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RESEARCH PAPER

Financial feasibility analysis of drip irrigation technology in banana: A case of south Gujarat

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Abstract: The present study attempted to make a comparative assessment of the economic feasibility of drip irrigation technology against conventional irrigation technology in banana.120 banana growers each practicing drip and conventional irrigation technology from Bharuch and Narmada districts were purposively selected there by making a total sample size of 240. The financial feasibility measures used for analyzing the investment in these technologies were Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR) and Pay Back Period (PBP). The results revealed that drip irrigation system in banana was found to be financially more feasible and economically more viable compared to conventional irrigation since all the criteria of project evaluation like discounted BCR, NPV and IRR were higher and PBP value was lower in case of drip irrigation compared to conventional irrigation as a result of higher net cash flows. Hence, awareness needs to be created about the benefits of this technology among the farming community through extension functionaries, NGOs, SAUs *etc* by the coordinated efforts of both public and private sectors.

Key words: Benefit cost ratio, Drip irrigation, Internal rate of return, Net present value, Payback period

Introduction

Horticulture has a significant role in improving land holding productivity, generating employment, raising socio-economic conditions of the farming community and entrepreneurs, augmenting exports in addition to providing nutritional security to the people. The sector comprises of fruits, vegetables, spices, floriculture and coconut, among others. India is the second largest producer of fruits and vegetables, after china. Realizing the importance of fruit cultivation, many growers are diverting their resources towards plantation of fruit crops. Area under fruit crops is therefore, increasing day by day specially in the vicinities of cities as it offers a ready market for the disposal (Pal, 2019). As reported by Food and Agriculture Organization (2020), amongst the fruits, the country ranks first in the production of bananas (26.29%), papayas (43.26%) and mangoes (including mango steens and guavas) (45.14%). Andhra Pradesh, Maharashtra and Gujarat were the top three banana producing states in the country in 2021 (NHB, 2021). At present, Gujarat has a share of nearly 13.36 per cent banana production and is ranked second in banana productivity in India.With regard to seven districts of South Gujarat, the districts of Bharuch (12286 ha) and Narmada (9240 ha) had the highest area under banana crop. Moreover, these districts also had the highest production *i.e.* 896878 MT in Bharuch district and 662323 MT in Narmada district, as well as highest productivity of banana crop *i.e.,* 73.00 MT/ha in Bharuch district and 71.68 MT in Narmada district (Table 1).

Banana cultivation is water intensive being heavily dependent on ground water and hence drip irrigation can play an important role in conserving water and increasing the water use efficiency in crop cultivation. However, several studies have revealed that high initial cost of investment in the drip irrigation set is a major constraint in adoption of drip irrigation technology. Besides, very little information is available on whether the crop is being cultivated efficiently under this technology. Any project subjected to evaluation by financial measures can be visualized with the meaningful conclusions and adoptability over time. Hence, the present study attempted to examine the economic feasibility of drip irrigation technology adoption in banana.

Material and methods

Sources of data

For the purpose of our study multi stage random sampling method was used. In the first stage, two major districts *viz.* Bharuch and Narmada were selected on the basis of highest area under banana crop in South Gujarat region.Two major talukas were selected randomly from each district *i.e.* Jhagadiya and Bharuch talukas were selected from Bharuch district and Nandod and Garudeshwar talukas from Narmada district. So, in all a total of four talukas were selected. Further,five villages from each of the four talukas based on the availability of banana

Table 1. District-wise area, production, productivity of banana crop in South Gujarat for the year 2019-20

Name of District	TOTAL		
	Area (ha)	Prod. (MT)	Yield (MT/ha)
Surat	8692	613829	70.62
Narmada	9240	662323	71.68
Bharuch	12286	896878	73.00
The Dangs	31	1208	38.97
Navsari	3183	176657	55.50
Valsad	1075	61006	56.75
Tapi	1293	77580	60.00
Zone Total	35800	2489481	69.54

growers practicing drip as well as conventional method of irrigation were selected. Therefore, overall, 20 villages were selected. Considering the size of population, time and resources at disposal of the investigator, a sample of 12 farmers' *i.e.* six farmers who adopted drip irrigation and six farmers practicing conventional methods of irrigation were selected from each of the villages randomly. Thus, the village-wise sample size was 12, district-wise sample size was 120 and irrigation method-wise sample size was 120, thereby making the total sample size of 240. Thus, the total sample size was 240 and the study was conducted in the year 2019-20.

