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Banana Cultivation under Drip and Conventional Irrigation Methods in Karnataka : An Economic Analysis

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ABSTRACT

The present study was carried out to analyze the comparative economics of banana cultivation under drip and conventional irrigation methods. The data needed for the study were collected from the 60 banana producing farmers using random sampling technique in the North eastern region of Karnataka state. The finding of the study revealed that total cost of establishment of the Drip Irrigation System (DIS) for irrigating the banana crop was ₹1,31,182/ha and G-9 was the most popular variety being cultivated among the samples banana farmers. The result also showed that the average yield per hectare was found significantly higher (18.93 %) on drip irrigated farm by over conventionally irrigated banana, which indicated that productivity of banana was higher under drip system than conventional irrigation method. Further, net return per hectare realised was ₹328537 in Drip irrigated banana and ₹227888 conventional banana farms and it was higher by 44 % in Drip irrigated banana farms as against conventional banana farms. The returns realised per rupee of expenditure (BC ratio) in drip and conventional banana farm was 3.14 and 2.37 respectively. Since banana is a water intensive crop, drip irrigation is an appropriate water saving technology for banana for efficient use of water.

Keywords Banana, Drip irrigation, Conventional, Water, Net return.

INTRODUCTION

Banana is a water intensive crop and it requires on an average, 1700 mm rainfall distributed throughout the year for its adequate growth. It requires large quantity of water during its life cycle. Nowadays water scarcity is increasing worldwide due to various reasons (Dave *et al.* 2016). The problem of water scarcity is expected to be aggregated further. India is having largest irrigated area in the world but India too has started facing severe water scarcity in different regions. The demand for water is increasing enormously due to various reasons, but the potential water available for future use has been diminishing at a faster rate. The agricultural sector (irrigation), which uses over 80% of the available water in India, continues to be the major water-consuming sector due to the intensification of agriculture (Agarwal *et al.* 2016). Therefore,

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water is a precious and limited resource and should be conserved and used carefully in the most efficient way, to minimize the dependence of agriculture on monsoon. The solution lies in examining the innovative models for their contribution to higher efficiency of water usage.

Micro irrigation like drip and sprinkler methods of irrigation is proved to be a one such efficient method which enables better control and monitoring of existing water which can be translated into higher water usage efficiency. Efficiency is an important concept in production economics when resources are meagre and opportunities for developing and adopting better technologies are competitive (Sharma and Wilson 2016). Drip irrigation ensures 30 to 70% savings in water, 25 to 100% increase in yield and 15 to 30% reduction in operating crop production costs. It economizes energy usage around 50% by reducing pumping hours and frictional losses (Kaushal *et al.* 2012). Resultantly, it can double the area under irrigation as well as improve quality of end product. Generally, farmers look for a method of irrigation which is most efficient with less water, labor, fertilizers and power requirements. Drip irrigation system is such an efficient method which has the potential for substantial water savings, conveyance losses are negligible, uniformity in water application is high as compared to other irrigation methods (Anonymous 2004). The present study was undertaken with the objective to compare the profitability of banana cultivation under micro irrigation and convention irrigation system.

MATERIALS AND METHODS

The multistage purposive random sampling procedure was followed for the selection of district and taluks. The random sampling procedure was followed for the selection of villages and respondents from the selected taluks. Total 60 sample farmers were selected, out of which 30 were from micro irrigated farmers and 30 were from conventionally irrigated farmers. The primary data needed for the study was collected from banana cultivating farmers using a well-structured schedule through the personal interview method. The primary data needed for the study includes information about size of the land holding, area under cultivation, Crop yield, Inputs used, Price of output and inputs, Resource use pattern, Costs and returns. The collected data were tabulated and analyzed using following tools and techniques.

Estimation of costs of groundwater irrigation

a. The variable cost of groundwater irrigation **:** In the present study, the variable cost of groundwater is obtained by amortizing investment on drilling and casing of borewells over the subsistence life of borewell or economic life of borewell (whichever is relevant for the specific borewell) plus the operation and maintenance cost of the borewell. The amortized investment is divided by the volume of groundwater extracted in the recent year of collecting field data (2021), to obtain the variable cost of groundwater per acre inch.

b. The fixed cost of an irrigation well **:** The fixed cost of groundwater is obtained by amortizing investment on irrigation pump sets, pump house, electrification charges, groundwater storage structure (constructed if any), groundwater delivery pipe investment. The amortized fixed investment is divided by the volume of groundwater extracted in the recent year (2021) to obtain the fixed cost of groundwater per ha cm or acre inch.

