

From the detailed discussion on the present status and prospectus of Micro – Irrigation in Bhiwani district, the following issues are worth reporting:

- The sprinkler (mini) irrigation is boon for this area and most needed activity in view of critical shortage of water and poor water quality. Every farmer should be covered in the program and most of the available bore-wells appear to have been covered. Even two to three brothers / partners are using the same well.
- Though water table is 100 to 130m, 20HP motors are giving very limited discharge and have to be given rest every two to three hours as discharge drops down.
- The water is so scarce that flood irrigation is absolutely not advisable.
- Drip is much less in this area due to smaller land holding. Youth is getting engaged in industry and jobs and agriculture is gradually becoming subsidiary occupation.
- The use of pesticides and fertilizers is much less. More use of urea increases more foliage which attract pests. The white fly is washed with spray of mini-sprinklers.
- The late release of subsidy is often reported by farmers. As much, the farmers are satisfied with the almost free type installation. The complaints about sprinkler irrigation are seldom raised in district level meetings.

7.6 Discussion with Sh. Mandeep Singh District Horticulture Officer on 04.09.2020

The area under Horticulture both Fruit and Vegetable crops is very much limited in Narnaul due to chronic shortage of water. The soil and water testing is compulsory in such cases. Most of mini sprinklers have 6 to 7 years of life and life depends upon care of farmers' particularly proper wrapping and storage when not in use. Presently, the subsidy is credited to the account of Dealer who installs the system from the company funds.

In case of Kinnow Rs.8000/ha is given for maintenance of plantation @ of Rs.4800, Rs.1600 and Rs.1600/-. He informed that, Kinnow is very sensitive crop and comes up on best soils, good quality water and good care. The second crop is Guava which comes on medium type soil and water quality. The Ber is most hardy plant and can thrive on poor quality lands but wildlife damage is severe particularly Neel Gai like its leafy foliage very much.

The total provision is Rs.10000/ acre but farmer is to pay only GST. The materials of Jain and Macaft Company are much better than others and have more durability. Jain prefers cases where there is 85% subsidy. He suggested the names of few farmers who have successfully raised citrus and those farmers were already covered in the survey conducted for this study.

Photo 7.4: Interaction with Deputy Director Agriculture and his officers on 04.09.2020 at Narnaul

7.7 Discussion with Assistant Soil Conservation Officer Narnaul on July 14, 2020

Sh Hari Ram is the Assistant Soil Conservation Officer Narnaul. He served in this area for a pretty long time and has in depth knowledge and experience of micro-irrigation in Narnaul area. He is responsible for MI program implementation of the Department of Agriculture Haryana. He is one of the stake holders in this program.

Photo7.5 & 7.6: Discussion with Assistant Soil Conservation Officer Narnaul

He was of the view that micro-irrigation is the most appropriate technology to sustain the agricultural economy of this drought prone area. The problem of acute shortage of water and harsh climate can only be addressed by most efficient use of water. First of all, bigger sprinklers

were introduced in early nineties but technology further developed and mini-sprinklers were introduced about 15 years back and these are more convenient and appreciated by the farmers. As this area was declared as dark zone, now farmers are to pay only GST and the system is installed free of cost. There is lot of saving in irrigation water and labour and crop yields are higher by about 30 percent as compared to flood irrigation. The area under drip irrigation is now increasing as its use in vegetable crops is most appropriate and farmers get good returns. He shared the list of projects which were sanctioned during the last five years. The ASCO assured us all help and assistance in the conduct of this study.

District Nuh

7.8 Discussion with District Horticulture Officer Nuh

On 18/9/2020 a meeting was held with Dr Deen Mohmad Khan District Horticulture Officer Nuh and following points emerged from his discussion

- About 5000 acres area is covered here in Nuh under drip and mini sprinklers.
- Mini sprinklers are used for Wheat, Mustard and Bajra crops.
- Horticulture is giving subsidies on mini sprinklers also though in other area the subsidy on field crops are given by soil conservation officer of agriculture department.
- Drips are being used for Tomato and Onion Vegetables.
- Life of drip is normally 2-3 years but drip of Jain Irrigation and Netafin companies can last for about five years if these are kept safely after use.

Photo 7.7: Meeting in office of DHO Nuh

CHAPTER-8

INTERACTION WITH FARMERS AND OBSERVATIONS OF FIELD VISITS

8.1 Important observations made during the field visits in Bhiwani area

- The mean annual rainfall is very low and varies from 300 to 400 mm and 80 percent occurs during monsoon season.
- The soils are sandy in nature with low organic carbon and poor water holding capacity.
- The ground water is very deep but farmers have installed submersible motors to extract water from 70 to 100m depth.
- Khejri (*Prosopis* cineraria) is the main fodder tree which is faithfully retained by the farmers because of its multiple benefits (Photo 8.1).

Photo 8.1 & 8.2: Khejri (*Prosopis cineraria*) in dry areas of Bhiwani (left) and cultivated pearl millet (right)

- Bajra is the main Kharif crop and good short duration varieties have been adopted (Photo 8.2). It suits the climate because of its low water requirement and meets three major requirements. The weeds are culled and used as green fodder, the stalks are used as fodder and grain is the staple food of this area. In Kharif season one finds Bajra in the entire landscape (Photo above).
- Cotton is the second most important cash crop of this area which is sown in lines and is generally drip irrigated. It is the main commercial crop of this area and now short duration dwarf varieties have come up. Since sprinkler irrigation is not advisable in Cotton after boil formation, drip irrigation came as a better choice. Drip is not suitable for grain crops like Wheat but most suitable for line sown crops like Cotton, sugarcane, fruit and vegetable crops. Line sown Cotton cover large tracts of light textured undulating lands as seen in photographs.

Photo 8.3 & 8.4: Large scale Cotton cultivation on sandy soils and drip irrigated in Bahal Block (Khejri trees in the landscapes)

- During the Rabi season, the choice of crops includes Mustard as the main cash crop and Wheat is sown in a limited area to meet the need of dry forage for livestock and as food for domestic use. Mustard is low water requiring crop and provide good returns. Some farmers keep part of the land as fallow during the monsoon season and raise Mustard on the residual moisture present in the soil after monsoon rains.
- Due to low rainfall, sandy nature of soils and water scarcity, micro irrigation has been promoted. Some area is irrigated by canals also in Tosham block but it has caused salinity problem. Sprinkler irrigation was widely adopted and promoted through subsidy driven programs of the Government.
- Why the crop yields in Behal are less and more in Narnaul? The farmers explained the reasons which are tabulated in Table 8.1.

