Drip Irrigation: A Solution to Reduce Impact of Industrial Effluent Contaminated Chambal River Water

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ABSTRACT - *Recently, water use efficiency improvement and water quality assessment are big reason to worry about because farmers are facing water scarcity problem in irrigation. GOI and non-beneficial organizations in India are running many programs which help farmers economically, providing training to adopt cost effective micro irrigation technique. So, for agricultural development some efforts to be made from our side in research, which helps farmers in the sense that they can able to produce more yield per drop of water.*

Drip irrigation is best option available to reduce impact of industrial effluent contaminated Chambal river water used in irrigation. Drip irrigation reduces water consumption to 50.48% which in turn reduces impacts of river water without any adequate treatment of water. Analysis in this work shows advantages of drip irrigation over conventional surface irrigation or say flood irrigation (i.e. less fertiliser use, less pesticide use, less weed problem, less labour cost, water saving, increases yield etc.).

The study focused on the area nearby Chambal river in Madhya Pradesh Region from Nagda [23.453^{o}N 75.415^{o}E] downstream to Gandhi Sagar Dam [24^{o}42'24"N 75^{o}33'12"E] upstream. Where it is greater need to promote drip irrigation technique because farmers in this region mainly use conventional surface irrigation and depends upon river water. As we come to know about the advantages of drip irrigation these are 12.34% productivity gain, 62% electricity saving, 31.28% reduction in cost of cultivation, 19% fertilizer cost saving, 31.37% pesticide cost saving and 20.79% labour cost saving.

Keywords: **-** Drip Irrigation, Chambal River, Productivity Gain, Water Use Efficiency

INTRODUCTION

The scarcity of water leads to the overexploitation of groundwater for agriculture result in falling water table in Malwa Region. It is an important issue to find new resources of water for irrigation and reuse of river water. Chambal River like most rivers in India plays an integral role in the lives of thousands of communities living along the banks of the river. Near river bank there are various types of industries such as fertilizer, textile, cement, sugar, dye, steel/iron furnishing industries, small scale treatment and production industries (distillery, dairy, chemical and pesticides). Effluents from these industries contain N, P, K, heavy metals, organic and inorganic pollutants and toxic colors. Industries near river bank discharged their effluent into fresh water without any adequate treatment (Bharti *et al.*, 2013)**[3][5]**. Reuse of industrial waste water provides an alternate source of water and nutrients in it are beneficial to accelerate growth of crops, which in turn helps farmers economically by reducing chemical fertilizer use **[8]**.

Chambal River water when used in irrigation leads to the degradation of soil quality and crop health. There is need to find possible solution for efficient and cost effective use of water mitigating all problem associated with it. Micro-irrigation reduces the cost of cultivation, weed problems, soil erosion and increases water use efficiency as well as electricity use efficiency, besides helping reduce the overexploitation of groundwater. Many research revealed that Micro-irrigation saves around 25% **[1]** to 50% **[2]** water. (Ibragimov et al., 2007)**[7]** analysed 18–42% saving of irrigation water and the water use efficiency (WUE) expanded by 35–103% in comparison with flood method of irrigation (FMI).

Drip method irrigation (DMI) is a water saving technology that delivers water through small holes or emitters in plastic tubes installed on or below the soil surface almost directly to the roots of plants (see **Fig -1**). Flow rates are slow, from 0.2-20 l/h **[4]**, and regular application is the basic concept underlying this method to supply the amount of water needed by the plant

Fig -1: Watering plant using DMI

This study therefore attempts to assess the impact of DMI on different parameters of crop cultivation using field-level data collected from farmers by tabular and graphical comparisons with FMI. The main objectives are:

- To analyse the impact of drip irrigation technology on production and productivity of crop by comparing it with non-drip irrigated crop;
- To analyse the pattern and efficiency of water use with drip and non-drip irrigated crop;
- To estimate electricity saving due to DMI in crop cultivation.
- To analyse the economic viability of drip investment in crop cultivation by profit analysis; and
- To analyse fertilizer, pesticide and labour cost saving.

This study is carried out in the area along Chambal River from Nagda; a city situated 59.5 km away from holy city Ujjain, to Gandhi Sagar Dam in the historical Malwa region includes districts of western Madhya Pradesh (**Fig -2**).

