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**EVALUATION OF DRIP IRRIGATION SYSTEM  
IN MAHARASHTRA**

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## FOREWORD

Importance of irrigation in the development of agriculture has been well documented. However, owing to rapid commercialisation of agriculture, the demand for water by the agricultural sector has been increasing. As a result, the available potential of water for irrigation, both from surface and groundwater sources, has been declining. The efficiency in the use of water is low in the flood method of irrigation on account of the enormous evaporation and losses in conveyance. Different programmes have been introduced to increase the efficiency in the use of water in the flood method of irrigation. Another method introduced to increase the efficiency in the use of water in irrigation is the drip method. In this method, water is supplied at the root zone of the crops through a network of pipes. In India, this method of irrigation was introduced in the early eighties. The State of Maharashtra is one of the leading states in the country in using drip irrigation.

The present study entitled "Evaluation of Drip Irrigation System in Maharashtra" was carried out at the Agro-Economic Research Centre of the Institute. The main objective of the study is to evaluate the overall beneficial impact of the drip irrigation system at the field level. This study was conducted in two districts, namely, Nashik and Jalgaon, of the Maharashtra State where drip irrigation is predominantly used for the cultivation of crops.

The results of the study indicate that the productivity as well as the profits were significantly higher for the crops cultivated under the drip method of irrigation in comparison with those under the flood method. The study further shows that investment on drip irrigation is economically feasible though this method is capital-intensive. The study suggests that drip irrigation can also be profitable in the areas facing scarcity of water.

It is hoped that the results of the study will be useful to the researchers as well as the policy-makers.

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March 12, 1996

## PREFACE

Importance of drip irrigation has been recognised in increasing the productivity of the crops and reducing the consumption of water in most of the countries where it is used extensively. This method of irrigation is very useful in the areas facing scarcity of groundwater. Though it was introduced in the early eighties through the Governments' schemes, the growth of area under drip irrigation is quite insignificant except in a few states. Among the states, area under drip irrigation has increased impressively in Maharashtra. Though it has enormous beneficial impact, none of the study has brought out the importance of drip irrigation by using field level information. In this work, we have studied the importance of drip irrigation including its economic viability in more detailed manner by using field level data in Maharashtra.

During the period of the study, many of my senior colleagues of the Institute and Government officials, who are involving in promoting drip irrigation in Maharashtra, have rendered help in many ways to complete this study. At the outset, I wish to express my deep sense of gratitude to Dr. R.S.Deshpande for his invaluable help throughout the study.

I am grateful to Professor D.C.Wadhwa, Director of our Institute for his constant encouragement right from the beginning of the study. I have benefitted from various government officials for this study. Among them notable are Mr. Mukhe and Mr. Gayake of Drip Irrigation Cell, Commissionerate of Agriculture, Pune; Mr. Bhausahab Barhate and Mr. M.R. Jalmarkar, Agriculture Development Officers

(iii)

respectively in Jalgaon and Nashik Districts; Mr. B.D. Pawar, Block Development Officer of Jalgaon Taluk and Block Development officer of Raver Taluk. I express my sincere thanks to all of them.

I owe a lot to all our sample farmers for providing necessary information which we sought from them. I am grateful to them. Without their kind cooperation, the study would not have been possible to this stage. I would like to thank our field staffs Mr. V.B. Lokare and Mr. V.G. Kasbe for collecting primary data from the field and processing the data in time.

I acknowledge with pleasure my profound gratitude to Dr. R.K. Sivanappan, Founder Director, Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, for providing me the list of sources of literature in time. I am thankful to the Chief Librarian of the Institute of Rural Management, Anand, Gujarat, for providing me a list of sources of literature.

March, 1996

A. Narayanamoorthy

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## ABBREVIATIONS

AO	- Agricultural Officer
BDO	- Block Development Officer
BC	- Benefit Cost
CGWB	- Central Groundwater Board
CMIE	- Centre for Monitoring Indian Economy
CI	- Cropping Intensity
CSB	- Central Scheme Beneficiaries
DMI	- Drip Method of Irrigation
FMI	- Flood Method of Irrigation
FR	- Flat Rate
FAI	- Fertiliser Association of India
GCA	- Gross Cropped Area
GOI	- Government of India
GWA	- Groundwater Area
GIA	- Gross Irrigated Area
HP	- Horse Power
II	- Irrigation Intensity
LUI	- Land Use Intensity
MI	- Minor Irrigation
MMI	- Major and Medium Irrigation
NABARD	- National Bank for Agriculture & Rural Development
NB	- Non Beneficiaries
NAT	- New Agricultural Technology
NCPA	- National Committee on the Use of Plastics in Agriculture
NFCA	- Non-Foodgrains Cropped Area
NSA	- Net Sown Area
NPW	- Net Present Worth
NIA	- Net Irrigated Area
RFA	- Rain-Fed Area
SIA	- Surface Irrigated Area
SSB	- State Scheme Beneficiaries
TIA	- Total Irrigated Area
TE	- Total Expenditure
TR	- Total Revenue
UCL	- Uncultivated Area
WEMs	- Water Extraction Machineries
WUE	- Water Use Efficiency

## Chapter - I

### INTRODUCTION

#### 1.1 Introduction:

Importance of irrigation in agricultural development has been well documented in India and all over world. Studies have unambiguously confirmed that use of modern inputs, productivity of crops and intensity of cropping are significantly higher in irrigated lands compared to unirrigated lands.<sup>1</sup> Owing to continuous changes in the cropping pattern - from less water consuming crops to water intensive crops - consumption of water by agricultural sector has been increasing continuously. As a result, net available potential of water for irrigation from both surface and groundwater has been declining drastically. The rate of groundwater exploitation is going beyond the socially and environmentally acceptable level in agriculturally advanced states like Punjab, Haryana, Uttar Pradesh, Tamil Nadu etc.<sup>2</sup>

Since water is a crucial input for agricultural development and especially for future's food security of the country, many new measures/techniques have been introduced to conserve water and increase its efficiency. One of the techniques introduced to increase the water use efficiency is drip irrigation. Both central and state Governments are keen in promoting drip irrigation in a large scale. A budget of

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<sup>1</sup> (i) Vaidyanathan A, et al., (1994), "Impact of Irrigation on Productivity of Land," Journal of Indian School of Political Economy, Vol.6, No.4, October-December, pp. 601-645.

(ii) Dhawan B.D, (1988), "Role of irrigation in Raising Intensity of Cropping", Journal of Indian School of Political Economy, Vol.3, No.4, October-December, pp. 632-671.

<sup>2</sup> Dhawan, B.D, (1995), "Magnitude of Groundwater Exploitation", Economic and Political Weekly, April 8, p.770.

about Rs. 250 crores has been allotted by the government of India in the Eighth Five Year Plan to promote drip irrigation. Government offers up to 50 per cent of the total capital outlay as subsidy for the farmers who are ready to adopt drip irrigation for crop cultivation. Maharashtra is one of the leading states in India in using drip irrigation. As per the latest (1992) available information, it has about 32900 hectares of drip irrigated area, occupying about 46 per cent of the total area under drip irrigation in India. Large number of farmers have taken benefit of state and central schemes of drip irrigation. This is the evaluation study of the farmers who use drip irrigation under the government scheme in Maharashtra.

Before evaluating the economic impact of drip irrigation at field level in Maharashtra, let us see the importance of drip irrigation in crop cultivation and the potential as well as prospects of drip irrigation in Indian agriculture. Drip irrigation is introduced mainly to increase the water use efficiency in agriculture. It is a kind of micro irrigation.<sup>3</sup> This was primarily used for growing vegetable crops in Israel which is also a pioneer in this technique. In this method, water will be supplied constantly at the root zone of the crops through a network of pipes with the help of emitters. Since water is supplied constantly at the root zone of the crops, conveyance and distribution losses of water could be minimised substantially.<sup>4</sup> Evaporation of water is

<sup>3</sup> Micro irrigation includes drip, sprinkler, mulching, green houses and perforated earthenware pipes.

<sup>4</sup> (i) Sivanappan R.K (1994), "Prospects of Micro irrigation in India," Irrigation and Drainage Systems, No.8, pp. 49-58.

(ii) Sivanappan R.K (1994a), "Micro irrigation is the Answer: To bring more area under Plough," Business Line, Madras, October, 18.

much less compared to flood or surface method of irrigation.<sup>3</sup>

According to an estimate of National Committee on the Use of Plastics in Agriculture (NCPA), through drip irrigation water saving could be attained up to 100 per cent compared to flood or conventional method of irrigation.<sup>4</sup> But the rate of water saving varies depending upon the nature of the crops.

The experiences of the countries which use drip irrigation extensively for crops indicate that drip irrigation is economically feasible, socially and environmentally acceptable. It is being widely used in countries like USA, Spain, Australia, South Africa, Israel, Italy etc. Drip area of the world has increased from meagre 40 ha. in 1960 to about 4.13 lakh ha. in 1981. A recent (1991) worldwide survey conducted by International Commission on Irrigation and Drainage (ICID) has identified that drip irrigation is being practised in 35 countries and the total area of drip irrigation is 17.85 lakh ha. (INCID, 1994). Among the countries, United States occupies the first place with about 33 per cent of the area in the world (Table 1.1). India occupies seventh position with nearly four per cent of the area. Surprisingly, the entire Israel's cultivated area is now under drip irrigation.<sup>7</sup>

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<sup>3</sup> Irrigation methods like flood, conventional, furrow and gravity are almost similar in nature. These terms are used interchangeably in this report and carry the same meaning.

<sup>4</sup> See INCID (1994), Drip Irrigation in India, Indian National Committee on Irrigation and Drainage, New Delhi, July.

<sup>7</sup> Sivanappan R. K (1994), "Micro Irrigation: Macro Future", *Kisan World*, Vol. 21 (3), March, pp. 12-15.

Table 1.1: Area Under drip irrigation in Different Countries in 1991

Country	Drip Area (1991)	Total Irrigated area in 1992 (in '000 ha.)
1. United States	606000	20300
2. Spain	160000	3403
3. Australia	147011	2069
4. South Africa	144000	1140
5. Israel	104302	180
6. Italy	78600	3150
7. India	70859	45800
8. Egypt	68450	2645
9. Mexico	60600	6100
10. Japan	57098	2802
11. France	50953	1190
12. Thailand	41150	4400
13. Colombia	29500	na
14. Cyprus	25000	na
15. Portugal	23565	633
16. Brazil	20150	2800
17. China	19000	49030
18. Jordan	12000	65
19. Taiwan	10005	na
20. Morocco	9766	1280
21. Chile	8830	1268
22. Canada	6149	700
23. United Kingdom	5510	108
24. Philippines	5041	1581
25. Poland	4000	100
26. Yugoslavia	3820	na
27. Hungary	3709	224
28. Netherlands	3000	560
29. Czechoslovakia	2310	135
30. Austria	2000	4
31. Germany	1850	475
32. Malawi	389	an
33. Malaysia	177	340
34. Turkey	32	3674
35. Ecuador	20	na
<b>TOTAL</b>	<b>1784846</b>	<b>249624</b>

Source: 1. INCID (1994), Drip Irrigation in India, New Delhi.  
2. FAI (1994), Fertiliser Statistics, New Delhi.

### 1.2 Advantages of Drip Irrigation:

Drip irrigation has many advantages over the method of flood irrigation. As indicated already, conveyance and distribution losses of water are substantially less in drip method of irrigation compared to conventional irrigation methods. Available results in this regard show that water saving under drip irrigation ranges from 40 to 80 per cent compared to flood irrigation method. It not only increases

the water use efficiency but also substantially increases the yield of the crops. Preliminary research studies conducted in crops which use drip irrigation have shown that yield of crops is substantially higher than the crops which are cultivated with the help of flood method of irrigation.

As far as the crops are concerned, all wide spaced perennial and high remunerative crops like Grapes, Banana, Coconut, Mango, Pomegranate, Citrus, Spato etc., have proved to be the most suitable crops for drip irrigation. However, it can also be used efficiently in narrow spaced crops like Sugarcane, Groundnut and Cotton. But the initial or the capital cost which required to install drip irrigation system will be higher compared to wide spaced crops. Besides water saving and yield increase, it has many advantages over the method of conventional irrigation. Studies have shown that drip irrigation method reduces the cost of cultivation especially in inputs like fertilisers, labour, tilling and weeding when compared to flood irrigation method. Since fertilisers are supplied along with water (which is called fertigation) for the crops, the wastage of fertiliser through leaching and evaporation is much less compared to conventional method (like basal and top dressing) of fertiliser use. As a result, efficiency of fertiliser increases significantly. It also reduces consumption of fertiliser nearly 30 to 50 per

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(i) Kulkarni, S. Y (1987), "Sprinkler and Drip irrigation System", Sinchan, No. 3, October, pp. 56-61.

(ii) Patil, B.P (1988), "Crop Response to Sprinkler and Drip irrigation with Special reference to Konkan area", Sinchan, No.2, July, pp. 58-60.

(iii) Magar, S. S et al., (1988), "Importance of Drip irrigation", Sinchan, No.2, July, pp. 61-62.

cent.\* Yield of crops which are cultivated under drip irrigation method is substantially higher than the crops cultivated in the same environmental conditions with flood irrigation. The NCPA has estimated that yield of Banana and Grapes is higher about 52 and 23 per cent respectively, while the same is varied from 75 to 98 per cent in crops like Papaya, Pomegranate and Watermelon compared to conventional method of irrigation (see, table 1.2 for crop-wise yield). Apart from this, it also helps to increase the vegetative growth of crops and good quality produces.

### 1.3 Benefit-Cost Pattern of Drip Irrigation:

Since drip irrigation is high capital intensive, there are common doubts among the farmers that whether the investment can be realised, what will be the rate of water saving and can the investment be justified. No doubt, the initial capital requirement of drip system is more. However, the fixed investment is small compared to its benefits. The estimated cost of drip irrigation system for different crops is presented in table 1.3. As indicated already, the cost of the system varies depending upon the nature of the crops, its space, amount of water requirements, conditions of the terrains, discharge capacity of the emitters and, of course, distance of water source. It is clear from the estimate of NCPA that average per hectare cost of drip irrigation is substantially higher for the narrow spaced crops like sugarcane, vegetables and Banana. For instance, average per hectare cost comes to about Rs. 33000 for Banana, while the same varies only from about Rs. 9000 to Rs. 16000 in crops

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\* Sudhakar, M.S. (1994). "New Joint Ventures in Drip Irrigation: Drip Irrigation Technology Comes of Age in India", in Agriculture and Industry Survey: 1993-94, Vadamalai Media Ltd., Coimbatore, Tamil Nadu.

like Coconut, Mango, Grapes, Pomegranate etc.<sup>10</sup>

Table 1.2: Yield increase and water saving in drip irrigation over the method of conventional irrigation<sup>1</sup>

Crop	(increase in percentage)	
	Yield	Water
Banana	52	45
Grapes	23	48
Mosambi ('000 No.)	50	61
Pomegranate ('000 No.)	98	45
Surgarcane	33	65
Tomato	50	39
Watermelon	88	36
Cotton	27	53
Ladies finger	16	40
Brinjal	14	53
Bitter Gourd	39	53
Ridge Gourd	17	59
Cabbage	2	60
Papaya	75	68
Radish	2	77
Beet Root	7	79
Chillies	44	62
Sweet Potato	39	60

Source: Compiled from INCID (1994).

Though the average cost of drip irrigation system is more, its relative cost is less when compared to the average cost of surface system. For instance, during the seventh plan, the investment requirement to create one hectare of irrigation in Major and Medium Irrigation (MMI) is over Rs. 70000 in current prices.<sup>11</sup> Likewise, cost of minor irrigation has also been increasing alarmingly. Moreover, one should take into account the benefit-cost ratio (B:C ratio) of any project for justification. Studies conducted on benefit-cost ratio of drip irrigation have shown an impressive results. Existing studies have computed BC ratio in two ways: including water saving and excluding water saving. The

<sup>10</sup> Unit cost of drip irrigation system approved by the NABARD for various crops widely varies with crops and states. Estimated cost based on the field level data also varies with states. For more details see: INCID (1994).

<sup>11</sup> Narayanamoorthy A (1994), "Farmers Role in Water Management", The Hindu, Madras, July, p.25.



results of different crops show that the BC ratio excluding water saving is up to 13 and it goes up to 32 when water saving is also accounted for the purpose of calculation. That is, for every rupee of investment in drip irrigation farmers will get an additional income of Rs.13 to Rs.32. This is substantially higher than the surface method of irrigation where BC ratio varies from 1.8 to 3.9.<sup>12</sup> Convinced with the advantage of drip irrigation, farmers have increased their drip area significantly in districts like Jalgaon and Nashik in Maharashtra in the recent years.<sup>13</sup> Large number of farmers are willing to take drip irrigation in crops like Banana and Grapes.

Table 1.3: Estimated cost and Benefit-cost ratio of drip irrigation for different crops:

Crop	Per ha. Cost	BC Ratio	
		Excluding water Saving	Including Water Saving
Coconut	11053	1.41	5.14
Grapes	19019	13.35	32.32
Banana	33765	1.52	3.02
Orange	19859	2.60	11.05
Acid Lime	19859	1.76	6.01
Pomegranate	19919	1.31	4.04
Mango	11053	1.35	8.02
Papaya	23465	1.54	4.01
Sugarcane	31492	1.31	2.78
Vegetables	31492	1.35	3.09

Note: BC ratio is computed without taking subsidy amount.  
Source: INCID (1994).

#### 1.4 Need for Drip Irrigation:

There are many legitimate reasons for having more area under drip irrigation besides water saving and yield increase. The available water for the future use of irrigation has been declining drastically. Most of the states have already

<sup>12</sup> INCID (1994), op cit.

<sup>13</sup> District-wise and crop-wise growth of drip irrigated area is available in chapter two of this report.

exploited their easily available surface water resources for irrigation purposes. Further exploitation of surface water by constructing new dams and reservoirs will take more investment and also make way for adverse environment problems. Though we have enormous quantity of untapped groundwater potential, owing to rapid commercialisation of agriculture, exploitation of groundwater has been increasing continuously. A recent estimate (1992)<sup>14</sup> of groundwater potential and utilisation has shown that the use of groundwater going beyond the socially acceptable limit in agriculturally advanced states. The problem of over-exploitation can be easily restricted when drip irrigation is adopted extensively.

The flood or gravity irrigation method which is largely in practice has many serious problems. Since independence government has spent about Rs. 405.7 billion - up to seventh plan - on irrigation sector, however, it could irrigate only about 33 per cent of the gross cultivated area (GCA). Problems like cost escalation, inefficient use of water, low recovery rate, water logging and salinity, poor participation of farmers and widening gap between potential created and utilised are going beyond the control in majority of the surface irrigation system in India. For instance, expenditure incurred to create one hectare of irrigation under MMI has increased from Rs. 1526 in first plan to over Rs. 70 thousand in the seventh plan in current prices.

Likewise, according to the Vaidyanathan Committee report on Pricing of Irrigation Water, the revenue which was collected from Major and Medium Irrigation (MMI) is not even

<sup>14</sup> CGWB (1993), Groundwater Statistics, New Delhi.

enough to meet the operation and maintenance cost<sup>15</sup>. That is, while the revenue covering about 25 per cent of the operation and maintenance cost in 1977-78, by 1986-87 declined to a meagre 9 per cent. Importantly, owing to many man-made problems, water use efficiency is much less in most of the MMI systems. Command Area Development Programme which was mainly introduced to increase the efficiency of water use in the command area and bridge the prevailing gap between created potential and utilised in MMI, however, it could not completely succeed in its objectives.

Unlike flood irrigation, drip irrigation can be efficiently operated in all types of areas - undulating terrain, rolling topography, hilly areas, shallow soils, area which has saline water and of course, water scarce areas. As per the land use data of 1991, about 58 million ha. of areas are available in the form of fallow, cultivable waste, barren land etc. Some of these areas can be brought under drip irrigation and hand over to the poor and landless labourers under participatory irrigation management (PIM). This will not only help to increase the area under irrigation but also reduce the level of poverty which prevails in rural India with less investment.

Further, production of foodgrains and other agricultural commodities have to be increased at faster rate to match the ever increasing population. The growth of foodgrains productivity is almost constant for the last three four years and goes down sharply whenever fluctuations occur in the rainfall. To avoid this problem, new areas with irrigation facility should be brought under cultivation. As indicated

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<sup>15</sup> GOI (1992), Report of the Committee on Pricing of Irrigation Water, Planning Commission, New Delhi, September.

earlier, creating irrigation facilities through major and medium irrigation system will cost more for the exchequer and take long gestation period. Moreover, potential for constructing new MMI projects has also been declining owing to environmental reasons. We have nearly 100 million hectares of rainfed cultivated areas (RFCA), where productivity is low owing to erratic nature of rainfall and less use of yield increasing inputs. With the available groundwater potential of these areas, drip irrigation can be efficiently operated as it requires less water compared to flood irrigation.

#### 1.5 Schemes for Drip Irrigation:

Since drip irrigation is a new technology and high capital venture, government operates schemes for drip irrigation with subsidy. Both central and state governments are operating separately drip irrigation schemes in Maharashtra. Central scheme was started in 1982-83 (during the sixth plan) by the Ministry of Water Resources (Minor Irrigation Division), Government of India. However, it was started only from 1991-92 in Maharashtra. When the central scheme was started in 1982-83, government had provided a subsidy of 50 per cent to the farmers with a matching contribution of 50 per cent from the state governments for installation of micro-irrigation devices. Of the total amount of subsidy, 75 per cent was allotted for small and marginal farmers and the balance of 25 per cent for other farmers. Government of Maharashtra has made pioneering efforts for the successful adoption of drip irrigation system and to make it cost effective by providing subsidies to small and marginal farmers to the extent of Rs. 2282.35 lakhs during the period 1986-93.

Central scheme of drip irrigation was also introduced during the seventh plan with following modifications:

(i) the non-conventional energy devices like solar pumps and wind mills were excluded from this subsidy scheme as the same were included in the scheme operated by the department of non-conventional sources of energy.

(ii) the subsidy was limited to the small and marginal farmers only, excluding other farmers from the scope of the scheme.

(iii) the percentage of subsidy eligible under the scheme was on par with Integrated Rural Development Programme.

(iv) farmers growing horticultural crops like Grapes, Papaya, Arecanut and Coconut were also eligible for subsidy.

(v) SC and ST farmers belonging to small and marginal categories and co-operative community schemes of small and marginal were provided with 50 per cent subsidy under the scheme (Table 1.4).

Table 1.4: Subsidy structure of Central Scheme of Seventh Plan.

	Rate (percentage)	Upper limit (Rs/ha.)
Small farmers	25	10000
Marginal farmers	33.33	13333
Small farmers (SC&ST)	50	20000
Marginal farmers (SC&ST)	50	20000
Community and Cooperatives	50	20000

Source: INCID (1994)

However, the central scheme of drip irrigation did not get good response during the seventh plan since the subsidy was limited to small and marginal farmers who could not afford these systems even at the subsidized cost. After knowing the ground realities, many new measures have been included under the new schemes which introduced during the eighth plan.

Under the new schemes, the subsidy amount is limited to either 50 per cent of actual cost or Rs.15000 for ha. whichever is lower. The government of India has contributed the entire 50 per cent subsidy upto the financial year 1994-95 and thereafter the state governments have to contribute 10 per cent towards subsidy for the years 1995-96 and 1996-97 which will add upto 50 per cent with centre's contribution of 40 per cent. However, a beneficiary can avail subsidy for a maximum area of one hectare only.