Analytical framework

Financial feasibility analysis

The techniques used for the financial feasibility analysis of investment on drip irrigation system in banana were as follows:

1. Net Present Value (NPV)
2. Internal Rate of Return (IRR)
3. Benefit-Cost Ratio (B:C Ratio)
4. Pay Back Period (PBP)

Net Present Value (NPV): The net present value represents the discounted value of the net cash inflows to the project. In the study, a discount factor of 10 per cent was used to discount the net cash inflows representing the opportunity cost of capital. It can be represented as:

$$NPV = \sum_{i=1} Y_n (1+r)^{-n} - I \quad \text{..... (1)}$$

Where,

Y_n = Net cash inflows in the year n

r = Discount factor

I = Initial investment

The decision rule associated with the net present value is, the investment on drip irrigation will be feasible if its value is positive and is infeasible if its value is negative (if the net present value is zero, it is a matter of indifference).

Internal Rate of Return (IRR): The rate at which the net present value of returns from investment on drip irrigation is equal to zero is internal rate of return (IRR). The net cash inflows were discounted to determine the present worth by following the interpolation technique. The method of interpolation followed was as under:

$$IRR = \left[\begin{array}{c}\text{Lower}\\ \text{discount}\\ \text{Rate}\end{array}\right] + \left[\begin{array}{c}\text{Difference}\\ \text{between two}\\ \text{discount Rate}\end{array}\right] \times \left[\frac{\text{Present worth of cash flow at lower discount rate}}{\text{Sum of absolute values of present worth of cash flows at the discount rates}}\right]$$

The investment on drip irrigation is feasible if calculated IRR is greater than the ongoing opportunity cost of capital. Internal rate of return is a relative measure.

Benefit Cost Ratio (B: C Ratio): BCR was worked out at 10 per cent discount rate byusing following formula:

$$\text{B:C ratio} = \frac{\text{Discounted cash inflow}}{\text{Discounted cash outflow}}$$

It measures the present value of returns per rupee of investment and it is a relative measure. The decision rule is that, the investment on drip irrigation is feasible when BCR is greater than one, but if BCR is less than one, it is infeasible and if BCR is zero, it is a matter of indifference**.**

Pay Back Period (PBP): Payback period represents the length of time required for the stream of cash proceeds produced by the investment to be equal to the original cash outlay *i.e.* the time required for the project to pay for itself. In the present study, PBP was calculated by successively deducting the initial investment from the net returns until the initial investment was fully recovered.

According to the payback criterion, the shorter the payback period, the more desirable is the investment on drip irrigation.

For financial feasibility analysis, cost of motor set, cost of pipeline and cost incurred for electricity sanction was taken as the initial investment under conventional method of irrigation and along with this cost the cost of drip irrigation system was taken as initial investment under drip method of irrigation. For the analysis of financial feasibility of investment under drip/ conventional method of irrigation in cultivation of banana crop the total cost of irrigation structure was converted into per hectare initial investment by dividing the total investment by average size of land holding. The other part of the financial feasibility analysis was cash flow estimation. The cash flows were assumed to be same throughout the life period of drip irrigation system (10 years) and were discounted at 10 per cent. Moreover, the issues faced by farmers in adoption of drip irrigation system were identified and ranked using the Garrett Ranking Technique.

Results and discussion

Financial feasibility of investment on drip and conventional irrigation technologies

To evaluate the financial feasibility of investment on drip irrigation system as well as on conventional method of irrigation in banana cultivation the financial feasibility measures *viz.*, Benefit-Cost Ratio (BCR), Net Present Value (NPV), Internal Rate of Return (IRR) and Pay Back Period (PBP) were computed. The cash outflows and cash inflows were assumed to be constant throughout the life period of the drip irrigation system. The average life span of the drip irrigation system was considered as ten years based on the experience gathered from the adopters of drip irrigation (Rudrapur, 2016). The technology used in cultivating banana crop was assumed to remain constant during the entire life period of the drip set. To compare the financial feasibility of investment on drip irrigation system with that of conventional method of irrigation the cash flows for conventional method of irrigation were also worked out for a period of ten years.

