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Impact of Drip Irrigation Technology on Input use and Productivity in Banana: Evidence from Gujarat

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Authors' contributions

This work was carried out in collaboration between both authors. This work was done by RKB under the guidance of author YCZ. Author RKB performed statistical analysis and wrote the first draft of this manuscript. Author YCZ managed the literature section and approved the final draft of this manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The impact of drip irrigation technology in banana cultivation on input use and productivity was studied by collecting data from 120 drip farms and 120 non-drip farms of Anand and Vadodara districts during 2017-18. It was revealed from the study that per ha cost of cultivation of banana *i.e.* cost C_2 was slightly less *i.e.* Rs 205190.4 under drip method of irrigation whereas under conventional method, it was Rs 212972.8. The average yield per ha *i.e.* 785.68 quintal and net gains over cost C_2 per ha *i.e.* Rs 330924.4 was higher for drip irrigated farms as compared to conventional banana growers, in which average yield per ha was 660.15 quintal and net gains over cost C_2 was Rs 239536.4. The yield and net profit were found significantly higher (about 19% and 38%) on drip farms over conventionally irrigated farms, which indicated that productivity was higher in drip method due to efficient use of inputs or resources. Due to drip irrigation system resources were saved over conventionally irrigated farms *i.e.* labor (19.99%), water (31.11%), growth regulators (22.72%), plant protection chemicals (22.30%), fertilizers (13.23%) and manures (7.78%). Benefit cost ratio over cost-C_2 under drip and conventional method of irrigation was 2.61 and 2.12, respectively. Therefore these revealed the advantages of drip in terms of yield and returns.

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1. INTRODUCTION

Banana being one of the most important fruit crops of the world grown in 120 countries worldwide. Banana is grown in the tropics and valued worldwide for its flavour, nutritional contents, and availability round the year. It is cheapest and most nourishing of all fruits. It contains all essential nutrients including mineral and vitamins. Banana fruit is reserve of energy, contains more of carbohydrate, phosphorus, calcium and iron. Used as dessert fruit and for culinary purpose. The leaves are used as biological plates. The various products like banana puree, powder, flour, chips, vinegar, jam, jelly and wine can be prepared. In the year 2016-17, globally 114 million tonnes of banana are produced and India had 27% share in it, which made it largest producer with 30477 thousand MT production [1]. The major producing states in India are Gujarat (13.73%), Andhra Pradesh (13.60%), Tamil Nadu (11.95%), Uttar Pradesh (10.10%) and Maharashtra (10.08%) [2].

In Gujarat area, production and productivity of banana has increased during last decade. The area and production of banana was 57.67 thousand ha and 3158 thousand MT in the year 2007-08 respectively and it increased up to 66.31 thousand ha and 4293.23 thousand MT in the year 2016-17 with growth rate of 1.37 & 2.93 (highly significant), respectively. In Gujarat, major banana producing districts are Bharuch, Anand, Surat, Narmada and Vadodara, which together contributes 75.6% of total production and 72.2% of total area, respectively during the year 2016-17 [3]. It was noteworthy that in Gujarat, Anand district contributes second highest in area (12540 ha) *i.e.* 18.91% under banana with 777229 MT (18.10%) of production [4].

1.1 Drip Irrigation

One of the management strategies introduced to control water consumption in Indian agriculture is Micro Irrigation (MI), which includes mainly drip and sprinkler irrigation method. It is proved that a use of irrigation water and its management in scientific way help to increase the agricultural production many folds [5]. Drip technology enhances water use efficiency as potential water available for future use is declining with faster rate [6,7,8]. Area under micro irrigation was 572980 ha in India, out of which 355516 ha were under drip and 217464 ha was under sprinkler irrigation [2].

