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RESEARCH PAPER

Can Drip Irrigation Method Doubling the Farmers Income? Evidence of Banana Crop Cultivation from Tamil Nadu

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ABSTRACT

India is one of the world's highest producers in agricultural products, including food grains, fruits, vegetables and milk etc. Irrigation contributes the major role in the sustainable agricultural growth in India. The inadequate of future water storage in addition to the raising demand for consumption of water for various purposes, this situation has become urgent need to adopt new irrigation technology for avoid the water scarcity in the future. One such a method introducing in water management is drip method irrigation. Numbers of studies are available related to use of farm level survey data all over the state have confirmed that the saving of water consumption of different horticultural crops cultivated under drip irrigated method is highly significant as contrast to conventional irrigated method. However, many studies are not discussed detail on fruit banana cultivation in farm survey data particularly in the Indian circumstances. As a result of previous study, a special effort made in this analysis to bridge this space using farm survey data collected from different villages in Sivagangai district of Tamil Nadu State. The result of analysis clearly suggests that the consumption of water have been reduced due to the adoption of drip irrigated method in Banana crop is evaluated to be 52% higher than the conventional irrigation of Banana crop cultivation. Increased Productivity due to drip irrigated method in Banana crop cultivation is 8.11% higher than the conventional irrigation of Banana crop cultivation. The BCR drip irrigated method in Banana crop cultivation is 24.33 percent with subsidy and 10.58 percent without subsidy. The study has proved from the use of drip irrigated method contributes to reduce water consumption, decrease the cost of banana crop cultivation and raise the banana crop yield in contrast to conventional irrigation in Sivagangai district from Tamil Nadu State. The field survey study suggested that most of the farmers are not aware of the drip technology is useful for cultivating various horticultural crops. Therefore, needs to put some additional efforts to raise the use of drip irrigated method in all suitable crops to conserve water and to raise the performance of agriculture.

HIGHLIGHTS

- Evidence from South India shows that water saving due to the adoption of drip method of irrigation in banana crop is estimated to be 52 percent over the flood irrigated banana crop. Productivity gain due to drip irrigation in Banana is 8.11 percent over the flood irrigated Banana crop.
- The benefit-cost ratio drip method of irrigation in Banana crop is 24.33 percent with subsidy and 10.58 percent without subsidy. Evidence from South India suggests that drip irrigation can increase farm profits and income.

Keywords: Drip Irrigation Method, Benefit Cost Ratio, Net Present Value, Productivity, Farms Income, Sustainable Agricultural Development, Water and Energy Saving

Irrigation plays a crucial role for success of density plantation system. As a result, farmers and agricultural experts continually explore

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innovative techniques and practices to optimize crop production while minimizing environmental impact (Palanisami *et al.* 2008). One such a method introducing in water management is drip irrigated method. With this technique, water is distributed directly to the crop root zone by the way of pipelines with the support of emitters. Initially, the drip irrigated method was used for horticultural crops cultivation especially vegetable crops in Israel and thus Israel could achieve more productivity although of critical water shortages (Dhawan, 2002; Suresh and Palanisami, 2011 and Narayanamoorthy *et al.* 2020). The worldwide survey conducted by the INCID (1994) and ICID (2016) showed that the coverage of area using drip irrigated method has raised from 40 hectares in 1960 to about 54600 has in 1975 to about 1.78 mha in 1991 and further to about 52.62 mha in 2016. Number of studies are available related to use of farm level data all over the state of the country have confirmed that the reduce the consumption of water in cultivation of different crops using drip irrigated method is highly significant as compared to flood irrigated method. (Narayanamoorthy, 2004, 2005 & 2009; Dhawan, 2002, Sivanappan, 1994; INCID, 1994; FICCI, 2016, Devika *et al.* 2018).

Despite the future benefits of drip irrigated method are obvious, the installation of drip system is still not widely promoted in across all states of India. It is point out that the absolute operating resources of environment for the contribution of new irrigation techniques in efficient irrigated areas would be a respective price of electricity, which would generate a direct incentive for efficient water use (Narayanamoorthy *et al.* 2024). Drip irrigated method has confirmed to be technically viable, specifically since the positive impact of drip irrigated method on agricultural sector considered for small and more research remains to be done. In this regard, drip method of irrigation has obtained more attention from policymakers and other researchers, as it can crucially increase the progress of groundwater resources, yield of agricultural sector, contribution of economic growth and environmental sustainability.