METHODOLOGY

Initiation of project starts by selecting 20 model farmers from Ujjain, Mandsaur and Neemuch district of Madhya Pradesh. 10 farmers (F1-F10) using drip and 10 (F11-F20) without drip for cultivation of 10 crops namely sevanthi, marigold, onion, garlic, wheat, mustard seed, tomato, potato, papaya, coriander. Farm level survey data is collected from farmers during winter seasonal (2016) crops by regular interval interviews at farm and telephonically according to interview guide prepared questioning at different level of crop cultivation.

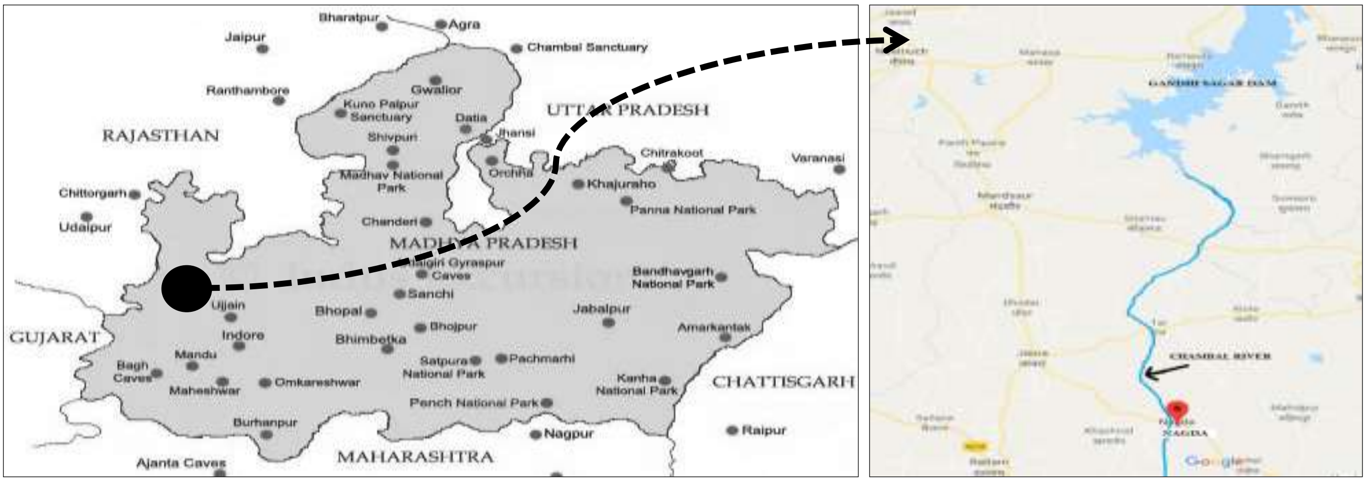


Fig -1: Study Area **[6][9]**

Drip Economization Parameters (Primary Data):- IT = Time to irrigate once; IF = Irrigation frequency; IP = Cultivation period; POP = Power of pump; WD = Well depth (head); P = Production; FP = Field preparation cost; SEED = Seed cost; FC = Fertiliser cost; PC = Pesticide cost; LC = Labour cost; OE = other expense; MP = Market price.

Drip Economization Parameters (Secondary Data):- COP = Capacity of pump; THI =Total hour of irrigation; WC = Water consumption; EC = Electricity consumption; GY =Grain yield; COC = Cost of cultivation; PG = Productivity gain

Table 1(a): Primary data collection from sample farmers using DMI

Farmer	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**
Crop	**Sevanthi**	**Marigold**	**Onion**	**Garlic**	**Wheat**	**Mustard**	**Tomato**	**Potato**	**Papaya**	**Coriander**
AREA (ha)	0.2	0.4	0.8	1.2	5	1	0.2	0.4	1	0.6
IT (hr)	2.5	3	4	6	3	2	2	4	5	4
IF ($month^{-1}$)	4	4	3	3	2	2	4	4	3	1
IP (month)	5	4	5	5	4	3	5	5	6	3.5
POP (hp)	8	3	3	12	10	3	3	5	3	5
WD (ft)	1000	160	120	600	60	30	120	250	120	70
P (kg)	3750	8000	16000	14800	30000	1880	8000	9800	55000	1457
FP (Rs)	600	800	1500	6000	12000	2000	1000	2000	2500	700
SEED (Rs)	100	100	500	70000	15625	1200	600	4400	11000	1000
FC (Rs)	3000	1800	4800	9000	12000	1800	3600	2900	7200	1500
PC (Rs)	2800	1400	450	1500	3000	600	4100	1000	3600	1500
LC (Rs)	30000	20000	15000	22500	23000	3600	8000	9000	15000	1600
OE (Rs)	6000	8000	5000	20000	1000	1400	2000	1500	3000	500
MP (Rs/kg)	40	15	8	60	16.5	58	12	10	10	60