1.2 Importance of Study

In order to inspire the farmers to maximize agriculture production/income at minimum cost by adopting scientific water management technology to bring in revolutionary transformation of the agriculture scenario, this study was designed. The consequent effects of drip irrigation system are reflected in terms of generating more income in banana by saving of resources, improving yield and quality of produce which ultimately improving the overall economic condition of banana growers. Therefore, any technology that is adopted needs to be assessed periodically in terms of cost and returns, its impact on resources and yield.

1.3 Objectives

- To compare the level of input use of banana production in drip v/s conventional irrigation technology
- To compare the cost and returns structure of banana production in drip v/s conventional irrigation technology
- To find out the benefit cost ratio of banana production in drip v/s conventional irrigation technology

1.4 Reviews

More et al., [9] studied on labour utilization and input use pattern in banana cultivation in Maharashtra. The study revealed that the major proportion of human labour was used for irrigating the banana crop. Hence, there is a need to encourage farmers to adopt the drip irrigation method, which is somewhat costly but labour-saving.

Birari et al. [10] conducted study on economic analysis of drip method of irrigation for banana in Jalgaon district of western Maharashtra. They observed that the use levels of important resources were low in the drip system of irrigation till the cost at various levels, cost 'A', cost 'B' and cost 'C' were relatively higher than that of the cost levels under conventional method of irrigation. The benefit cost ratio for drip irrigated banana was also high (1.40) as compared to flood method of irrigation.

2. METHODOLOGY

In Gujarat, Anand and Vadodara was purposively selected, as they were the major growing as well as producing districts of banana, contributing together 27.8% of area and 26.59% of production under banana in Gujarat. A total of 240 banana growers comprising of 120 drip and 120 conventional irrigated farmers formed an ultimate sample. To ascertain the impact of drip irrigation technology "with" or "without" approach was followed. The primary data was collected by using pre tested interview schedule for the year 2017-18, compiled, systematically analyzed and presented in tabular form. Techniques such as mean, percentage, ratios and simple comparisons were used in whole study for interpretation, wherever needed. To know whether the difference is significant or not "t-value" worked out with SPSS Software.

2.1 Cost Concepts

The cost concepts in brief, are Cost A, Cost B, Cost C_1 and Cost C_2. The different cost items that are included under each cost concept are detailed below with their imputation procedures.

Cost A =	Value of hired human labour + value of bullock labour (owned / hired) + Value of seeds (owned / purchased) + Value of manure (owned / purchased) + Value of fertilizer + Value of pesticides and insecticides + Irrigation charges + charges for machineries (owned/hired) + Other paid out expenses if any + Depreciation on farm Building and implements + Interest on working capital
Cost B =	Cost A + Rental value of owned land + Interest on fixed capital assets (excluding land)
Cost C_1 =	Cost B + Imputed value of family labour
Cost C_2 =	Cost C_1 + 10% of the Cost C_1 as a managerial charges
Cost of Production per quintal	Cost C_2/ Yield of main product in quintal

2.1 Imputational Procedure for Owned Inputs

The procedures adopted for deriving imputed value of some inputs are as under:

1. In drip, the cost of irrigation was worked out considering total hours of irrigation run during the total period of crop.
2. Interest on working capital was charged at the rate of 12% per annum, according to duration of the crops.
3. Interest on owned fixed capital was charged at the rate of 10% per annum.
4. Depreciation of owned fixed capital was charged at the rate of 2% for pakka and 5% for kachcha buildings per annum for the period of crop. While it was worked out 10% of drip installation cost.

2.3 Income Measures

1. Value of Gross output (Gross Income): It is calculated by considering the total production in quintal and prevailing prices per quintal.
2. Farm Business Income : Gross income – Cost A
3. Family labor income: Gross income – Cost B
4. Farm Investment Income: Net income + Rental value of owned land + Interest on owned fixed capital
5. Net returns/ Profit: Value of gross output - Cost C_2
6. Input-Output ratio: Gross Income/ Cost C_2

2.4 Partial Budgeting

Partial budgeting is a statement of anticipated changes in costs, return and profitability for a minor modification. It consists of four elements *viz*. Added costs, Added returns, Reduced costs and Reduced returns. Partial budgeting is used to evaluate the profitability of input substitution, enterprise substitution and scale of operation. Net change in income was calculated by differencing the two *i.e.* (added returns + reduced cost) - (added cost + reduced returns).