Table 8.1: Comparison of soils in Behal and Narnaul blocks

	Behal Block	Narnaul Block
1	Poor water quality, more irrigations needed	Water quality is good and less number of irrigations are needed
2	Sandy nature of soil, area near to Rajsthan	Sandy loam – more retentive soil
3	Less organic matter	More organic matter
4	Deep ploughing needed due to crust formation below root zone at about 16” depth	No crust formation, simple harrowing is enough – 6” deep ploughing is enough

- The east of Loharu towards mainland comprising of Mahendergarh, Satnali, Narnaul – the water quality is good. But west of Loharu towards Bahal, the water quality is poor. The north of Loharu in Shiwani area water is very deep, water quality is bad, saline soils. In Tosham, almost no ground water, canal water is added into bore-well and then irrigated. In about 40 sq.km area around Behal, the water is of poor quality, more irrigation are needed, relatively sandy soils, windblown dune type lands and area is closer to Rajasthan.

District Bhiwani

8.2 Interaction with farmers of Bahal block of Bhiwani district on 20.08.2020

In view of acute scarcity of water and depleting ground water, the micro-irrigation was promoted in the drought prone areas dominated by sandy soils in six southern districts of Haryana since eighties. While there is no doubt about saving in irrigation water, better crop yields and suitability of MI System for this belt, but fast depletion of ground water is the serious concern. There are several financial, implementation and administrative constraints in successful implementation of this otherwise beneficial system. Detailed interaction was held on issues and concerns of MI program implementation with beneficiary farmers of Bahal block on 20.08.2020. Our team met couple of farmers at village Sudal and had interesting session (Photo 8.5).

Photo 8.5: Meeting with farmers at Village Sudal

The main issues which emerged from these discussions are flagged:

- Most of the installation of MI work after sanction of the project is handed over to the dealers and departmental supervisory role has drastically reduced. Staff shortage would be the probable reason.
- The services provided by the dealers are not to the satisfaction of the farmers.
- Complete awareness about the procedure and financial arrangements is generally not given to the farmers.
- Bigger farmers means bigger share of subsidized work and in the process smaller farmers are marginalized. Up to five hectare of land, all farmers are eligible for subsidy.

- The quality of the material, its life, guarantees and after sale services are not as per the satisfaction of the farmers. Jain and one or two other companies supply better material and others not.
- As regards the input and benefits are concerned, farmers of Narnaul get more production and net benefits and farmers of Bahal block get low yield and poor net returns.
- Some farmers of Bahal report very low net returns from Cotton indicating high cost of inputs, irrigation, labour and harvesting costs. Yet they are opting for Cotton using drip irrigation system mainly due to acute scarcity of ground water which is depleting fast.
- Very small area has gone under Fruit and Vegetables in Bhiwani district perhaps because of marketing problems, water scarcity and long gestation period of Fruit crops.

Why farmers are shifting from sprinkler to drip in Cotton- the farmer's perspective?

- Cotton cannot be irrigated with sprinkler after boll formation.
- Sprinkler creates moist micro-environment which attract more diseases / pests
- In hot summer months of May – June sown Cotton crop need more irrigations in case of sprinklers due to high evaporation losses.
- Once installed, drip has very low irrigation cost.
- There is high subsidy (almost free) on drip system.
- It is removed after Cotton, properly wrapped and stored in shade.
- Last irrigation to Cotton is also used as pre-sowing irrigation of Wheat.

Advantages of Drip System over Sprinkler System-farmers point of view

- Sprinkler irrigation is not advisable after boil formation of Cotton but drip system can be used throughout the crop growing season.
- Drip system ensures more uniform distribution of water than sprinkler system.
- Drip system required 30-50% less water than sprinkler system to mature Cotton crop.
- The water use efficiency of drip system is higher than sprinkler system.
- There is 30-50% saving in fertilizer when used through fertilization system in drip system.
- Drip irrigation result into 20-25% more Cotton yield than flood /SP irrigation system.
- Drip system reduces irrigation labour cost.
- Drip system required less energy as water flows at low pressure where sprinkler system require high pressure to generate flow of jets.
- Drip system can be used during night.
- Drip system can operate even when wind spread is high. Sprinklers do not distribute water uniformly under high wind speed conditions.
- There is least disturbance of surface soil in drip system but in case of sprinkler system, soil is dispersed when plant cover is less.
- When crops are raised on ridges in drip system, the weeding, hoeing and earthing up is much easier than flat-bed sowing.

Photo 8.6: A typical set up of tube well with fertilizer mixer and main pipeline

8.3 Points emerged from discussion with farmers of Tosham block on 20.08.2020

Most beneficiary farmers were having their residences on the farms itself. Since there is no labour migration from UP and Bihar in this area, so most of the farm operations are carried out by family labour and hence presence at the farm is necessary. We met two beneficiary farmers whose formats were filled by our resource persons. On giving brief introduction and purpose of the visit, these farmers become quite friendly and opened up for discussion. We have been saying that we have not brought officers with us and have not come in Government vehicles because then farmers hesitate to tell the truth.

Photo 8.7 & 8.8: Discussion with farmers of Tosham Block

The information which we could gather from these two discussions is summarized as under.

- With the use of sprinkler irrigation in Cotton before boll formation, it improves photosynthesis as it washes down the dust. The white fly and its eggs are also washed.
- In some Tosham area, people have canal irrigation, so they do not use drip when the bolls in the Cotton start blooming and only use canal water for irrigation. Otherwise they use sprinklers at the early stage of crop growth.
- Now the farmers have started raising Cotton and other crops in lines.

- Cost of cultivation is high in Loharu area due to light soil, more deserts like conditions due to its nearness to Rajasthan. Soils are sandy in nature; water is very deep as compared to Narnaul area.
- More irrigation is needed in June to Cotton when there is no rain and climate is hotter / harsh. Cotton is sown in May after pre-sowing irrigation.
- Farmers of Narnaul are more laborious and take good care of agricultural operations, so their yield is higher in almost all crops.
- In Narnaul, the Wheat and Mustard yield is more than the state average, even more than Kurukshetra and Karnal districts.
- Farmers of Narnaul keep both multi-sprinkler / mini-sprinkler sets on one tube-well.
- Land holdings in Narnaul area are small as compared to Bhiwani.
- Some information regarding cultivation of different crops is compiled in Table 8.2

Table8.2: Cost of cultivation as came out from discussion with farmers of Village Biran and Saghan (Tosham) on 26.08.2020 (Rs. Per acre)

Item	Cotton	Bajra	Mustard	Wheat
Tillage and sowing	1500	1500	2000	2000
Seed	1200	850	350	1150
DAP	1050	-	1050	1050
Urea	290	290	290	290
Chemical and spray labour	800	-	-	2800 (irrigation)
Picking (Rs.20/5kg)	4000	2000	2200	4200
Harvesting	1500	500		1200
Total	**10340**	**5140**	**5890**	**12690**