Government of Maharashtra has also been providing subsidy under state schemes from 1986-87. It varies from 30 to 50 per cent of the capital cost or Rs. 12250 to 20500/ha. depending upon the landholding size and community of the farmers (See table 1.5). The government of Maharashtra has recently announced (on 14th May, 1992) that subsidy will be given for all farmers irrespective of their landholding. That is, currently both the schemes supply 50 per cent of the capital cost as subsidy for all type of farmers in Maharashtra.

Table 1.5: Subsidy percentage for drip irrigation in Maharashtra

Landholding	Rate (%)	Upper Limit (in Rs.)
2 ha. (SC/ST farmers)	50	20500
2-6 ha. farmers	35	14350
above 6 ha. farmers	30	12250

Source: Agricultural Department, Commissionerate of Agriculture, Government of Maharashtra, Pune.

#### 1.6 Need of the Study:

Maharashtra is one of the water scarce states in India. Area under irrigation in the state is about 11 per cent of the gross cropped area in 1991, which is quite low compared to

many states and Indian average of 33 per cent of GCA. Moreover, horticultural crop like grapes, pomegranate, banana etc. are also being extensively cultivated in this state under drip irrigation. State government is also keen on promoting irrigation through drip system by providing more subsidy for farmers who are ready to take drip irrigation. Importantly, area covered by drip system is substantially higher in Maharashtra compared to any other state in India. For instance, in the India's total area of 60000 ha. (in 1993), Maharashtra state alone accounted for about 40000 ha. Since the existing groundwater exploitation of Maharashtra is only 24 per cent of the recharge<sup>17</sup> and the well irrigation is most suitable source of efficient utilisation of drip irrigation, the remaining potential of groundwater can be shifted under drip system. Above points clearly show that Maharashtra is the most appropriate state to study the problems and prospects of drip irrigation. Hence, Maharashtra is selected as a study area to study drip irrigation elaborately.

### 1.7 Objectives and Methodology:

Though drip irrigation is an important water saving technique, detailed studies are rarely available. Moreover, the studies which are available related to the working nature of drip irrigation have not been conducted by using scientific way of methodology. Most of the studies have been carried out based on the experience of single farmer or some group of farmers who use drip irrigation and some of them are purely based on the results supplied by the research station. Since "drip irrigation is a new technique and diffusion is less in

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<sup>17</sup> Dhawan, B.D, (1995), "Magnitude of Groundwater Exploitation", Economic and Political Weekly, April 8, p.770.

the country, studies have to be conducted on the socio-economic conditions of the farmers who use drip irrigation for making policy conclusions. Taking into account the above considerations, the present study entitled "Evaluation of Drip Irrigation System" has been conducted in two districts of Maharashtra with the following objectives.

1. To evaluate the impact of drip irrigation technology on production and productivity of horticultural crops.
2. Performance evaluation of drip irrigation system at farmer's field in respect to awareness of the technology operation and maintenance of the system.
3. Evaluation of possible remedies in respect of problems encountered by the farmers in adopting the technology.

First of all, we have decided to select two districts in Maharashtra, where drip irrigation is being extensively used for crop cultivation based on the area and number of beneficiaries. For this, data related to drip irrigation for both central and state schemes have been collected from the drip irrigation cell, Commissionerate of Agriculture, Government of Maharashtra, Pune. Two districts namely Nasik and Jalgaon have been identified from the district-wise data of drip irrigation<sup>1\*</sup>. These two districts are dominating in area under drip irrigation since 1986-87 when state scheme was introduced. Since the economic impact of drip irrigation varies from crop to crop, we decided to select two dominating crops, one from each district. For this, we have collected crop-wise and block-wise area under drip irrigation from the

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<sup>1\*</sup> Detailed analysis related to development of drip irrigated area, including crop-wise, across the different districts of Maharashtra is available in chapter two.



two selected districts.\* As per the information supplied by the agricultural officer of the respective district, two crops namely Banana for Jalgaon district and Grapes for Nashik district have been selected. After identifying the crops, two blocks (one from each district), where these two crops are being cultivated extensively, have been selected for detailed survey. The two selected blocks are Raver in Jalgaon district and Niphad in Nashik district (Table 1.6).

Table 1.6: Block-wise area under drip irrigation in two selected districts : 1986-87 to 1994-95.

NASHIK district			JALGAON District		
Blocks	Area	% to total	Blocks	Area	% to total
<u>Niphad</u>	<u>3566.72</u>	<u>32.62</u>	<u>Jalgaon</u>	<u>265.90</u>	<u>5.35</u>
Nashik	1738.24	15.90	Yeval	427.26	8.59
Dindori	1436.55	13.14	<u>Raver</u>	<u>1634.36</u>	<u>32.86</u>
Malegaon	1039.86	9.51	Bhusawal	170.85	3.34
Satana	1143.50	10.46	Edalabad	249.32	5.01
Kalwan	343.35	3.14	Pachora	508.05	10.21
Sinnar	501.10	4.58	Chalisgaon	301.04	6.05
Yevala	362.83	3.32	Jamnar	454.80	9.14
Nandgaon	83.13	0.76	Bhadgaon	317.59	6.38
Chandwad	700.27	6.40	Amalner	98.57	1.98
Igatpuri	16.36	0.15	Chopada	79.90	1.61
Peth	1.53	0.01	Parola	190.75	3.83
Surgana	1.58	0.01	Erandol	276.02	5.55
<b>Total</b>	<b>10935.02</b>	<b>100.00</b>		<b>4974.41</b>	<b>100.00</b>

Note: Underline indicates the selected sample blocks.  
Sources: Agriculture Department of Nashik and Jalgaon districts.

After selecting the district, blocks and crops, the sample farmers have been selected with the help of beneficiaries list of 1992-93. In each district, 50 farmers - 25 beneficiaries and 25 non-beneficiaries have been selected. Thus, a total of 100 sample farmers have been selected altogether for survey. While beneficiaries have been selected by using random sampling method, non-beneficiaries have been

\* We have also made detailed discussion with officials who are implementing drip irrigation schemes before selecting the crops and blocks to understand the total working nature of

selected purposively with the help of village account. Since it is a evaluation study, comparison has been made between drip and non-drip farmers (who use furrow method of irrigation) for the same crops to assess the economic impact of drip irrigation in crop cultivation.

The central scheme was introduced in 1991-92. Therefore, the impact of scheme would not have stabilised during such a short period. The scheme funded by the state government has been in progress since 1986-87. Hence, the sample farmers have been selected from the lists of both the schemes. Since it is a study of impact of drip irrigation on crop's productivity and water consumption, the latest year 1993-94 has been considered as a reference period for collecting the information from the farmers.

#### 1.8 Scope and Limitations of the Study:

The present study entitled "Evaluation of Drip Irrigation System in Maharashtra" has six chapters. In the introductory chapter, we have discussed the importance of drip irrigation, benefits and costs as well as the need for drip irrigation. Objectives and methodology of the study are also explained in this chapter. The second chapter provides district-wise, region-wise and crop-wise development scenario of drip irrigated area in Maharashtra. Impact of drip irrigation technology on crop pattern, input use, productivity of the crops and benefit cost pattern are explained elaborately in chapter three. Water use pattern of drip and non-drip farmers is analysed in chapter four. Chapter five presents the performance evaluation of drip system with respect to working nature of the system as well as the scheme at field level. A brief summary of the findings, conclusions and

possible remedies in respect of problems in adopting drip irrigation are presented in the final chapter.

This study has also three limitations. Firstly, since study considers only two important crops (Grape and Banana), the results of the study cannot be compared with other similar crops. Secondly, the two selected districts are most advanced in drip irrigation and hence the results of the study cannot be generalised for the less developed districts under drip irrigation. Thirdly, since the study has considered only the farmers who have installed drip system through government subsidy schemes, the results of the study may differ from the farmers who use drip irrigation without subsidy.

## Chapter - II

### DEVELOPMENT OF DRIP IRRIGATION IN MAHARASHTRA

This chapter presents the development of area under drip irrigation in Maharashtra: district-wise, region-wise and crop-wise. A detailed analysis on the factors which influence the growth of drip irrigation in Maharashtra is also given in the same chapter.

#### 2.1 Position of Maharashtra in India:

Drip irrigation was initially introduced in the early seventies by the agricultural universities and other research institutions in India. However, the development was very slow in the initial years and significant development has been achieved in the recent years. Area under drip irrigation in India has increased from 1500 ha. in 1985 to 70589 ha. in 1992.<sup>1</sup> Though India has enormous potential and prospects, the development of drip irrigation is not impressive in most of the states.<sup>2</sup> Table 2.1 shows State-wise area under drip irrigation and its percentage to total irrigated area. It is clear from the table that drip irrigated area constitutes a very meagre percentage in the total irrigated area in all the states of India. In the total area of 70589 hectares, Maharashtra state alone covers about 46 per cent followed by Andhra Pradesh (16.3 per cent), Karnataka (16.1 per cent) and Tamil Nadu (7.6 per cent). Lack of awareness and less popularity among the farmers about the advantage of drip irrigation are the main reasons for the less development of

<sup>1</sup> INCID (1994), Op cit.

<sup>2</sup> Narayanamoorthy, A. (1996), "Micro-Irrigation", Kisan World, January, pp. 51-53.

drip irrigation in India.<sup>3</sup>

Table 2.1: State-wise Area under Drip Irrigation.  
(in hectares)

States (1)	Drip area (1992) (2)	GIA* (1990-91) (3)	GWA* (4)	(2/3) (in per cent) (5)	(2/4) (6)
Andhra Pradesh	11585	5369	1303	0.22	0.89
Assam	180	572	-	0.03	-
Bihar	80	4192	1519	meagre	
Gujarat	3560	2904	1989	0.12	0.18
Haryana	120	4237	1247	meagre	
Himachal Pradesh	54	167	4	0.03	1.35
Karnataka	11412	2598	713	0.44	1.60
Kerala	3035	383	65	0.79	4.67
Madhya Pradesh	1415	4431	2147	0.03	0.07
Maharashtra	32924	2489	1132	1.32	2.91
Orissa	44	2314	741	meagre	
Punjab	20	7055	2233	meagre	
Rajasthan	304	4652	2341	meagre	
Tamil Nadu	5357	2894	1059	0.19	0.51
Uttar Pradesh	111	14771	6933	meagre	
West Bengal	100	1911	712	meagre	
Other States	560	837	23	0.06	2.43
India	70589	61776	24161	0.11	0.29

Note: \* - thousand hectares.

GIA - gross irrigated area.

GWA - groundwater irrigated area.

Source: INCID (1994), CMIE (1994).

Drip irrigated area has been consistently increasing in Maharashtra since 1986-87. It has increased from 236 ha. in 1986-87 to about 60120 ha. in 1994-95. There are many reasons for the rapid development of drip irrigation in Maharashtra. First of all, State government is very keen in promoting drip irrigation on a large scale by providing subsidy, technical and extension services for farmers.<sup>4</sup> Maharashtra government providing subsidy since 1986-87 onwards. Secondly, area under irrigation from both surface and groundwater is quite low hence, many farmers have adopted drip

<sup>3</sup> Padhye, A.H. (1989), "Micro and Sprinkler Irrigation in India", Proceedings of the International Congress on the use of Plastics in Agriculture, New Delhi.

<sup>4</sup> Sivanappan, R.K. (1994), "Micro Irrigation and Macro Future", Kisan World, Vol. 21 (3), March, pp. 12-15.

irrigation to avoid water scarcity largely in divisions like Nashik, Pune etc. Thirdly, owing to continuous depletion of groundwater, farmers were not able to cultivate wide spaced and more lucrative crops like Grapes, Banana, Pomegranate, Orange, Mango etc., by using surface method of irrigation in regions like Nashik and Pune. As a result, farmers had to adopt drip irrigation as these crops are most suitable for drip irrigation. Importantly, the farmers who adopted drip irrigation initially for their crops have received very promising results. This has further induced many farmers to adopt drip method in some of the regions of Maharashtra.

## 2.2 District-wise Development of Drip Irrigation:

Though the drip irrigated area has been consistently increasing in Maharashtra, the trends in development of drip area are not be same across different districts of the State. Development of drip irrigation is determined by factors like availability of surface water sources, groundwater development, pattern of crop, economic conditions of the farmers, rainfall, area under commercial and wide spaced crops, types of farmers, structure of farming (commercial or subsistence) availability of extension services and policy of the government. It is obvious that these determining factors widely vary across districts and regions. To understand the district-wise and region-wise development of drip irrigated area of Maharashtra, analysis has been done across the districts from 1986-87 to 1994-95. Table 2.2 shows district-wise area under drip irrigation and its district-wise proportion to total area in the state. It is clear from table that drip irrigated area of Maharashtra has consistently increased from about 236 ha. in 1986-87 to 60129 ha. in 1994-95, implying a rise of 254 times during the nine years period.

TABLE 2.2. DISTRICT-WISE DRIP AREA AND ITS PROPORTION IN MAHARASHTRA: CENTRAL AND STATE

District (1)	YEARWISE DRIP AREA				Ratio (5/2):		YEARWISE PROPORTION		
	1986-87 (2)	1990-91 (3)	1994-95 (4)	Total (5)	(6)	1986-87 (7)	1990-91 (8)	1994-95 (9)	All Total (10)
1. Thane	1.40	102.41	182.02	1173.66	838.33	0.59	1.61	1.37	1.95
2. Raigod	0.00	14.53	44.57	159.13		0.00	0.23	0.34	0.26
3. Ratnagiri	2.50	12.37	62.27	198.54	79.42	1.06	0.19	0.47	0.33
4. Sindhudurg	1.00	34.42	57.74	333.94	333.94	0.42	0.54	0.44	0.56
Total Konkan Dn.	4.90	163.73	346.60	1865.27	380.67	2.07	2.57	2.62	3.10
5. Nasik	15.80	1529.06	2537.51	10937.75	692.26	6.68	24.01	19.17	18.19
6. Dhule	0.00	20.82	184.31	914.83		0.00	0.33	1.39	1.52
7. Jalgaon	10.00	355.97	1817.95	5374.66	537.47	4.23	5.59	13.73	8.94
Total Nasik Dn.	25.80	1905.85	4539.77	17227.24	667.72	10.91	29.93	34.29	28.65
8. Ahmaednagar	20.40	626.82	800.09	5210.20	255.40	8.63	9.84	6.04	8.66
9. Pune	14.60	255.89	1237.46	3676.37	251.81	6.17	4.02	9.35	6.11
10. Solapur	55.40	287.37	1224.75	4663.68	84.18	23.42	4.51	9.25	7.76
Total Pune Dn.	89.40	1170.08	3262.30	13550.25	151.57	37.89	18.37	24.64	22.54
11. Satara	4.10	94.76	229.85	1421.19	346.63	1.73	1.49	1.74	2.36
12. Sangli	35.90	238.68	608.25	3287.57	91.58	15.18	3.75	4.59	5.47
13. Kolhapur	7.00	151.12	120.23	1222.84	174.69	2.96	2.37	0.91	2.03
Total Kolhapur	47.00	484.56	958.33	5931.60	126.20	19.87	7.61	7.24	9.86
14. Aurangabad	0.00	532.18	560.15	3377.40		0.00	8.36	4.23	5.62
15. Jalna	4.00	161.71	345.11	1534.88	383.72	1.69	2.54	2.61	2.55
16. Beed	3.30	62.49	188.35	942.78	285.69	1.40	0.98	1.42	1.57
Total Aurangabad	7.30	756.38	1093.61	5855.06	802.06	3.09	11.88	8.26	9.74
17. Latur	3.00	239.75	230.16	2049.85	683.28	1.27	3.77	1.74	3.41
18. Osmanabad	11.50	131.52	156.74	936.97	81.48	4.86	2.07	1.18	1.56
19. Nanded	2.00	304.10	369.08	1799.72	899.86	0.85	4.78	2.79	2.99
20. Parbhani	4.00	210.33	538.49	1926.60	481.65	1.69	3.30	4.07	3.20
Total Latur Dn.	20.50	885.70	1294.47	6713.14	327.47	8.67	13.91	9.78	11.16
21. Buldhana	2.00	171.18	139.80	1418.73	709.37	0.85	2.69	1.06	2.36
22. Akole	3.20	148.91	208.65	1269.32	396.66	1.35	2.34	1.58	2.11
23. Amravati	5.60	349.43	314.53	2672.00	477.14	2.37	5.49	2.38	4.44
24. Yavatmal	10.00	155.38	197.04	1196.01	119.60	4.23	2.44	1.49	1.99
Total Amravati Dn.	20.80	824.90	860.02	6556.06	315.20	8.79	12.95	6.50	10.90
25. Wardha	9.00	90.03	278.72	827.53	91.95	3.81	1.41	2.11	1.38
26. Nagpur	9.00	50.56	106.31	733.70	81.52	3.81	0.79	0.80	1.22
27. Bhandara	0.00	22.00	14.60	271.43		0.00	0.35	0.11	0.45
28. Chandrapur	2.00	8.04	6.58	59.25	29.63	0.85	0.13	0.05	0.10
29. Gadchiroli	0.00	6.00	1.20	13.07		0.00	0.09	0.01	0.02
Total Nagpur Dn.	20.80	176.63	407.41	1954.98	93.99	8.79	2.77	3.08	3.25
Demonstration			476.08	476.08		0.00	0.00	3.60	0.79
Total Maharashtra	236.50	6367.83	13238.59	60129.68	254.25	100.00	100.00	100.00	100.00

Source: Commissionerate of Agriculture, Pune, Maharashtra.

However, the development of drip area is not uniform across the districts. The rate of increase is well above the State average in divisions like Nashik, Aurangabad and Latur while, it is less in divisions like Konkan and Nagpur. For instance, the increasing rate is about 667 times in Nashik, 802 times in Aurangabad between 1986-87 to 1994-95, while the same is only 254 times in the state as a whole during the same period. There are two main reasons for the rapid increase of drip irrigated area in divisions like Nashik, Pune and Aurangabad. Firstly, crops which are most suitable for drip irrigation are being extensively cultivated in these regions by using groundwater. Secondly, these divisions are particularly facing water scarcity problem due to depletion of groundwater. Since it is a water saving technology, farmers have installed drip system for their crops extensively.

Area under groundwater and wide spaced crops is less in Konkan and Nagpur divisions. This factor is important for the development of drip irrigation, growth is not impressive in these two divisions. Though there are variations in the development of drip area across the districts, the overall development is very impressive in majority of the districts in 1994-95 compared to the position of 1986-87.

To understand the district-wise relative changes of drip irrigated area over the period of nine years, we have computed proportions with total area under drip irrigation in the state for each district and division of Maharashtra. The relevant results are reported in table 2.2. Proportion of drip area has significantly changed during the period of 1986-87 to



1994-95 in majority of the districts. Proportion of Nashik<sup>3</sup> division has consistently increased, while the proportion in Kolhapur has declined during this period. For instance, proportion of Nashik division has increased from 11 per cent in 1986-87 to about 34 per cent in 1994-95, while the same has declined from 38 per cent to 24 per cent in Pune division during the same period. The results of the other divisions are more volatile and not consistent. This implies that though there is a consistent increase in the total drip area of Maharashtra, the proportion varies across the districts and divisions.

### 2.3 Area under Drip Irrigation by Central and State Schemes:

As indicated earlier, both central and state schemes are currently operating in Maharashtra to promote drip irrigation. State schemes operated from 1986-87, while central schemes started functioning from 1990-91. Data related to area under drip irrigation for both State and Central schemes are furnished in table 2.3.<sup>4</sup> Out of the total drip area of 60129 ha., 45357 ha. is under state scheme and constituting about 75 per cent of the total area in 1994-95. State scheme occupies more area in all the districts of Maharashtra compared to Central schemes.<sup>7</sup> District-wise percentage to total area shows that the area coverage under state as well as central scheme is higher in the same districts. In other

<sup>3</sup> The two districts (Jalgaon and Nashik) which we selected for the present study are from the division of Nashik.

<sup>4</sup> Year-wise data are not separately available for State and Central Schemes. Hence, we used total area of Central and State schemes to understand the magnitude of these two schemes.

<sup>7</sup> State scheme area here refers to the area under drip irrigation by the farmers benefitted from state scheme, whereas central scheme refers to the area under drip irrigation benefitted from central scheme.

TABLE 2.3 AREA UNDER DRIP IRRIGATION BY CENTRAL AND STATE  
SCHEMES OF SUBSIDY: 1986-87 TO 1994-95 (in ha.)

Districts	Total area	Area		PROPORTION	
		Central	State	CENTRAL	STATE
1. Thane	1173.66	240.21	933.45	20.47	79.53
2. Raigad	159.13	65.97	93.16	41.46	58.54
3. Ratnagiri	198.54	66.44	132.1	33.46	66.54
4. Sindhudurg	333.94	86.12	247.82	25.79	74.21
Total Konkan Dn.	1865.27	458.74	1406.53	24.59	75.41
5. Nasik	10937.75	3167.79	7769.96	28.96	71.04
6. Dhule	914.83	186.61	728.22	20.40	79.60
7. Jalgaon	5374.66	1927.19	3447.47	35.86	64.14
Total Nasik Dn.	17227.24	5281.59	11945.65	30.66	69.34
8. Ahmednagar	5210.20	1313.90	3896.3	25.22	74.78
9. Pune	3676.37	664.33	3012.04	18.07	81.93
10. Solapur	4663.68	1196.45	3467.23	25.65	74.35
Total Pune Dn.	13550.25	3174.68	10375.57	23.43	76.57
11. Satara	1421.19	313.87	1107.32	22.09	77.91
12. Sangli	3287.57	1076.13	2211.44	32.73	67.27
13. Kolhapur	1222.84	124.58	1098.26	10.19	89.81
Total Kolhapur	5931.60	1514.58	4417.02	25.53	74.47
14. Aurangabad	3377.40	674.54	2702.86	19.97	80.03
15. Jalna	1534.88	283.38	1251.5	18.46	81.54
16. Beed	942.78	135.57	807.21	14.38	85.62
Total Aurangabad Dn.	5855.06	1093.49	4761.57	18.68	81.32
17. Latur	2049.85	298.88	1750.97	14.58	85.42
18. Osmanabad	936.97	151.54	785.43	16.17	83.83
19. Nanded	1799.72	442.60	1357.12	24.59	75.41
20. Parbhani	1926.60	440.35	1486.25	22.86	77.14
Total Latur Dn.	6713.14	1333.37	5379.77	19.86	80.14
21. Buldhana	1418.73	308.80	1109.93	21.77	78.23
22. Akola	1269.32	173.89	1095.43	13.70	86.30
23. Amravati	2672.00	359.00	2313	13.44	86.56
24. Yavatmal	1196.01	201.53	994.48	16.85	83.15
Total Amravati Dn.	6556.06	1043.22	5512.84	15.91	84.09
25. Wardha	827.53	223.14	604.39	26.96	73.04
26. Nagpur	783.70	149.29	634.41	19.05	80.95
27. Bhandara	271.43	13.89	257.54	5.12	94.88
28. Chandrapur	59.25	8.00	51.25	13.50	86.50
29. Gadchiroli	13.07	1.80	11.27	13.77	86.23
Total Nagpur Dn.	1954.98	396.12	1558.86	20.26	79.74
Demonstration	476.08	476.08	0	100.00	0.00
Total Maharashtra	60129.68	14771.87	45357.81	24.57	75.43

Source: Commissionerate of Agriculture, Pune, Maharashtra.

words, the relationship between area under State and Central scheme is perfectly positive in all the districts. For instance, Nashik division accounted for about 26 per cent of area in the State total, while the same division accounted for about 35 per cent in Central scheme. Likewise, Pune division accounted for about 21 and 22 per cent in Central and State schemes respectively. Since State scheme started nine years back, it has occupied considerable amount of drip irrigated area (DIA) in all the districts.