3. RESULTS AND DISCUSSION

Comparative results of level of input use, operation wise use of human labour, each component wise cost, yield, farm harvest price, gross income, net income or profit and benefit-cost ratio in banana production through drip and conventional irrigation technology are given in this section. The profitability aspect of both the methods has been analyzed and presented herewith.

3.1 Level of Input Use

The use of different inputs, which in turn affects farm productivity and income in banana cultivation on sampled farms are discussed as under.

Banana is annual crop, which required round the year human labor for various operations. The Table 1 showed that utilization of human labor for drip growers was less *i.e.* 251.88 man days as compared to conventional growers in which per ha utilization of human labor was 312.61 man days. It indicated that labor utilization was less (60.73 man days) in drip method as compared to conventional method. The use of bullock labor was 2.38 and 4.86 pair days per ha in banana production for drip and non-drip farms, respectively. So, there was saving in bullock labor of 2.48 pair days, because drip method does not require much ploughing and inter-cultivation. Further this table showed that drip and non-drip cultivators on an average applied 17.05 and 18.49 trolleys of FYM, respectively. On an average per ha use of planting material for drip farms was 2991.64 and for non-drip farms it was 2946.89. Banana crop generally required 35-40 number of irrigation per vigha during its life period. It was also observed that irrigation (in hours) required for drip and non-drip cultivators were 302.04 and 438.46 respectively.

Among use of inputs drip technology was more efficient as it saved 51.03% bullock labor (pair days), 31.11% irrigation (hrs), 19.43% human labor (man days), 7.78% manures (trolleys) and 1.52% planting material (no.) over conventional farms and it was highly significant (at 1% level). Further it was inferred that in drip technology use of input is minimized with efficient utilization.

Table 1. Level of input use per ha (Quantity/ha)

Sr. No.	Particulars	Drip	Conventional	Change in drip over conventional farms	
				Amount & %	"t" Statistics
1.	Family labor (man days)	111.14 (44.12)	144.47 (46.21)	-33.33 (-23.07)	5.91**
2.	Hired labor (man days)	140.74 (55.88)	168.14 (53.79)	-27.4 (-16.29)	7.16**
3.	Total human labor (man days)	251.88 (100.00)	312.61 (100.00)	-60.73 (-19.43)	17.08**
4.	Bullock labor (pair days)	2.38	4.86	-2.48 (-51.03)	10.42**
5.	FYM (trolley)	17.05 (78.64)	18.49 (78.65)	-1.44 (-7.79)	3.91**
6.	Poultry manure (trolley)	4.63 (21.36)	5.02 (21.35)	-0.39 (-7.77)	3.91**
7.	Total Manures (trolley)	21.68 (100.00)	23.51 (100.00)	-1.83 (-7.78)	3.91**
8.	Planting material (No.)	2991.64	2946.89	44.75 (1.52)	3.09*
9.	Irrigation (hours)	302.04	438.46	-136.42 (-31.11)	24.39**
10.	Tractor (hours)	14.74	13.68	1.06 (7.75)	4.15**

*Source: Field Survey; Note: Figures in parentheses indicate percentage; **significant at 1% * significant at 5%*

3.2 Operation-wise use of Human Labor

The utilization of total human labor per ha in conventional method was more (312.61 man days) than that in drip method (251.88 man days). Table 2 showed that labor utilization was less in drip or it saves labor (60.73 man days) as compared to conventional method. Out of total labor saving, maximum saving was in irrigation (44.26%) followed by manuring (16.07%), earthing-up (9.76%), weeding (9.00%), inter culturing (8.38%) and de-suckering (8.08%) operations. Similar results were found by More et al., [9]. They found that labour utilization was more in drip irrigated banana as compared to traditional irrigated banana.