The amortized cost of irrigation = Amortized cost of Bore well+ Amortized cost of pump set and electrical installation + Amortized cost of groundwater structure + annual Repairs and maintenance cost.

c. Life and age of irrigation borewells **:** Life of irrigation bore well refers to the number of years a borewell functioned or yielded water. Age of irrigation borewell refers to the number of years the borewell is serving at the time of field data collection (Kiran and Chandrakanth 2016).

d. The amortized cost of bore well (BW)

Amortized Cost of BW= CC of BW × $(1 + i)^{AL}$ ×(i) / $(1 + i)^{AL}$ - (1)

CC of BW = Historical Investment on Borewell × (1 + i) Reference Year-Year of Drilling
Where,

i = Interest rate
AL = Average life of wells
CC = Compounded cost

e. The amortized cost of pump set (PS) and electrical installation (EI) **:**

Amortized Cost of PS = (CC of PS + CC of EI) × (1 + i) ^{10} × (i) / (1 + i) ^{10} - (1)

CC of PS = Historical Investment on PS × (1 + i) Reference Year-Year of Drilling

CC of EI = Historical Investment on EI × (1 + i) Reference Year-Year of Drilling

f. Yield of irrigation well **:** The yield of the well was recorded as perceived by farmers and converted to gallons per hour (GPH) as 1 inch = 1000 GPH, 2 inches = 2000 GPH, inches = 3000 GPH and its multiples.

g. Water used for irrigation **:** The number of acre-inches of water used for irrigating each crop in each season (Summer, *kharif, rabi*) = ((area irrigated in each crop) × (frequency of irrigation per month) x (number of months of crop stand) × (number of hours for one irrigation) × (Average yield of well in GPH)) / 22611.

One acre-inch is equivalent to 22611 gallons or 3630 cubic feet and one cubic foot is equivalent to 28.32 liters. Total water used per farm is the total acre inch of water used in different seasons including acre inch of water used per farm for perennial crops.

The labor cost of irrigation is merged with the costs of other cultural operations. Thus, the labour cost involved in irrigation is excluded from the cost of irrigation. This total cost of irrigation is then apportioned to include individual crops according to the proportion of water used in each crop: Cost of irrigation per meter cube = (Total amortized cost of irrigation) ÷ (Total meter cube of water used). The cost of irrigation for each crop is worked out by multiplying the cost per meter cube of water by the number of meter cube of water applied to each crop (Priyanka 2009, Chandrakanth *et al.* 2013).

h. Cost concepts **:** The fixed cost items include land revenue, depreciation, rental value of land and interest on fixed capital. Land revenue was charged at the rates imposed by the government. Depreciation was arrived by straight line method of compounding as

$$\text{Annual depreciation} = \frac{\text{Purchase value} - \text{junk value}}{\text{Economic life of the asset}}$$

The charges on account of minor repairs of implements and machinery during the year were added to the depreciation charges. It was apportioned on the basis of area of land allocated for crops during the year. Rental value of land was estimated by considering the prevailing rate in the study area was considered. Interest on fixed capital was calculated at 12% annum on the total value of fixed assets.

Variable cost is referred as cost which varies with the level of production. The items comes under variable cost are labor cost, cost of inputs, plant protection chemicals, marketing cost, irrigation cost and interest on working capital. Returns per rupee of expenditure were arrived at by dividing the gross returns with the total cost.

RESULTS AND DISCUSSION

The data related to per hectare investment on drip irrigation system for banana is given in the Table 1. The data presented in the table revealed that, the per farm total cost of investment on Drip Irrigation System (DIS) for irrigating the banana crop was ₹ 254471. Out of the total investment ₹ 113182.70

Table 1. Investment on irrigation infrastructure (₹/farm).

Sl. No.	Particulars	Irrigation system	
		Drip (n=30)	Conventional (n=30)
1	Cost of drilling borewell	48812.50	43407.36
2	Electric motor (IP set)	30905.43	24324.33
3	Pipeline	61570.37	23831.63
4	Drip equipments	113182.70	
5	Total	254471.00	91563.32

Table 2. Cost of installation of drip irrigation system ₹/ha.