It can be seen from the district level data that State scheme occupied more than two third of the total area in majority of the districts. However, Raigad district of Konkan division has more than 41 per cent in Central scheme. The main difference that we noted between Central and State scheme is that the complete demonstration area of drip irrigation comes under the Central scheme. It seems that State scheme does not have area exclusively for demonstration purpose as in the Central scheme.

We also have the data on number of farmers who have adopted drip irrigation and the amount of money distributed in the form of subsidy separately for State and Central schemes for each district (See: table 2.4). Altogether upto 1994-95, 90668 farmers have taken drip irrigation from both Central and State schemes. In the total, 70397 farmers are the beneficiaries of State scheme and the rest Central scheme. Out of the total subsidy of Rs. 8371.49 lakhs, about Rs. 6586 lakhs have been distributed under the State scheme. Like in the area, total number of farmers and the amount distributed in the form of subsidy are substantially higher in State schemes. Area under drip irrigation increases when the amount

Table 2.4: Central and State Schemes subsidy: 1986-87 to 1994-95 (SUBSIDY IN RS. LAKH)

Districts	STATE	CENTRAL	TOTAL	NUMBER OF FARMERS		PER HECTARE SUBSIDY			
	SUBSIDY	SUBSIDY	SUBSIDY	STATE	CENTRE	Total	State	Central	
1. Thane	70.85	17.54	88.39	613	146	759	7531.14	7590.12	7301.94
2. Raigad	9.82	4.68	14.5	138	68	206	9112.05	10541.00	7094.13
3. Ratnagiri	15.28	7.53	22.81	215	110	325	11488.87	11566.99	11333.53
4. Sindhudurg	24.68	5.86	30.54	365	84	449	9145.36	9958.84	6804.46
Total Konkan Dn.	120.63	35.61	156.24	1331	408	1739	8376.27	8576.43	7762.57
5. Nasik	1166.58	423.29	1589.87	17136	5925	23061	14535.62	15013.98	13362.31
6. Dhule	104.50	23.51	128.01	996	276	1272	13992.76	14350.06	12598.47
7. Jalgaon	694.13	259.15	953.28	5176	1814	6990	17736.56	20134.48	13447.04
Total Nasik Dn.	1965.21	705.95	2671.16	23308	8015	31323	15505.44	16451.26	13366.24
8. Ahmednagar	588.55	124.27	712.82	6763	1724	8487	13681.24	15105.36	9458.10
9. Pune	365.72	98.03	463.75	4001	1183	5184	12614.35	12141.94	14756.22
10. Solapur	508.56	127.83	636.39	5319	1550	6869	13645.66	14667.62	10684.11
Total Pune Dn.	1462.83	350.13	1812.96	16083	4457	20540	13379.53	14098.79	11028.83
11. Satara	184.10	31.90	216	1909	465	2374	15198.53	16625.73	10163.44
12. Sangli	444.48	114.67	559.15	5876	2296	8172	17008.00	20099.12	10655.78
13. Kolhapur	161.02	12.43	173.45	1955	194	2149	14184.19	14661.37	9977.52
Total Kolhapur	789.60	159.00	948.6	9740	2955	12695	15992.31	17876.31	10497.96
14. Aurangabad	334.42	65.39	399.81	3225	719	3944	11837.80	12372.82	9694.01
15. Jalna	155.87	30.18	186.05	1401	339	1740	12121.47	12454.65	10650.01
16. Beed	108.73	14.51	123.24	1120	206	1326	13071.98	13469.85	10702.96
Total Aurangabad Dn.	599.02	110.08	709.1	5746	1264	7010	12110.89	12580.30	10066.85
17. Latur	217.05	31.22	248.27	1976	366	2342	12111.62	12395.99	10445.66
18. Osmanabad	112.67	19.08	131.75	1081	230	1311	14061.28	14345.01	12590.74
19. Nanded	176.87	49.05	225.92	1648	456	2104	12553.06	13032.75	11082.24
20. Parbhani	208.34	57.73	266.07	1683	490	2173	13810.34	14017.83	13110.03
Total Latur Dn.	714.93	157.08	872.01	6388	1542	7930	12989.60	13289.23	11780.68
21. Buldhana	118.18	21.74	139.92	1220	386	1606	9862.34	10647.52	7040.16
22. Akola	123.81	17.94	141.75	1156	241	1397	11167.40	11302.41	10316.87
23. Amravati	252.13	33.31	285.44	2377	393	2770	10682.63	10900.56	9278.55
24. Yavatmal	118.90	19.68	138.58	1332	247	1579	11586.86	11956.00	9765.30
Total Amravati Dn.	613.02	92.67	705.69	6085	1267	7352	10763.93	11119.86	8883.07
25. Wardha	71.99	17.06	89.05	764	173	937	10760.94	11911.18	7645.42
26. Nagpur	54.11	10.83	64.94	533	155	688	8286.33	8529.18	7254.34
27. Bhandara	14.55	1.00	15.55	269	23	292	5728.92	5649.61	7199.42
28. Chandrapur	7.07	0.62	7.69	125	8	133	12978.90	13795.12	7750.00
29. Gadchiroli	1.28	0.14	1.42	25	4	29	10864.58	11357.59	7777.78
Total Nagpur Dn.	149.00	29.65	178.65	1716	363	2079	9138.20	9558.27	7485.11
Demonstration	172.66	144.42	317.08			0	66602.25		30335.24
Total Maharashtra	6586.90	1784.59	8371.49	70397	20271	90668	13922.39	14522.09	12081.00

Source: Commissionerate of Agriculture, Pune, Maharashtra.

of money distributed in the form of subsidy increases in almost all the districts of Maharashtra. Since the government's scheme does not allow a farmer to get subsidy for more than one hectare, the relationship between drip area and amount of subsidy money is perfectly positive. The calculated per hectare subsidy comes about Rs 12981/ha. for Central scheme and Rs. 14522/ha. for State schemes. This figure is almost matching with the schemes' subsidy limit of Rs.15000 to 20000/ha.\*

#### 2.4 Crop-wise Area under Drip Irrigation:

This section explains how the crop pattern of drip irrigated area varies across the districts in Maharashtra. More than 20 crops are being cultivated by using drip irrigation in the state. The important crops are Grape, Banana, Pomegranate, Orange, Mango, Ber and Sugarcane. These seven crops altogether accounted for about 52200 ha. occupying nearly 87 per cent (52200 of 60130 hectares) of the total area under drip irrigation. To understand the crop-wise distribution of each district, we have calculated crop-wise proportion for each district for Central and together for Central plus State schemes. The crop-wise proportion of Central plus State total is presented in table 2.5. Need less to emphasise that crop composition of drip area will vary depending upon the existing crop pattern and ecological conditions of a particular division or district. It is clear from the table that distribution of crop varies widely across districts. In the total area under drip irrigation in Maharashtra, Grape accounted for more than one fourth of the area (27 per cent) followed by Sugarcane (16.7 per cent),

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\* Government's subsidy details are given in chapter one of this report.

TABLE 2.5 CROP-WISE PROPORTION OF DRIP AREA: 1986-87 TO 1994-5: CENTRAL &amp; STATE

District	Coconut	Grape	Banana	Pomegrana	Orange	Mango	Chiku	Ber	Sugarcane	others	Total
1. Thane	15.78	0.00	10.29	0.00	2.37	12.26	36.31	0.00	0.00	22.99	100.00
2. Raigad	45.59	0.00	0.00	0.00	0.00	40.86	0.74	0.00	0.00	12.81	100.00
3. Ratnagiri	37.46	0.00	1.01	0.00	0.00	40.50	0.30	0.00	0.00	20.74	100.00
4. Sindhadurg	54.89	0.00	1.85	0.34	0.00	19.71	0.60	0.00	0.00	22.60	100.00
Total Konkan Dn.	27.63	0.00	6.91	0.06	1.49	19.04	23.05	0.00	0.00	21.81	100.00
5. Nasik	0.04	83.20	0.00	9.05	0.23	0.50	0.36	0.47	4.40	1.76	100.00
6. Dhule	0.10	20.53	14.99	8.85	2.90	3.27	1.34	4.03	37.66	6.32	100.00
7. Jalgaon	0.04	1.37	79.01	1.61	4.93	1.10	0.38	0.30	6.99	4.27	100.00
Total Nasik Dn.	0.04	54.34	25.44	6.72	1.84	0.83	0.42	0.61	6.97	2.78	100.00
8. Ahmednagar	0.24	26.12	0.88	10.46	5.13	4.78	5.96	4.47	30.95	11.00	100.00
9. Pune	1.00	18.60	5.17	11.15	15.66	5.12	2.34	3.67	20.01	17.32	100.00
10. Solapur	0.48	26.51	0.76	21.24	0.84	2.63	1.86	19.97	17.93	7.79	100.00
Total Pune Dn.	0.53	24.21	1.99	14.36	6.51	4.13	3.57	9.59	23.50	11.61	100.00
11. Satara	1.24	15.50	0.95	15.28	0.74	10.72	1.74	6.88	28.78	18.97	100.00
12. Sangli	0.41	58.23	0.73	5.21	0.07	1.80	1.07	3.23	27.24	2.01	100.00
13. Kolhapur	5.84	4.86	5.91	1.57	10.22	15.75	4.04	0.27	46.82	4.78	100.00
Total Kolhapur	1.73	36.99	1.85	6.86	2.32	6.82	1.84	3.50	31.64	6.45	100.00
14. Aurangabad	0.77	6.70	5.15	5.66	27.43	11.69	5.01	4.55	18.75	14.28	100.00
15. Jalna	0.26	7.07	26.88	2.51	23.94	6.48	2.94	3.74	17.02	9.48	100.00
16. Beed	0.53	12.78	6.93	6.20	17.22	10.08	3.61	3.61	26.25	12.79	100.00
Total Aurangabad Dn.	0.60	7.78	11.13	4.92	24.87	10.06	4.24	4.19	19.51	12.70	100.00
17. Latur	1.87	19.42	4.79	6.42	6.60	7.51	4.89	7.11	27.60	13.79	100.00
18. Osmanabad	0.28	35.46	3.42	7.36	3.56	3.66	0.91	3.47	27.01	14.87	100.00
19. Nanded	4.74	1.89	26.66	2.74	16.85	7.92	4.28	4.93	19.98	9.99	100.00
20. Parbhani	0.89	5.19	15.19	4.25	26.17	5.29	2.64	2.94	24.98	12.46	100.00
Total Latur Dn.	2.14	12.88	13.45	4.95	14.54	6.45	3.52	4.82	24.72	12.54	100.00
21. Buldhana	0.07	9.48	10.35	8.26	26.84	5.45	2.47	4.04	11.09	21.96	100.00
22. Akola	0.54	1.25	7.79	6.34	44.48	4.00	2.82	1.63	11.98	19.16	100.00
23. Amravati	0.00	2.71	3.23	4.16	38.50	6.13	3.20	4.40	11.01	26.67	100.00
24. Yavatmal	0.01	1.82	5.32	3.23	39.60	5.33	4.48	4.48	13.60	22.13	100.00
Total Amravati Dn.	0.12	3.73	6.04	5.30	37.34	5.42	3.20	3.80	11.69	23.37	100.00
25. Wardha	1.04	0.00	18.92	0.58	38.35	7.23	2.54	2.76	7.36	21.22	100.00
26. Nagpur	0.00	0.09	1.88	0.54	45.59	6.51	2.60	5.07	16.20	21.51	100.00
27. Bhandara	0.00	0.00	2.17	0.00	5.74	6.03	0.00	0.00	5.65	81.00	100.00
28. Chandrapur	0.00	0.68	0.00	2.65	10.68	28.42	7.68	3.63	6.45	39.81	100.00
29. Gadchiroli	0.00	0.00	0.00	6.12	0.00	36.73	0.00	2.75	0.00	54.40	100.00
Total Nagpur Dn.	0.44	0.06	9.07	0.59	35.55	7.61	2.35	3.33	10.59	30.42	100.00
Demonstration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Total Maharashtra	1.48	27.28	11.67	7.47	11.54	4.97	3.05	4.15	16.69	10.90	100.00

Source: Commissionerate of Agriculture, Pune, Maharashtra.

TABLE 2.6 CROP-WISE PROPORTION OF DRIP AREA: 1986-7 TO 1994-5: CENTRAL SCHEME

District	Coconut	Grape	Banana	Pomegrana	Orange	Mango	Chiku	Ber	S/Orange	Others	Total area
1. Thane	7.92	0.00	13.88	0.00	0.00	21.87	42.17	0.00	0.00	14.15	100.00
2. Raigad	61.79	0.00	0.00	0.00	0.00	38.21	0.00	0.00	0.00	0.00	100.00
3. Ratnagiri	63.44	0.00	1.51	0.00	0.00	23.59	0.15	0.00	0.00	11.32	100.00
4. Sindhudurg	66.28	0.00	2.65	0.00	0.00	18.58	0.00	0.00	0.00	12.49	100.00
Total Konkan Dn.	34.66	0.00	7.98	0.00	0.00	23.85	22.10	0.00	0.00	11.40	100.00
5. Nashik	0.03	87.02	0.00	7.76	0.08	0.64	0.29	0.39	0.06	3.74	100.00
6. Dhule	0.11	40.32	27.34	11.96	2.93	6.12	0.85	4.33	0.00	6.06	100.00
7. Jalgaon	0.00	1.27	90.60	0.13	1.60	1.16	0.35	0.29	1.01	3.59	100.00
Total Nashik Dn.	0.02	54.08	34.02	5.12	0.74	4.02	0.33	0.49	0.41	3.77	100.00
8. Ahmednager	0.39	49.40	1.02	8.04	4.92	5.98	8.97	7.52	4.14	9.61	100.00
9. Pune	0.96	30.45	9.67	12.22	1.00	5.90	3.99	9.99	0.39	25.43	100.00
10. Solapur	0.28	33.95	0.00	21.25	0.54	3.24	1.90	28.16	0.12	10.56	100.00
Total Pune Dn.	0.47	39.61	2.45	13.89	2.45	4.93	5.26	15.82	1.84	13.28	100.00
11. Satara	1.33	20.96	0.65	21.91	0.25	19.29	1.40	11.51	0.00	22.68	100.00
12. Sangli	0.72	83.52	0.09	6.49	0.00	2.40	2.35	3.17	0.00	1.25	100.00
13. Kolhapur	20.92	7.40	4.32	0.00	0.00	31.79	13.95	0.00	0.00	21.62	100.00
Total Kolhapur	2.50	64.30	0.56	9.15	0.05	8.32	3.11	4.64	0.00	7.37	100.00
14. Aurangabad	0.34	6.79	9.76	9.38	21.42	7.09	7.19	9.95	20.39	7.69	100.00
15. Jalna	0.00	13.13	8.94	0.26	12.90	4.62	7.18	2.40	38.86	11.70	100.00
16. Beed	0.74	28.10	8.76	3.02	7.80	7.64	5.30	13.22	19.64	5.78	100.00
Total Aurangabad Dn	0.30	11.08	9.43	6.23	17.53	6.52	6.95	6.40	25.08	8.49	100.00
17. Latur	0.76	28.77	2.86	4.28	9.01	17.39	6.77	14.61	1.99	13.56	100.00
18. Osmanabad	0.26	54.78	1.22	1.86	0.00	2.14	0.29	2.41	0.00	37.03	100.00
19. Nanded	4.05	0.54	38.76	1.73	17.65	7.14	5.86	3.02	9.70	11.55	100.00
20. Parbhani	0.00	1.50	25.07	0.23	42.50	6.04	0.86	0.23	5.17	18.40	100.00
Total Latur Dn.	1.55	13.35	21.93	1.82	21.91	8.51	3.78	4.62	5.38	17.16	100.00
21. Buldhana	0.32	6.59	17.13	1.36	12.92	4.53	2.98	1.76	11.94	40.46	100.00
22. Akola	0.81	0.29	8.64	0.35	9.72	4.00	0.75	0.00	13.93	61.52	100.00
23. Amravati	0.00	0.00	0.93	0.25	25.02	4.72	0.30	0.00	36.08	32.69	100.00
24. Yavatmal	0.06	0.38	3.68	2.07	21.00	3.54	0.78	0.00	21.85	46.63	100.00
Total Amravati Dn.	0.24	2.07	7.54	0.95	18.11	4.32	1.26	0.52	22.49	42.49	100.00
25. Wardha	0.00	0.00	30.58	1.34	33.49	7.51	0.09	0.54	10.84	15.60	100.00
26. Nagpur	0.00	0.00	3.85	1.25	20.56	1.34	0.00	0.00	33.20	39.79	100.00
27. Bhandara	0.00	0.00	0.00	0.00	53.28	0.00	0.00	0.00	0.00	46.72	100.00
28. Chandrapur	0.00	0.00	0.00	0.00	0.00	11.75	0.00	0.00	47.75	40.50	100.00
29. Gadchiroli	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	100.00
Total Nagpur Dn.	0.00	0.00	18.68	1.23	28.49	5.43	0.05	0.30	19.58	26.24	100.00
Demonstration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Total Maharashtra	4.71	38.60	19.32	9.41	9.06	7.71	6.24	8.11	7.98	13.98	100.00

Source: Commissionerate of Agriculture, Pune, Maharashtra.

Banana (11.5 per cent) and Orange (11.5 per cent). However, this picture is not the same for all the districts. Three crops namely Coconut (27.5 per cent), Chiku (23 per cent) and Mango (19 per cent) accounted for nearly 70 per cent of the Konkan region's total area under drip irrigation, while crops like Grape (54.3 per cent) and Banana (25.4 per cent) accounted for more than three fourth of the total drip irrigated area in Nashik division. Likewise, while in Pune division Grape (24 per cent), Sugarcane (24 per cent) and Pomegranate (15 per cent) are important crops, Aurangabad is dominated by Orange (24 per cent), Sugarcane (20 per cent) and Banana (11.1 per cent). This shows that crop composition of drip irrigated area varies widely with districts and divisions.

The crop composition of Central scheme (table 2.6) is almost the same as in the Central plus State schemes. However, Sugarcane crop is completely absent in the Central scheme. This is because of the fact that Central scheme does not provide subsidy for Sugarcane. Government of Maharashtra provides subsidy even for sugarcane crop through its own budgetary resources.\*

District-wise proportion of drip area for each crop is presented in table 2.7. This is done to understand how a particular crop concentrates in each district and division. Coconut is mainly concentrated in Konkan division (57.8 per cent), while Grape in Nashik (57 per cent) and Pune (20 per cent) divisions. About 62 per cent of Banana area concentrates in Nashik division. Likewise, Pomegranate is concentrated mainly in Pune (43.3 per cent) and Nashik

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\* See: INCID (1994), Op cit.



TABLE 2.7 DISTRICT-WISE PROPORTION OF DRIP AREA 1986-7 TO 1994-5 CENTRAL AND STATE SCHEMES

District	Coconut	Grape	Banana	Pomegra.	Orange	Mango	Chiku	Ber	Sugarcane	others	Total area
1. Thane	20.76	0.00	1.72	0.00	0.40	4.81	23.22	0.00	0.00	4.12	1.95
2. Raigad	8.13	0.00	0.00	0.00	0.00	2.18	0.06	0.00	0.00	0.31	0.26
3. Ratnagiri	8.34	0.00	0.03	0.00	0.00	2.69	0.03	0.00	0.00	0.63	0.33
4. Sindhudurg	20.55	0.00	0.09	0.03	0.00	2.20	0.11	0.00	0.00	1.15	0.56
Total Konkan Dn.	57.78	0.00	1.84	0.03	0.40	11.88	23.43	0.00	0.00	6.21	3.10
5. Nasik	0.45	55.48	0.00	22.05	0.37	1.83	2.12	2.07	4.79	2.93	18.19
6. Dhule	0.11	1.15	1.95	1.80	0.38	1.00	0.67	1.48	3.43	0.88	1.52
7. Jalgaon	0.25	0.45	60.50	1.93	3.82	1.98	1.12	0.64	3.74	3.50	8.94
Total Nasik Dn.	0.81	57.07	62.45	25.78	4.57	4.81	3.91	4.19	11.96	7.32	28.65
8. Ahmednagar	1.40	8.30	0.65	12.13	3.85	8.33	16.93	9.35	16.07	8.75	8.66
9. Pune	4.14	4.17	2.68	9.13	8.30	6.30	4.70	5.41	7.33	9.72	6.11
10. Solapur	2.51	7.54	0.51	22.06	0.56	4.10	4.71	37.34	8.33	5.54	7.76
Total Pune Dn.	8.05	20.00	3.84	43.33	12.71	18.73	26.34	52.10	31.73	24.00	22.54
11. Satara	1.98	1.34	0.19	4.84	0.15	5.10	1.35	3.92	4.07	3.94	2.36
12. Sangli	1.49	11.67	0.34	3.81	0.03	1.98	1.91	4.26	8.92	1.01	5.47
13. Kolhapur	8.01	0.36	1.03	0.41	1.80	6.44	2.69	0.13	5.70	0.89	2.03
Total Kolhapur	11.48	13.38	1.56	9.06	1.99	13.53	5.95	8.31	18.70	5.84	9.86
14. Aurangabad	2.93	1.38	2.48	4.26	13.35	13.21	9.22	6.16	6.31	7.36	5.62
15. Jalna	0.45	0.66	5.88	0.86	5.29	3.33	2.46	2.30	2.60	2.15	2.55
16. Beed	0.56	0.73	0.93	1.30	2.34	3.18	1.85	1.37	2.47	1.84	1.57
Total Aurangabad Dn.	3.94	2.78	9.28	6.42	20.98	19.71	13.53	9.83	11.38	11.35	9.74
17. Latur	4.29	2.43	1.40	2.93	1.95	5.15	5.46	5.85	5.64	4.31	3.41
18. Osmanabad	0.29	2.03	0.46	1.54	0.48	1.15	0.46	1.30	2.52	2.13	1.56
19. Nanded	9.57	0.21	6.83	1.10	4.37	4.77	4.20	3.56	3.58	2.74	2.99
20. Parbhani	1.92	0.61	4.17	1.83	7.26	3.41	2.77	2.27	4.79	3.66	3.20
Total Latur Dn.	16.08	5.27	12.86	7.40	14.07	14.48	12.89	12.98	16.53	12.84	11.16
21. Buldhana	0.11	0.82	2.09	2.61	5.49	2.58	1.91	2.30	1.57	4.75	2.36
22. Akola	0.77	0.10	1.41	1.79	8.14	1.70	1.95	0.83	1.52	3.71	2.11
23. Amravati	0.00	0.44	1.23	2.47	14.82	5.48	4.66	4.71	2.93	10.87	4.44
24. Yavatnal	0.01	0.13	0.91	0.86	6.83	2.13	2.92	2.15	1.62	4.04	1.99
Total Amravati Dn.	0.90	1.49	5.64	7.74	35.27	11.89	11.44	9.99	7.63	23.37	10.90
25. Wardha	0.97	0.00	2.23	0.11	4.57	2.00	1.14	0.91	0.61	2.68	1.38
26. Nagpur	0.00	0.00	0.21	0.10	5.15	1.71	1.11	1.59	1.26	2.57	1.30
27. Bhandara	0.00	0.00	0.08	0.00	0.20	0.55	0.00	0.00	0.15	3.35	0.45
28. Chandrapur	0.00	0.00	0.00	0.03	0.09	0.56	0.25	0.09	0.04	0.36	0.10
29. Gadchiroli	0.00	0.00	0.00	0.02	0.00	0.16	0.00	0.01	0.00	0.11	0.02
Total Nagpur Dn.	0.97	0.01	2.53	0.25	10.01	4.98	2.50	2.61	2.06	9.07	3.25
Demonstration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79
Total Maharashtra	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Commissionerate of Agriculture, Pune, Maharashtra.