3.3 Per ha Cost of Establishment of Drip Irrigation System

The Table 3 showed that per ha total cost of investment on drip irrigation system for irrigating the banana crop was Rs 155426.12. About 63.65% of total cost invested was accounted by drippers/inline lateral pipes followed by main pipeline (7.93%), filters (7.16%) and sub main pipeline (5.64%). Out of total investment 50% amount was given as a subsidy by the government and remaining 50% incurred by the purchaser of the drip irrigation system.

Table 2. Operation-wise use of human labor per ha (Man days/ha)

Sr. No.	Operations	Drip	Conventional	Change in drip over conventional farms
1.	Primary tillage	11.06 (4.39)	12.29 (3.93)	-1.23 (-2.02)
2.	Manuring	15.87 (6.30)	25.63 (8.20)	-9.76 (-16.07)
3.	Sowing	12.59 (5.00)	13.46 (4.31)	-0.87 (-1.43)
4.	Inter culturing	11.32 (4.49)	16.41 (5.25)	-5.09 (-8.38)
5.	Weeding	13.60 (5.40)	19.07 (6.10)	-5.47 (-9.00)
6.	Irrigation	39.80 (15.80)	66.68 (21.33)	-26.88 (-44.26)
7.	Plant protection chemicals application	3.02 (1.20)	7.82 (2.50)	-4.80 (-7.90)
8.	De suckering	33.98 (13.49)	38.89 (12.44)	-4.91 (-8.08)
9.	Leaves cutting	8.67 (3.45)	9.75 (3.12)	-1.08 (-1.77)
10.	Earthing up	6.02 (2.39)	11.95 (3.82)	-5.93 (-9.76)
11.	Harvesting	56.42 (22.40)	57.21 (18.30)	-0.79 (-1.30)
12.	Miscellaneous	39.53 (15.69)	33.45 (10.70)	6.08 (10.01)
	Total Labor	251.88 (100.00)	312.61 (100.00)	-60.73 (100.00)

Source: Field Survey; Note: Figures in parentheses indicate percentage to total in each category

Table 3. Per ha investment cost on drip irrigation system for banana (Rs/ha)

Sr. No.	Particulars	Cost (Rs)	%
1.	Main pipeline	12324.97	7.93
2.	Sub main pipeline	8762.23	5.64
3.	Header	9769.95	6.29
4.	Drippers/ inline lateral pipes	98923.82	63.65
5.	Filters	11132.87	7.16
6.	Control; valves	4943.60	3.18
7.	Flush valves	417.47	0.27
8.	Pressure gauge	504.78	0.32
9.	Start nipple	128.61	0.08
10.	End nipple	117.52	0.08
11.	Joiners	128.61	0.08
12.	Others	8271.69	5.32
13.	Total capital investment	155426.12	100.00
	Subsidy	77713.06	50.00
	Net investment	77713.06	50.00

Source: GGRC (Gujarat Green Revolution Company)

Table 4. Comparative cost of cultivation of banana under drip and conventional system (Rs/ha)