The annual net cash flows were discounted at a discount rate of 10 per cent to obtain the present value of net benefits

Table 2. Cash flows from banana farms adopting drip method of irrigation(₹ /ha)

Year	Cash outflow	Cash inflow	Net Return	Discounted Cost	Discounted Return	Discounted Net Return
With Subsidy						
0	62185.33	0.00	-62185.33	62185.33	0.00	-62185.33
1	283236.13	766661.84	483425.71	257487.39	696965.31	439477.92
Without Subsidy						
0	123491.49	0.00	-123491.49	123491.49	0.00	-123491.49
1	284564.87	766661.84	482096.97	258695.34	696965.31	438269.97

from the different methods of irrigation. The initial investment made on different irrigation methods was then deducted from the present value of their net benefits.

Average cash flows from drip method of irrigation

The average cash flows per hectare from farms adopting drip method of irrigation are presented in Table 2. The cash flows were discounted at the rate of 10 per cent per annum. In the initial year, capital investment on the drip irrigation system with subsidy was worked out to be ₹ 62185.33, while ₹ 123491.49 was spent on the establishment of the drip irrigation system without subsidy in banana cultivation. Theper hectare expenses incurred in the first year were ₹ 283236.13 for drip irrigation with subsidy while it was ₹ 284564.87 for drip irrigation without subsidy.

The gross returns were found to be ₹ 766661.84 per hectare in first year of banana cultivation under drip method of irrigation. The net returns were ₹ 483425.71 in first year for drip irrigation with subsidy, while it was ₹ 482096.97 for drip irrigation without subsidy.

The discounted costs were computed to be ₹ 257487.39 during the first year for drip irrigation with subsidy and it was ₹ 258695.34 for drip irrigation without subsidy. The discounted returns were worked out to be ₹ 696965.31 per hectare in the first year for drip irrigation in both the cases. The discounted net returns were found to be ₹ 439477.92 in the first year for drip irrigation with subsidy whereas it was ₹ 438269.97 for drip irrigation without subsidy. The findings are in line with that of Shivakumar *et al.* (2000), Cetin *et al.* (2004), Narayanmoorthy (2008), Maddileti (2012) and Ndeketeya *et al.* (2014).

Average cash flows from conventional method of irrigation

The average cash flows per hectare under conventional method of irrigation are presented in Table 3. The cash flows were discounted at the rate of 10 per cent. In the initial year, capital investment on the irrigation structure was worked out to be ₹ 3420.89 per hectare under conventional method of irrigation.

The expenditure incurred in the first year was ₹ 328363.19. The gross returns and net returns were ₹ 627147.00 and ₹ 298783.81 per hectare, respectively in the first year of banana cultivation.

The discounted costs were computed at ₹ 298512.00 while the discounted returns were ₹ 570133.64 in first year of banana cultivation. The discounted net returns were worked out to be ₹ 271621.64 per hectare under conventional method of irrigation.

Financial feasibility measures of drip and conventional Methods of Irrigation

Benefit Cost Ratio (BCR) criterion indicates the rate of returns per rupee invested in banana cultivation (Table 4). The discounted BCR for investment on drip irrigation system with subsidy and without subsidy were 2.66 and 2.61, respectively. In a nutshell, B: C ratio was more than unity and hence it could be concluded that investment on drip irrigation system in cultivation of banana in the study area was economically feasible.TheNet Present Value (NPV) of investment was computed which indicates the difference between the present value of a series of inflows (returns) and outflows (costs) over the economic life period of banana crop. The NPV of the investment on drip irrigation system was ₹ 2386382.05 with subsidy and ₹ 2322018.93 without subsidy (Table 4). The positive NPV indicated that the investment made on drip irrigation system in cultivation of banana was financial feasible. The Internal Rate of Return (IRR) was calculated which measures the rate of return that can be earned by investing on drip irrigation system. It also indicates the re-investment opportunities which are absent in other techniques. It can be seen from Table 4 that, the IRR with and without subsidy were 37.00 per cent and 36.00 per cent, respectively. The investment on drip irrigation in the cultivation of banana in the study area was found to be financially feasible since the IRR was higher than the opportunity cost of capital which was 10 per cent as considered in the study.

The period required to recover the initial investment incurred on drip irrigation system in banana orchard is indicated by Pay Back Period (PBP). The pay back periods for drip irrigation system with and without subsidy were 0.71 years and 0.85 years, respectively. Hence, the investment on drip irrigation in cultivation of banana in the study area was found to be financially feasible since the investment made could be recovered in a relatively short span of time.