TABLE 2.8 DISTRICT-WISE PROPORTION OF DRIP AREA FROM 1986-7 TO 1994-5: CENTRAL SCHEME

District	Coconut	Grape	Banana	Pomegra.	Orange	Mango	Chiku	Ber	S/Orange	Others	Total area
1. Thane	7.96	0.00	1.35	0.00	0.00	7.54	21.42	0.00	0.00	2.06	1.63
2. Raigad	17.04	0.00	0.00	0.00	0.00	3.62	0.00	0.00	0.00	0.00	0.45
3. Ratnagiri	17.62	0.00	0.04	0.00	0.00	2.25	0.02	0.00	0.00	0.45	0.45
4. Sindhudurg	23.86	0.00	0.09	0.00	0.00	2.29	0.00	0.00	0.00	0.65	0.58
Total Konkan Dn.	66.48	0.00	1.48	0.00	0.00	15.69	21.44	0.00	0.00	3.16	3.11
5. Masik	0.33	50.97	0.00	25.68	0.29	2.89	1.94	1.61	0.27	7.17	21.44
6. Dhule	0.09	1.39	2.97	2.33	0.60	1.64	0.33	1.07	0.00	0.68	1.26
7. Jalgaon	0.00	0.45	70.75	0.26	3.41	3.22	1.42	0.74	2.63	4.18	13.05
Total Masik Dn.	0.42	52.81	72.82	28.27	4.30	7.75	3.69	3.42	2.90	12.03	35.75
8. Ahmednagar	2.15	12.00	0.54	11.04	7.17	11.26	24.91	13.03	7.37	7.64	8.89
9. Pune	2.65	3.74	2.60	8.48	0.74	5.62	5.61	8.75	0.35	10.22	4.50
10. Solapur	1.39	7.51	0.00	26.55	0.71	5.57	4.81	44.42	0.19	7.64	8.10
Total Pune Dn.	6.19	23.25	3.15	46.06	8.62	22.45	35.33	66.20	7.92	25.50	21.49
11. Satara	4.74	1.22	0.08	7.18	0.09	8.69	0.93	4.76	0.00	4.31	2.12
12. Sangli	3.22	16.62	0.84	7.30	0.00	3.70	5.36	4.50	0.00	0.82	7.28
13. Kolhapur	10.90	0.17	0.22	0.00	0.00	5.68	3.68	0.00	0.00	1.63	0.84
Total Kolhapur	15.86	18.01	0.34	14.48	0.09	18.07	9.96	9.26	0.00	6.75	10.25
14. Aurangabad	0.95	0.85	2.67	6.61	16.00	6.86	10.25	8.85	18.63	3.14	4.57
15. Jalna	0.00	0.69	1.03	0.08	4.05	1.88	4.30	0.90	14.92	2.01	1.92
16. Beed	0.42	0.70	0.48	0.43	1.17	1.49	1.52	2.36	3.61	0.47	0.92
Total Aurangabad Dn.	1.37	2.24	4.18	7.12	21.22	10.22	16.08	12.11	37.16	5.62	7.40
17. Latur	0.95	1.59	0.35	1.33	2.98	7.46	4.28	5.76	0.81	2.45	2.02
18. Osmanabad	0.17	1.54	0.07	0.29	0.00	0.47	0.09	0.48	0.00	3.39	1.03
19. Nanded	7.50	0.04	6.95	0.80	8.65	4.54	5.48	1.76	5.82	3.09	3.00
20. Parbhani	0.00	0.12	4.47	0.10	20.72	3.82	0.80	0.13	3.09	4.90	2.98
Total Latur Dn.	8.62	3.29	11.85	2.53	32.35	16.27	10.66	8.13	9.71	13.84	9.03
21. Buldhana	0.42	0.38	2.14	0.44	4.42	2.01	1.95	0.72	4.99	7.56	2.09
22. Akola	0.59	0.01	0.61	0.06	1.87	1.00	0.27	0.00	3.28	6.47	1.18
23. Amravati	0.00	0.00	0.14	0.09	9.95	2.43	0.23	0.00	17.55	7.10	2.43
24. Yavatmal	0.05	0.01	0.30	0.44	4.69	1.02	0.33	0.00	5.97	5.68	1.36
Total Amravati Dn.	1.06	0.40	3.19	1.03	20.92	6.46	2.79	0.72	31.80	26.81	7.06
25. Wardha	0.00	0.00	2.77	0.31	8.28	2.40	0.04	0.16	3.28	2.11	1.51
26. Nagpur	0.00	0.00	0.23	0.20	3.40	0.29	0.00	0.00	6.72	3.59	1.01
27. Bhandara	0.00	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.39	0.09
28. Chandrapur	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.52	0.20	0.05
29. Gadchiroli	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.01
Total Nagpur Dn.	0.00	0.00	3.00	0.51	12.49	3.08	0.04	0.16	10.51	6.29	2.68
Demonstration	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.22
Total Maharashtra	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Commissionerate of Agriculture, Pune, Maharashtra.

divisions (26 per cent). It is clear that crop's concentration varies across the districts depending upon the climatic and other ecological factors. Although, there is a wide variation in concentration of crops across the districts, Pune division occupies an important place in all the major crops. It seems that Pune's climatic factors and cropping pattern are most suitable for further development of drip irrigation.

District-wise distribution of crop in Central scheme is almost similar like State scheme especially in the distribution of area under different crops (table 2.8).

### 2.5 Factors Contributing the Development of Drip Area:

We have seen in the earlier section that development of drip irrigated area is not uniform across the districts of Maharashtra. In some districts, drip irrigated area has increased quite impressively, while in some other districts it is quite less. To understand this variation and the factors which influence the development of drip irrigation, we have made detailed analysis across the districts by including factors like rainfall, area under groundwater, irrigation intensity, cropping intensity, area under non-foodgrains crops etc. We understand from the existing studies<sup>10</sup> that the above mentioned factors either directly or indirectly influence the development of drip irrigation.

<sup>10</sup> (i) Shrestha, R.B. and Gopalakrishanan, C. (1993), "Adoption and Diffusion of Drip Irrigation Technology: An Econometric Analysis," Economic Development and Cultural Change, Vol. 41(2), January, pp. 407-418.

(ii) Puranik, R.P. et al., (1992), "Constraints and Problems as Perceived by Non-Adopters and Adopters of Drip Irrigation System," Agricultural Situation in India, Vol. XLVII, No.1, April, pp. 33-34.

Before going to see the empirical relationship of these factors, let us see theoretically how these factors can influence the development of drip irrigation. As the drip method of irrigation is mainly used for water saving, farmers hesitate to adopt drip irrigation in the area where rainfall is in abundance. Hence, development of drip irrigation will be slow in good rainfall regions. Availability of groundwater is also one of the important factors for the development of drip irrigation since it is most suitable for groundwater based irrigation. Adoption of drip irrigation can be expected more in the area where farmers face groundwater scarcity or groundwater depletion, while it will be slow in the area with good groundwater potential. Crop pattern of a particular district/region also influences the adoption of drip irrigation. The existing technology of drip irrigation is not suitable for foodgrain crops like Paddy, Wheat etc. Hence, the development of drip irrigation will be slow in the food crops regions. The rate of adoption will be more in the area where wide spaced crops like Grape, Banana, Mango, Pomegranate etc are being cultivated extensively by using surface method of irrigation. Surface irrigation sources like canal and tank will also influence the drip irrigation to some extent. Farmers are normally reluctant to adopt drip irrigation when they know that the surface irrigation is assured and available for future development.

Two types of methods of analysis have been used to understand the factors which influence the development of drip irrigation. They are: (1) simple percentage (comparing proportion of each independent variable with drip irrigated area of different divisions), and (2) correlation and regression analysis - both simple and multiple regressions.

TABLE 2.9 REGION-WISE DRIP IRRIGATED AREA AND ITS RELATED FACTORS

Region	Rainfall :in mm.	Fertiliser :per. ha.	SIA/NIA :in %	GIA/NIA :in %	GIA/GCA :in %	II :in %	CI :in %	NPCA/GCA :in %	Drip Area :Ratio (%)
1. Konkan	: 2694.88 :	: 43.6 :	: 76.67 :	: 23.33 :	: 4.99 :	: 118.11 :	: 108.28 :	: 36.53 :	: 3.1 :
2. Nashik	: 764.83 :	: 88.3 :	: 24.17 :	: 75.83 :	: 15.35 :	: 124.68 :	: 116.68 :	: 35.41 :	: 28.65 :
3. Pune	: 576.13 :	: 47.9 :	: 31.11 :	: 68.89 :	: 21.1 :	: 119.56 :	: 115.14 :	: 19.62 :	: 22.53 :
4. Kolhapur	: 1105.47 :	: 114.8 :	: 44.33 :	: 55.67 :	: 20.56 :	: 123.01 :	: 113.42 :	: 35.49 :	: 9.86 :
5. Aurangabad	: 691.1 :	: 38.5 :	: 38.05 :	: 61.95 :	: 18.29 :	: 123.2 :	: 125.1 :	: 28.28 :	: 9.74 :
6. Latur	: 687.38 :	: 49.5 :	: 31.65 :	: 68.35 :	: 14.45 :	: 135.57 :	: 129.65 :	: 36.88 :	: 11.16 :
7. Ameravati	: 869.08 :	: 51.5 :	: 24.09 :	: 75.91 :	: 5.08 :	: 150.4 :	: 118.79 :	: 47.26 :	: 10.96 :
8. Naggur	: 1240.68 :	: 88.1 :	: 76.79 :	: 23.21 :	: 17.88 :	: 119.32 :	: 112.44 :	: 31.51 :	: 3.25 :
Demonstration	:	:	:	:	:	:	:	:	: 0.79 :
Maharashtra	:	: 57.7 :	: 39.1 :	: 60.9 :	: 15.03 :	: 124.94 :	: 118.49 :	: 33.71 :	: 400 :

## Note:

GIA - Gross Irrigated Area, NIA - Net Irrigated Area,

GCA - Gross Cropped Area, II - Irrigation Intensity,

CI - Cropping Intensity, SIA - Surface Irrigated Area

NPCA - Non-Foodgrains Cropped Area

(1) Rainfall related to 1992, (2) Fertiliser related to 1992-93

(3) Irrigation related to 1989-90, (4) other data related to 1993-94

Source: Government of Maharashtra, District-wise Agriculture Statistical  
Information of Maharashtra, Part II, 1993-94 & 1994-95, Commissionerate  
of Agriculture, Pune.

The results of the simple percentage analysis are given in table 2.9. It is clear from table that there is a negative association between rainfall and drip irrigated area. Because of good rainfall the development of drip irrigated area is very less in divisions like Konkan, Nagpur and Kolhapur. This is obvious that when farmers get good rain water for irrigation they need not go for capital intensive methods like drip irrigation as indicated already. Second important result of the analysis is the positive relationship between groundwater area and drip irrigated area. Ratio of groundwater area to total irrigated area is much higher in divisions like Nashik, Pune, Latur and Amravati compared to State's average. As a result, proportion of area under drip irrigation of these divisions is quite high compared to the other divisions. Farmers adopt drip irrigation extensively when they face water scarcity particularly in the groundwater dominating area. The results of our analysis support this fact. As indicated already, owing to depletion of groundwater, many farmers had faced water problem in divisions like Pune and Nashik to cultivate high remunerative crops by using surface method of irrigation. This has brought tremendous pressure on farmers to adopt drip irrigation for those crops. As a result, area under drip irrigation has increased substantially in these divisions.

Correlations are computed for the above mentioned variables to understand the nature of statistical relationship. The values are given in the last column of table 2.10. It is clearly observed that the association between groundwater area and drip area is positive and strong. This means that drip area is more whenever the ratio of groundwater area (GWA) to net irrigated area (NIA) is higher.

The association is negative and strong between rainfall and drip irrigated area as expected. Other than groundwater and rate of rainfall, the correlation value is very weak with other variables. Much against our expectation, the sign of correlation with ratio of non-food crops area (NFCA) to gross cropped area (GCA) turned out to be negative, however, it was not significant.

Table 2.10, Results of simple regression and correlation:

variables	Constant	Coefficients	R <sup>2</sup>	r
1. Rainfall in mm.	3571.31	-1.35 <sup>a</sup> (0.55)	0.18	-0.43
2. Fertiliser consumption (per ha.)	1155.41	15.49 (12.76)	0.05	0.23
3. Ratio GWA to NIA	-257.18	40.22 <sup>a</sup> (14.99)	0.21	0.46
4. Ratio SIA to NIA	3764.38	-40.22 <sup>a</sup> (14.99)	0.21	-0.46
5. Ratio GIA to GCA	1439.68	42.39 (52.92)	0.02	0.15
6. Irrigation Intensity	3658.94	-12.44 (26.80)	0.007	-0.08
7. Cropping Intensity	-262.26	19.77 (39.03)	0.009	0.09
8. Ratio of NFCA to GCA	2762.66	-20.84 (32.69)	0.014	-0.12

Note: Figures in parentheses are standard error.

a - indicates significant at 1 per cent level.

GWA - groundwater area, NIA - net irrigated area,

GIA - gross irrigated area, GCA - Gross cropped area,

NFCA - non-food crops area, SIA - Surface irrigated area.

After knowing the relationship of each variable with drip irrigated area, we have computed regression (both simple and multiple) for the variables which are considered to be important in influencing the adoption of drip. The results of simple and multiple regression are separately presented in table 2.10 and 2.11. Among the eight linear regression models, the co-efficients of three variables namely rainfall,

groundwater area and surface irrigated area show a significant value. The negative co-efficients of rainfall shows that one unit increase in the rainfall will reduce about 1.35 unit of drip irrigated area. This is not surprising because when rainfall of a particular district or region is more naturally farmers will hesitate to take drip irrigation for their crop cultivation. The co-efficient of groundwater area indicates that one unit increase in the area under groundwater irrigation will increase more than 40 unit in the drip area. This is also statistically significant. The co-efficients of other variables show a very weak relationship with drip irrigated area.

Table 2.11, Results of multiple regression.

Variables	Co-efficients	Standard Error
1. Rainfall	-0.27	0.90
2. Fertiliser (per ha.)	23.29	13.88 <sup>a</sup>
3. Ratio of GWA/NIA	43.43	24.63 <sup>a</sup>
4. Cropping intensity	-7.09	36.72
5. NFCA/GCA	-74.15	47.16 <sup>a</sup>
6. GIR/GCA	-12.96	82.35
R <sup>2</sup>		0.38
Constant		2040.73
N		29

Note: a and b denote significant at 1 and 10 per cent level, respectively.

The results of multiple regression show that groundwater area plays a significant role in increasing the area under drip irrigation. It is from the co-efficient of fertiliser consumption that the districts which consume more fertiliser (per ha.) also have more area under drip irrigation. This indirectly indicates that agriculturally advanced districts of Maharashtra have more drip irrigated area. Altogether, the results of correlation and regression show that rainfall and



groundwater area are the two important variables which influence the growth of drip irrigated area in Maharashtra.

To sum up, area under drip irrigation is substantially higher in Maharashtra compared to any other state in India. As per the data of 1992, it ranks the first place in India, occupying nearly 46 per cent of the total area. Drip irrigated area has consistently increased from 236 ha. in 1986-87 to 60129 ha. in 1994-95. Development of drip irrigated area varies with districts and regions. Districts which come under the divisions of Nahnk and Pune continue to dominate in the state's total since the beginning of the schemes, while the development is less in districts which belong to the division of Konkan and Nagpur. State schemes accounted for about three fourth of the total area in almost all the districts of Maharashtra. Crop-wise proportion of drip irrigated area varies widely across the districts in both Central and State schemes. The main drip irrigated crops in the state are Grapes (27.3 per cent), Sugarcane (16.7 per cent), Banana (11.6 per cent) and Orange (11.5 per cent). The area of Central scheme is more wherever the area of State scheme is more. The only difference between State and Central scheme is that the absence of area under Sugarcane in Central scheme, whereas the same crop occupies a considerable amount of area in State scheme. Statistical analysis shows that groundwater area and rainfall are the two main factors which influence the growth of drip irrigation significantly in Maharashtra.

## Chapter - III

### IMPACT OF DRIP IRRIGATION ON INPUT USE AND CROP'S PRODUCTIVITY

As indicated already, there are not many studies dealing with drip irrigation at field level. Drip irrigation is a relatively new method of irrigation hence it is useful to understand the socio-economic conditions of the adopters group as well as its impact in order to arrive at policy conclusion. Though the importance of drip irrigation in increasing the yield of crops and water saving has been indicated by some research station results, the results may differ when we study the field level conditions. Moreover, since it is a capital intensive technique, it becomes necessary to study the economic viability of investment in drip irrigation by taking into account field level information.

#### 3.1 Characteristics of the Sample farmers

Adoption of new technological components is not only determined by its profit but also by the socio-economic characteristics of the adopters group.<sup>1</sup> Many studies have confirmed that farmers' age, education, experience and their social status play a greater role in adopting any new technique in agriculture. Hence, it is pertinent to see the characteristics of the adopters and the non-adopters group before going to analyse the impact of drip irrigation on productivity of crops and water consumption.

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<sup>1</sup> Dasgupta, S (1989), *Diffusion of Agricultural Innovations in Village India*, Wiley Eastern Ltd, New Delhi.

Table 3.1 shows the characteristics of both the drip adopters and the non-drip adopters. According to the existing studies, adoption of new technological components will be more in the young farmers' group than the old farmers' group. This is clearly reflected in our sample. In both the districts, the beneficiaries' age is comparatively less than the non-beneficiaries (the non-drip users).

Education of the farmers also influences the adoption of new methods in agriculture.<sup>2</sup> Modern agriculture is more complicated and needs day to day information for which education is indispensable. Educated farmers can get all information through news papers and other communication media. Hence, they could become early adopters. This is confirmed by our study. The average schooling years of the beneficiaries are significantly higher than the non-beneficiaries in both the districts. For instance, in Jalgaon district, the average of schooling years is about nine for the beneficiaries while, it is only about seven years for the non-beneficiaries (NBs). Similarly, we have noted schooling years as nine and six years respectively for the beneficiaries and the non-beneficiaries in Nashik district.

Farming experience is also an important variable in determining the adoption of the new technological components.<sup>3</sup> It is positively related to age of the farmers. Normally, experienced or older farmers are more conservative and thus often reluctant to use new innovative methods in

<sup>2</sup> Chaudhri, D.P. (1979), *Education, Innovation and Agricultural Development: A study of North India (1961-72)*, Vikas Publishers, New Delhi.

<sup>3</sup> Narayanamoorthy, A. (1994), "Impact of Farmers Education, Age and Experience on Fertiliser Use and Yield", *Productivity*, Vol. 34 (4), January-March, pp. 710-714.

agriculture. Unlike this group, the less experienced farmers try to adopt all new methods in their cultivation when they feel a particular technique is more profitable as well as essential. To understand this phenomenon, we have calculated farming experience (in terms of years) for both the beneficiaries and the non-beneficiaries. This analysis also confirms the negative relationship between experience and adoption.

Table 3.1: Characteristics of the sample farmers:

Variables	Jalgaon		Nashik	
	No. of farmers	Ave.	No. of farmers	Ave.
<b>Age:</b>				
SSB	11	37.56	12	38.83
CSB	14	47.00	13	44.85
SSB + CSB	25	42.84	25	41.96
NB	25	52.08	25	42.28
<b>Education:</b>				
SSB	11	9.45	12	9.33
CSB	14	8.71	13	9.08
SSB+CSB	25	9.04	25	9.20
NB	25	7.06	25	6.96
<b>Farming Experience:</b>				
SSB	11	12.55	12	14.92
CSB	14	22.93	13	24.46
SSB+CSB	25	18.36	25	18.84
NB	25	25.20	25	20.36
<b>Farmers' Status:</b>				
SSB	11	9 (Fp) & 2 (Fs)	12	10 (Fp) & 2 (Fs)
CSB	14	13 (Fp) & 1 (Fs)	13	11 (Fp) & 2 (Fs)
SSB+CSB	25	22 (Fp) & 3 (Fs)	25	22 (Fp) & 4 (Fs)
NB	25	24 (Fp) & 1 (Fs)	25	24 (Fp) & 1 (Fs)

Note: SSB & CSB - State Scheme and Central Scheme Beneficiaries respectively, NB - Non-beneficiaries.

(Fp) - Farmers, (Fs) - farmers in service.

Source: Primary survey data.

Contact with officials of the agricultural department and level of urban contacts would help farmers to get new information regarding modern agriculture. Generally, most of the Indian farmers have less exposure in modern agriculture BECAUSE of low literacy. There is a positive relationship

between land size of the farmers and frequency of contact. Extension officials often used to contact the rich and high status farmers and supply information about new techniques. Since drip irrigation is a new technique and introduced recently, we have tried to find out the status of the adopters and the non-adopters in our sample. For this, we have broadly divided the sample farmers into two: farmers (Fp) and the farmers who are in service (Fs)\* in both the beneficiaries and the non-beneficiaries group. As we expected, the number of farmers who belong to the service category are more in the adopters group than in the non-adopters group. This indirectly informs that status of farmers also plays a role in adoption of modern techniques like drip irrigation.

### 3.2 Land Holding Details by Source of Irrigation.

Land size and source of irrigation are the two important factors which determine the use of drip irrigation to a considerable extent. For adopting drip irrigation, at least one acre of land is required. Generally, land size of the adopters group will be higher than the non-adopters group.<sup>5</sup> Table 3.2 shows the total landholding details of both the beneficiaries and the non-beneficiaries by source of irrigation. We expect that the average land size of the beneficiaries will be higher than the non-beneficiaries as drip requires more area for profitable cultivation. But the results of our survey failed to confirm our expectation. Average land size per household is higher for the non-beneficiaries group than the beneficiaries group in both the

\* Service includes Businessmen, working in government and non-government organisations, etc.

<sup>5</sup> See, Shrestha and Appalakrishnan, (1993), op cit.

districts. In Jalgaon district, the average land size comes about 2.11 ha. for the beneficiaries, while the same is about 2.49 hectares for the non-beneficiaries. Similar conditions were observed in Nashik district. This is because of the reason that the beneficiaries might not have been disclosed their original land details because of subsidy facility.

Table 3.2: Landholding details by Source of Irrigation.  
(area in ha.)