However, they are still widely adopted in many parts of the country and elsewhere. With these issues in mind, this study attempted to achieve the four important objectives:

1. To evaluate the present status of area covered under drip irrigation method across state as well as India as a whole.
2. To assess the impact of using drip irrigated method in cultivation of Fruit Banana crop.
3. To analyse the expenditure and returns of drip and conventional irrigated method of Fruit Banana crop cultivation.
4. To estimate the BCR of drip and conventional irrigated method Fruit Banana crop cultivation.

METHODOLOGY

Despite of drip irrigated method has been started since mid-1980s in India, but still drip irrigated method is considered as new irrigated method of agriculture sector in India. After the introduction subsidy schemes provided by state and central government of India, the adoption of drip irrigated area was increased in the year of late1990s. However, a very few studies are available based on farm level data especially in cultivation of banana crop under drip irrigated method in all over state of the country. Many studies are available based on experimental data or on the experience of one or a few farmers adopting DMI (Narayanamoorthy, 2005, Devika and Narayanamoorthy, 2017 and Devika *et al.* 2017). Therefore, the current study is focus on using both secondary and primary data. The secondary data is focused on overall state of development of drip irrigated method in India. The secondary hand information is collected from different sources such as INCID Report, Agriculture at a glance, Horticulture at a glance, Ministry of agriculture and farmer's welfare, FICCI report and PMKJY Report. The farm survey data has been collected from different villages in Sivagangai district of Tamil Nadu state. For this study, Primary data was collected from total of 50 banana cultivating farmers consisting of 25 drip irrigated banana cultivating farmers and 25 conventional irrigated banana cultivating farmers. The drip irrigated farmers have been selected by using statistical method from the list of names of drip irrigated farmers during the year 2023-24.

To determine the financial profitability of the drip method of irrigation investment in banana farming, we calculated both the net present value (NPW) and

the benefit cost ratio (BCR) using the discounted cash flow technique (Gittinger, 1984). NPW and BCR can be mathematically defined as follows:

$$NPW = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t} \quad \ldots(1)$$

$$BCR = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t}} \quad \ldots(2)$$

[Where, B_t = benefit in year t; C_t = cost in year t; t = 1, 2, 3,…….n; n = project life in years; i = rate of interest or the assumed opportunity cost of the investment]

Fixed capital is required for adopting drip method of irrigation in any crop and therefore, it is necessary to take into account the income and cost stream for the whole life span of drip investment. But it is difficult to collect the actual cash flows for the entire life span of drip investment because of the absence of observed temporal information on benefits and costs (Devika *et al.* 2018). Therefore, the following realistic assumptions are used to estimate the cash inflows and outflows for drip investment:

1. The life period of the drip-set is assumed as five years for banana as followed by the INCID (1994) study.
2. The cost of cultivation incurred and income generated through banana cultivation using drip method of irrigation is assumed constant during the entire life period of drip-set.
3. Different rates of discount (interest rates) are considered to study the sensitivity of investment to the change in capital cost. They are assumed at 10, 12 and 15 per cent as alternatives representing different opportunity costs of capital (Narayanamoorthy *et al.* 2016).