Sr. No.	Items	Drip		Conventional		Change in drip over conventional farms		
		Value	%	Value	%	Value	%	"t" statistics
1.	Hired labor	18897.02	9.21	22723.61	10.67	-3826.59	-16.84	7.10**
2.	Family labor	14976.32	7.30	19615.03	9.21	-4638.71	-23.65	5.83**
3.	Total human labor	33873.34	16.51	42338.64	19.88	-8465.3	-19.99	15.01**
4.	Bullock labor	1191.08	0.58	2432.05	1.14	-1240.97	-51.03	10.42**
5.	Tractor charges	7372.45	3.59	6157.53	2.89	1214.92	19.73	8.32**
6.	Manures	20060.65	9.78	21747.87	10.21	-1687.22	-7.76	3.91**
7.	Fertilizers	20109.33	9.80	23175.77	10.88	-3066.44	-13.23	6.73**
8.	Planting material	26924.74	13.12	26522.02	12.45	402.72	1.52	3.10*
9.	Irrigation	15102.15	7.36	21922.93	10.29	-6820.78	-31.11	24.39**
10.	Plant protection chemicals	5649.89	2.75	7270.97	3.41	-1621.08	-22.30	16.23**
11.	Repair & maintenance	539.27	0.26	-	-	539.27	-	49.05**
12.	Growth regulators	865.14	0.42	1119.44	0.53	-254.3	-22.72	5.63**
13.	Miscellaneous	1588.18	0.77	2025.97	0.95	-437.79	-21.61	12.85**
14.	Depreciation	16646.51	8.11	1645.46	0.77	15001.05	911.66	364.72**
15.	Total working cost	134946.4	65.77	136743.6	64.21	-1797.2	-1.31	0.99
16.	Interest on working capital	16193.57	7.89	16409.23	7.70	-215.66	-1.31	0.99
17.	Cost A	151140	73.66	153152.9	71.91	-2012.9	-1.31	0.99
18.	Rental value of owned land	17889.99	8.72	18293.55	8.59	-403.56	-2.21	0.31
19.	Interest on fixed capital	2530.47	1.23	2550.16	1.20	-19.69	-0.77	1.80
20.	Cost B	171560.4	83.61	173996.6	81.70	-2436.2	-1.40	1.05
21.	Cost C_1	186536.8	90.91	193611.6	90.91	-7074.8	-3.65	5.25**
22.	Management charges	18653.68	9.09	19361.16	9.09	-707.48	-3.65	5.25**
23.	Cost C_2	205190.4	100.00	212972.8	100.00	-7782.4	-3.65	5.25**

*Source: Field Survey; **significant at 1% * significant at 5%*

3.4 Comparative Economic Analysis of Drip and Conventional Banana

It was observed from the Table 4 that per ha cost of cultivation of banana *i.e.* cost C_2 was slightly less *i.e.* Rs 205190.4 under drip method of irrigation whereas under conventional method, it was Rs 212972.8. It can also be observed that on an average Cost A formed 73.66% (Rs 151140) of total cost in drip and 71.91% (Rs 153152.9) of total cost in conventional method, while cost B accounted for 83.61 (Rs 171560.4) and 81.70% (Rs 173996.6)% of total cost under drip and conventional farms, respectively. The major cost items for drip banana farms were human labor (16.51%), planting material (13.12%), fertilizers (9.80%), manures (9.78%), management charges (9.09%), rental value of owned land (8.72%), depreciation (8.11%) and interest on working capital (7.89%). In case of conventional banana growers, major items of cost were human labor (19.88%), planting material (12.45%), fertilizers (10.88%), irrigation (10.29%), manures (10.21%), management charges (9.09%) and rental value of owned land (8.59%).

While comparing the break-up of total cost of drip and conventional banana, it was seen that the cost of important resources *i.e.* bullock labor (51.03%), irrigation (31.11%), growth regulators (22.72%), plant protection chemicals (22.30%), miscellaneous (21.61%), human labor (19.99%), fertilizers (13.23%) and manures (7.76%) was significantly (at 1% level) less under drip method as compared to conventional method of irrigation.

The results were in agreement with previous studies done by researchers like-Birari et al. [10]) for banana crop in western Maharashtra, Jadav & Kumbhar [11] for grapes in Maharashtra and Dave et al. [12] for banana in Anand district of Gujarat and they found that drip irrigation system was more beneficial in terms of inputs saving and better yield or income.