District	Well	Surface	RFA	UCL	Total owned area
<b>Jalgaon:</b>					
SSB	13.78 (77.45)	--	3.81 (21.42)	0.20 (1.12)	17.79 (100.0)
CSB	30.68 (87.91)	--	3.07 (8.79)	1.15 (3.29)	34.90 (100.0)
SSB+CSB	44.46 (84.38)	--	6.88 (13.05)	1.35 (2.56)	52.69 (100.0)
NB	50.27 (80.73)	--	12.00 (22.77)	--	62.27 (100.0)
<b>Nashik:</b>					
SSB	12.20 (51.19)	7.00 (29.37)	4.49 (18.84)	0.14 (0.58)	23.83 (100.0)
CSB	21.50 (79.34)	3.02 (11.14)	2.58 (9.52)	--	27.10 (100.0)
SSB+CSB	32.70 (64.21)	10.02 (19.67)	7.07 (13.88)	0.14 (0.27)	50.93 (100.0)
NB	53.78 (95.78)	2.37 (4.22)	--	--	56.15 (100.0)

Note: TIA - total irrigated area, RFA - rain-fed area.  
UCL - Un cultivated land.  
Figures in brackets are percentage to total area.

Source: Primary survey data.

Like land, source of irrigation is also an important factor for adopting drip method of irrigation. The existing technology of drip is proved to be most suitable for ground water source of irrigation. In both the districts and in both the group of farmers, the main source of irrigation is groundwater. The difference between Jalgaon and Nashik is

that the sample farmers of Jalgaon district have ground water as the main and only source of irrigation and they do not have any other supplementary source of irrigation. But, surface irrigation occupies nearly 20 per cent of the irrigated area in the beneficiaries group of Nashik district. Rain-fed area is relatively less in the beneficiaries group of Jalgaon district compared to the non-beneficiaries group while, the same is totally absent in Nashik district among the non-beneficiaries.

On the whole, landholding details by sources of irrigation show that the average size of land is relatively more in the non-beneficiaries group in both the districts. Well irrigation dominates in both the districts as well as in both the group of sample farmers.

### 3.3 Cropping Pattern:

Cropping pattern generally varies with districts and regions depending on the soil quality, irrigation status, etc.

In India, both macro-level data and micro-level studies have confirmed that cropping pattern of the irrigated regions is entirely different from the un-irrigated regions. Normally, more water consuming crops can be seen in the assured irrigated area. Since drip method of irrigation consumes less water, farmers who use drip irrigation can increase the irrigated area and allot more area for water consuming crops. Hence, there can be a difference between the drip and the non-drip adopters in the cropping pattern. Table 3.3 shows the cropping pattern of both the drip and the non-drip adopters separately for Jalgaon district. Since the study areas are different in terms of ecological condition and irrigation status, we cannot directly compare the cropping

pattern of the two selected districts. Comparison between the drip and the non-drip adopters would be more meaningful. Hence, we compared between the drip and the non-drip adopters for each district separately. It is clear from the table that there is no significant difference between SSBs and CSBs in the cropping pattern of Jalgaon district. Both the group of farmers have allotted around 60 per cent of their cropped area for Banana. However, the cropping pattern of the beneficiaries is significantly different than the non-beneficiaries. Though Banana is the main crop for both the group of farmers, proportion of area under this crop to total cropped area varies significantly between the beneficiaries and the non-beneficiaries. Farmers belonging to the beneficiaries group have allotted nearly 60 per cent of the total cropped area for Banana crop whereas, it is only 38 per cent in the non-beneficiaries group.

Table 3.3: Cropping pattern of Jalgaon district:  
(area in ha.)

	Banana	Cotton	Jowar	S.cane	Other crops	Total
SSB	10.78 (61.28)	4.00 (22.74)	2.41 (13.70)	--	0.40 (2.27)	17.59 (100.0)
CSB	20.02 (59.32)	5.12 (15.17)	4.00 (11.85)	2.05 (6.07)	2.56 (7.58)	33.75 (100.0)
SSB+CSB	30.80 (59.99)	9.12 (17.76)	6.41 (12.49)	2.05 (3.99)	2.96 (5.76)	51.34 (100.0)
NB	24.82 (37.94)	15.00 (22.93)	19.25 (29.42)	--	6.35 (9.71)	65.42 (100.0)

Note: Figures in brackets are percentages.

Source: Primary survey data.

Less water consuming crops like cotton and jowar account for about 52 per cent of the cropped area in the non-beneficiaries group but, these crops account for only about 30 per cent of the cropped area in the adopters group. This



indicates that the non-beneficiaries are not able to allot more area for crops like Banana because of surface irrigation method, which requires comparatively more water. Since it reduces water consumption, the drip adopters could increase the area under Banana crop. Some of the non-beneficiaries have expressed that because of surface irrigation method they could not increase the area for more lucrative crops like Banana and Sugarcane. Some of the farmers, who are traditionally Banana cultivators, have recently shifted their crop from Banana to less water consuming crops because of water problem.

Table 3.4: Cropping pattern of Nashik district.  
(area in ha.)

	Grape	Bajara	Jowar	S.cane	Others	Total
SSB	9.62 (33.40)	5.46 (18.95)	2.09 (7.26)	0.40 (1.39)	11.23 (39.99)	28.80 (100.0)
CSB	8.65 (27.020)	6.67 (20.84)	2.20 (6.87)	6.60 (20.62)	7.89 (24.65)	32.01 (100.0)
SSB+CSB	18.27 (30.04)	12.13 (19.95)	4.29 (7.05)	7.00 (11.51)	19.12 (31.44)	60.81 (100.0)
NB	13.97 (21.91)	3.67 (5.76)	--	22.11 (34.68)	24.00 (37.64)	63.75 (100.0)

Note: Figures in brackets are percentages.  
Source: Primary survey data.

In Nashik district also the cropping pattern (Table 3.4) of the beneficiaries is different from the non-beneficiaries, however, the crop composition is different than Jalgaon district. In Jalgaon, area under Banana crop is much higher than the other crops in both the beneficiaries and the NBs groups. But, the pattern is slightly different in the case of Nashik district where other crop group (particularly vegetable crops\*) have more area than the main crop namely Grape. This

\* Among the vegetables crops, Onion occupies considerable amount of area in both the group of farmers.

is because of the fact that farmers of Nashik district have good market for vegetables as these areas are situated very near to Nashik city. Though there are differences in the cropping pattern, area allotted for Grapes<sup>7</sup> by the beneficiaries is much higher than the NBs. For instance, the average area of Grape per household comes about 0.73 ha. for the beneficiaries, while the same is only 0.56 ha. for the NBs.

Altogether, there is a difference between the beneficiaries and the NBs in cropping pattern in both the districts. Areas allotted for irrigated crops are relatively more in the group of beneficiary. We cannot simply attribute this to the influence of drip irrigation. Analysis of area share under different crops before and after the introduction of drip irrigation would give more meaningful conclusion in this regard. However, we do not have information on area under different crops before and after the introduction of drip irrigation.

#### 3.4 Cropping Pattern by Method of Irrigation:

It is obvious that cropping pattern varies with mode of irrigation. Cropping pattern of canal irrigated areas may not be same as that of the tank irrigated areas. Likewise, cropping pattern of groundwater irrigated area differs from canal and tank irrigated areas. In our study, we have tried to find out whether the crops being cultivated under drip and flood method of irrigation and how these vary between the beneficiaries and the non-beneficiaries. Table 3.5 gives the details of cropping pattern by method of irrigation for Jalgaon district. It is clear from the table that except for

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<sup>7</sup> It is worth noting here that Grape is one among the two crops selected to study the impact of drip irrigation in detail at field level.

Banana, no other crops were cultivated by using drip method of irrigation. This indicates that farmers use drip irrigation only for the heavy water consuming crops to avoid water problem. Though cotton and sugarcane are the suitable crops for adopting drip irrigation, farmers did not use drip method of irrigation for these crops due to less exposure and less profit.

Table 3.5: Cropping pattern by mode of irrigation in Jalgaon district. (area in ha.)

Crop	GCA	Drip	Flood	Rain-fed
<b>Banana:</b>				
SSB	10.78	10.78	--	--
CSB	20.02	19.62	0.40	--
SSB+CSB	30.80	30.40	0.40	--
NB	24.82	--	24.82	--
<b>Cotton:</b>				
SSB	4.00	--	3.00	--
CSB	5.12	--	5.12	--
SSB+CSB	9.12	--	9.12	--
NB	15.00	--	9.60	--
<b>Jowar:</b>				
SSB	2.41	--	2.41	2.41
CSB	4.00	--	2.40	1.60
Total	6.41	--	2.40	4.01
NB	19.25	--	12.70	6.55
<b>Sugarcane:</b>				
SSB	--	--	--	--
CSB	2.05	--	2.05	--
SSB+CSB	2.05	--	2.05	--
NB	--	--	--	--
<b>Others:</b>				
SSB	0.40	--	--	--
CSB	2.56	--	--	--
SSB+CSB	2.96	--	--	--
NB	6.35	--	4.55	1.80
<b>Total</b>				
SSB	17.59	10.78	3.00	3.81
	(100.0)	(61.29)	(17.06)	(21.66)
CSB	33.75	19.62	11.06	3.07
	(100.0)	(58.13)	(32.77)	(9.09)
SSB+CSB	51.34	30.40	14.06	6.88
	(100.0)	(59.21)	(27.39)	(13.40)
NB	65.42	--	51.67	13.75
	(100.0)	--	(78.98)	(21.02)

Note: Figures in brackets are percentages.

GCA - Gross Cropped Area.

Source: Primary survey data.

Drip irrigation is used only for Grape by the beneficiaries in Nashik district (Table 3.6). Even though, drip irrigation is currently used more for Banana and Grapes,

most of the farmers are willing to use drip irrigation for crops like Sugarcane and Cotton. Hence, one may expect that drip irrigated area may further increase in these districts in future.

Table 3.6: Cropping pattern by mode of irrigation in Nashik district.

(area in ha.)				
Crop	GCA	Drip	Flood	Rain-fed
<b>Grape:</b>				
SSB	9.62	8.62	1.00	---
CSB	8.65	8.65	---	---
SSB+CSB	18.27	17.27	1.00	---
NB	13.97	---	13.97	---
<b>Bajara:</b>				
SSB	5.46	---	---	5.46
CSB	6.67	---	1.00	5.67
SSB+CSB	12.13	---	1.00	11.13
NB	3.67	---	0.67	3.00
<b>Jowar:</b>				
SSB	2.09	---	2.09	---
CSB	2.20	---	0.60	1.60
SSB+CSB	4.29	---	2.69	1.60
NB	---	---	---	---
<b>Sugarcane:</b>				
SSB	0.40	---	0.40	---
CSB	6.60	---	6.60	---
SSB+CSB	7.00	---	7.00	---
NB	22.11	---	22.11	---
<b>Others:</b>				
SSB	11.23	---	11.23	---
CSB	7.89	---	7.51	0.38
SSB+CSB	19.12	---	18.74	0.38
NB	24.00	---	24.00	---
<b>All Total:</b>				
SSB	28.80	8.62	14.72	5.46
	(100.0)	(29.93)	(51.11)	(18.96)
CSB	32.01	8.65	15.71	7.65
	(100.0)	(27.02)	(49.08)	(23.89)
SSB+CSB	60.81	17.27	30.43	13.11
	(100.0)	(28.39)	(50.04)	(21.56)
NB	63.75	---	60.75	3.00
	(100.0)	---	(95.29)	(4.71)

Note: Figures in brackets are percentages.  
Source: Primary Survey data.

### 3.5 Intensity of Land Use, Cropping and Irrigation:

Needless to say that both cropping intensity and irrigation intensity are determined by the availability of

irrigation. Cropping intensity in the assured irrigated area is significantly high. It has been proved by studies and research station results that drip method of irrigation saves enormous amount of water and helps to increase the irrigated area. To understand these relationship in drip irrigated area, we have calculated land use intensity, cropping intensity and irrigation intensity for both the beneficiaries and the non-beneficiaries. The results are reported in table 3.7. As in the cropping pattern, we have calculated intensities separately for the SSB, the CSB and for the NBs.

Land use intensity (LUI) is defined as the ratio of net sown area (NSA) to total area owned (ie.,  $NSA/TAO \times 100$ ). It explains how intensively farmers use the land which they owned. It increases with irrigation. Calculated LUI does not show much difference between the drip adopters and the non-drip adopters. LUI is marginally higher for the non-drip adopters than that of the drip adopters. Since both the group of farmers have more irrigated area, LUI does not vary significantly. The high intensity of cultivation shows that both the group of farmers have less amount of uncultivated area.

Cropping intensity (CI) is the ratio of gross cropped area (GCA) to the net sown area (NSA) (ie.,  $GCA/NSA \times 100$ ). For calculating cropping intensity, we have considered the cropped area of the annual crops (like Grapes, Banana, Sugarcane etc) as equivalent to three times the sown area.\*

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\* For more details in this regard see:

(i) Agarwal, Bina (1983), *Mechanisation in Indian Agriculture, An analytical Study based on the Punjab*, Allied Publishers, New Delhi.

(ii) Nagraj and Shanbhakanth (1995), "Low Yielding

For instance, if a farmer cultivates one hectare of Grape or Banana, it will be considered as three hectares for calculating cropping intensity. As indicated already, in a given amount of water, irrigated area can be increased when drip method of irrigation is adopted compared to flood method of irrigation. In our study, we have tried to see how CI varies between the beneficiaries and the non-beneficiaries. Our survey does not give any clear cut relationship in this regard. In Jalgaon district, the CI of the beneficiaries significantly more than the non-beneficiaries. For instance, while the cropping intensity of the non-beneficiaries is only about 208 per cent, the CI of beneficiaries is about 245 per cent, indicating a difference of about 36 per cent points. However, the pattern is different in the case of Nashik district where cropping intensity of the non-beneficiaries is higher compared to the beneficiaries. Since, the non-beneficiaries of Nashik district cultivate more sugarcane compared to the beneficiaries, the intensity of cropping is relatively higher for the non-beneficiaries.

Irrigation intensity is the ratio of gross irrigated area (GIA) to net irrigated area (NIA) (ie.,  $GIA/NIA \times 100$ ). For calculating irrigation intensity, we followed the same method which we used for calculating cropping intensity. The main difference between CI and II is that in CI, we include both irrigated and un-irrigated crops for calculation whereas, in II, only the area of irrigated crops is included. As in the cropping intensity, irrigation intensity is much higher for the beneficiaries (especially for the SSBs), compared to the non-beneficiaries in Jalgaon district. For instance, the II

Irrigation Wells in Peninsular India: An Economic Analysis, Indian Journal of Agricultural Economics, Vol.50, No.1, January-March, pp.47-58.

of the non-beneficiaries is only about 214 per cent whereas, the same is about 266 per cent for the beneficiaries. This is slightly different in the case of Nashik district. The II is more for the NBs. This is because of the fact that the non-beneficiaries have some supplementary source of irrigation besides well irrigation.

**Table 3.7: Cropping intensity, Irrigation intensity and Land use intensity.**

	Jalgaon district	Nashik district
<b>Land Use Intensity:</b>		
SSB	100.00	99.41
CSB	96.70	100.00
SSB+CSB	97.43	99.73
NB	100.00	100.00
<b>Cropping Intensity:</b>		
SSB	245.31	206.16
CSB	245.95	230.66
SSB+CSB	245.73	219.24
NB	208.86	242.05
<b>Irrigation Intensity:</b>		
SSB	278.23	225.94
CSB	260.58	223.74
SSB+CSB	266.04	224.70
NB	214.65	236.71

Source: Computed from primary data.

### 3.6 Operation-wise cost of cultivation:

One of the advantages of drip irrigation is that it enormously reduces the cost of cultivation particularly in labour intensive operations like weeding, irrigation, ploughing etc. When labour cost reduces total cost of cultivation also reduces because labour cost constitutes a considerable portion in the total cost of cultivation. To understand the impact of drip irrigation on cost of

cultivation of different operations, we have compared cost of each operation between the farmers who adopt drip irrigation and flood irrigation method. We have calculated cost saving in terms of percentage as well as in the absolute value by comparing the non-beneficiaries' cost with cost of the beneficiaries. Further, we have divided the irrigation expenditure into two components as the expenditure is incurred exclusively on labour and other charges.\* This is done to understand the impact of drip irrigation on the labour cost of irrigation.

Table 3.8 shows the operation-wise cost of cultivation per hectare for both the beneficiaries and the non-beneficiaries for Banana crop (Jalgaon district). It is clear from table that drip irrigation reduces the total cost of cultivation by about Rs.1300/ha. for the beneficiaries as compared with the NBs. Though the cost saving in terms of percentage is less (2.5 per cent) in aggregate, it varies across different operations. Among the different operations, cost saving is very high in the labour cost of irrigation (about 35 per cent). Since water is supplied through pipe network in drip method of irrigation, it does not require more labour. But in the case of surface method of irrigation, labour input is necessary to control water supply - changing course of water from one field to other - and to govern leakages and seepage. Second highest saving under cost of cultivation is noticed in ploughing operation (about 22 per cent). This is because of the fact that drip method of irrigation does not warrant much ploughing as it supplies water at the root zone of the crops.

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\* Other charges include cost of electricity, maintenance, spare parts etc.



Table 3.8, Operation-wise cost of cultivation for Banana crop  
(in Rs. per ha. ave.)

Operation	SSB	CSB	SSB+CSB	NBs	Cost saving in per cent (+/-)
Ploughing	3038.03	2410.80	2633.22	3223.21	22.41 (589.99)
Seed & Sowing	6474.95	4703.11	5331.41	5415.79	1.58 (84.88)
Fertiliser	19328.85	14756.16	16377.66	17493.63	6.81 (1115.97)
FYM	10824.67	9508.66	9974.64	8315.87	-16.63 (1658.77)
Pesticides	27.83	--	9.87	--	--
weeding	2305.66	1561.92	1825.66	2122.88	16.28 (297.22)
Irrigation					
i. Labour	5046.38	3140.93	3816.61	5170.02	35.46 (1353.41)
ii. Others	2465.83	1689.13	1940.09	1208.66	-37.70 (731.43)
Harvesting	5442.95	4156.47	4612.66	5546.94	20.25 (934.28)
Transport & Marketing	2573.28	2780.07	2706.08	2346.49	-13.29 (359.59)
Others	1716.14	2477.06	2207.24	1895.04	-14.14 (312.20)
Total	59244.59	47183.32	51436.66	52738.56	2.53 (1301.84)

Note: Figures in brackets are cost saving in Rs.

Negative sign means cost is more for the beneficiaries.

Source: Primary survey data.

The cost saving is also high in weeding operation as indicated by the earlier studies. Drip irrigation does not allow weed to come up in the non-crop space as it does not spread water beyond the root zone of the crop. Some of the studies have reported that drip irrigation also reduces the cost of fertiliser enormously as it can be supplied with water

- liquid fertiliser.<sup>10</sup> But, in our survey, no one is used liquid fertiliser and hence the cost of cultivation does not reduce significantly for Banana crop. However, some of the farmers have argued that even without using liquid form, the fertiliser consumption can be reduced by avoiding wastage.

Within the beneficiaries group, drip reduces the cost of cultivation more for the State scheme beneficiaries compared to the Central scheme beneficiaries. The cost difference in total cost of cultivation is about Rs.12000/ha between SSBs and CSBs. This is because of the fact that the farmers of SSBs have used more fertiliser, manures etc compared to the CSBs. We have also noticed while conducting survey that the cost of cultivation varies with situational factors like soil quality, condition of the terrain, farmers' approach etc.

Generally cost of cultivation varies with crops as the nature of operation varies. Operation-wise cost of Banana crop may not be same with Grape. Banana requires less amount of pesticides whereas, pesticides is a necessary input for Grapes. Hence, there may be a difference in the impact of drip irrigation on the cost of different operations between Grape and Banana. To understand the impact of drip irrigation on the cost of different operations of Grape, we have calculated operation-wise cost saving for Grapes as we did for the Banana crop. The results are reported in table 3.9. It is clear from table that drip technology saves more cost for Grape than Banana. In Banana, cost saving because of drip irrigation is only about 2.5 per cent whereas, the same is

<sup>10</sup> Application of fertiliser through water is called fertigation. It substantially reduces consumption of fertiliser and wastage compared to methods like basal and top dressing. As a result efficiency of inputs increases in drip method of irrigation.

nearly 10 per cent in Grape for the beneficiaries. As in the Banana crop, cost saving varies with operations. Cost saving is found in operations like weeding, irrigation, fertiliser, ploughing and pesticides use. However, cost saving is more in the operations which are more labour intensive.

Table 3.9, Operation-wise cost of cultivation for Grape.  
(in Rs. per ha. ave.)

Operation	SSB	CSB	SSB+CSB	NBs	Cost Saving in per cent (+/-)
Ploughing	5475.64	6358.38	5917.78	6130.99	3.60 (213.21)
Fertiliser	21890.95	21765.32	21828.02	25329.28	16.04 (3501.26)
FYM	11113.69	15424.85	13273.02	16410.16	23.64 (3137.14)
Pesticides	46287.70	49098.26	47695.42	50107.37	5.06 (2411.95)
Weeding	6676.33	8884.39	7782.28	8854.69	13.78 (1072.41)
Irrigation					
i. Labour	9489.56	6242.77	7863.35	8840.37	12.42 (977.02)
ii. Others	922.65	563.34	722.47	588.55	-18.54 (133.92)
Harvesting	17662.41	10861.27	14255.93	11907.66	-16.47 (2348.27)
Transport & Marketing	6728.54	1213.87	3966.42	5322.12	34.18 (1355.70)
Others	9048.72	13346.82	11201.50	14423.76	28.77 (3222.26)
<b>Total</b>	<b>135296.19</b>	<b>133759.29</b>	<b>134506.19</b>	<b>147914.96</b>	<b>9.97</b> <b>(13408.77)</b>

Note: Figures in brackets are cost saving in Rs.  
Negative sign means cost is more for the beneficiaries.  
Source: Primary survey data.

Altogether, our survey results have clearly shown that drip irrigation has reduced the cost of cultivation in many

labour intensive operations in both Banana and Grape. Cost saving varies with operations in both the crops. Among the two crops, cost saving is relatively more for the Grape.

### 3.7 Crop-wise Productivity Differences:

Productivity of crop varies with mode of irrigation - canal, tank and groundwater. Productivity of canal irrigated crops is higher than the tank irrigated crops. Productivity of crops which are cultivated by groundwater irrigation is much higher than canal and tank irrigated crops.<sup>11</sup> Most of the time yield is affected because of moisture stress. It is difficult to maintain the water supply constantly for crops by surface method of irrigation. Studies<sup>12</sup> related to drip irrigation have confirmed that problem of moisture stress is completely reduced by providing irrigation through drip as it supplies water continuously at the root zone of the crops. As a result, the yield of drip irrigated crops is much higher than the crops which are cultivated under the method of flood or surface irrigation.

In order to understand the yield difference between the drip and the non-drip crop, we have calculated per hectare yield separately for Banana and Grapes. Table 3.10 shows the productivity of Banana and Grape. Productivity is significantly higher for the farmers who adopt drip irrigation compared to the non-drip adopters for both the crops. Among the two crops, yield of Banana is relatively higher than Grape in terms of both percentage as well as in absolute value (in quintal). For instance, in the case of

<sup>11</sup> Dhawan, (1988), *Irrigation in India's Agricultural Development: Productivity, Stability, Equity*, Sage Publications, New Delhi.