Table 1(b): Primary data collection from sample farmers using FMI

Farmer	**F11**	**F12**	**F13**	**F14**	**F15**	**F16**	**F17**	**F18**	**F19**	**F20**
Crop	**Sevanthi**	**Marigold**	**Onion**	**Garlic**	**Wheat**	**Mustard**	**Tomato**	**Potato**	**Papaya**	**Coriander**
AREA(ha)	0.2	0.2	0.4	0.6	3	1	0.4	0.4	0.2	0.1
IT (hr)	4	3.5	8	15	13	25	5	8	4	4
IF ($month^{-1}$)	3	3	2	2	2	1	5	3	2	2
IP (month)	5	4	5	5	4	3	5	5	6	3.5
POP (hp)	8	5	3	8	10	5	3	5	10	3
WD (ft)	420	300	120	600	250	240	120	210	270	170
P (kg)	3070	3500	7400	6000	16500	1700	15000	8800	9800	230
FP (Rs)	600	600	900	4000	8000	2000	2400	2000	3000	300
SEED (Rs)	100	100	200	42000	12000	1300	1350	4600	4200	400
FC (Rs)	8000	3400	3000	4800	9000	1980	7000	3800	1500	200
PC (Rs)	7565	1400	330	1500	2700	600	9000	2000	800	300
LC (Rs)	37000	18000	12000	12000	17000	3700	17000	9000	5000	400
OE (Rs)	8470	4500	3000	13000	1000	1600	6000	1800	700	500
MP(Rs/kg)	40	15	8	60	16.5	58	12	10	10	60

Formulae	
$COP = \frac{899414 \times POP}{WD}$ $THI = IT \times IF \times IP$ $WC = \frac{COP \times THI}{AREA}$ $EC = \frac{0.746 \times POP \times THI}{AREA}$ $GY = \frac{P}{AREA}$ $COC = \frac{FP + SEED + FC + PC + LC + OE}{AREA}$	$INCOME = GY \times MP$ $PROFIT = INCOME - COC$ $\Delta WC = WC(FMI) - WC(DMI)$ $\Delta EC = EC(FMI) - EC(DMI)$ $PG = \Delta GY = GY(DMI) - GY(FMI)$ $\Delta COC = COC(FMI) - COC(DMI)$ $INCOME = INCOME(DMI) - INCOME(FMI)$ $\Delta PROFIT = PROFIT(DMI) - PROFIT(FMI)$ $\%\Delta\Psi = \frac{\Delta\Psi}{\Psi(FMI)} \times 100$ Where, Ψ= WC, EC, GY, COC, INCOME, PROFIT

Table 2(a): Secondary manipulated data of sample farmers using DMI

Farmer	Crop	COP (l/hr)	THI (hr)	WC (l/ha)	EC (kWh/ha)	GY (kg/ha)	COC (Rs/ha)	INCOME (Rs/ha)	PROFIT (Rs/ha)
F1	Sevanthi	7195.312	50	1798828	1492	18750	212500	750000	537500
F2	Marigold	16864.01	48	2023682	268.56	20000	80250	300000	219750
F3	Onion	22485.35	60	1686401	167.85	20000	34062.5	160000	125937.5
F4	Garlic	17988.28	90	1349121	671.4	12333.33	107500	740000	632500
F5	Wheat	149902.3	24	719531.2	35.808	6000	13325	99000	85675
F6	Mustard	89941.4	12	1079297	26.856	1880	10600	109040	98440
F7	Tomato	22485.35	40	4497070	447.6	40000	96500	480000	383500
F8	Potato	17988.28	80	3597656	746	24500	52000	245000	193000
F9	Papaya	22485.35	90	2023682	201.42	55000	42300	550000	507700
F10	Coriander	64243.86	14	1499023	87.03333	2428.333	11333.33	145700	134366.7