SI. No.	Particulars	Value (Rs)	%
1	Main pipe line	14095.03	12.45
2	Sub main pipe	12588.03	11.12
3	Header	6002.66	5.30
4	Drippers / Laterals	63279.46	55.95
5	Screen filters	666.83	0.58
6	Sand filters	5501.03	4.86
7	Control valve	2951.46	2.60
8	Flush value	404.10	0.35
9	Pressure gauge	396.336	0.35
10	Start nipple	83.73	0.07
11	End nipple	76.16	0.08
12	Joiners	97.66	0.08
13	Installation charge	4286.26	3.78
14	Others	2753.96	2.43
15	Total investment	113182.70	100

was accounted by drip equipments, ₹ 61570.37 was accounted by the pipelines followed by borewell (₹48812.5) and electric motor (₹ 30,905.43). However, total investment on irrigation structures under the conventional irrigated system of banana cultivation was ₹ 91563.32. Investment on Borewell constitutes a major share of ₹ 43407.36 followed by electric motor (₹ 24324.33) and pipeline (₹ 23831.63).

Cost of installation of drip irrigation system: The data presented in Table 2 revealed that, the per hectare total cost of investment on Drip Irrigation System (DIS) for irrigating the banana crop was ₹1,31,182. About 55.95% of the total cost invested was accounted by the drippers/inline lateral pipes. Next to this, in order of the proportionate share in the cost were main pipeline (12.45 %), sub-main pipe (11.12%), header (5.30%), filters (4.86 %), and control valves (2.60%). Out of total cost of investment 50% amount was given as a subsidy by the Government and the remaining 50% was incurred by the farmers of the Drip Irrigation System (DIS).

Per hectare use of planting material

In the study area, all the selected farmers used suckers for banana cultivation. Per hectare use of number of banana tissue on drip and conventional sample farms was presented in the Table 3. The table revealed that on an average per hectare use of seedlings for drip farmers was 2500 and for conventional banana farmers was 3086.

Table 3. Input use pattern per hectare in banana cultivation.

Sl. No.	Particulars	Irrigation system Drip (n=30)	Conventional (n=30)
I	**Planting material**		
a	Spacing (m)	2*2	1.8*1.8
b	Number of plants	2500	3086
II	**Labor**		
a	Human labor (man days)	178.05	216.92
b	Bullock labor (Pair days)	5.08	8.43
c	Machine labor (hours)	12.66	10.43
III	**Organic manures and chemical fertilizers**		
a	FYM (tonnes)	27.83	27.93
b	Poultry manure (tonnes)	2.84	2.96
c	Nitrogen (kg)	456.50	504.70
d	Phosphorus (kg)	257.60	319.20
e	Potassium (kg)	464	527.43
f	Other micro nutrients (kg)	110.60	122.50

Utilization of labor per hectare

Farm productivity, gross income and net income of the crop mostly depend upon the level of input use, resource management and managerial skill. Hence, the use of different inputs in banana cultivation on sample farms is discussed. Use of labor per hectare is presented in the Table 3. Banana is an annual crop, which require round the year human labor for various operations. The data presented in the table indicates that per hectare utilization of human labor for drip banana farmers was 178.05 man-days and for conventional banana farmers per hectare utilization of human labor was 216.92 man-days.

The probable reason behind that may be some activities like weeding, irrigation, fertilizer applications, required less labor in drip method as compared to conventional method. Further, the table depicts that bullock labor usage in both systems of banana

Table 4. Variety wise area under drip and conventional irrigated banana.

Sl. No.	Varieties	Category: Drip (n=30) No. of farmers	%	Conventional (n=30) No. of farmers	%
1	Grand Naine (G-9)	28	93.33	25	83.33
2	Kamalapur red banana	11	36.66	12	40.00
3	Green cavendish	8	26.66	6	20.00

production was 5.08 and 8.43 pair days per hectare for drip and conventional farms, respectively. In the above table, it clearly indicated that there was saving in bullock labor of about 3.35 pair day because drip method does not require much ploughing and inter cultivation as it supplies water at the root zone of the crops. The motor use for intercultural and manuring was found to be more in drip irrigation system compared to conventional irrigation system. Machine labor use i.e. tractor use was more under drip because of more use of tractors by the banana farmers adopting drip irrigation system. The tractor used for intercultural operation was found to be reduced which may be because of less intensity of weed due to drip irrigation system.