These figures are much less than those reported at Bahal

District Mahendergarh

8.4 Interaction with farmers of Tejpur village of Ateli block of Narnaul district

This village was visited on 4th September 2020 afternoon. One of the beneficiary farmers Sh. Hari Om had filled up his format and we wanted to check the correctness of the information provided by him. He told that to increase pressure in mini sprinkler, they reduce the number of nozzles. Mini sprinkler is a boon to this area and without it crop cultivation is not possible. Here water quality is good and they sow Cotton, Bajra and Guar in Kharif and Wheat and Mustard in Rabi. This farmer took two mini sprinklers one in his own name and the second in the name of his son by hypothecating a portion of his land to his son. Water table has gone down to 35m due to overuse and less recharge. Now all farmers are using submersible pumps. They save more in Mustard per acre as compared to other crops. The farmer was satisfied with his system and had no complaints. We checked the entire format and found that entries made by resource persons were correct. His net returns were quite impressive. We appreciated the bumper crop of Bajra

near maturity in his field. It was provided two irrigations from mini-sprinkler at early stage when area received no rainfall.

Photo 8.9: Meeting at the farm of Sh Hari Om

In a separate meeting in the same village, it emerged after discussion that farmers were satisfied with the installation and payment of subsidy and had no problem and they just paid their share and rest all formalities were done by the dealer /company. The maintenance of the system depends upon individual farmer that how it is kept after use.

The Gram Panchayat Pardhan (on easy chair at right) informed that almost all farmers and all tube wells are covered under this wonderful system of irrigation having large number of benefits. In fact, due to drip irrigation farmers find some free time to attend other family responsibilities. Number of buffaloes has reduced to about one in most of the families mainly due to the reason that girls start going to schools.

Photo 8.10: Meeting with farmers of Tejpur Village

8.5 Discussion with the farmers of Village Patikra of Narnaul Block on 14.07.2020

At the farm house of Mr. Om Parkash, a beneficiary farmer whose questionnaire-format was filled up by our resource person, we had a detailed discussion on the cost of cultivation of different mini-sprinkler and drip irrigated crops and net returns. Two more beneficiary farmers joined the discussion and provided us a detailed account and answered all our critical questions.

Photo 8.11: Meeting with Om Parkash

They explained the layout of mini-sprinklers in the field with main and lateral lines and nozzles and their spacing. According to them, mini-sprinklers are more appropriate and efficient than bigger sprinklers

Photo 8.12: Layout of mini-sprinklers in the field Photo 8.13 Sprinkler system parts

They were of the view that for longer life of the equipment, proper care is necessary. After crop harvest, the pipes should be properly wrapped, cleared of dirt and soil and kept under shade particularly in hot summer months. The wrapped up pipes and risers are shown in photo given above. These farmers were cultivating mini-sprinkler irrigated Pearl Millet, Mustard and Wheat

crops and drip irrigated vegetables like Brinjal and Tomato. We carefully noted the data on cost and benefit of cultivation of these crops (Table8.3).

Table8.3: Cost of cultivation in Narnaul Block of Narnaul District (Rs/Acre)

S. No	Cultivation operation	Bajra	Mustard	Wheat	Vegetable brinjal
1	Tillage operation	3 @Rs.500 = 1500	4 @Rs.500 = 2000	3 @ Rs 500= 5000	5@ 500 2500 Bunds making 800
2	Cost of seed	550	500	1000	Seed = 600 Nursery = 500
3	Cost of fertilizer / DAP		800	1200	FYM = 5000 DAP = 1200 Urea = 540
4	Urea	One bag = 270	One bag = 270 Sulphar = 750	540	NPK = 1100 Spray = 540
5	Hoeing / weeding	2400		2400	
6	Irrigation		3 No @500 = 1500	6 No @300 = 1800	15000
7	Harvesting	3000	2200	5000	60000
8	Threshing	Rs.100/quintal = 1200	1200	1500	
	Total	**8920**	**9220**	**14940**	**87780**
Gross return **Rs./Acre**					
	Main product	12Q @Rs.2150 = 25800	10 q/4450/q = 44500	20q@1950/q = 39000	250q@Rs10/kg = 250000
	By product	Sticks = 6000	Sticks = 1200	Busa = 8500	
	Total	**31800**	**45700**	**47500**	**250000**
	Net Return	**22880**	**36480**	**32560**	**162220**
Return of System					
	Crop rotation	Cost of cultivation	Gross Return	Net Return	
	Bajra – Mustard	18140	77500	59360	
	Bajra – Wheat	23860	79300	55440	
	Bajra – Vegetable	96700	281800	185100	

Evidently, the net benefits are very high in Vegetable crops irrigated by drip system but the market risks are also very high. The low cost of irrigation and use of family labour in Vegetable cultivation result in higher profitability.

Photo 8.14: A mini-sprinkler irrigated bumper crop of Bajra in a Narnaul village

District Nuh

8.6 Field observations and discussion with farmers at village Chandeni of Nuh district on 13.07.2020

- Chandeni village is in Nuh district and is located in foot of the Aravali Hills having good quality ground water. As per the topo-sequence, a belt of about 1.5km width along the hills has good quality water then comes a belt of highly saline soils and almost barren land with no crops. Some field bunding work has been done to conserve rainwater *in situ*. This is a pocket of low lying area and the quality of land improves after rainwater harvesting by bunding.
- Bajra and multi-cut sorghum are the main Kharif crops used as fodder as well as Bajra grain as staple food.
- The crop sequence in Kharif and Rabi is shown in the Table 8.4 given below.

Table 8.4 Crop sequence in different months under different irrigation methods

Months of the year	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
Flood irrigation				Bajra----------				Mustard ----------				
Sprinkler irrigation				Bajra----------				Wheat ----------				
Drip Irrigation				Bajra ----------				Tomato ----------				

- Farmers keep 4-5 buffalos due to Bajra / Sorghum green and dry fodder and sell milk. This is a *Muslim* dominated area having livestock rearing as an old tradition unlike Narnaul.
- Farmers installed tube-wells and started first with flood irrigation but the discharge was low as water table had gone down to 30m and could irrigate limited area with a tube-well.
- As the sprinkler irrigation started, they could cover more area under irrigation. The Wheat and Mustard needed 6-7 and 2-3 irrigations, respectively.
- Somewhere in 2012, drip irrigation was introduced and each farmer added 1 to 2 acres of Tomato and planted on raised beds/ridges and started drip irrigation. Since drip is not used for Kharif crops of Mustard and Bajra so it is removed after use from July to April and again used for Rabi sown Tomato crop.
- There is lot of variation in the quality of the rubber used in drip sets. One farmer informed that he used Jain Irrigation equipment which is considered the best and it is in good condition even after 8 years of use.
- In case of another farmer who installed drip system from Sagar Company locally called dealer, the material was of poor quality and pipes lost strength after 2 to 3 years.
- Incidentally, Sagar has become the lead supplier for Nuh area where Jain is not interested to work in this area. Sagar got the monopoly and started cheating farmers.