<sup>12</sup> For example, Givanabhan, (1994), *op. cit.*

Banana the yield in the beneficiaries group is about 29 per cent more than that of non-beneficiaries whereas, the same is only about 19 per cent for Grapes. There are mainly two reasons for more yield in drip irrigated crops. Firstly, because of less moisture stress the number of fruits in each bunch of Banana and grapes have increased. Secondly, unlike the surface method of irrigation, drip does not encourage any growth of weed which has ultimately helped to increase the yield of crop.<sup>13</sup> Weeds consume considerable amount of yield increasing inputs and reduce the yield of crop in surface method of irrigation.<sup>14</sup> Though the expenditure incurred by the non-beneficiaries on different yield increasing inputs is more than the beneficiaries in both the crops, this does not coincide with increased yield of the crops. Hence, one may conclude that this yield increase is because of drip method of irrigation.

Table 3.10, Crops' Productivity of Beneficiaries and Non-Beneficiaries.

Farmers Category	(Ave. per ha. in quintal)	
	Banana	Grape
SSBs	699.93	237.24
CSBs	668.50	249.25
SSBs+CSBs	679.54	243.25
NBs	526.35	204.29
<b>Yield increase over NBs:</b>		
In percentage	29.10	19.07
In quintals	153.54	38.96

Source: Primary survey data.

<sup>13</sup> Narayanamoorthy, A. (1992), "Impact of Tractors and Weedicides on Yield and Employment in Sugarcane Cultivation", *Journal of Rural Development*, Vol.11 (3), May, pp. 351-362.

<sup>14</sup> Alstorn, Styrbjorn. (1980), *Fundamentals of Weed Management in Hot Climate Peasant Agriculture*, Crop Science, Department of Grass Production Science, Swedish University of Agricultural Sciences, Uppsala, Sweden.

We have also calculated expenditure incurred to produce one quintal of Banana and Grape for both the beneficiaries and the non-beneficiaries to understand how unit cost varies between the drip and the non-drip adopters. Per quintal cost is calculated by dividing the total cost of cultivation by per hectare yield. The average per quintal cost is presented in table 3.11. It shows that the non-beneficiaries spend about Rs.24 over the beneficiaries to produce every unit of Banana. Likewise, in Grape, the same farmers spend about Rs.171 per quintal over the beneficiaries. It clearly indicates the importance of the drip irrigation in reducing the per unit cost of cultivation.

Table 3.11, Expenditure incurred to produce one quintal of Banana and Grape.

Farmers Category	(value in Rs.)	
	Banana	Grape
SSBs	84.68	570.29
CSBs	70.58	536.65
SSBs+CSBs	75.69	552.95
NBs	100.19	724.04

Source: Computed from field level data.

### 3.8 Input and Output Pattern of Grape and Banana:

Profit of a crop is not only determined by its total quantity of output but also its quality. Market condition plays a crucial role in determining the price of agricultural commodities. Quality produce can fetch good price in the market and earn more profit. Studies have proved that drip irrigation not only helps to increase the yield of the crops but also quality of the produces.<sup>11</sup> Let us see how profit

<sup>11</sup> See, INCID (1994), op cit., Sivanappan (1994), op cit.

varies between the drip and the non-drip crops in our present study.

The impact of drip irrigation on crops is measured in terms of profit per hectare. To calculate per hectare profit, we subtract the total cost of cultivation by total income of drip and non-drip crops.<sup>14</sup> Table 3.12 shows the income and expenditure pattern of Banana and Grape for both the beneficiaries and the non-beneficiaries. Total income (in Rupees) is calculated by multiplying total yield by the selling price which prevailed during the marketing period. It is clear from table that per hectare profit of the beneficiaries is significantly higher than the non-beneficiaries in both Banana and Grape. This is not surprising because drip irrigation reduces the cost of cultivation and increases the yield of crops. In Grapes, profit of the beneficiaries is Rs.50187/ha. higher than the profit of the non-beneficiaries while, the same is about Rs. 32400/ha. in the case of Banana. Owing to the nature of the crop the profit is more for Grapes as with compared Banana.

Among the beneficiaries, per hectare profit of the Central scheme beneficiaries is higher compared to the State scheme beneficiaries in both Banana and Grapes. The profit of the CSBs is about Rs.9880/ha and Rs.19640/ha for Banana and Grapes respectively above the profit accrued to the SSBs. As indicated earlier, this is due to the differences in input use and the influence of some situational factors.

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<sup>14</sup> Benefit cost analysis by using discount rate technique for the entire life period of drip investment is given separately in the next section.

Table 3.12 Income and expenditure details of Banana and Grape.  
(in Rs. Ave/ha.)

	TE	TR	Net Profit
<b>Banana:</b>			
SSBs	59244.59	135448.05	76203.46
CSBs	47183.32	133272.17	86088.85
SSBs + CSBs	51436.66	134043.75	82607.09
NBs	52738.56	102934.73	50196.17
<b>Grape:</b>			
SSBs	135296.19	238747.09	103450.90
CSBs	133759.29	256855.49	123096.20
SSBs + CSBs	134506.19	247817.02	113310.83
NBs	147914.96	211037.93	63122.97
<b>Percentage increase/ decrease over the NBs:</b>			
Banana	-2.53	23.21	39.23
Grape	-9.97	14.84	44.29

Note: TE - Total Expenditure, TR - Total Revenue.  
Source: Primary survey data.

Per quintal price is also calculated for both Banana and Grapes in order to understand whether the profits are due to quality differences or yield differences. This is done to test the common argument that drip crop fetches higher price because of its good quality. Per quintal price is computed by dividing per hectare total income with per hectare yield (TR/Q). Table 3.13 gives the per quintal price of Banana and Grapes for both drip and the non-drip farmers. Calculated per quintal price does not clearly confirm the common argument that drip farmers get more price than the non-drip farmers. For Banana, the drip adopters earn two rupees per quintal higher price above the non-drip adopters. But contrary to the common belief, the non-drip adopters earn about Rs.14/quintal more than the drip adopters. This suggests that the



beneficiaries earn more profit not because of price effect but only because of yield effect. This also discards the common argument that drip crop fetches higher price because of its quality. Be that as it may, the results of our survey undoubtedly confirm the importance of drip irrigation in increasing the per hectare profit of crops.

Table 3.13, Average per quintal price of Banana and Grapes.

Farmers' Category	Banana	Grape
SSBs	193.59	1006.35
CSBs	199.36	1030.51
SSBs+CSBs	197.26	1018.77
NBs	195.56	1033.03

Source: Computed from field level data.

### 3.9 Benefit Cost Analysis:

It is clear from the foregoing section that per hectare profit of the crops which are cultivated under drip method of irrigation is significantly higher than the crops cultivated by flood method of irrigation. The farmers who adopt drip irrigation for Banana earn about Rs.32410/ha. higher profits than the non-drip adopters. Likewise, Grape cultivators earn Rs. 50187/ha. higher profit of the non-drip adopters of the same crop. However, it cannot be considered as a real profit of the crops cultivated under drip irrigation because we did not take into account the capital cost of the drip-set, its depreciation value and interest rate of the fixed capital while calculating the net profit of the crops. The life period of drip-set is one of the important variables in determining the per hectare profit. Importantly, since it is a capital intensive technique, there is always a question about economic viabilities of drip investment. To answer

this this question, we have computed benefit cost ratio (hereafter BC ratio) and net present worth (NPW) by using discount cash flow technique<sup>17</sup> for the entire life period of the drip-set for both Banana and Grape.

For estimating cash inflows and cash outflows of the drip investment, we have taken the following assumptions. The assumptions are;

1. The life period of the drip-set is considered as five years for Banana and 10 years for Grape for calculating BC ratio and NPW as followed by the INCID study.<sup>18</sup>

2. There will not be any change in the cost of cultivation and income generated by the drip irrigation during the entire life period of both the crops.

3. Discount rate is considered as 15 per cent. of the opportunity cost of the capital.

4. The technology which is used for crop cultivation is assumed constant for both Banana and Grape.

Before analysing the BC ratio and NPW, let us see the original cost incurred on different items such as capital cost of drip-set, its operation and maintenance cost and production cost (cost of cultivation) during the reference period. The capital cost and gross value of production are given in table 3.14. There is no significant difference in the capital cost of drip set between Banana and Grape. However, cost of production and gross value of production vary widely between the two crops.

<sup>17</sup> Bittinger J, Price. (1984), *Economic Analysis of Agricultural Projects*, Second Edition, The Johns Hopkins University Press, London.

<sup>18</sup> INCID. (1994), Op. Cit.

Table 3.14, Capital and Production cost drip irrigation,  
(ave. per ha. in Rs.)

Variables	Banana	Grape
Capital cost of Drip set	33595.00	32721.00
Operation & Maintenance cost	1940.00	723.00
Production Cost	49497.00	133783.19
Gross value of Production	134043.75	247817.02
Profit without discount	82607.79	113310.83

Source: Primary survey data.

Taking into account the earlier mentioned assumptions, we have calculated income flow for the entire life period of drip set for both Banana and Grapes. The income flow of Banana for the life period of five years with 15 per cent discount rate is given in table 3.15. It is clear from table that net present worth of drip investment in Banana is about Rs.241750/ha. for the entire life period of drip-set. This means that farmers will get about Rs.2.41 lakhs at the end of the life period from their investment in drip irrigation after deducting all the production cost including interest rate on the fixed capital. The calculated BC ratio comes about 2.16 for the beneficiaries who cultivate Banana with drip irrigation. This indicates that for every rupee of investment on drip irrigation, farmers will gain an additional amount of Rs.2.16 from Banana crop. The BC ratio of the non-drip adopters for the same crop is only 1.95 (See table 3.17 also).

The computation of net present worth<sup>19</sup> of Banana crop further shows that the first year value of NPW itself is more

<sup>19</sup> The NPW is the difference between sum of present value of benefits and the sum of the present value of costs. If the present value of the benefits is greater than the present value of costs, the investment can be treated as economically viable.

$$\frac{X_0(D23) \cdot 2315 N_9}{N_6}$$

239543

than the capital cost of drip-set. The NPW of the first year is Rs.36640/ha, which is about 10 per cent over the capital cost of drip-set. This indicates that farmers can pay back the entire drip capital cost of Rs. 33595 from their net profit of the very first year. It undoubtedly confirms that drip irrigation is economically viable even for the farmers who own one hectare of land.

Table 3.15, Computation of Net Present Worth for Banana crop. (value in Rs.)

year	Discount factor at 15 %	Present worth of Gross Cost	Present worth of Gross income	NPW at year end
1	.870	79977.84	116618.06	36640.22
2	.756	38886.37	101337.08	62450.71
3	.658	33845.55	88200.79	54335.24
4	.572	29421.96	76673.02	47251.06
5	.497	25564.19	66619.74	41054.83
Total	3.353	207695.91	449448.69	241752.78

Net Present Worth =  $449448.69 - 207695.91 = 241752.78$

BC ratio =  $449448.69/207695.91 = 2.16$

Source: Computed from field level data.

As in Banana crop, BC ratio and NPW are calculated separately for Grape by using discounted cash flow technique.

The results are presented in table 3.16. The capital cost of grape is almost the same as that of Banana. However, life period of drip-set for Grape varies significantly from Banana. The life period of drip-set for Banana is only five years whereas, the same is 10 years for Grape. Per hectare cost of cultivation also varies significantly between Grape and Banana. Hence, there may be a difference in NPW and BC ratio between these two crops. As we expect, BC ratio varies significantly between Banana and Grapes. BC ratio of

Grape is relatively less compared to Banana, however, the NPW of Grape is significantly more than Banana. The BC ratio of Banana is 2.16 whereas, the same is only 1.76 for Grape.

**Table 3.16, Computation of Net present worth for Grape.**  
(value in Rs.)

year	Discount factor at 15 %	Present worth of Gross Cost	Present worth of Gross income	NPW at year end
1	.870	145487.65	215600.81	70113.16
2	.756	101086.68	187349.67	85662.99
3	.658	88505.07	163063.59	74558.52
4	.572	76937.54	141751.33	64813.79
5	.497	66849.58	123165.06	56315.48
6	.432	58106.67	107056.95	48950.28
7	.376	50574.33	93179.19	42604.86
8	.327	43983.52	81036.17	37052.65
9	.284	38199.76	70380.03	32180.27
10	.247	33223.03	61210.80	27987.77
Total	5.019	703553.83	1243793.60	540239.77

$$\text{NPW} = 1243793.60 - 703553.83 = 540239.77$$

$$\text{BC ratio} = 1243793.60 / 703553.83 = 1.76$$

Source: Computed from field level data.

However, our main aim is not to compare the BC ratio of Grape with Banana but to understand how the drip investment is economically viable for the farmers who adopt drip irrigation in Grape. The NPW of Grape is about Rs.5.4 lakhs per hectare. The NPW shows further that farmers can realise the whole capital cost of drip-set of Rs. 32720/ha from the profit of the very first year in Grape also. The NPW of the first year is Rs. 70113/ha. which is about 114 per cent higher than the capital cost of drip-set. The computed BC ratio of Grape under the method of drip irrigation is 1.76 while, it

is only 1.42 under the flood method of irrigation. This confirms that investment on drip irrigation for Grapes is also economically feasible.

Table 3.17, BC ratio of Drip and Non-Drip Crops:

	Banana	Grapes
Drip Crops:		
Without discount	2.61	1.84
With discount	2.16	1.76
Non-Drip Crops	1.95	1.42

Source: Computed from field level data.

Altogether, the benefit cost analysis of drip irrigation clearly shows that BC ratio of the drip irrigated crops is much higher than the same crops which are cultivated under flood method of irrigation. The NPW value also undoubtedly confirms that investment on drip irrigation for these two crops is economically feasible even for the small farmers who own one hectare of land.

To sum up, average land size of the drip adopters is marginally less than the non-drip adopters in both the districts. Groundwater is the main source of irrigation for both the drip and non-drip adopters. Cropping pattern of the drip adopters is varied from the non-drip adopters. There is no clear cut relationship in cropping intensity and irrigation intensity between the drip and non-drip adopters. Land use intensity does not show much difference between the two groups of farmers. Per hectare cost of cultivation is much less for the crops which are cultivated under drip method of irrigation. Cost saving is found more in the operations which are more labour intensive. Productivity is

significantly higher for the drip irrigated crops. In both the crops, per hectare profit is significantly higher for the farmers who adopt drip method of irrigation. The results of discount cash flow technique show that BC ratio of the drip irrigated crops is significantly higher than the crops which are cultivated by flood method of irrigation. It also further confirms that investment on drip irrigation is economically viable for both Banana and Grapes.

## Chapter - IV

### WATER AND ELECTRICITY USE PATTERN OF DRIP AND NON-DRIP ADOPTERS

We have seen in the previous chapter that drip method of irrigation (DMI) reduces the cost of cultivation and increases the productivity of crops. The pattern of water use under drip and non-drip conditions also assumes great importance for comparative analysis. Earlier studies have confirmed that DMI reduces the water consumption substantially. Hence, we shall see how water consumption under DMI varies from the non-drip crops in our study.

#### 4.1 Pattern of Water Use:<sup>1</sup>

Generally, water use pattern varies with the mode of irrigation. In the canal irrigated area, it is determined usually by the irrigation authorities. Time and hours of water supply vary depending upon the position of water level in the dam/reservoir. Likewise, in tank irrigated area, pattern of water use is determined by the availability of water in the tank and the rainfall condition. But farmers themselves determine the water use in groundwater area as it is owned by the farmers.<sup>2</sup> Government control on water use is negligible in the groundwater irrigated conditions. Since groundwater is essentially a private activity, pattern of water use varies significantly from surface source of irrigation. Studies have shown that efficiency of water use is significantly higher with groundwater when compared with

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<sup>1</sup> Pattern of water use includes number of irrigation, hours required to irrigate one hectare of land etc.

<sup>2</sup> Narayanamoorthy, A. (1995), "Electric Pumpset and Groundwater Management: Macro and Micro Evidence", The Asian Economic Review, Vol. XXXVII, April, pp. 87-110.



canal and tank irrigation. Farmers face uncertainty for irrigation water in surface irrigation sources like tank and canal. Owing to this, farmers use more water under surface irrigation than required for crops whenever they get water. This overuse leads to inefficiency in water consumption.

Since farmers use groundwater for drip irrigation, they can control the water supply. Pattern of water use under drip irrigation may not be the same with the farmers who use flood method of irrigation. In the present study, we have tried to analyse the pattern of water use between drip and non-drip farmers. For this, we have calculated number of irrigations used per hectare and hours of water used per irrigation by the two groups separately. The results are reported in table 4.1. In both the crops, the number of irrigations used per hectare are significantly higher for drip adopters.<sup>3</sup> For Banana crop, the drip adopters have irrigated 78 times more than the non-drip adopters. Likewise, for Grapes, the farmers who have adopted drip method irrigation (DMI) have applied about 82 irrigations more than the non-drip farmers. To maintain the moisture level, farmers using DMI use water for crops almost thrice a week which increases the actual number of irrigation for this group. However, this consumes less water as compared with surface method of irrigation. This is not possible under surface method of irrigation as it requires more water for each irrigation.

Though the number of irrigation used by drip farmers is

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<sup>3</sup> A study related to sprinkler irrigation has also arrived the same result. See; NABARD (1989), Sprinkler Irrigation in Semi-Arid Areas of Rajasthan: An Ex-post Evaluation Study, Evaluation study series No.36, Bombay, p.31.

significantly higher than the non-drip farmers, the time utilised in hours per irrigation is significantly less for drip farmers. For instance, for Banana, on an average, drip farmers have used nearly seven hours, while the non-drip farmers have used nearly 19 hours for each turn of irrigation. The same result is arrived in Grapes as well. Since drip method of irrigation supplies water only at the root-zone of the crop, time required per irrigation is much less. But in the case of surface method, farmers have to spend more time for each irrigation because it supplies water not only for the crop zone but also the non-cropped zone. Importantly, uneven land surface and water conveying channels also consume considerable quantity of water in surface method of irrigation. Evaporation losses are very high in open-water conveying channels which increases the requirement of time used in using water. But these problems are very meagre or completely nil in drip method of irrigation as it supplies water through pipe network.

Table 4.1: Pattern of Water use by drip and non-drip farmers:

	No. of irrigation per hectare	Hrs. used per irrigation per hectare	Pumpset HP
<b>Nashik (Grape):</b>			
SSB	185.61	7.54	4.99
CSB	188.44	6.36	4.17
SSB+CSB	187.03	6.95	4.98
NBs	104.37	18.89	8.94
<b>Jalgaon (Banana):</b>			
SSB	166.97	6.12	9.46
CSB	123.85	4.89	7.28
SSB+CSB	139.14	5.33	9.82
NBs	66.19	16.44	10.82

Note: All farmers have electric pumpsets.  
Source: Field level data.

#### 4.2 Quantity of Water Consumption:

Factors like horse power of the pumpset, water level of the well, capacity of the pump, size of delivery pipes, condition of the water extraction machineries (WEMs), distance between place of water source etc determine the per hectare water requirement. These factors vary considerably across farmers. Heavy horse power pumpsets lift more water per unit of time and helps to irrigate more land in less time. That is, more horse power pumpset with higher HP take less time to irrigate per unit of land compared to the pumpset which has lower horse power. Most of the research station based studies<sup>4</sup> have measured water consumption in terms of centimetre (cm) in drip irrigation. But, in practice, measuring water in terms of cm is not a easy task at field level since HP of the pumpsets and water level of the well vary across the farmers. Because of these difficulties, we have measured water consumption in terms of hours of irrigation.<sup>5</sup> Since horse power of the pumpset varies between the farmers, we have computed HP hours of water<sup>6</sup> for each farmer to keep uniformity in hours of water consumption. After calculating HP hours of water for each farmer, we have calculated per hectare HP hours of water. Per hectare HP hours of water is calculated by dividing the total HP hours of water by total area irrigated.

Table 4.2 shows per hectare consumption of water for drip and non-drip adopters for both Banana and Grapes. It is

<sup>4</sup> Results of different research stations for different crops are available in INCID (1994).

<sup>5</sup> We believe measuring water consumption in terms of hours is the most appropriate method at field level.

<sup>6</sup> HP hours of water can be computed by multiplying the HP of the pumpset with hours of water used.

clear from the table that consumption of water by crops under drip irrigation is significantly less than the crops which are cultivated by flood method irrigation (FMI). Water saving is about 41 per cent for Banana and about 59 per cent for Grapes.

Among the two crops, water saving in terms of HP hours is much higher in Banana when compared to Grapes. For instance, for Banana, drip saves about 3240 HP hours per hectare, while it is only 1968 HP hours in the case of Grapes. Banana is more water intensive crops compared to Grapes hence, the former crop saves more water. It shows that drip technology helps saving more water in water intensive crops like Banana.

Table 4.2: HP hours of water consumption by drip and non drip farmers.

Farmer's category	(average/hect)	
	Jalgaon (Banana)	Nashik (Grapes)
SSB	8005.10	3653.13
CSB	7818.55	2968.79
SSB+CSB	7884.70	3310.36
NB	11130.34	5278.35
<u>Water Saved by using drip irrigation method:</u>		
In percentage	41.16	59.45
In HP hours	3245.64	1968.02
Additional area can be irrigated (in ha.)	0.41	0.60

Source: Computed from field level data.

Since DMI saves water, irrigated area can be increased by taking drip irrigation with the same amount of water. To understand this, we have estimated how much of additional area can be brought under irrigation by saving water under Grapes and Banana crops. Computed figures show that with saving of water an additional amount of 0.60 hect. (1.48 acres) can be

brought under irrigation for every hectare of drip irrigation under Grapes. Likewise, in Banana, an additional amount of 0.41 hectares (1.01 acres) can be brought under irrigation by taking drip irrigation.<sup>7</sup> This undoubtedly confirms the importance of drip irrigation in saving of water and bringing more area under irrigation.

#### 4.3 Water Consumption per quintal of Yield:

Though per hectare consumption of water is a good indicator to measure the efficiency of water use in drip and non-drip crops, water consumed to produce one quintal of yield of the crop is the most appropriate method to judge the efficiency of water consumption in drip and non-drip crops. This is also the simplest way to understand the importance of drip irrigation in increasing the efficiency of water use. Studies have proved that water use efficiency is higher in drip irrigated crops.<sup>8</sup> In order to understand this relationship, we have calculated consumption of water required to produce one quintal of yield of the crop by the drip adopters and the non-drip adopters. To calculate per quintal water requirement, we have divided per hectare consumption of water by per hectare yield. Water utilised to produce one quintal of yield for both the crops is given in table 4.3.

As indicated by other studies, the results of our analysis also show that water use efficiency (WUE) is substantially higher in drip irrigated crops. The calculated figures show that Banana crop under drip method of

<sup>7</sup> However, in our survey, none of the farmers have increased the irrigated area after they installed drip system.

<sup>8</sup> See, INCID (1994), op cit.

Irrigation consumes only 11.60 hours of water to produce one quintal of yield when compared to the same crop under non-drip conditions, which is 21.14 HP hours. That is, to produce one quintal of yield, Banana crop under non-drip conditions consumes about 9.54 HP hours of water over the consumption of drip crops. In the case of Grape, drip crop consumes about 13.6 HP hours of water compared to the non-drip crop consumption of 25.84. This clearly shows that DMI not only reduces the per hectare consumption of water but also consumption per unit of crop yields.