Table 2(b): Secondary manipulated data of sample farmers using FMI

Farmer	Crop	COP (l/hr)	THI (hr)	WC (l/ha)	EC (kWh/ha)	GY (kg/ha)	COC (Rs/ha)	INCOME (Rs/ha)	PROFIT (Rs/ha)
F11	Sevanthi	17131.7	60	5139509	1790.4	15350	308675	614000	305325
F12	Marigold	14990.23	42	3147949	783.3	17500	140000	262500	122500
F13	Onion	22485.35	80	4497070	447.6	18500	48575	148000	99425
F14	Garlic	11992.19	150	2998047	1492	10000	128833.3	600000	471166.7
F15	Wheat	35976.56	104	1247187	258.6133	5500	16566.67	90750	74183.33
F16	Mustard	18737.79	75	1405334	279.75	1700	11180	98600	87420
F17	Tomato	22485.35	125	7026672	699.375	37500	106875	450000	343125
F18	Potato	21414.62	120	6424386	1119	22000	58000	220000	162000
F19	Papaya	33311.63	48	7994791	1790.4	49000	76000	490000	414000
F20	Coriander	15872.01	28	4444163	626.64	2300	21000	138000	117000

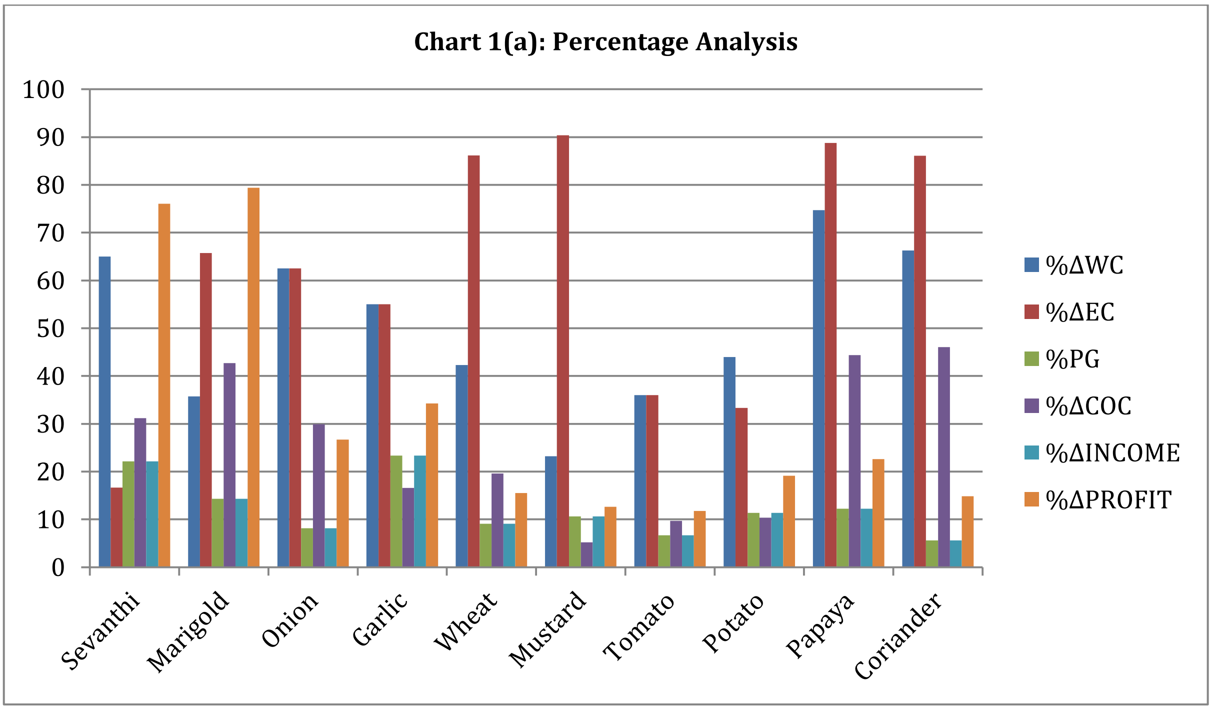
RESULTS AND DISCUSSION

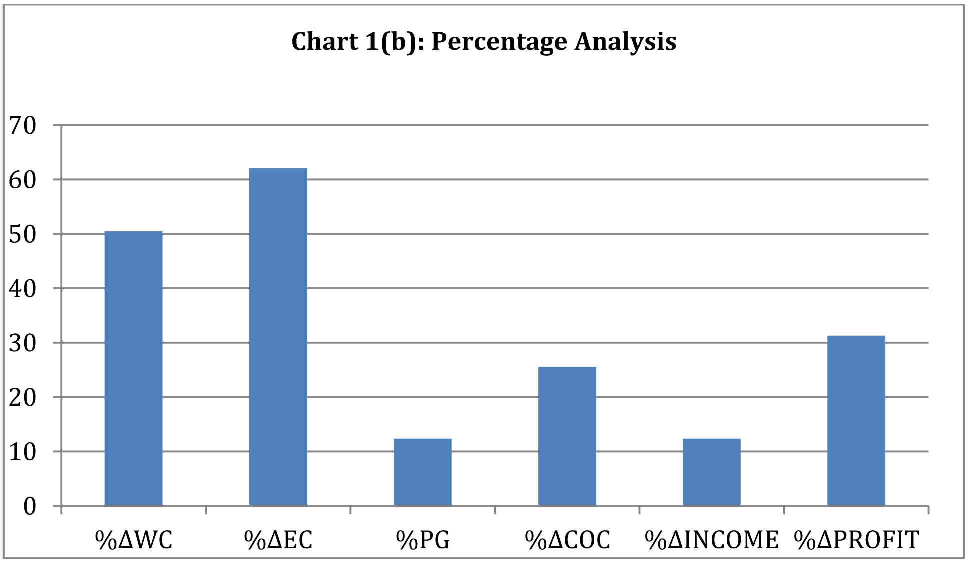
The farmer attributes the higher yield of crop under DMI to the following three reasons. First, the growth of crop was very good under DMI mainly due to less moisture stress. Second, the weed growth is less because of supplying of water only at the root zone of the crop. Third, since fertilisers are supplied through water (fertigation), the efficiency of fertilisers was very high as losses occurring through evaporation and leaching with water are less under DMI. Because of higher productivity of crop under DMI, the efficiency of water use along with the efficiency of cost as well as electricity is also found to be significantly higher under drip irrigated crop when compared to the same cultivated under FMI.

Cost reduction is generally realized more in labour intensive operations like ploughing, weeding, irrigation, etc. Since water is supplied at the root zone of the crops, the lands that are used for drip method of irrigation do not require many ploughing as in the case of surface method of irrigation. Similarly, since water is supplied only at the root of the crops, weed problem is less and thus the cost required for weeding operation reduces significantly. Cost of irrigation (both labour cost and other costs) is substantially less under drip method of irrigation because of the following two reasons: First, the requirement of labour is less for managing irrigation under drip method of irrigation. Second, since water saving is very high under drip method, it substantially reduces the working hours of pump set which extensively reduces the cost on electricity/diesel.