Per hectare use of organic manures and chemical fertilizers **:** Plants generally receive nutrients required for their growth from soil. To compensate the loss of nutrients from the soil, manures and fertilizers have to be added. If this is not done, the fertility level of the soil gradually decreases. The detail of application of farm yard manures and poultry manures are given in Table 3. The table shows that drip and conventional banana cultivators on an average applied 27.83 and 27.93 tonnes of FYM, respectively. Further, the use of poultry manures were 2.84 and 2.96 tonnes for drip and conventional banana farms, respectively. It was also observed that, on an average N, P and K applied by the conventional drip banana farmers were 504.70 kg, 319.20 kg and 527.43 kg per hectare, respectively. In the case of drip banana farmers N, P and K applied was 456.50 kg, 257.60 kg and 464.00 kg per hectare,

Table 5. Cost of cultivation of banana crop under different irrigation systems ₹/ha.

Sl. No.	Particulars	Category: Drip Value (Rs)	%	Conventional Value (Rs)	%	Difference over conventional (Rs)	Change in %
Variable cost							
1	Human labor	44581.7	29.1	54233.3	32.79	-9651.6	-17.80
2	Machine labor	6396.2	4.18	5693	3.44	703.2	12.35
3	Bullock labor	1474.68	0.96	2093	1.27	-618.32	-29.54
4	Planting materials	27081.4	17.68	29496	17.83	-2414.6	-8.19
5	Manure	23912	15.61	27753	16.78	-3841	-13.84
6	Fertilizer	9771.01	6.38	11510	6.96	-1739	-15.11
7	Plant protection chemicals and herbicides	1270.46	0.83	1423	0.86	-152.54	-10.72
8	Irrigation	8956.7	5.85	11498	6.95	-2541.3	-22.10
9	Interest on working capital @7%	8641.09	5.64	10059	6.08	-1417.9	-14.10
A	**Total variable cost**	132085	86.23	153758	92.97	-21673	-14.10
Fixed cost							
1	Depreciation	4529	2.96	520	0.31	4009	770.96
2	Land revenue	211.97	0.14	168.9	0.1	43.07	25.50
3	Rental value of land	14097	9.2	9693.5	5.86	4403.5	45.43
4	Interest on fixed capital @12%	2260.55	1.48	1245.88	0.75	1014.66	81.44
B	**Total fixed cost**	21098.5	13.77	11628.3	7.03	9470.24	81.44
	Total cost (A+B)	153184	100	165387	100	-12203	-7.38

Table 6. Costs and returns in banana cultivation under drip and conventional farm.

Sl. No.	Particulars	Category			
		Drip value (Rs)	Conventional value (Rs)	Difference over conventional (Rs)	% change
1	Cost of cultivation	153184	165387	-12203	-7.38
2	Yield (q/ha)	665.3	559.42	105.88	18.93
3	Price (Rs/q)	724	703	21	2.99
4	Gross returns	481721	393275	88446.5	22.49
5	Net returns	328537	227888	100649	44.17
6	Return per rupee of investment	3.14	2.37	0.77	32.49

respectively. From the Table 3, it was clear that the use of chemical fertilizers in drip irrigated banana cultivation was lower than in conventional irrigated banana cultivation. This was because of the supply of fertilizers along with water in drip irrigation system and there will not be any wastage of fertilizers unlike in conventional irrigated system. Thus, it was inferred from the above table that, the use of drip irrigation system in banana cultivation can be considered as an input minimization technique compared to conventional system in the study area.

Variety wise area under drip and conventional irrigated banana

Variety wise area under drip and conventional irrigated banana were presented in Table 4. In drip irrigated farmers, G-9 was the most popular variety being cultivated. It was adapted by 93.33% of drip farmers, followed by Kamalapur red Banana (36.66 %), and Green Cavendish (26.66%). Similarly, in the case of conventional farmers, G-9 variety of banana was grown by 83.33% of the farmers, followed by Kamalapur red Banana (40.00 %) and Green Cavendish (20.00 %).

So it can be concluded that, G-9 variety of banana was the most popular one and majorly cultivated by large number of farmers in the study area. It might be because of the reason that G-9 was having high yield contributing factors and disease resistant characteristics.

***Cost of cultivation of banana crop under different irrigation systems* :** The information on comparative costs of cultivation of banana under drip system of irrigation vis-a-vis conventional method of irrigation is given in the Table 5. On examination of the cost data, it was observed that the per hectare total cost of cultivation of banana was ₹153183.8 under drip method of irrigation whereas under conventional method of irrigation, it was ₹165386.5. It can also be observed that the cost of human labor, machine labor and bullock labor was ₹44581.67(29.10%), ₹6396.20 (4.17 %) and ₹1474.68 (0.96 %) respectively in drip irrigated farms while it was ₹54233.28 (32.79%), ₹5693 (3.44%) and ₹2093 (1.26 %) in conventional irrigated banana farms. Further, the cost of planting material, manure, fertilizers and irrigation was ₹27081 (17.67%), ₹23912 (15.61%), ₹9771 (6.37%) and ₹8956 (5.85%) respectively in drip irrigated farms while it was ₹29496 (17.83 %), ₹27753 (16.78%), ₹11510 (6.95 %) and ₹11498 (6.95%) in conventional irrigated banana farms.