Table 4.3: Water consumption per unit of yield of the crops.  
(HP hours/quintal)

Farmers category	Jalgaon (Banana)	Nashik (Grapes)
SSB	11.44	15.39
CSB	11.69	11.91
SSB + CSB	11.60	13.61
NB	21.14	25.84

Source: Computed from field level data.

#### 4.4 Electricity Consumption by Drip and non-Drip Crops:

Owing to the rapid development of rural electrification and energisation, of pumpsets, consumption of electricity by agricultural sector has been increasing continuously. Generally, consumption of electricity increases with the number of electric pumpsets. In India, pumpset which is used to lift water from wells consumes about 70 per cent of the electricity in agriculture. Studies related to drip irrigation have shown that this micro-irrigation technology is

\* For more details in this regard see: Narayanamoorthy (1995), Op. cit.

10 Sharma, Anil (1994), "Electricity for Minor irrigation", Seminar, NO. 41B, June, pp. 21-24.

not only useful to reduce the consumption of water but also useful in energy saving. It is obvious that as the number of working hours of pumpset reduces the consumption of electricity also reduces. Thus consumption of electricity is positively related to the hours of operation of the pumpset.

Table 4.4: Per hectare consumption of electricity in KWH by drip and non-drip crops.

Farmers category	Jalgaon (Banana)	Nashik (Grapes)
SSB	6003.83	2739.85
CSB	5863.91	2226.59
SSB + CSB	5913.53	2482.77
NBs	8347.75	3958.78
<u>Electricity Saving by using DMI:</u>		
In percentage	41.16	59.45
In KWH	2434.00	1476.01

Source: Computed from field level data.

We saw in the previous section that hours of water used per hectare under drip method of irrigation are less than flood method of irrigation. As indicated earlier that while working hours of pumpset reduce, consumption of electricity also reduces. In order to know the impact of drip irrigation on electricity saving, we have estimated electricity consumption based on the hours of pumpset operation for both drip and non-drip crops. Further for estimating electricity, we have assumed that for every hour of operation, 0.75 kwh of power is used per HP.<sup>11</sup> Since all the farmers in both the groups have used only electrical pumpsets, we have simply

<sup>11</sup> For more details in this regard see: Shah, Tushaar (1993), Groundwater Markets and Irrigation Development: Political Economy and Practical Policy, Oxford University Press, Delhi, pp. 92-112.

multiplied HP hours of water with assumed power consumption of 0.75/kwh/HP to arrive at the per hectare electricity consumption. Table 4.4 shows the per hectare consumption of electricity in KWH. It is clear from the table that DMI using farmers use very less amount of electricity, for both the crops, compared to non-users. Farmers who cultivate Banana under DMI save about 2430 kwh of electricity per hectare compared to non-users. Likewise, in Grapes, DMI helps to save about 1470 kwh of electricity per hectare compared to flood method of irrigation.

Table 4.5, Estimates of Money and electricity saved under DMI. (Average/hectare)

	Banana	Grape
Electricity saving in KWH	2434.00	1476.00
In terms of Rs.	1217.00	738.00

Note: It is assumed 0.50 paise/kwh to estimate electricity cost in terms of rupees.

Source: Computed from field level data.

It is clear from the above analysis that farmers with drip irrigation operate less number of hours of pumpsets and because of this consumption of electricity is quite low. This will also reduce the electricity cost to be paid by the farmers. We have also calculated the money saved in the total electricity bill per hectare by energy saving for both Banana and Grapes. Since state supplies electricity on flat-rate (FR) basis for agriculture<sup>1</sup>, it was not possible to get per kwh price of electricity. Therefore, we have assumed 50 paise/kwh as a nominal rate to estimate the electricity bill in monetary terms. According to the calculations (see table 4.5), about Rs.1217/ha. in Banana and Rs.738/ha. in Grape

<sup>1</sup> Presently Government of Maharashtra is changing Rs.300/hp/year from pumpset owning farmers.



can be saved on electricity bill alone. This indicates drip irrigation technology not only helps to save the precious inputs like electricity but also reduces the cost of cultivation enormously by reducing the cost of electricity.

#### 4.5 Electricity Consumed to Produce one Quintal of Yield:

To explain the saving of electricity in a simplest way in drip irrigation, we have calculated electricity consumed to produce one quintal of yield under both the conditions - DMI and FMI. As in water consumption, energy used to produce one quintal of yield is computed by dividing per hectare energy consumption by yield.

Table 4.6: Electricity consumption per quintal of yield.  
(in kwh)

Farmers category	Banana	Grape
SSB	8.58	11.58
CSB	8.77	8.93
SSB + CSB	8.70	10.21
NB	15.86	19.37

Source: Computed from field level data.

Table 4.6 shows the per quintal consumption of energy for both Grapes and Banana. As we expected, energy consumed to produce one quintal of yield is quite low for drip adopters both for Banana and Grapes. Among the two crops, consumption of energy per quintal is higher for Grapes when compared with Banana. For instance, Grape cultivators under DMI spend about 10.21 kwh to produce one quintal of yield whereas, the same is only 8.70 kwh for Banana. This is due to the higher yield of Banana than Grapes. However, both for Banana and Grapes, drip adopters save more than 80 per cent of energy compared with the non-drip adopters to produce one quintal of the crop. For cultivating Banana,

drip farmers spend about 8.7 kwh/quintal as against 15.86 kwh/quintal by the non-adopters of drip. Likewise, for Grapes, the electricity consumption is 10.21 kwh/quintal and 19.37 kwh/quintal respectively for drip and non-drip adopters. Because of higher productivity of drip crops, per quintal consumption of electricity is much less in drip crops.

To sum up, farmers who adopt drip method of irrigation have used more number of irrigation per hectare when compared with non-drip farmers. However, hours of water consumption is very less in drip method of irrigation compared to flood method of irrigation both for Banana and Grapes. Drip irrigation reduces about 41 per cent of water for Banana and about 59 per cent for Grapes compared to the same crops cultivated under flood method of irrigation. Water consumed to produce one quintal of yield is significantly lower under the drip method of irrigation for both the crops. Consumption of electricity per hectare is also significantly lower for the drip adopters for both the crops. Drip irrigation reduces about 2430 kwh of electricity per hectare in Banana crop and about 1470kwh/ha. in Grapes over the consumption of non-drip crops. Electricity consumed to produce one quintal of yield of the crop (in both Banana and Grapes) is also significantly less for the drip adopters compared to the non-drip adopters.



## Chapter - V

### PERFORMANCE EVALUATION OF DRIP IRRIGATION SYSTEM

DMI is a capital intensive technique therefore Government provides subsidies and services to the farmers who are ready to adopt drip irrigation. Some studies indicated that farmers face lot of problems in getting loans from Bank and subsidy from the distributing authorities. It is also reported that working condition of the drip system is quite poor at field level owing to the poor technical services given by the authorities. Therefore, it is important to study the overall performance of the drip irrigation system at field level.

#### 5.1 Investment Pattern of Drip Adopters:

Drip irrigation is a capital intensive technique. It requires investment of about Rs.30000/ha. for crops like Grapes and Banana. One of the arguments for the less diffusion of drip irrigation in rural India is about its capital intensive nature. Small farmers are not able to mobilise money to install drip system. Though the Banks are ready to lend money, the process of application and sanctioning loan takes a long time.

We have tried to understand here how many farmers utilise own resources as against those who avail Bank finance and what are the reasons for not using Bank finance for installing drip irrigation system. For this, we have divided the sample farmers based on land size into three groups viz, small (up to 2 hectares), medium (2-4 hectares) and large farmers (above 4 hectares). Source-wise investment pattern for both Banana and Grape crops is given in table 5.1. As we expect, most of

the small farmers (about 60 per cent) have used Bank finance for installing drip-system for crop cultivation in both the districts. It shows the importance of Bank finance in helping the small farmers for adopting capital intensive techniques like drip irrigation.

Table 5.1 Investment Pattern of Drip Farmers.

Farmers Category	Source of investment			Average amount per hectare	
	Bank (No. of farmers)	Own	Total (100)	Bank (in rupees)	Own
<u>Jalgaon district:</u>					
< 2 hec.	9 (65)	5 (36)	14 (100)	29864.86	39736.80
2-4 hec.	8 (89)	1 (11)	9 (100)	35887.85	58500.00
> 4 hec.	2 (100)	0	2 (100)	31097.05	--
All	19 (76)	6 (24)	25 (100)	31097.05	42537.31
<u>Nashik district:</u>					
< 2 hec.	10 (63)	6 (37)	16 (100)	34779.41	30240.96
2-4 hec.	4 (57)	3 (43)	7 (100)	25556.60	25201.45
> 4 hec.	1 (50)	1 (50)	2 (100)	25000.00	21000.00
All	15 (60)	10 (40)	25 (100)	31504.78	29130.06

Note: Figures in brackets are percentages to total.  
Percentages rounded off to the nearest integer.  
Source: Field level data.

The number of farmers who used own finance are significantly more for Grapes compared to Banana. For instance, about 40 per cent of the beneficiaries have used own money for Grapes cultivation, whereas the same is only 24 per cent for Banana. There are three reasons for the use own finance in Grape. Firstly, the farmers who cultivate Grape in Nashik district are generally (also traditionally) rich farmers and they do not want to approach the Bank for this meagre amount. Secondly, since they know that the capital

cost of drip technology can be realised from the first year profit itself, most of the farmers are investing from their own saving without any hesitation. Thirdly, large number of the farmers are depending upon the support from relatives because of regulations imposed by the Bankers in sanctioning loan.<sup>1</sup>

In the case of Banana crop, only one fourth of the farmers have used own finance for drip and the remaining farmers have used Bank loan. This is because of the fact that most of the Banana cultivators are not as wealthy as their counterparts viz., Grape cultivators. Moreover, since Bank money is available for low interest rate (12-14 per cent), most of them use bank money instead of spending own savings.

The per hectare cost of drip-set varies significantly between the farmers who use own finance and Bank finance. For instance, among the Grapes cultivators using bank finance the investment is nearly Rs.2400/ha higher than those using own finance. Similarly, among the Banana cultivators own finance using farmers spent about Rs.11400/ha. more than the farmers using bank finance. The wide difference between groups of cultivators when they are using the same technology for the same crops is quite perplexing. Possibly there are two reasons for such differences in the capital cost between the farmers. Firstly, the cost varies with quality of materials used for the system, and secondly, capital cost is mostly determined by the distance between the field and place of water source (well). For instance, if the well is situated

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<sup>1</sup> For getting loan from bank, farmers have to surrender their original land documents to the bank officials. Farmers should also produce a certificate indicating that he is not a defaulter in any bank.

near the boundary of the drip field, it will require a small main pipe otherwise it will require longer pipe. The cost of the system thus gets related to the length of main pipes.<sup>2</sup>

### 5.2 Details of Subsidy:

Subsidy is one of the important components which induces the adoption of new technological components in agriculture. Government provides subsidy for farmers to increase the diffusion whenever, it introduces new schemes in agriculture. Since drip irrigation is a capital venture and a new technique, Government provides nearly 50 per cent of the capital cost as subsidy to the farmers who take drip irrigation in Maharashtra. However, studies<sup>3</sup> related to drip irrigation have indicated that farmers face lot of problems for getting subsidy from Government. To examine this, we have made extensive discussion with sample farmers. But surprisingly, none of the farmers faced problem in getting subsidy. All the beneficiaries have received subsidy from the government schemes. However, some of the farmers had to spent more time for getting subsidy because of the verification of the documents.

Unlike other government schemes, there is no direct link between subsidy and Bank loan. Subsidy is sanctioned on the basis of the recommendation of the drip irrigation authority (agricultural department), whereas the Bank loan is sanctioned by the bank officials after verifying the documents submitted

<sup>2</sup> See, NABARD. (1989), Op cit.

<sup>3</sup> A study entitled "Constraints and problems as perceived by non-adopters and adopters of drip irrigation system", conducted in twenty villages in Nagpur district of Maharashtra has indicated that non-availability of subsidy and loan facilities are the main reasons for non adopting drip irrigation in crop cultivation (Puranik et al., 1992, Op. cit.).

by the farmers. If the farmers require bank loan for installing drip system, they can individually approach bank officials even without getting subsidy. For getting bank loan, farmers have to produce a BDO's (Block Development Officers) certificate indicating that a particular farmer is going to install drip system in his farm. Before sanctioning the subsidy to farmers, verification is made by the agricultural officials at the farmers field. On the basis of the recommendation of the agricultural officers, subsidy amount will be sanctioned.

Since drip irrigation scheme has huge subsidy, we have also tried to understand the leakages in the subsidy through extensive discussion with the beneficiaries. That is, whether the entire amount of subsidy reaches to the farmers or it goes in the form of bribes and kickbacks to the distributing authorities. However, none of the farmers reported that they pay bribe for getting subsidy from authorities.

It is necessary to understand the variations in per hectare subsidy. This is done mainly for two reasons: firstly, to understand the relationship between capital cost and amount of subsidy, and secondly, to see if the subsidy amount is matching with government's limit or not.\* The average per hectare subsidy on the basis of farmers category is given in table 5.2 for both Banana and Grape cultivators. It is clear from table that, for both the crops, the calculated average subsidy amount falls within the government's limit. Per hectare subsidy varies from about

\* According to the new guidelines, the subsidy amount is limited to either 50 per cent of the actual capital cost or Rs.15000/ha. whichever is lower.



Rs. 13200 to Rs.6250 across the different types of farmers. Among the two crops, the subsidy amount is slightly more for Grapes than that of the Banana.

Table 5.2 Capital cost and subsidy by size of farmers.  
(average/hect.)

Farmers category (1)	Capital cost		Subsidy amount		Percentage	
	Jalgaon (2)	Nashik (3)	Jalgaon (4)	Nashik (5)	(4/2) (6)	(5/3) (7)
< 2 hec.	37313	33516	13272	12917	35	39
2-4 hec.	34357	29043	11662	12501	34	43
> 4 hec.	23571	38125	6250	10938	27	29
All	33595	32720	11359	12620	34	39

Note: Figures rounded off to the nearest integer.  
Source: Computed, from field level data.

It is observed that when size of land increases, average per hectare subsidy decreases. In Grape, average subsidy of small farmers is about 12900/ha, while the same is only about Rs. 10930/ha. for the farmers who own more than four hectares of land. Likewise, in Banana, the average subsidy of the farmers belonging to the group of less than 2 hectares is about Rs.13270/ha, while it is Rs.6250 for the above four hectares of land owning farmers. This is because of the differences in capital cost of the system. Subsidy amount increases with capital cost of the system. Most of the large farmers' fields are situated very near the water source (well). This has helped them to reduce the cost of capital. As a result, the per hectare subsidy is relatively less for large farmers.

On the whole, the evaluation on subsidy shows that the beneficiaries seldom face problem in getting subsidy from the distributing authorities. Subsidy amount is fixed based on the value of the capital cost of the system by taking into

account the scheme guidelines without any discrimination. Average per hectare amount of subsidy decreases when land size of the farmers increases. Amount of subsidy varies depending on the material cost of the system and distance between place of water source and the field to be irrigated.

### 5.3 Farmers' Perception on the Working Nature of Drip System:

To understand the working nature of drip irrigation system, we have evaluated the overall perception of the farmers on the different aspects of drip irrigation. That is, what farmers feel about availability of Bank loan, capital cost of drip irrigation, working condition of the drip system at the field level, availability of spare parts and plan of extending drip area in future. The perception of the sample farmers on different aspects of drip irrigation is given in table 5.3.

Bank loan is important for the adoption of drip system as it requires enormous fixed capital. There is an argument that Bank makes unnecessary delay in sanctioning loan for the farmers. But, contrary to the common argument, about 90 per cent of the farmers in both the districts have accepted that there is no problem in getting loan from Banks. However, nearly 28 per cent of the sample farmers have accepted that Bank takes lot of time to process the application. This ultimately affects the farmers to adopt drip irrigation in time.

Regarding the capital cost of drip irrigation, about 58 per cent of the farmers - most of them are small farmers - have expressed that it is a high cost venture. Farmers reluctant to adopt drip because of its capital intensive.

Many farmers from both Banana and Grapes cultivating areas have expressed that this high capital cost does not allow them to adopt DMI for crops which give less profit. It implies that if the drip technology is made available in low cost for farmers, drip area can be increased at faster rate.

Table 5.3: Farmers Perceptions on the Working condition of the scheme.

Variables	(No. of farmers)								
	Jalgaon			Nashik			Total		
	Yes	No	Tot.	Yes	No	Tot.	Yes	No	Tot.
1. Problem in getting loan	3 (12)	22 (88)	25 (100)	2 (17)	23 (83)	25 (100)	5 (10)	45 (90)	50 (100)
2. Bank takes long time.	4 (16)	21 (84)	25 (100)	10 (40)	15 (60)	25 (100)	14 (28)	36 (72)	50 (100)
3. High initial Cost.	14 (56)	11 (44)	25 (100)	15 (60)	10 (40)	25 (100)	29 (58)	21 (42)	50 (100)
4. Satisfaction on working drip system	25 (100)	0	25 (100)	25 (100)	0	25 (100)	50 (100)	0	50 (100)
5. Working condition of drip emitters is good.	25 (100)	0	25 (100)	25 (100)	0	25 (100)	50 (100)	0	50 (100)
6. Spare parts available in time	25 (100)	0	25 (100)	25 (100)	0	25 (100)	50 (100)	0	50 (100)
7. Plan of extending drip area future	7 (28)	18 (72)	25 (100)	20 (80)	5 (20)	25 (100)	27 (54)	23 (46)	50 (100)

Note: Figures in brackets are percentage to total. Percentages rounded off to the nearest integer.

Source: Computed from field level data.

On the working condition of drip system, we have asked three questions from the beneficiaries. The questions are: (i) overall working condition of drip system, (ii) working condition of the drip emitters, and (iii) problems in getting spare parts for the drip system. These questions are asked

mainly to understand the functioning of the drip system at the field level. One of the common arguments for the slow growth of drip irrigated area in India is the failure of the system at field level. Farmers face major problems like system clogging because of using poor quality drip accessories. However, the results of the present study do not corroborate these arguments. All the sample farmers have expressed satisfaction on the overall working condition of the drip system in the field. Some of the farmers have faced occasionally problems like non-availability of spare parts in Jalgaon district. Other than this, rat and rodent infestation is also causing damage to the drip tubes to some extent in both the districts. This affects the distribution of water to plants. Contrary to the common arguments, none of the sample farmers have faced major problems like system clogging at field level. Farmers have complete freedom to choose the drip materials even if they adopt drip irrigation through government schemes. This helps farmers to choose genuine drip materials in the market.

Regarding the plan of extending drip area in future, the response of the farmers is not satisfactory. Only about 54 per cent of the sample beneficiaries have indicated plan to extend drip area in future. Farmers response varies between the two crops in this regard. Nearly 80 per cent of the farmers who cultivate Grapes by drip method of irrigation, have the plan to extend drip area in future, whereas only about 28 per cent of the farmers, who cultivate Banana have expressed positive opinion in this regard. There are two reasons for the poor response from the Banana cultivators. Firstly, unlike Grape, once in two or three years Banana cultivators have to change the Banana plant and re-arrange the

drip tubes which consumes more labour and involves lot of work. Secondly, farmers feel that drip irrigation for Banana crop is not a highly remunerative as compared to Grape. In the case of Grape, once the drip-set is installed farmers need not re-arrange the tubes and pipes for atleast ten years as it is a long-term crop.

#### 5.4 Farmers' Preferences for Adopting Drip Irrigation:

DMI helps to increase the productivity of crops and reduce the cost of cultivation. It also increases the efficiency of consumption of water as well as electricity compared to flood method of irrigation. Although it increases the yield of crops and efficiency of water consumption, reasons for using drip irrigation may not be the same across the farmers. Some farmers may adopt for enjoying subsidy facility alone, while others may adopt this method for increasing the productivity of the crops. Studies<sup>9</sup> relating to drip irrigation have also shown that farmers' preferences for using drip irrigation vary with crops and ecological condition of the regions.

To understand the preferences of the farmers for adopting drip irrigation, farmers are asked to rank the eight reasons according to their option. The eight reasons are; (i) for less water consumption, (ii) for subsidy, (iii) for labour problem, (iv) to protect soil erosion, (v) for weed problem, (vi) to reduce cost of cultivation, (vii) because of un-even terrain, and (viii) to increase yield. Ranks according to the farmers option for different reasons are presented in table 5.4 for both Banana and Grape cultivators separately.

<sup>9</sup> For example see, Puranik, et al., (1992), "Constraints and Problems as Perceived by Non-adopters and Adopters of Drip Irrigation System", Agricultural Situation in India, Vol. XLVII, No.1, April, pp. 33-34.

Table 5.4: Farmers' Preferences for using Drip Irrigation.  
(in percentage)

Ranks	WSA	SUBY	LOPR	PSER	LWEP	LCC	UET	YIED	Total
<b>Jalgaon:</b>									
1	20	4	16	0	0	0	4	56	100
2	33	21	17	13	4	4	4	4	100
3	29	4	13	0	21	8	4	21	100
4	13	13	12	12	46	4	0	0	100
5	0	4	0	9	21	58	0	8	100
6	4	34	0	29	4	21	4	4	100
7	6	12	0	29	12	12	29	0	100
8	0	25	12	13	0	0	38	12	100

**Nashik:**

1	100	0	0	0	0	0	0	0	100
2	0	0	44	0	24	8	0	24	100
3	0	0	8	4	40	28	0	20	100
4	0	9	4	13	26	26	0	22	100
5	0	38	0	29	4	8	13	8	100
6	0	42	0	16	11	5	26	0	100
7	0	17	0	42	0	8	8	25	100
8	0	40	0	0	0	10	30	20	100

Note: WSA - water saving, SUBY - subsidy, LOPR - labour problem, PSER - Protect soil erosion, LWEP - less weed problem, LCC - Less cost of cultivation, UET - uneven terrain, YIED - yield.

Figures rounded off to the nearest integer.

Source: Computed from field level data.

It is proved by studies that drip irrigation means water saving technology. Farmers mostly prefer DMI to avoid water shortages. But, results of the present study show a mixed response in this regard. Preference of the farmers varies widely between Banana and Grapes. While all the 25 farmers (100 per cent) cultivating Grape have accepted that they use drip irrigation primarily to reduce the consumption of water, only 20 per cent of the farmers cultivating Banana have given first rank for less water consumption. It shows that the farmers preferences for using drip irrigation vary with Crops. The reason for giving first rank by all farmers for water saving in Nashik is that the drip method of irrigation has partly solved their acute problem of water shortage which they used to face before introducing drip irrigation.

Both Central and State schemes are currently providing 50 per cent of the capital cost as subsidy for farmers who take drip irrigation in crop cultivation. There is a common argument that farmers take drip irrigation because drip scheme offers huge subsidy. But, in our survey, very a few farmers have expressed that they adopt drip irrigation only due to availability of subsidy. In fact, majority of the farmers have given sixth and seventh rank for this reason. Importantly, none of the farmers cultivating Grapes have given first, second or third rank for subsidy. It is also understood from the field that some of the farmers are willing to adopt drip irrigation even without subsidy. This indicates if a technology is considered to be useful, farmers will adopt even without subsidy. It also discards the argument that farmers adopt DMI for enjoying subsidy.