3.5 Comparative Returns from Drip and Conventional Banana

A perusal of Table 5 showed that the average yields per ha was 785.68 and 660.15 quintal for drip and conventional banana growers, respectively. The yield was found significantly higher (19.02%) on drip farms over conventional irrigated farms, which indicated that productivity was higher in drip method due to efficient use of inputs and weed free plots. The price (per quintal) received by two types of cultivators observed unison. The drip banana growers received slightly higher price as compared to non-drip farmers due to good quality of fruits. The value of gross output was Rs 536114.9 per ha and Rs 452509.2 per ha for drip and conventional farms, respectively. It was significantly higher by 18.48% on drip farms in middle Gujarat condition.

3.6 Partial Budgeting

Partial budgeting technique (Table 6) was used to find whether the drip irrigation technology is economically viable over conventional irrigation or not. The comparative advantages among two systems are estimated using added cost and added return concept. The net income was found positive (Rs 91388.01), which indicated that drip irrigation system is more profitable as compared to conventional irrigation system.

3.7 Net returns Over Different Costs

The Table 7 showed that per ha net gains over operational Cost C_2 was higher *i.e.* Rs 330924.4 under drip method as compared to the conventional method in which it was Rs 239536.4. Drip irrigation system provides (Rs 91388 per ha) 38.15% significantly higher net profits over Cost C2 compared to conventional method of irrigation.

3.8 Farm Business Income, Family Labor Income, Farm Investment Income and Net Profit from Banana

It is clear from Table 8 that banana growers fetches the higher benefits in terms of farm business income (FBI), family labor income (FLI) and farm investment income (FII) from drip irrigation system compared to conventional farms by 85618.6 Rs, 86041.8 Rs and 90964.8 Rs respectively. The net profit was significantly higher on drip farms by Rs 91388 (38.15%) over conventional farms. This was due to reduced use of inputs, higher yield, higher price and good quality under drip cultivation, which in turn have vast potential of generating income and employment.

Table 5. Comparative yield, Farm Harvest Price (FHP) and Gross Income of banana under drip and conventional system

Sr. No.	Items	Drip	Conventional	Change in drip over conventional farms		
				Value	%	"t" statistics
1.	Bunch No.	2563.03	2519.43	43.6	1.73	3.33**
2.	Bunch Weight (kg)	30.67	26.46	4.21	15.91	12.45**
3.	Yield (q/ha)	785.68	660.15	125.53	19.02	11.28**
4.	Average FHP (Rs/q)	687.46	682.86	4.6	0.67	0.60
5.	Gross income (Rs/ha)	536114.9	452509.2	83605.7	18.48	9.17**

*Source: Field Survey; **significant at 1% * significant at 5%*

Table 6. Partial budgeting for banana under drip and conventional system

Sr. No.	a. Added Cost		b. Added Income	
	Items	**Value (Rs)**	**Items**	**Value (Rs)**
1.	Tractor charges	1214.92	Gross income from main product	83605.7
2.	Seedlings	402.72		
3.	Repair & Maintenance	539.27		
4.	Depreciation	15001.05		
	Total (a)	17157.96	Total (b)	83605.7
Sr. No.	**c. Reduced Return**		**d. Reduced cost**	
	Items	**Value (Rs)**	**Items**	**Value (Rs)**
1.			Total labor	8465.3
2.			Bullock labor	1240.97
3.			Manures	1687.22
4.			Fertilizers	3066.44
5.			Irrigation	6820.78
6.			Plant protection chemicals	1621.08
7.			Growth regulator	254.3
8.			Miscellaneous	437.79
9.			Interest on working capital	215.66
10.			Rental value of owned land	403.56
11.			Interest on fixed capital	19.69
12.			Management charges	707.48
	Total (c)	0	Total (d)	24940.27
	Total (a+c)	17157.96	Total (b+d)	108545.97
Net Income from change = Rs 91388.01				

Source: Field Survey

Table 7. Net profit over different cost of banana under drip and conventional system (Rs/ha)

Sr. No.	Items	Drip	Conventional	Change in drip over conventional farms		
				Value	**%**	**"t" statistics**
1.	Cost A	384974.9	299356.3	85618.6	28.60	9.33**
2.	Cost B	364554.4	278512.6	86041.8	30.89	9.38**
3.	Cost C_1	349578.1	258897.6	90680.5	35.03	9.78**
4.	Cost C_2	330924.4	239536.4	91388	38.15	9.84**