- A farmer got drip system in 2018 and attached farad, Aadhar Card, Bank details with the application. He paid Rs.12000/- as farmer share to the dealer. His system was installed by the company with a promise that he will pay the subsidy credited in his account to the dealer. The farmer was told that this is the procedure. He paid Rs.12000/- as his share, got the drip system and faithfully gave the subsidy credited in his account to the dealer.
- Once installed, the staff of Horticulture Department came to verify the installation, took photographs and verified the case and credited subsidy in the farmer's account.
- The innocent, illiterate, poor farmers are cheated by the dealers.
- Farmers do not know how much amount was sanctioned and how much subsidy was sent and credited to his account. Dealer is considered to be in glove with the bank and gets signature of the farmer and the amount is paid to the dealer and not the farmer.
- Drip is basically for Tomato and the cost of cultivation is around Rs.90000/acre. In case prices are good, one crate of 22 kg is sold at the rate of Rs.300 to 400/ crate and the farmer earns gross profit of Rs.150000/- and net profit of Rs.60000/acre which is much more than the returns from the Wheat and Mustard crops. His domestic labour is used for picking, grading and handling almost on daily basis. Cost of irrigation with drip is negligible and hence it becomes a viable proposition.


Photo 8.15 & 8.16: Meeting with farmers at Chandeni village of Nuh District of Haryana

8.7 Interaction with Farmers of Kaniana block of Nuh district on 5th September, 2020

As already stated, around 25 villages of Nuh and Kanina block are situated in the foot of Aravali hills and runoff water recharges the ground water of these villages. Large numbers of earthen dams have been constructed below the hills to harvest rainwater for ground water recharge (Photo).


Photo 8.17: Aravali hills in the background Photo 8.18: Farm lands below the hills

Here the farmers use only flood and drip irrigation. Because of heavy soil, sprinkler irrigation is not suitable. Vegetable crops are cultivated on raised beds and drip irrigated. (Photo)

Photo 8.19: Fields being prepared for sowing Vegetable crops on raised beds

8.8 Discussion with farmers in Village Ghaghas (Nuh)

This village was visited on 5th September 2020 and many other farmers joined for interaction held in the house of Fazal Mohmad. His sons and other farmers were present in the discussion. It was informed that earlier there used to be sufficient ground water availability at about 35m depth because of its nearness to the long Aravali hill range just above the village. In 1980, there were hardly 10 tube wells in the village and water was lifted with centrifugal pumps. But now the tube wells number has gone more than 400 and underground water level has gone from 35 to 100m. It all resulted into brackish water because of ingress of water from the adjoining area, which is quite unfit for drinking and irrigation and has replaced the good quality water on account of reverse underground flow.

Photo 8.20: Meeting with farmers of Ghaghas village of Nuh district

In this village, main Kharif crops are Bajra, Sorghum and Tomato. In Rabi season it is Vegetables mostly Onion, Wheat and Barseem as fodder. Here they use only drip irrigation in Vegetables and no sprinkler or mini sprinkler. During the visit, farmers were preparing fields for winter Onion crop. The cost of cultivation of main crops and net income was worked out on the basis of information given by the farmers (Table 8.5)

Table8.5: Cost of cultivation per acre of different crops and net returns

Items	Bajra	Wheat	Mustard	Tomato(Drip)	Onion(Drip)
Cultivation Cost	7490	14680	7170	121000	60000
Yield q/acre	10	20	8	800 crates @250/crate	250 @Rs.4/kg
Income Main Crop	19000	34000	35000	200000	100000
Additional	1000	2000	1000	----	----
Total Income	20000	36000	36000	200000	100000
Net Income	12510	21320	28830	79000	40000

The drip irrigated crop of Tomato provided real good returns.

8.9 Discussion in Village Kansli of Nuh district: The next discussion was held in village Kansali of Nuh district where Mohamad Yaheta, Sabudeen and Yusuf Khan joined for discussion. This village is also situated in the foothills of Aravalis. Same cropping pattern is followed as in Ghaghas. Underground water has turned brackish over a period of about 40 years. Earlier, like Ghaghas water quality was good due to recharge from the hills. Now tube well number is about 300 which was only 8 in early eighties and the water table has also gone down to more than 100m.

Photo 8.21: Meeting with farmers of village Kansali

Here the cost of cultivation of Bajra is about Rs 7000, and gross income is Rs 30000 with net profit of Rs 23000. In case of drip irrigated Tomato, cost of cultivation is Rs 60000 to 65000 and gross income is between Rs 2.5 to Rs 3.0 Lakh. Similar is the case of Wheat and Mustard as in village Ghaghas. The Vegetable crops are drip irrigated and other crops are flood irrigated with total absence of sprinklers due to heavy soil.

Here the number of buffaloes is more about 5-7 per family unlike Narnaul area and they sell milk that is why they mentioned about the need of fodder in discussion (Photo).

Photo 8.22: More buffaloes in Nuh which add to family income (Left)

Photo 8.23: Only one or two buffaloes/house in Narnaul (Right)

CHAPTER -9

ECONOMICS OF MICRO-IRRIGATED CROPS RAISED IN PROJECT AREA

The ultimate adoption of a technology mainly depends upon the gainful economic returns to the farmers. In case of MI, the main cause of adoption was the suitability of the local conditions, acute shortage of water and saving in labour cost. However, it gradually became very clear that MI not only saved water but also increased net income of the beneficiary farmers. These facts were authenticated with the help of primary data collected from the farmers during interaction with them. During group discussions, efforts were made to collect data on cost of cultivation with various inputs including irrigation cost, gross returns and net returns. This exercise was necessary to understand variations across the selected three districts and level of returns to the farmers from agriculture enterprise. By perusal of data it makes clear that there is huge variation in the input costs and output returns. Some of the examples are tabulated in this chapter.

9.1 A Typical Case of Nuh District

It is clear from collected data (Table 9.1) that the cost of cultivation of crops like Bajra, Wheat, Mustard, Tomato and Onion were Rs 7490, 14680, 7170, 121000 and 60000 and net returns were Rs12510, 21320, 28630, 79000 and 40000, respectively. Here, only the drip irrigated Tomato and Onion crops have provided substantial income to the farmers and also gainful employment to their families at their own farms.