As indicated already farmers also prefer drip technology to avoid labour problems. Drip technology reduces human labour in operations like irrigation, weeding, on-farm works etc. It was noted under the cost of cultivation section that drip method of irrigation reduces enormous amount of labour cost compared to non-drip method using farmers. In the present study, farmers response on labour problem varies between Grapes and Banana. In both the crops, very few farmers have given first rank to the labour problem. However, about 44 per cent of the farmers in Nashik, where farmers cultivate Grapes by using drip irrigation, have given second rank as the reason for taking drip irrigation. It is because of the reason that Nashik district is one of the developed districts of Maharashtra where labour availability is constrained. DMI reduces demand for human labour to some

extent and thus most of the farmers have given second rank for reduction of labour problem.

DMI helps to augment the yield of crop compared to flood method of irrigation. We have also undoubtedly confirmed that yield is significantly higher in crops which are cultivated under DMI as against flood method of irrigation. Since drip helps increasing the yield of crop, we tried to understand the farmers perception about it. As in the other cases, farmers response varies between Grapes and Banana. About 56 per cent (14 out of 25) of the Banana cultivating farmers have given first rank for yield increasing capability of DMI, while none of the Grapes farmers have given first rank to this. It shows farmers' perception in giving rank for using drip irrigation varies from crop to crop.

Farmers in both the districts have given very lower ranks for reasons like protecting soil erosion, less cost of cultivation and un-even terrain. However, considerable number of farmers have given third and fourth ranks for less weeds problem. Since the drip irrigation restricts water supply only at the root zone of the crop, weeding is controlled in the non-crop space. Owing to this reason, requirement of labour for weeding operation has reduced. Hence, a considerable numbers of farmers have given third and fourth rank for less weeds problem.

Altogether, it is clear that reasons for adopting drip irrigation vary between the crops and the farmers. Most of the Banana cultivators have given first rank for yield as the main reason for taking drip irrigation, while all the 25 Grapes cultivators have given first rank for water saving



capability. It is clear thus that farmers mainly adopt drip irrigation for two reasons - increasing yield and reducing water consumption. None of the farmers in both the crops have given first rank for less cost of cultivation as the main reason for adopting drip irrigation.

### 5.5 Sources of Information Used by Farmers:

Farmers receive information related to new technology of agriculture from various sources. Extension officials play a crucial role in introducing new technology in agriculture. Since drip irrigation is a new technology, we tried to know what are the sources of information farmers have used for solving problems related to drip irrigation. For this, we have divided the sources of information into four broad categories. They are, government sources [Block Development Officer (BDO) and Agriculture Officer (AO)], drip manufactures, co-villagers and others.\* Source-wise use of information by sample farmers is given in table 5.5.

Table 5.5: Sources of Information Used by Farmers.

Source	Jalgaon (No. of farmers)	Nashik (No. of farmers)	Total
BDO/AO	18 (72)	13 (52)	31 (62)
Drip Manufactures	5 (20)	4 (16)	9 (18)
Co-villagers	2 (8)	7 (28)	9 (18)
Others	0	1 (4)	1 (18)
Total	25 (100)	25 (100)	50 (100)

Note: Figures in brackets are percentage to total.  
Source: Computed from field level data.

\* Others include information received from Radio, TV, News papers etc.

In both the districts, most of the farmers use Government source (BDD and AD) for solving problems related to drip irrigation. Out of the total, 62 per cent of the farmers have used government source as the main source of information. However, information sources used by the farmers vary between Jalgaon and Nashik district. For instance, in Jalgaon, nearly 72 per cent of the farmers primarily rely on BDD and AD to rectify problems related to drip irrigation, whereas, the same is only 52 per cent in Nashik district (Grapes area). About 28 per cent of the farmers have received information primarily from co-villagers in Nashik district. Since drip is in practice for the past seven eight years in Nashik district, farmers who started installing drip irrigation recently are using co-villagers advice whenever, they face problem. Only a very few farmers rely on other sources (media) of information. We have also tried to verify the common argument that government officials primarily supply the information about agriculture only to the rich and high caste farmers. However, farmers did not complaint any such practice in both the districts. Most of the farmers have expressed satisfaction about the providing information on drip irrigation by BDD and AD.

## Chapter - VI

### SUMMARY AND CONCLUSIONS

#### 6.1 Introduction:

Experience of the countries which use drip irrigation extensively indicate that the method of drip irrigation enhances the yield of crop, reduces the consumption of water as well as the cost of cultivation. Results of the different research stations in India have also confirmed the importance of drip irrigation in increasing the productivity of the crops and reducing the consumption of water. However, the over all development of drip irrigated area is not appreciable in India except in a few states. Measures have been introduced in the recent years to promote this water saving technology on a large scale. In the Eighth Plan period a centrally sponsored scheme namely "Use of Plastics in Agriculture" has been launched for promotion of various plasticulture techniques like drip irrigation, mulching and green houses with the objectives of achieving higher productivity with optimum utilisation of water resources. The total outlay assigned under this scheme is Rs. 250 crores. Drip irrigation forms the major component of the scheme with an outlay of Rs.200 crores and the total area coverage targeted is 1.39 lakh hectares. Large number of farmers have taken benefit of the state and central schemes of drip irrigation. Present study is undertaken to evaluate the performance of drip irrigation system provided under the Government's schemes in Maharashtra.

Maharashtra is one of the water scarce states in India. Area under irrigation in the state is only 11 per cent of

Gross Cropped Area (GCA) in 1991 which is quite low when compared with other states of India. Moreover, horticultural crops like Banana, Grapes, Pomegranate etc are also being extensively cultivated by using groundwater in the state. Currently two schemes are operating in Maharashtra for promoting drip irrigation. They are funded separately from state and central funds. The state scheme began from 1986-87, while the central scheme started in 1991-92. Importantly, area covered under drip irrigation system is substantially higher in Maharashtra compared to any other states in India.

#### 6.2 Objectives and Methodology:

The study is taken up with the following objectives.

1. To evaluate the impact of drip irrigation technology on production and productivity of the horticultural crops.
2. Performance evaluation of drip irrigation system at farmer's field in respect to awareness of the technology operation and maintenance of the system.
3. Evaluation of the possible remedies in respect of problems encountered by the farmers in adopting the technology.

Two districts in Maharashtra where drip irrigation is being extensively used for crop cultivation have been selected to evaluate the performance of drip irrigation at field level from the district-wise data of drip irrigation supplied by the drip irrigation cell, Commissionerate of Agriculture, Government of Maharashtra, Pune. The two selected districts are Jalgaon and Nashik. Since the economic impact of drip irrigation varies from crop to crop, we have selected two dominating crops, one from each district. The selected crops are Banana (from Jalgaon district) and Grapes (from Nashik

district). After selecting the crops, two blocks (one from each district) where these two crops are being cultivated extensively, have been selected for the detailed survey. Sample farmers have been selected with the help of beneficiaries list of 1992-93. In each district, 50 farmers - 25 beneficiaries and 25 non-beneficiaries (non-drip adopters) have been selected. Thus, a total of 100 sample farmers have been selected for the survey. While beneficiaries have been selected by using random sampling method, non-beneficiaries have been selected purposively with the help of village accountants. The year 1993-94 has been considered as a reference year for the detailed survey.

### 6.3 Development of Drip Irrigation in Maharashtra:

Development of drip irrigated area is very phenomenal in Maharashtra compared to any other state in India. Maharashtra state alone accounted for about 46 per cent (32924 of 70589 hectares of the country) of the total area in India in 1992.<sup>1</sup> Drip area has consistently increased from about 236 hectares in 1986-87 to 60129 hectares in 1994-95. Development of drip irrigated area is not uniform across the districts of Maharashtra. Development of area under DMI is quite impressive in districts which come under Nashik, Pune and Amravati divisions, while growth is quite low in the districts of Konkan and Nagpur division.

Among the central and state schemes, state scheme accounted for about 75 per cent of the total area in the state at the end of 1994-95. It also occupied more area in almost all the districts compared to the central schemes. Central scheme

<sup>1</sup> State-wise data on area under drip irrigation are not available after 1992.

has more area wherever state scheme has more area. One of the main differences that we have noted between the central and the state scheme is the demonstration area of drip irrigation comes specifically under the central scheme.

Like area, total number of beneficiaries and amount of money distributed in the form of subsidy are also substantially higher in the state scheme. The per hectare subsidy calculated at the state level comes to about Rs.12981/ha. for the central scheme beneficiaries and about Rs. 14522/ha for the state scheme beneficiaries.

More than 20 crops are being cultivated by using drip method of irrigation in Maharashtra. The important crops are Grapes, Banana, Sugarcane, Pomegranate, Orange, Mango and Berry. In the total area, Grapes accounted for more than one fourth of the area (27 per cent) followed by sugarcane (16.7), Banana (11.7 per cent) and Orange (11.5 per cent). Crop composition is not uniform across the different districts of Maharashtra. The main crops of Nashik division are Grape and Banana, while Coconut, Chiku and Mango are the important crops in Konkan division. There is no much difference in the crop composition of beneficiaries coming under the state and the central scheme. However, sugarcane is completely absent in central scheme as it does not provide subsidy for sugarcane crop.

District-wise analysis showed that, among the various factors, rainfall and area under groundwater are the two factors which significantly influence the growth of drip irrigated area in Maharashtra. Area under drip irrigation is very less in the districts where rainfall is higher. Drip

irrigated area is more in the districts where area under groundwater is more. Correlation and regression results have also corroborated that rainfall and groundwater area are the two important factors which are mainly associated with the development of drip irrigation in Maharashtra besides government's keen involvement.

#### 6.4 Impact of Drip Irrigation on Input Use and Productivity:

Socio-economic factors (education, age, farming experience and status) of drip adopters are much better than non-drip adopters in the both Jalgaon and Nashik districts. Average land size of the drip adopters is less than the non-drip adopters. In Jalgaon district, the average size of land is about 2.11 ha. and 2.49 ha. respectively for the drip and non-drip adopters. The same is about 2.04 ha. and 2.24 ha. respectively for the drip and non-drip adopters in Nashik district.

The main source of irrigation is groundwater for both the districts as well as both the group of farmers. Well irrigation accounted for more than 80 per cent of the cultivated area in both the districts. Sample farmers of Jalgaon district do not have any supplementary source of irrigation except well. But surface irrigation accounted for about 20 per cent of the irrigated area in the beneficiaries group of Nashik district.

Cropping pattern of the beneficiaries (drip adopters) significantly varies from that of the non-beneficiaries (non-drip adopters) in both the districts. Crop composition is also not the same between the two selected districts. In Jalgaon, Banana crop accounted for nearly 60 per cent of the

cultivated area in the beneficiary group, while it is only about 37 per cent in the non-beneficiaries group. Likewise, in Nashik, Grapes accounted for about 30 per cent of the beneficiaries cropped area, while it is only about 21 per cent in the non-beneficiary group.

In the total irrigated area of the beneficiaries, drip area accounted for about 59 per cent in Jalgaon district and about 28 per cent in Nashik district. The beneficiaries have adopted drip method of irrigation only for Banana in Jalgaon district and for Grapes in Nashik district. All other crops are being cultivated by surface method of irrigation.

Land Use Intensity (LUI) does not show much difference between the farmers who use drip method of irrigation and flood method of irrigation in both the districts. LUI is marginally higher for the non-drip adopters than that of the drip adopters.

Cropping Intensity of the beneficiaries (246 per cent) is significantly higher than that of the non-beneficiaries (209 per cent) in Jalgaon district. But the same is more for the non-beneficiaries (245 per cent) than that of the beneficiaries (219 per cent) in Nashik district.

Irrigation Intensity is not the same between the drip and non-drip adopters in the two selected districts. Irrigation intensity of the drip adopters is about 51 per cent points more than the non-drip adopters in Jalgaon district. But it is not the same in Nashik district where irrigation intensity is marginally higher for the non-drip adopters.



In both the districts, per hectare cost of cultivation is much less for the crops which are cultivated under drip method of irrigation. The cost saving is about 2.5 per cent (in terms of Rs.1300/ha) for Banana and nearly 10 per cent (in terms of Rs.13400/ha) for Grapes compared to the same crops which are cultivated under surface method of irrigation. Among the different operations, the cost saving is found more in labour cost of irrigation, weeding, ploughing and fertiliser.

Productivity of the crops is significantly higher for the farmers who adopt drip method of irrigation compared to the non-drip adopters for both the crops. Among the two crops, yield increase is more in Banana compared to Grapes both in terms of percentage as well as in absolute value (in quintal). The yield of Banana is about 29 per cent (about 153 quintals) higher in the case of the drip adopters than the non-drip adopters, while the same is about 19 per cent (about 38 quintals) in Grapes.

Cost incurred to produce one quintal of yield is significantly less in the case of the drip adopters both for Banana and Grapes. The non-drip adopters have incurred cost of about Rs.24 more than the cost of drip adopters to produce every unit of Banana. Likewise, for Grapes, the non-drip adopters have incurred cost of about Rs.170 more than the drip adopters to produce one quintal of yield.

Profit<sup>2</sup> of the crops which are cultivated by drip method of irrigation is significantly higher than the non-drip crops.

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<sup>2</sup> This profit is computed without considering interest rate of the capital, life period of the drip-set and depreciation value of the capital.

Among the two crops, profit is more for Grapes compared to Banana. In Grapes, profit of the drip adopters is about Rs.50100/ha more than the profit of the non-drip adopters. Likewise, profit of the drip adopters is about Rs.32400/ha more than the profit of the non-drip adopters for Banana crop. In terms of percentage, the profit of drip adopters more than the non-drip adopters is 39 per cent for Banana and 44 per cent for Grapes. It is also found that the huge profit of drip irrigation is not because of price effect but because of the yield effect.

Discount cash flow technique is used to understand the economic feasibility of drip investment. This has clearly confirmed that the BC ratio of the drip irrigated crops is significantly higher than the non-drip irrigated crops in both the districts. The calculated BC ratio for Banana is 2.16 for the drip adopters as against the non-drip adopters ratio of 1.95. The BC ratio for Grapes crop under the method of drip irrigation is 1.76, while it is only 1.42 under the flood method of irrigation.

The computation of Net Present Worth (NPW) shows that the drip adopters in both the crops can realise the whole capital cost of drip-set from the profit of the very first year itself. This un-ambiguously confirmed that investment on drip irrigation for these crops is economically feasible even for one hectare of land owning farmers.

#### 6.5 Water and Electricity Use Pattern of Drip Adopters:

The number of irrigations applied per hectare and per crop season is significantly more for the drip adopters compared to the non-drip adopters. For instance, drip

adopters in Banana have applied nearly 78 irrigation per hectare more than the non-drip adopters. Likewise, the farmers who adopt drip method of irrigation in Grapes have applied about 82 irrigations more than the non-drip farmers. However, hours required per irrigation to irrigate per hectare of Banana/Grapes is significantly less for the drip adopters.

Per hectare consumption of water in terms of quantity is much less in drip method of irrigation compared to flood method of irrigation in both the crops. Water saving is about 41 per cent in Banana and about 59 per cent in Grapes compared to the same crops cultivated by flood method of irrigation. It is estimated that, from the saving of water, an additional amount of 0.60 ha (1.48 acres) in Grapes and about 0.41 ha (1.01 acres) in Banana can be brought under irrigation for every hectare of drip irrigation.

Water consumed to produce one quintal of yield<sup>3</sup> is also significantly less in drip irrigated crops compared to non-drip crops. It was seen that Banana crop under DMI required only 11.60 HP hours of water to produce one quintal of yield as against water consumption of Banana (21.14 HP hours of water) under flood method of irrigation. In the case of Grapes, crop under DMI required only about 13.6 HP hours of water to produce one quintal of yield as against the non-drip crop consumption of 25.84 HP hours of water.

We have also estimated electricity consumption from the working hours of pumpsets for both drip and non-drip farmers. The results showed that per hectare consumption of electricity

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<sup>3</sup> It is otherwise called as water use efficiency in drip method of irrigation.

is quite low for both the crops under DMI, compared to non-drip crops. Electricity saved due to drip method of irrigation is about 2430 kwh/ha for Banana and 1470 kwh/ha for Grapes cultivators.

As in the case of water, electricity required to produce one quintal of yield of crop is significantly less under drip method of irrigation in both the districts. For example, farmers who cultivated Grapes under DMI spent about 10.21 kwh to produce one quintal of yield as against the non-drip crop consumption of 19.37 kwh. The same is about 8.7 kwh per quintal under DMI and about 15.86 kwh per quintal under condition of non-DMI for Banana.

#### A.6 Performance Evaluation of Drip Irrigation System:

The results of investment pattern showed that farmers in both the districts mostly rely on Bank loan for installing drip irrigation system. About 76 per cent of the total beneficiaries in Jalgaon and 60 per cent of the beneficiaries in Nashik have used Bank loan for buying drip materials. Among the different categories of beneficiaries (small, medium and large) majority of the small farmers who own up to 2 hectares of land, have used Bank loan.

The per hectare capital investment of drip irrigation varies between the farmers who have used own finance and Bank loan. The investment of the farmers who use Bank loan in Grapes is Rs.31504/ha, while the same is Rs. 29130/ha for the farmers using own finance. For Banana crop, the beneficiaries have invested Rs.31097 if they use the Bank loans whereas, those using their own funds have invested Rs. 42537/ha. The per hectare capital cost also varies across the different size

of farmers in both the districts. Enquiry revealed that capital cost of the system is mostly determined by the distance between the place of water source (well) and field.

The per hectare subsidy varies from about Rs.13200 to Rs.6250 across different sizes of farmers. In both the districts, when land size of the farmer increases average amount of per hectare subsidy decreases. For instance, in Grapes, the average per hectare subsidy of small farmer is Rs.12900, while the same is only about Rs.10930/ha for the farmers who own more than four hectares of land (large farmers).

Rate of subsidy is fixed on the basis of the recommendation of the agricultural officers who verify the system functioning and materials used for the drip-set at the farmers' field. It is also found that the beneficiaries seldom faced problem in getting subsidy from the distributing authorities. Leakages in the subsidy in the form of bribes and kickbacks were not noticed even a small percentage.

The overall perception of the farmers on different aspects of drip irrigation system showed satisfactory results. More than 90 per cent of the farmers in both the districts have not face any problem in getting loan from Banks. However, about 28 per cent of the farmers have reported that delays in sanctioning of loans. Regarding the capital cost of the system, though it is an assured profitable venture, ABOUT 58 PER CENT of the farmers have expressed that drip is a capital intensive technique. Almost all the beneficiaries from both the districts have expressed positive opinion about the working condition of drip system at field level.

functioning of emitters and availability of spare parts. None of the farmers faced major problems like system clogging at their fields. However, some of the farmers reported the problem of rat and rodent in damaging the drip tubes.

Farmers' preferences for adopting drip irrigation widely vary between Grapes and Banana. All the sample farmers cultivating Grapes have given first priority for 'water saving' as the main reason for adopting drip irrigation, while only 20 per cent of the Banana cultivators confirmed this. About 56 per cent of the farmers have given first rank for yield increase as the main reason for adopting drip irrigation in Banana. Contrary to the common belief, only a few farmers have expressed that they adopted drip irrigation because of the subsidy facility. In fact, most of the farmers have given sixth and seventh rank preferences to the reason pertaining to subsidy. Some of the farmers are ready to adopt drip method of irrigation even without subsidy if government is ready to provide other technical assistance. Although DMI reduces labour problem and cost of cultivation, very few farmers only have given first rank for it. Altogether, it is clear that the farmers mainly adopt drip method of irrigation for increasing the productivity of crops and water saving.

Among different source of information, farmers have used mainly government sources (Block Development officer and Agricultural Officer) for solving problems related to drip irrigation. About 62 per cent of the farmers primarily used government sources for solving problem. It also varied between the two districts. Nearly 72 per cent of the farmers primarily rely on BDO and AO in Jalgaon district, while it is

only 52 per cent in Nashik district. About 28 per cent of the farmers in Nashik have adopted the ideas of the co-villagers. Majority of the farmers have expressed satisfaction on Block Development Officers and Agricultural Officers in providing information related to drip irrigation.

#### 6.7 Remedial Measures:

1. Majority of the farmers in our study have expressed that initial investment required to install drip irrigation is very high. Because of this reason, most of the farmers are reluctant to adopt drip method of irrigation for crops which give less remuneration. If it is made available in less cost, area under drip irrigation can be increased at a faster rate. Hence, measures can primarily be taken to reduce the fixed cost of drip irrigation by promoting research and development activities.

2. Because of non-availability of subsidy through government schemes, majority of the non-drip adopters are forced to adopt flood method of irrigation for crop cultivation. It is understood that this is because of the inadequate allotment of fund for each district. Government can make way for providing subsidy to all farmers who are ready to adopt drip irrigation by increasing the total amount of subsidy allotment. Allocation to different districts should be revised by taking in to account the progress of the schemes.

3. Presently central scheme does not provide subsidy for sugarcane crop. Since it is an important and also a more water consuming crop in Maharashtra, this restriction should be removed to increase the drip irrigated area at faster rate.

4. Currently rate of subsidy is fixed uniformly for both water intensive and less water intensive crops. This may be restructured. Special subsidy programme may be introduced for water intensive crops like sugarcane, Banana, vegetables etc. Differential subsidy rates can be fixed based on the types of crops and the rate of consumption of water.

5. Farmers have inadequate knowledge regarding the usefulness of drip irrigation. Even the beneficiaries do not know how much of subsidy is available per hectare for different crops. Owing to poor exposure, farmers are reluctant to invest such a huge money on drip irrigation. In fact, many farmers do not believe the fact that drip irrigation can also be used efficiently and economically for narrow spaced crops like sugarcane, cotton, vegetables etc. These problems can be removed by giving wide publicity and strengthening the existing extension services.

6. Farmers also have inadequate knowledge regarding the usefulness of liquid fertilisers. None of the farmers in our study used liquid fertilisers for crops. Most of the farmers are afraid to use liquid fertiliser through drip pipe network. They feel using fertiliser through water may lead to system clogging. These maladies should be removed by introducing regular and frequent demonstration. Importance of liquid fertiliser in increasing input efficiency and reducing the cost of cultivation should be clearly explained to the farmers by the extension officials.

7. It is understood from the macro level data that wherever state scheme has more area, there the central scheme has also more area. This means that both the schemes have



concentrated only in a few developed districts. This can be restructured and special emphasis can be given to less developed districts by the central scheme.

8. The price of drip accessories such as emitters, filters, laterals etc varies between shops and places. Sometimes farmers are also facing problem in getting spare parts in time. It is necessary to provide quality drip materials in time for farmers for the speedy adoption of drip irrigation. To avoid price variation and non-availability problem of spare parts, fair price shops can also be started in advanced districts head quarters, taluk head quarters and even at block level.

9. For speedy growth of drip irrigation, priority can be given in providing bank loan for digging wells and electricity connection for the farmers who accept to adopt drip irrigation for crop cultivation.

10. Manufacturing companies of drip irrigation sets should be involved intensively in promoting drip irrigation by introducing frequent demonstration at farmers field. They should also develop confidence among the farmers by showing the miracle performance of drip irrigation.

11. We understand that the officials who are involving in promoting drip irrigation, have inadequate knowledge about the technical details of drip irrigation. Since they are the promoters of the scheme, adequate training should be given to these officials who directly involve in developing drip irrigation.

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