RESULTS AND DISCUSSION

Current status and growth of area covered under drip irrigated method in India

In India, water is the main resources for agricultural production. The contribution of water resources is very high in agricultural sector development of the country (Palanisami *et al.* 2008 and Narayanamoorthy *et al.* 2023). Drip system is comparatively a very new method of irrigation in India. The improvement of drip irrigated method was very low in the initial years and steps have been taken particularly in the year of 2000s. In India, the coverage of area using drip irrigated method has raised from 0.07 mha during 1991-92 to 6.68 mha during 2021-22. Primarily, the drip system was used on a very small scale in selected district from India mainly focused on horticultural crops. The current analysis shows that State-wise area covered under drip irrigated method in India during 2017-16 to 2022-23 (Table 1). Observing the table, share of percentage of drip irrigated method area to the overall covered under drip irrigated method one can find that next to Andhra Pradesh (24 percent), Maharashtra (22 percent) recorded a better position compared to the states of India which are higher than the countrywide average in the year 2017-16 to 2022-23. It is also confirmed from the table that among the total covered area under drip irrigated method, Andhra Pradesh (22.90 percent), Maharashtra (22.12 percent), Gujarat (13.51 percent), Karnataka (12.27 percent) and Tamil Nadu (10.84 percent), Madhya Pradesh (5.65 percent), Rajasthan (4.67 percent), Telangana (3.25 percent) accounts for relatively higher area as contrasted to the other states.

Table 1: State-level area under drip irrigated method in India (2017-18 to 2022-23) (area in '000 ha)

Sl. No.	State	TE 2017-18 to 2019-20	%	TE 2020-21 to 2022-23	%
1	Andhra Pradesh	1152.84	24.06	1392.34	22.03
2	Arunachal Pradesh	0.61	0.01	3.63	0.06
3	Assam	0.35	0.01	4.73	0.07
4	Bihar	10.44	0.22	14.03	0.22
5	Chhattisgarh	22.38	0.47	31.47	0.50
6	Goa	1.15	0.02	1.37	0.02
7	Gujarat	639.16	13.34	862.56	13.65
8	Haryana	30.29	0.63	39.90	0.63
9	Himachal Pradesh	5.00	0.10	7.59	0.12
10	Jammu & Kashmir	0.02	0.00	7.59	0.12
11	Jharkhand	18.43	0.38	26.94	0.43
12	Karnataka	584.53	12.20	779.03	12.32

13	Kerala	23.19	0.48	24.16	0.38
14	Madhya Pradesh	290.90	6.07	336.61	5.33
15	Maharashtra	1097.91	22.92	1359.65	21.51
16	Manipur	0.31	0.01	0.36	0.01
17	Meghalaya	0.31	0.01	0.31	0.00
18	Mizoram	3.06	0.06	5.52	0.09
19	Nagaland	0.44	0.01	4.68	0.07
20	Odisha	23.53	0.49	29.30	0.46
21	Punjab	35.39	0.74	36.71	0.58
22	Rajasthan	228.88	4.78	290.22	4.59
23	Sikkim	6.04	0.13	6.67	0.11
24	Tamil Nadu	417.42	8.71	786.58	12.44
25	Telangana	154.38	3.22	207.24	3.28
26	Tripura	0.44	0.01	1.06	0.02
27	Uttar Pradesh	22.55	0.47	43.89	0.69
28	Uttarakhand	5.18	0.11	12.88	0.20
29	West Bengal	0.73	0.02	10.37	0.16
	All India	4790.87	100.00	6321.03	100.00

Source: *Agriculture at a glance, 2023.*

Analysis of survey data

As discussed earlier, DMI is initially adopted to decrease the consumption of water in horticultural crop cultivation, more studies have analysed that drip irrigated method has raising the yield and income of various horticultural crops, decreasing the consumption of electricity and cultivation cost of various horticultural crops. Financial feasibility of drip system investment is also proved to be feasible in various horticultural crops despite the absence of the capital subsidy programme offered by the Indian (both central and state) government. We now evaluate the applicability of this banana crop cultivation in sivagangai district from Tamil Nadu.

Impacts of drip irrigation on banana cultivation

Banana is one of the commercial crops cultivated in different State of the country (Dave *et al.* 2016; Singh *et al.* 2018 and Santhosh *et al.* 2024). Since drip irrigation helps to reduce water consumption while raising the yield of crop, farmers are cultivating the Banana crop under drip irrigation method (Singh *et al.* 2018). For the purpose of identify the effect of drip irrigated method in various parameters as compared the drip irrigated banana crop cultivation with that of non-drip irrigated banana crop cultivation. The major advantage of drip irrigated method is that to save considerable quantity of irrigation (water). The field survey data on different parameters for both drip irrigated banana crop cultivation and non-drip irrigated banana crop cultivation. It is clearly reveals that drip irrigated method saves water consumption of 52 percent in cultivation of banana crop over the conventional irrigated method. DMI raises the yield of banana crop cultivation as compared to conventional irrigated banana crop cultivation. The current analysis also find out the drip adopters are able to get 8.11 percent higher yield over the yield of banana crop cultivation achieved under the flood method of irrigation. DMI is decrease the moisture stress and therefore, the yield of banana crop cultivation is higher.