Likewise, the discounted Benefit Cost Ratioof investment on conventional method of irrigation was 1.91. It can be

Table 3. Cash flows from conventional method of irrigation (₹ /ha)

Year	Cash outflow	Cash inflow	Net Return	Discounted Cost	Discounted Return	Discounted Net Return
0	3420.89	0.00	-3420.89	3420.89	0.00	-3420.89
1	328363.19	627147.00	298783.81	298512.00	570133.64	271621.64

Table 4.Financial feasibility of investment on drip and conventional irrigation

Particulars	Drip irrigation		
	Conventional irrigation	With subsidy	Without Subsidy
NPV (₹)	2386382.05	2322018.93	1367375.54
IRR (%)	37.00	36.00	25.00
B:C Ratio	2.66	2.61	1.91
PBP (Year)	0.71	0.85	1.11

Note: NPV, IRR and B: C Ratio were calculated at 10 % discount rate

concluded that investment on conventional method of irrigation in cultivation of banana in the study area was economically feasible since the Benefit Cost Ratio was more than one.

A close perusal of Table 4 shows that the Net Present Value of investment in conventional method of irrigation was ₹ 1367375.54. The positive Net Present Value indicates that the investment made on conventional method of irrigation in cultivation of banana was financially feasible.

Moreover, the Internal Rate of Return for conventional method of irrigation was 25.00 per cent. The investment on conventional method of irrigation in cultivation of banana was found to be financially feasible since Internal Rate of Return was higher than the opportunity cost of capital which was 10 per cent as considered in the study.

The Pay Back Period for conventional method of irrigation was worked out to be 1.11 years. Hence, the investment on conventional method of irrigation in banana cultivation was financially feasible in the study area but the investment could be recovered in a relatively longer span of time as compared to drip method of irrigation.

Thus, it could be concluded that the financial feasibility of investment in cultivation of banana using drip irrigation system was financially more feasible and economically more viable compared to conventional method of irrigation since the discounted benefit cost ratio, net present value, internal rate of returns were higher and the payback period value was lower. Besides, the net cash flows were higher in case of drip irrigation system than that of conventional method of irrigation. These findings were in confirmation with those reported by Jalajakshi and Jagadish (2009) and Narayanmoorthy (2010).

The results of Garett Ranking Technique presented in Table. 5 indicate the various constraints experienced by the banana growers in the adoption and maintenance of drip irrigation system in the study area. Amongst the constraints listed above, the most important constraint in banana cultivation under drip irrigation was high initial capital investment which was ranked

Table 5. Factors hindering adoption of drip irrigation system

Particulars	Drip Irrigation Method	
	Garrett Score	Rank
Lack of technical information about design, layout and operation of DIS	49.57	VII
High initial capital investment	81.59	I
Insufficient and delay in sanction of subsidy by Government	35.75	X
Inadequate/ fluctuations in power supply	58.58	IV
Clogging of emitters due to water salinity	74.15	II
Damage to the system during field operations/ Hindrance to farming operations	51.38	VI
Frequent damage of the system due to rodents, pigs and other animals	68.19	III
Unsatisfactory after sales service	25.50	XI
Crop specificity and limits crop diversification	39.13	IX
Maintenance problems	55.94	V
Irrigation to be done more frequently	41.63	VIII
Problem of theft	18.50	XII

first with a Garrett score of 81.59. The next two major constraints that followed in order of rank were the clogging of emitters due to water salinity and frequent damage of the system due to rodents, pigs and other animals with a Garrett score of 74.15 and 68.19, respectively.These constraints were subsequently followed by inadequate/ fluctuations in power supply (58.58), maintenance problems (55.94), damage to the system during field operations/ hindrance to farming operation (51.38), lack of technical information about design, layout and operation of DIS (49.57), irrigation to be done more frequently (41.63), crop specificity and limits crop diversification (39.13), insufficient and delay in sanction of subsidy by government (35.75), unsatisfactory after sales service (25.50) and the problem of theft (18.50).

Conclusion

The financial feasibility analysis of investment in banana cultivation using drip irrigation system was found to be financially more feasible and economically more viable compared to conventional method of irrigation since all the criteria of project evaluation like the discounted Benefit Cost Ratio (BCR), Net Present Value (NPV), Internal Rate of Returns (IRR) were higher and Pay Back Period (PBP) value was lower in case of drip irrigation compared to conventional method of irrigation as a result of higher net cash flows. Considering the adoption strategy of drip irrigation technology and its economic benefits, there is a need to create awareness among the farming community through extension agents, NGOs and SAUs with coordinated efforts of both public and private sectors.

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