Table9.1: Cost of cultivation of different crops of Nuh area (Rupees / acre)

Items	Bajra	Wheat	Mustard	Tomato	Onion
Tillage	2800	3500	2800	5000 + 1000	4200
				For bed prep Rs.1500	
Seed	350	2000	400	10000	7000
Fertilizer urea	270	540	270	20000	10000
					Also include sprays
DAP	1100 = 1370	1100 = 1640	Sulphate and Potash Rs.1000	Zinc / Potash	
Harvesting	2000	3000	2000	60000@3000	10000
				Per day 20 days	
Watering	700	4000	700	25000	20000
Total Cost	7490	14680	7170	121000	60000
Yield	10 Quintal	20 Q	8 Q	800 crates	250 q
				@250/crate	@Rs.4/kg
Returns Main crop	19000	34000	35000	200000	100000
Additional	1000	2000	1000	----	----
Total income	20000	36000	36000	200000	100000
Net Income	12510	21320	28830	79000	40000

9.2 A typical case of Bahal block of Bhiwani district

In this case, cost of cultivation and gross returns are high but net returns are comparable with the second case. However, net returns of Cotton are questionable as input costs quoted are very high and net returns are low. The irrigation and picking costs are also quoted very high (Table 9.2). Irrigation costs are high due to sandy nature of soil. The net gains in drip irrigated Tomato crop are very high justifying the importance of drip irrigation in vegetable crops.

Table 9.2 Cost of cultivation and income of different crops grown under micro-irrigation system in Bahal Block of Bhiwani District (Rs/Acre) - SIRIS village First case

S. No	Cultivation Operation	Bajra	Mustard	Wheat	Cotton	Tomato Drip
1	Cost of Seed	800	800	1600	2000	4000 1000 Nursery
2	Tillage	4 No. 3000	2500	2500	4 No. = 3000	2000
3	DAP	One bag 1200	1200 480	1200	1 bag = 1200	FYM = 10000 DAP = 1200
4	Urea	One bag = 270	Two bag = 540 Sulphar = 800	810	2 bag = 540	Urea = 200 NPK = 600
5	Hoeing / Weeding	2400	Spray = 1100	600	3 times = 1500	Mulching = 9600
6	Irrigation	2 No. = 2000	4 No. = 4000	6 No. = 6000	36 No. = 14400	6000
7	Harvesting	5000	2500	5700		15000
8	Threshing	1600	2000	3000		Winter Net = 20000
9	FYM				2800	
10	Single SS Phosphate				350	
11	Potash				50kg = 750	
12	NPK				10kg = 1000	
13	Spray				450	
14	Herbicide/Pesticide				3600	
15	Pesticide spray				1500	
16	Picking				1000/q = 8000	
	Total	**16270**	**15440**	**21410**	**41090**	**69600**
Gross Return Rs./Acre						
	Main Product	8q@2175 = 17400	7q @4400= 30800	16q@1925= 30800	8q@5500 = 44000	200000
	By Product	5000	1000	4000		
	Total	**22400**	**31800**	**34800**	**44000**	**200000**
	Net Return	**6130**	**16360**	**13390**	**2910**	**130400**

The data on net returns of the cropping system are summarized table 9.3.

Table 9.3 Economic Data on different cropping systems (Rs/Acre)

Return of system	Cost	Gross Return	Net Return
Bajra – Mustard	31710	43970	12260
Bajra – Wheat	37680	57200	19520
Bajra – Tomato	88870	222400	136530
Bajra – Cotton	57360	66400	9040

Bajra-Tomato crop sequence provided the highest net returns per acre.

Another case of Bhiwani district covering crop sequences is given below.

Crop sequence Bajra –Mustard

The data on cost of cultivation of Bajra and Mustard are shown in Tables 9.4 and 9.5, respectively.

Table 9.4 Cost of cultivation and returns of Bajra (Rs/Acre)

S.No	Items of input	Amount	Return
1	Cost of seed	500	Yield = 8 q
2	Cost of tillage	1000	Rate = Rs.1500/q
3	Cost of fertilizer	1000	Return = 12000
4	Labour on sowing, irrigation etc.	1500	Sale of dry fodder = 3000
5	Cost of pesticides	500	Gross return = 15000
6	Harvesting	4500	Total Cost = 9000
	Total	9000	Net Return = 6000

Table 9.5 Cost of cultivation and returns of Mustard (Rs./Acre)

S.No	Item of input	Amount	Returns
1	Cost of seed	500	Yield = 5 q
2	Cost of DAP	1200	Rate = Rs.4000/q
3	Cost of urea	300	Return = 20000
4	Cost of tillage	2000	Sale of sticks = 1000
5	Labour irrigation etc	1500	Gross return = 21000
6	Cost of harvesting	1000	Net return = 21000-6500
	Total cost	6500	Rs.14500
			Total return of system = 20500

- Mustard crop provide better net returns. In case land is kept fallow during monsoon Kharif season and put to Mustard in Rabi, there is 2 quintal more production.

Crop sequence Cotton – Wheat

The economics of cultivation of Cotton and Wheat are shown in Tables 9.6 and 9.7, respectively.

Table 9.6 Cost of cultivation and returns of Cotton (Rs./Acre)

S.N	Particulars of cost	Cost	Returns
1	Cost of seed	1000	Yield = 6 q / Acre
2	Cost of fertilizer	1200	Rate = Rs.5500/q
3	Cost of tillage	1500	Return = 33000
4	Cost of urea and spray	2000	Sale of sticks = 1000
5	Cost of picking	6000	
6	Labour irrigation etc	1000	Gross return = 34000
7	Cost of harvesting	2000	Net return = 34000 – 14700
	Total	14700	Rs.19300

Table 9.7 Cost of cultivation and returns of Wheat (Rs./Acre)

S.No	Paricular of cost	Amount	Returns
1	Cost of seed	1200	Yield = 13 q / Acre
2	Cost of DAP	1200	Rate = Rs.1925/q
3	Cost of urea	600	Return = 25025
4	Cost of tillage	3000	Value of dry forage = 6000/-
5	Labour on irrigation	2000	Gross return = 31025
6	Cost of harvesting	3000	Net return = 34000 – 12000
7	Cost of thrashing	1000	Rs.19025
	Total	12000	
	Total cost of system	26700	Total net return = 38325/-

Net return of Bajra – Sarson = Rs.20500/acre with limited irrigation from mini sprinklers

Net return of Wheat – Cotton System = Rs.38325/acre mini sprinkler and drip irrigated

- Farmers prefer Wheat for home use and its forage for animal
- They prefer Cotton for cash return and sticks for fuel wood
- Cotton cannot be irrigated with sprinkler after boll formation and hence drip is the best option in addition to several other benefits.