Table 3(a): Percentage Analysis

CROP	%ΔWC	%ΔEC	%PG	%ΔCOC	%ΔINCOME	%ΔPROFIT
Sevanthi	65	16.67	22.12	31.16	22.12	76.04
Marigold	35.71	65.71	14.29	42.68	14.29	79.39
Onion	62.5	62.5	8.11	29.88	8.11	26.67
Garlic	55	55	23.33	16.56	23.33	34.24
Wheat	42.31	86.15	9.09	19.57	9.09	15.49
Mustard	23.2	90.4	10.59	5.19	10.59	12.61
Tomato	36	36	6.67	9.71	6.67	11.77
Potato	44	33.33	11.36	10.34	11.36	19.14
Papaya	74.69	88.75	12.24	44.34	12.24	22.63
Coriander	66.27	86.11	5.58	46.03	5.58	14.84
Average	**50.468**	**62.062**	**12.338**	**25.546**	**12.338**	**31.282**





CONCLUSIONS

Above study shows that Drip irrigation is best option available to reduce impact of industrial effluent contaminated Chambal river water used in irrigation, also for each drop more crop initiative. Following conclusions help us in understanding our objectives.

- It can be seen that profit of the adopters is significantly higher than that of the non-adopters in both methods under consideration. The profit of the adopters is about 2 to 3 times higher than that of the non-adopters. In percentage terms, the profit of the adopters is higher up to 80% for water intensive crops, 11-34% for less water consuming crops and an average estimate of 31.28%.

- Average productivity gain percentage is calculated 12.3411% on per hectare basis means farmers income increases by 12.3411%.

- Adopting drip method of irrigation from each hectare of crop can save over 50.48% of water

- Electricity required for irrigating one hectare of land also reduces significantly. Our estimate reported an average 62% can be saved from each hectare of crop cultivation by adopting drip method.

- This is not surprising because drip irrigation both reduces the cost of the cultivation of crop and increases its yield. As farmers can an average reduces their cost of cultivation up to 25.55%, fertiliser cost 19%, pesticide cost 31.37% and labor cost 20.79% by adopting DMI.

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