The interest on working capital was worked out to be Rs 8641.09 per hectare for the production of banana which was 5.64% of the overall cost of cultivation in drip irrigaton method. Under the conventional method, the interest on working capital worked out to be Rs 10058.95 which was 6.0% of the overall cost of cultivation. Depreciation, land revenue, rental value of land and interest on fixed capital were all factored into the overall fixed cost. The expenditure incurred on depreciation of farm implements, land revenue, rental value of land and interest on fixed capital contributed for 2.95, 0.13, 9.20 and 1.47 respectively in drip method. In conventional method, depreciation, land revenue, rental value of land and interest on fixed capital accounted for 0.31, 0.10, 5.86 and 0.75%

respectively. The overall total fixed cost was found to be ₹21098.53 (13.77%) and ₹11628.29 (7.03%) whereas total variable cost was ₹132085.2 (86.22 %) and ₹153758.2 (92.96%) in drip and conventional irrigation systems of banana cultivation respectively. The difference between two irrigation techniques i.e. a change in drip farms over conventional farms found negative in the cost of human labor, bullock labor, planting materials, manure, fertilizers, PPC as well as irrigation while in positive difference was observed in case of machine labor and growth regulators. The negative difference indicated a positive sign in the use of resource in cultivation of banana adopting drip irrigation system.

Rental value of land was computed as one-sixth of the value of gross produce less land revenue and other taxes. Hence it was found higher in case of drip irrigation method because of the higher gross returns when compared to conventional method of irrigation. Depreciation value was also found to be higher in drip method than compared to conventional irrigation method because the investment on irrigation structures, implements and machinery was higher in drip method. The results are in line with the results reported by Narayanamoorthy (2005) and Kumar (2021).

Returns from banana cultivation

Yield, value of gross output and per rupee of investment in drip and conventional banana farms are presented in Table 6.

The results presented in Table 6 revealed that the average yield per hectare was 665.3 quintals and 559.42 quintals for drip and conventional banana farm, respectively, with a difference of 105.88 quintals per hectare. It was found significantly higher (about 18.93%) on drip irrigated farm by over conventionally irrigated banana, which indicated that productivity of banana was higher under drip system than conventional irrigation method. It might be due to efficient use of fertilizers, weed free plot and maintenance of proper plant strength. On an average farm gross returns per hectare earned by the drip and conventional banana farmers was ₹481721.1 and ₹393274.6, respectively. It was higher by about 22.49%. This was because of the higher price received due to the fact that high quality of banana was observed under drip method of irrigation. Thus, as yield and price of banana was higher for drip banana as compared to conventional banana. The irrigation cost was found to be less among drip irrigated banana farmers and it was less by 22% against conventional method of banana farms. Further, net return per hectare obtained was ₹328537.3 and ₹227888 in drips and conventional banana farms and returns realised per rupee of expenditure in drip and conventional banana farm was 3.14 and 2.37 respectively.

CONCLUSION

Adoption of micro irrigation technologies like drip and sprinkler irrigation will reduce the water usage for irrigation in water scarce areas in India. From the findings of the study it was found that the total cost of establishment of the Drip Irrigation System (DIS) for irrigating the banana crop was ₹1,31,182/ha and G-9 was the most popular variety being cultivated among the samples banana farmers. The result also showed that the average yield per hectare was found significantly higher (18.93 %) on drip irrigated farm by over conventionally irrigated banana, which indicated that productivity of banana was higher under drip system than conventional irrigation method. Further, net return per hectare realised was 328537 in drip irrigated banana and ₹ 227888 conventional banana farms and it was higher by 44% in drip irrigated banana farms as against conventional banana farms. From the findings of the study it was revealed that drip irrigation is an appropriate water saving technology for banana for water scare regions and also a technique for increased productivity and profit for banana producing farmers. Hence, the relevant extension agencies should create more awareness about adoption of water saving technologies in production of water intensive horticultural crops for natural resource sustainability.

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