9.4 A case of Cotton cultivation without accounting for family labour

The economics of this system is shown in Table 9.8.

Table 9.8: Cost of cultivation and net profit with free home labour in Cotton cultivation

S.No	Paricular of cost	Amount	Returns
1	Cost of seed	1000	Yield = 6 q / bigha
2	Cost of fertilizer	1200	Rate = Rs.5500/q
3	Cost of tillage	1500	Return = 33000
4	Cost of pesticides 3 spray	2000	Cost of sticks = 1000
5	Cost of irrigation	1000	Gross return = 34000
	Total	6700	Net return = 34000 – 6700 = Rs.27300/-

Data shows most efficient use of home labour in picking and harvesting which reduce cost of cultivation and increase net returns from Rs.19300 to Rs.27300/Acre.

9.5 A composite case of farm irrigated by three different systems of irrigation

The economics of a composite case under three different systems of irrigation is shown in Table 9.9 and summary of the data in Table 9.10

Table 9.9 Comparison of cost of cultivation and net returns from three irrigation systems of a farmer having 15 acre of land (used the same cost of inputs and net returns as in second case of Bhiwani except Cotton)

Irrigation System	Crop Season	Crop Grown	Area Acres	Cost of Cultivation	Total Cost	Net Returns Rs/acre	Total Net Return
Flood Irrigation System before M.I.	Kharif	Bajra – Gwar	10	9000	90000	6000	60000
		Fodder	2	3000	6000	Home use	
		Fallow	3				
		Sub Total	15	12000	96000		60000
	Rabi	Mustard	12	6500	78000	14500	174000
		Fodder	3	3000	9000	Home use	
		Sub Total	15	9500	87000		174000
		Total			**138000**		**234000**
Sprinkler Irrigation System after M.I.	Kharif	Bajra – Gwar	3	9000	27000	6000	18000
		Cotton	10	14700	147000	19300	193000
		Fodder	2	3000	6000	Home use	
		Sub Total	15		166500		211000
	Rabi	Wheat	10	12000	120000	19025	190250
		Sarson	3	6500	19500	14500	43500
		Foddder	2	3000	6000	Home use	
		Sub Total	15		145500		233750
		Total			**312000**		**444750**
Drip System after M.I.	Kharif	Bajra – Gwar	3	9000	27000	6000	18000
		Cotton – SP	5	14700	73500	19300	96500
		Cotton – DP	5	10000	50000	24000	120000
		Fodder	2	3000	6000	Home use	
		Sub Total	15		143000		234500
	Rabi	Wheat	10	12000	120000	19025	190250
		Sarson	3	6500	19500	14500	43500
		Fodder	2	3000	6000	Home use	
		Sub Total	15		145500		233750
		Total			**288500**		**468250**

Table 9.10 Summary of data under three irrigation systems

Irrigation System	Cost of Cultivation	Gross Returns	Net return /Acre
Flood Irrigation	138000	234000	15600
Sprinkler Irrigation	312000	444750	29650
Drip Irrigation	288500	468250	31217

The perusal of data shows that the net returns of mini sprinkler irrigated crop over flood irrigated crop are almost double but drip irrigation raises it further but by only Cotton crop.

9.6 Economics of micro-irrigated crops in Narnaul district

The data are shown in Table 9.11

Table 9.11: Cost of Cultivation and income of different crops grown under Micro-Irrigation in Narnaul Block of Narnaul District (Rs/Acre)

S. No	Cultivation Operation	Bajra	Mustard	Wheat	Vegetable Brinjal
1	Tillage Operation	3 No. @Rs.500 = 1500	4 No@Rs.500 = 2000	3 No. = 1500	2500 Bunds 800
2	Cost of Seed	550	500	1000	Seed = 600 Nursery = 500
3	Cost of Fertilizer / DAP		800	1200	FYM = 5000 DAP = 1200 Urea = 540
4	Urea	One bag = 270	One bag = 270 Sulphar = 750	540	NPK = 1100 Spray = 540
5	Weeding	2400		2400	
6	Irrigation		3 No = 1500	6 No = 1800	15000
7	Harvesting	3000	2200	5000	60000
8	Threshing	Rs.100/q = 1200	1200	1500	
	Total	**8920**	**9220**	**14940**	**87780**
Gross Return Rs./Acre					
	Main Product	12q @Rs.2150 = 25800	10 q/4450/q = 44500	20q@1950/q = 39000	250q@Rs10/kg = 250000
	By Product	Sticks = 6000	Sticks = 1200	Busa = 8500	
	Total	**31800**	**45700**	**47500**	**250000**
	Net Return	**22880**	**36480**	**32560**	**162220**

Returnof System			
Return of system	Cost of cultivation	Gross Return	Net Return
Bajra – Mustard	18140	77500	59360
Bajra – Wheat	23860	79300	55440
Bajra – Vegetable	96700	281800	185100

While cost of cultivation is almost same as in Bhiwani for Bajra but about 30 to 50 % higher in case of Mustard and Wheat but net returns in Narnaul are more than double than Bhiwani because the yield levels are very high. The drip irrigated Vegetable cropping drastically increased the net returns of the farmer.

The above economic analysis clearly shows lot of variation in net returns between Bhiwani and Narnaul. At the same time, mini-sprinkler irrigation almost doubled the returns over flood irrigation. The drip irrigated Vegetable crops proved highly economical to the farmers.

CHAPTER-10

SUMMARY AND CONCLUSIONS

The fresh water crisis is deepening as demands for domestic, industrial and agricultural uses are escalating. The most efficient use of limited water resources has since long been advocated. Since crop irrigation was the major user of water, efforts were needed to economize and improve water use efficiency. Fortunately, a breakthrough came in the form of sprinkler and drip irrigation (Micro-Irrigation). Seeing the large potential of this technology, the Government of India pushed through this program in a big way. In collaboration with the states, several policy reforms were made and subsidized incentives were given to make the program acceptable to the farmers. The water deficit state of Haryana gave a big push to the program particularly in southern districts where this was the most suited on light textured sandy soils and area with low rainfall.