*Source: Field Survey; **significant at 1% * significant at 5%*

Table 8. FBI, FLI, FII & Net Profit for banana under drip and conventional system (Rs/ha)

Sr. No.	Items	Drip	Conventional	Change in drip over conventional farms		
				Value	**%**	**"t" statistics**
1.	Farm Business Income (FBI)	384974.9	299356.3	85618.6	28.60	9.33**
2.	Family Labor Income (FLI)	364554.4	278512.6	86041.8	30.89	9.38**
3.	Farm Investment Income (FII)	351344.9	260380.1	90964.8	34.94	9.78**
4.	Net Income	330924.4	239536.4	91388	38.15	9.84**

*Source: Field Survey; **significant at 1% * significant at 5%*

Table 9. Cost of production (Rs/q) of banana on the basis of different cost concepts

Sr. No.	Items	Drip	Conventional	Change in drip over conventional farms	
				Value	%
1.	Cost A	192.37	232.00	-39.63	-17.08
2.	Cost B	218.36	263.57	-45.21	-17.15
3.	Cost C_1	237.42	293.28	-55.86	-19.05
4.	Cost C_2	261.16	322.61	-61.45	-19.05
5.	FHP	687.46	682.86	4.6	0.67

Source: Field Survey

Table 10. Benefit-cost ratio for banana under drip and conventional system

Sr. No.	Items	Drip	Conventional
1.	Cost A	3.55	2.95
2.	Cost B	3.12	2.60
3.	Cost C_1	2.87	2.34
4.	Cost C_2	2.61	2.12

Source: Field Survey

3.9 Cost Per Quintal

The cost-price relationship generally decides the economic prosperity and degree of commercialization on the farms. It could be inferred from the Table 9 that the average per quintal paid out cost of production of banana under drip system was Rs 192.37, which was lower than conventional system (Rs 232). The cost of production of banana (Cost C_2) per quintal under drip farms was Rs 261.16 whereas on conventional farms it was Rs 322.61. So, banana cultivation using conventional irrigation method required higher investment by about 61 Rs/q than the drip irrigated method.

3.10 Benefit-Cost Ratio

The benefit-cost ratio reflects the criteria for economic viability of the crop based on return per rupee invested. The ratio over Cost A, B, C_1 and C_2 was 3.55, 3.12, 2.87, 2.61 under drip irrigation systems whereas, on conventional irrigation system it was 2.95, 2.60, 2.34 and 2.12, respectively. It indicated that an investment worth Rs 1 on all inputs used in the cultivation of drip and conventional banana yielded an output worth Rs 2.61 and 2.12 for drip and conventional banana farms, respectively.

4. CONCLUSION

In this study an attempt has been made to analyze the technological impact in banana as India is the largest producer globally. The analysis of economics of banana cultivation under drip and traditional method has revealed that the drip method of irrigation has a significant impact on saving of resources like labor, water, growth regulators, plant protection chemicals, fertilizers and manures. It was revealed from the study that per ha cost of cultivation of banana *i.e.* cost C_2 was less (Rs 7782.4 per ha) under drip method of irrigation as compared to conventional method, The yield (125.53 q/ha) and net profit (Rs 91388 per ha) were found significantly higher (about 19% and 38%) on drip farms over conventionally irrigated farms, which indicated that productivity was higher in drip method due to efficient use of inputs or resources. Banana growers also received higher prices for the banana when adopted drip irrigation system as quality was better in drip farms. The findings of this study demonstrate the superiority of drip in terms of yield and returns advantage as well as saving of input also occurs.

Considering findings of the study, the banana growers should be encouraged through government and extension agents to adopt the drip irrigation system for banana farming instead of flood irrigation system to get higher income and production by spending less on inputs.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by

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CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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