Table 2: Effect of drip irrigation on banana crop cultivation - with capital subsidy

Sl. No.	Particulars	DMI	FMI	DMI over FMI (%)
1	Fixed Cost (₹/acre)	11250	Nil	—
	(a) Life period (years)	5	Nil	—
	(b) Depreciation (₹)	2250	Nil	—
	(c) Interest (₹)	1350	Nil	—
	(d) Repair and maintenance cost (₹)	1250	Nil	—
	(e) Total (b+c+d) (₹)	4850	Nil	—
2	Cost of Cultivation (₹/acre)	79261	97801	-18.96
3	Seasonal total cost (1e + 2) (₹/acre)	84111	97801	-11.13
4	Water used (Hph)	1350	1900	-28.95
5	Yield of produce (tonne/ acre)	960	888	8.11
6	Selling price (₹/tonne)	200	200	—
7	Income from produce (5 × 6) (₹/acre)	192000	177600	8.11
8	Net seasonal income (7 - 3) (₹/acre)	107889	79799	21.67
9	Additional expenditure due to leaf cultivation	3820	3730	2.41
10	Additional income due to leaf cultivation	19420	18450	2.22
11	Additional Net income (10-9) (₹)	15600	14720	2.17
12	Gross Cost of Cultivation (3+9) (₹/acre)	87931	101531	-13.39
13	Gross Income (7+11)(₹)	207600	192320	7.65
14	Benefit cost ratio (13/12)	2.36	1.89	24.33

15	Net profit per Hph of water used (8/4)	79.91	41.99	90.30
16	Water use efficiency (5/4) × 100	71.11	46.73	52.17

Source: *Primary survey data.*

The present study reveals that the banana crop cultivation under drip irrigation is more gainful than the non-drip irrigated of banana crop cultivation. Also the study shows that the net seasonal income for drip irrigated banana crop cultivation is about ₹ 107889/acre, but it is only about ₹ 79799/acre for non-drip irrigated banana crop cultivation. The difference in net seasonal income between drip irrigated banana crop cultivation and conventional irrigated banana cultivation comes to 21.67 percent.

Table 3: Effect of Drip Irrigation on Banana Crop Cultivation – without capital subsidy

Sl. No.	Particulars	DMI	FMI	DMI over FMI (%)
1	Fixed Cost (₹/acre)	45000	Nil	—
	(a) Life period (years)	5	Nil	—
	(b) Depreciation (₹)	9000	Nil	—
	(c) Interest (₹)	5400	Nil	—
	(d) Repair and maintenance cost (₹)	1250	Nil	—
	(e) Total (b+c+d) (₹)	15650	Nil	—
2	Cost of Cultivation (₹/acre)	79261	97801	-18.96
3	Seasonal total cost (1e + 2) (₹/acre)	94911	97801	-2.95
4	Water used (Hph)	1350	1900	-28.95
5	Yield of produce (tonne/ acre)	960	888	8.11
6	Selling price (₹/tonne)	200	200	—
7	Income from produce (5 × 6) (₹/acre)	192000	177600	8.11
8	Net seasonal income (7 - 3) (₹/acre)	97089	79799	21.67
9	Additional expenditure due to leaf cultivation	3820	3730	2.41
10	Additional income due to leaf cultivation	19420	18450	2.22
11	Additional Net income (10-9) (₹)	15600	14720	2.17
12	Gross Cost of Cultivation (3+9) (₹/acre)	98731	101531	-2.76
13	Gross Income (7+11) (₹)	207600	192320	7.65
14	Benefit cost ratio (13/12)	2.10	1.89	10.58
15	Net profit per Hph of water used (8/4)	71.91	41.99	71.26
16	Water use efficiency (5/4) × 100	71	46.73	51.94