During the process of implementation in last more than 30 years, several constraints were noted which were coming in the way of achieving the potential of this technology. Keeping this in view, the National Bank of Agriculture and Rural Development supported a study on the efficacy of micro-irrigation in drought-prone areas of Haryana state. Based on the intensive study in three districts namely Bhiwani, Mohindergarm and Nuh exhaustive review of literature, field observations, interaction with officers and farmers and pre-designed Performa-based collection of data from 150 beneficiary farmers, several conclusions were drawn which are summarized as follows:

- The efficacy of the MI system has been proved beyond doubt because several benefits were listed by the farmers and other stakeholders and also confirmed from the analysis of collected data. The farmers believe that there is no way to sustain agriculture in the drought-prone areas where people are suffering from an acute shortage of water, low rainfall and sandy soils without water saving through micro-irrigation.
- The field data collected from number of farmers across three districts comparing the cost of cultivation, gross and net returns from crops irrigated by flood, mini sprinkler and drip irrigation has conclusively proved that financial benefits increase by 60 to 80 percent up on shifting from flood to mini-sprinkler irrigation and more than 100 percent upon adopting drip irrigation Such benefits in vegetable crops cultivated with drip irrigation were more than 200 percent as compared to flood irrigation.
- There is huge saving in labor cost of irrigation. For example, in case the cost of labour in flood irrigation is Rs 1000 per acre, it is around Rs 300 in mini-sprinklers and less than Rs 100 in drip irrigation system. The annual saving in irrigation cost goes very high and farmers use spare time to attend other farm operations.
- It was interesting to note that the cost of cultivation varied across blocks and districts. For example, in Narnaul area, the cost of cultivation is high since farmers tend to put all required in puts and hence their yields and net returns are much higher than Bhiwani.

- In case of Nuh, water is of good quality in foot of the Aravali hills where all farmers have opted for drip irrigated Tomato crop and earning profits ranging from Rs 60000 to one lakh per acre. The entire economy is sustained by Vegetable cultivation and livestock rearing.
- Though Bajra and Mustard are the main crops during Kharif and Rabi seasons but the economy of Bhiwani district is sustained by Mustard and Cotton. Mustard is a very useful crop requiring less water and less input costs yet provides handsome returns even by one or two irrigations using mini-sprinklers.
- It is interesting to note that all the micro-irrigation systems may be mini-sprinklers or drip system are operational and in fully functional with all the 150 beneficiary farmers contacted during survey.
- All of them by and large agree that their cases were processed by dealers of the company, they all participated in planning, and the design was prepared with their consent and they faced no problems in installation.
- Most farmers are of the view that after handing over the main responsibility to the companies, the department has gone in the back ground. Most rural farmers not being educated fail to understand procedures and formalities and have to be dependent on the dealers who are always not honest. This leads to less faith on dealers and an element of less transparency creeps in.
- The departments on the other hand complaint of acute shortage of staff. But payments are duly made after field verification at site and verification of bills. It is also claimed that now portal system is followed where all the information upwards and downwards flow through portal system and with this, the complaints due to delays have been reduced. The dealers are clever enough to get no objection/ satisfaction certificate from the farmers so that there is no problem in release of grant.
- The officers handling the program and KVK scientists were of the view that small farmers are only to make payment of GST and rest of the system duly installed at farm is free, so farmers are seldom seen making complaints in interactive meetings and workshops
- It also came to notice that in order to earn quick profit from the subsidy programs, many companies are marketing various sub-standard components in the market which affect the working condition of the system and creates doubt in the farmer's mind about the functioning of the system. It is to be ensured that only good quality components having the certification of Bureau of Indian Standards (BIS/ISO) are supplied to the farmers. It may be claimed but some farmers contest this claim.
- Lastly, as informed by Sarpanch and farmers of village Tejpur of Ateli block of Narnaul district, all the farmers having tube wells in the village has adopted MI system. Even in some cases two or three brothers who have separated their land are having separate systems but use the same tube well.
- Finally, the sum total of discussions was that there is no survival without adopting micro-irrigation system as water table has gone down and availability of water is very low.

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ANNEXURE - I

Study of Micro-Irrigation in the State of Haryana – HOUSEHOLD SURVEY SCHEDULE

I. Basic information of the respondent farmer

(A)	**LOCATION:** NAME OF INTERVIEWER:		DATE:
	1. Name of Village:	3. Block:-	
	2. Gram Panchayat :	4. District:-	
(B)	**HOUSEHOLD & LAND DETAILS**		
	1. Name of Respondent::	3. Mobile No.	
	2. Father's Name:	4. Relationship to Head of Household:	
	5. Social Category: General/SC/ST	6. Type of Farmer: SF/MF/LF	
	7. Brief Profile of Respondent:		

Name of land owner	**Age**	**Male / Female**	**Education**	**Occupation**		**Land self cultivated or on rent**
				Primary	**Secondary**	

8. Details of Operational Holdings (Acres).

Classification	**Own land**	**Leased In/out**	**Total**	**Ground water depth (m)**		
	Area	**Area**	**Area**	**3 to 10**	**10 to 20**	**More than 20**
a) Cropped						
(i) **Irrigated**						
(II) Un-Irrigated						
b) Fallow Land						
Total						

9. Soil Health

Has your soil ever been tested (Y/N)	**Name of Soil Testing Agency**	**Year of Soil Testing**	**Can you interpret SHC? (Y/N)**	**Did you follow the recommendations? (Y/N)**

(C)	**IRRIGATION**

1. Irrigated Area & Sources (Area in Acres) – to observe adequacy of irrigation source

Season	**Irrig. Source- canal**		**Irrig. Source -Tubewell**		**Groundwater Quality**		
	Area covered	**1.Adequate/ 2.inadeguate**	**Area covered**	**1.Adequate/ 2.inadeguate**	**1.Good**	**2.Average**	**3.Poor**
Kharif							
Rabi							
Total							

(D)	**How long your Drip (D)/ Sprinkler(S) irrigation system operated? _____ (Year)** **Is the system operation till date? Y/N if Y is it (fully functional (1), or Partly functional/seldom used(2)**

II. FORMAT FOR Minor Irrigation (M.I.) (Drip-D/Sprinkler –S) RELATED DETAILS

1. Pre-Project Scenario

a) What was your problem that made you to think about M.I. SI/DI?

i). _____
ii).____
iii).____
iv).____

b) What was the effect of these problems on rural life and normal living?

i)_____
ii)_____
iii)_____
iv)_____

c) What was the effect of these problems on agricultural production?

i). _____
ii). _____
iii). _____
iv).____

d) What kind of impact were these problems had on livestock and farming ?

i). _____
ii).____
iii).____
iv).____

2. Implementation of Micro-Irrigation Projects

a) When the M.I. project operated in your village? (Year_____ Month _____)
b) Were you given full information about this project? (Yes / No)
c) If yes, what method was adopted to inform you?
   - A meeting was held in the village
   - Notice was posted in the village
   - Announced on loudspeaker
   - Learned from other villagers ( )
   - Any other
d) When did you apply for the M.I. Project? Month_____ Year_____
e) What record was attached with the application?

Application Form ( ) Fard ( ) Adhaar Card ( ) Pan Card ( ) Bank A/C Detail ( )

   - Any other

f) When was your case sanctioned? _____
   Total Amount sanctioned Rs._____
   Subsidy amount sanctioned Rs._____
g) Did you face any problems in getting your case approved? (Yes/ No)
h) If yes, what were the problems?

i). _____
ii). _____
iii). _____
iv). _____

i) How those problems were solved?

i). _____
ii). _____
iii). _____
iv). _____

J. Who planned your project proposal? _____
- Did you participate in the planning? (Yes / No)
- Was the design made with your consent? (Yes/ No)

K. Problems and Constraints in Implementation

a) Did you face any problems during installation? (Yes/ No)

b) If yes, what were the problems?

i). _____
ii). _____
iii). _____
iv). _____

c) How the problems were solved?

i). _____
ii). _____
iii). _____
iv). _____

d) Are you satisfied with the service of the department (Yes/ No)

e) If no, what are the reasons of dis-satisfaction?

i). _____
ii). _____
iii). _____
iv). _____

f) What are your suggestions for improvement?

i). _____
ii)._____
iii)._____
iv)._____

3. Post Project Impacts

A. Impact on groundwater level
- What was the water level in your tube-well before the project started?

i. May - June _____m
ii. September - October _____m

- Level after starting the project

i. May - June _____m
ii. September - October _____m

- Is there any effect of the project on water level? (Yes / No)
- If yes, what are the effects

i). _____
ii). _____
iii). _____
iv). _____

B. Financial saving in irrigation operations

I. Irrigation System

Sr. No	How many hours	Irrigation System		
		Flood	Sprinkler	Drip
A	How many hours it take to irrigate one acre			
B	What is the cost per acre of labour for watering?			
C	How much money is saved per acre?			
D	Cost of domestic labour on irrigation per year			
E	How much money is saved per year ?			

C. Farm Level Constraints in adoption

i). _____
ii). _____
iii). _____
iv). _____

III. Impact on Crop Production, Productivity and Net Returns

(A) Comparison of cost of cultivation and net returns from three irrigation systems

Irrigation System	**Crop Season**	**Crop Grown**	**Area**	**Cost of Cultivation (Rs.)**		**Gross Return (Rs.)**		**Net Return)**
				Per acre	**Total**	**Per acre**	**Total**	
Flood Irrigation System before M.I.	Kharif							
		Sub Total						
	Rabi							
		Sub Total						
		Total						
Sprinkler Irrigation System after M.I.	Kharif							
		Sub Total						
	Rabi							
		Sub Total						
		Total						
Drip System after M.I.	Kharif							
		Sub Total						
	Rabi							
		Sub Total						
		Total						

[**Summary Table**

Irrigation System	Cost of Cultivation	Gross Return	Net Returns	CB
Flood Irrigation				
Sprinkler Irrigation				
Drip Irrigation				

Gross Return / Acre		Cost of cultivation Rs/Acre			
Bajra		Bajra			
Mustard		Mustard		SP	
Cotton – SP		Wheat			
Cotton - DP		Cotton		DP	
Wheat		Tomato			
Tomato		Fodder			

(B) **ORCHARD, PLANTATION CROPS & AGRO-FORESTRY**

Period	Type of Plant	Area Covered (in Ha)	No. of Trees	Year Started	Output (with Unit)	Net Income (Rs.)
Before						
After						

(C) **LIVESTOCK:** Details of Ownership of Livestock [Income is the Annual Income net of all Expenses,]

Period	Particulars	Nos. Owned	Output		Yearly Income (Rs.)
			Type *(Milk, etc.)*	**Qty Sold Lt/day**	
Before					
After					

(D) **WAGE LABOUR:** Receipts from Wage Labour

Period	Source	Days worked / Year	Months of Work	Rate (Rs. / Day)	Amount Received (Rs.)
Before Project					
After Project					

(E) **ANNUAL INCOME & NET RETURNS**

System	Agriculture	Orchard	Livestock	Wage Labour	Total
Flood					
Sprinkler					
Drip					

Signature of Data Collector

Signature of Respondent **Name:**

Mobile No:

NABARD Research Study Series

S. No.	Title of Study	Agency
1.	Whither Graduation of SHG Members? An exploration in Karnataka and Odisha	National Bank for Agriculture and Rural Development (NABARD)
2.	Study on Strengthening the value chain of TDF Wadi Projects in Andhra Pradesh	Administrative Staff College of India, Hyderabad
3.	Developing a roadmap of Social Enterprise Ecosystem- as a precursor for a viable Social Stock Exchange in India	Grassroots Research and Advocacy Movement (GRAAM)
4.	Sustainability of Old Self Help Groups in Telangana	Mahila Abhivrudhi Society, Telangana
5.	Impact Assessment of RuPay Card on Weaker and Marginalized Sections in Bihar and Uttar Pradesh	Rambhau Mhalgi Prabodhini, Mumbai
6.	Getting More from Less: Story of India's Shrinking Water Resources	Indian Council for Research on International Economic Relations (ICRIER)
7.	Identifying the Most Remunerative Crop-Combinations Regions in Haryana: A Spatial- Temporal Analysis	Centre for Research in Rural and Industrial Development (CRRID)
8.	Climate Change Impact, Adaption and mitigation: Gender perspective in Indian Context	ICAR- National Institute of Agricultural Economics and Policy Research (ICAR-NIAP)
9.	Achieving Nutritional Security in India: Vision 2030	Indian Council for Research on International Economic Relations (ICRIER)
10.	Development of Iron Enriched Spent Hen Meat Products for Boosting Layer Industry and Entrepreneurship	Assam Agriculture University, Guwahati
11.	Farmer Producer Organizations and Agri-Marketing: Experiences in Selected States, Relevance and their Performance in Punjab	Centre for Research in Rural and Industrial Development (CRRID)
12.	A Collaborative Study on Agriculture Marketing Infrastructure in Kerala	Centre for Agroecology and Public Health, Department of Economics, University of Kerala
13.	Construction of State-wise Rural Infrastructure Indices (RIIs) and A Scheme of Rural Infrastructure Development Fund (RIDF) Allocation	EPWRF, Mumbai
14.	Action Research on Sustainable Agricultural System	XIMB
15.	Study on Efficacy of Micro-Irrigation System in Drought Prone Parts of Haryana	Society for Promotion and Conservation of Environment (SPACE), Chandigarh

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