Source: *Primary survey data.*

As the productivity of banana crop cultivation is significantly higher in drip method of irrigation, the net seasonal income achieved attained by the drip irrigated banana farmers is significantly higher. The government gives subsidy for farmers who are adopting the drip set for different crops. The sample farmers have also received subsidy from the central and state government for adopting the drip set in banana crop. As a result, we have calculated the BCR under both with and without subsidy context. The current analysis shows that the BCR of drip system investment is 24.33 for with subsidy and 10.58 without subsidy in banana crop. This result shows that the drip investment is financially feasible to banana crop farmers even without subsidy.

Table 4: Economic worth and benefits of drip irrigated banana crop with and without subsidy

Particulars	Banana	
	Without subsidy	With subsidy
Present Worth of Gross Income (₹/ha)		
At 15 % discount rate	128723	128723
At 12 % discount rate	138423	138423
At 10 % discount rate	145566	145566
Present Worth of Gross Cost (₹/ha)		
At 15 % discount rate	60965	55095
At 12 % discount rate	65179	59152
At 10 % discount rate	68274	62138
Net Present Worth (₹/ha)		
At 15 % discount rate	67758	73627
At 12 % discount rate	73244	79271
At 10 % discount rate	77292	83428
Benefit Cost Ratio		
At 15 % discount rate	2.11	2.33
At 12 % discount rate	2.12	2.34
At 10 % discount rate	2.13	2.36

Source: *Primary Survey Data.*

To assess the potential impact of subsidy programs on the adoption of the drip method of irrigation, we calculated both NPW and BCR, considering scenarios with ad without subsides in the total fixed capital cost of drip investment. The net

present worth of the drip investment with subsidy scheme is higher than that of without subsidy for banana crop cultivation. At 15% discount rate, the net present worth of drip set investment is about ₹ 67758 per acre without subsidy and ₹ 73627 per acre with subsidy of banana crop cultivation. The result shows that the drip subsidy scheme provides the banana farmers to get a more advantage of ₹ 5869 per acre. It might also be clarified that the variation between the NPW using subsidy scheme (with and without) is decreasing along with each increase in the discount rate. As regards the NPW without subsidy, it increases from ₹ 67758 per acre at a 15% discount rate to ₹ 77292 per acre at a 10% discount rate. Based on subsidy schemes, the NPW raised from ₹ 73627 per acre at a 15 percent discount rate to Rs. 83428 per acre at a 10% discount rate. Related to this, under without subsidy condition, the BCR also raised from 2.11 at a 15 percent discount rate to 2.13 at a 10 percent discount rate (Table 4). The higher Benefit Cost Ratio (BCR) under subsidy indicates the constructive effect of subsidy on the economic feasibility of the drip method of irrigation in banana crop cultivation. Overall the results of the study suggests that the BCR under different discount rates shows that drip set investment in banana crop cultivation considered for detailed analysis remains financially feasible even without subsidy.

CONCLUSION AND RECOMMENDATIONS

This field survey study has proved the aforesaid from use of drip irrigation method not only reduce water consumption, but also decreases the expenditure of banana crop cultivation and increase the yield of banana crop cultivation as contrasted to conventional irrigated method in Sivagangai district form Tamil Nadu State. The analysis confirmed that the BCR drip irrigated method in banana crop cultivation is 24.33 percent with subsidy and 10.58 percent without subsidy. Water use efficiency under DIM is also found to be significantly higher as compared to CIM. The study has proved from the use of drip irrigated method not only contributes to reduce water consumption but also decreases the expenditure of banana crop cultivation and increase the banana crop productivity as contrasted to conventional irrigated method in Sivagangai district from Tamil Nadu State. The field survey study suggested that most of the farmers are not aware of the drip irrigated method is useful for cultivating various horticultural crops. Therefore, needs to put some additional efforts to raise the adoption of drip irrigated method in all suitable crops to conserve water and to raise the performance of agriculture it helps to increase the farmer's income and it leads to rededicate poverty in rural economy in India.

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