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An economic analysis of different methods of irrigation systems in red chilli cultivation in Bhadradri Kothagudem district of Telangana state

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Abstract
The use of drip cum plastic mulch irrigation system in red chilli cultivation has been a recent development in major chilli growing districts of Telangana such as Khammam, Bhadradri Kothagudem and Warangal etc. Red chilli production can be increased by a combination of advanced production technologies like high yielding hybrids, mulching, application of growth regulators, staking, drip fertigation and integrated pest and disease management. . Bringing more area under irrigation will largely depends on the water use efficiency. Balanced nutrition is most important factor affecting the growth and productivity of red chilli. The results indicated that the total cost C_3 of red chilli cultivation is Rs. 4,43,183.40, Rs. 4,03,109.80 and Rs. 3,33,476.02 per ha. under drip cum plastic mulch, drip and conventional irrigation systems respectively. The red chilli yield under drip cum plastic mulch irrigation technology is 65.91 q ha^{-1} and 24.90 per cent and 39.88 per cent higher than the only drip and conventional systems respectively. Accordingly the net returns per hectare is about Rs. 3,68,608.32 on drip cum plastic mulch red chilli farms whereas it is about Rs. 1,41,889.70 on drip and Rs. 1,06,691.90 on conventional farms.

Keywords: Red chilli, irrigation, drip cum plastic mulch, yield, net returns, cost concepts and income measures

1. Introduction
Red chilli is the second largest spice after Black pepper (*Piper nigrum* L.) in the international spice trade. It is considered to be a universal spice of India. India is the world's largest producer, consumer and exporter of chilies, owing to its uses as spice, condiment, vegetable, salad and pickle. India is the world leader in red chilli production with 17.64 lakh tonnes followed by China (3.21 lakh tonnes) Ethiopia (2.74 lakh tonnes) and Pakisthan (1.48 lakh tonnes) in 2018-19 (DES, 2021). Red chilli is grown throughout the India in almost all the states with an area of 7.33 lakh ha. accounting for 42.81 per cent of world area. In 2019-20, Telangana ranked second in red chilli area. The area, production and productivity of red chilli during 2019-20 were 0.85 lakh ha., 3.28 lakh tonnes and 3,859 kg/ha. respectively. Chilli area and production in Telangana accounts for 11.59 per cent and 17 per cent of all India area and production respectively. Bhadradri Kothagudem district is one of the major chilli growing districts in Telangana with total geographical area of 7, 48,300 ha. of which total crop sown area is 1,24,651 ha. (16.66 per cent) and irrigated area is 67,278 ha. (53.97 per cent) out of total crop sown area. The total cultivated area of red chilli is 3,586 ha. (5.33 per cent) in total irrigated area during 2020-21.
Micro-irrigation and fertigation are the only methods to replace the conventional method of irrigation to achieve fertilizer use efficiency and higher economics (Manohar, 2002) [6]. Farmers are also using plastic mulch along with drip system to increase the water use efficiency as well as fertilizer use efficiency. This Drip cum plastic mulch system of water management in red chilli cultivation is now widely adopted in major red chilli growing areas in Telangana state.
In this context this study explores the possibilities of increasing the productivity of red chilli with less water in Bhadradri Kothagudem district in drip cum plastic mulch, drip irrigation and conventional irrigation systems with the following specific objective,

1. To compare the costs and returns of different methods of irrigation in red chilli cultivation.

2. Materials and Methods
Bhadradri Kothagudem district was selected purposively for the present study, as it constitutes

major chilli growing area and a greater number of farmers are practicing drip cum plastic mulch and drip methods of irrigation for red chilli. Multistage stratified random sampling procedure was adopted for the study. Three mandals *viz.*, Sujatha nagar, Charla and Julurupadu were selected based on the maximum area of red chilli crop under three methods of irrigation systems. Two villages from each mandal were selected for this study. The selected villages were Nayakula gudem, Patha anjanapuram villages from Sujatha nagar mandal, Kothuru, Chinthakunta villages from Cherla mandal and Machinapeta, Kakarla villages from Julurupadu mandal. For each village, 30 sample farmers (10 each of drip cum mulch, drip, and conventional) were selected with proportionate representation of marginal, small, medium and large farm size groups. Therefore total sample size was 180. Primary data was collected from sample farmers through personal interview method with the help of pre – tested questionnaire, related to 2019-20 crop year.

2.1 Tabular Analysis

The data collected were subjected to conventional tabular analysis to work out the cost of cultivation per hectare, cost of production per quintal, gross and net returns under different methods of irrigation.

Annual amount of depreciation on machinery, equipment, implements, tools and drip system *etc.*, owned by the respondents was computed by straight line method.

$$\text{Annual amount of depreciation} = \frac{\text{Original cost of the asset} - \text{Junk value}}{\text{Useful life of the asset}}$$

2.2 Cost concepts

Different cost concepts were employed to estimate the economics of red chilli cultivation under different methods of irrigation. They are

A) Cost A_1

The following items include in Cost A_1

- Cost of hired human labour
- Cost of hired bullock labour
- Cost of owned bullock labour
- Machinery charges
- Cost of seeds
- Cost of organic manures (owned and purchased)
- Cost of chemical fertilizers
- Cost of plant protection chemicals
- Land revenue, cesses and other taxes
- Depreciation
- Cost of drip pipes and plastic mulch
- Interest on working capital
- Miscellaneous expenses

B) Cost A_2

- Cost A_1 + rent paid for leased in land

C) Cost B_1

- Cost A_1 + interest on value of owned fixed capital assets (excluding land)

D) Cost B_2

- Cost B_1 + rental value of owned land (net of land revenue) and rent paid for leased in land

E) Cost C_1

- Cost B_1 + imputed value of family labour

F) Cost C_2

- Cost B_2 + imputed value of family labour

H) Cost C_3

- Cost C_2 + 10 per cent of Cost C_2

I) Cost of production per quintal:

- Total cost (Cost C_3)/yield of main product in quintal

2.3 Farm Income measures

A. Total cost = Total fixed costs + Total variable costs
B. Net returns = Gross returns – Total cost
C. Farm business income = Gross income – Cost A_1
D. Family labour income = Gross income – Cost B_2
E. Farm investment income = Farm business income – Imputed value of family labour
F. Procedure for determining the value of the product:

The value of the product was computed at the actual prices received by the respondents from the market agency during the study period.

3. Results and Discussion

The results obtained in this study and inferences drawn in the discussion refers to cost and returns, cost of production of red chilli farmers under different irrigation systems.

3.1 Cost and return pattern of red chilli cultivation under different methods of irrigation systems

The detailed cost structure of both absolute values and percent to total cost for red chilli cultivation was worked out using the primary data under three situations, they were *viz.*, drip cum plastic mulch, drip and conventional irrigation systems.

The total cost of cultivation (Cost C_3) was estimated at Rs. 4,43,183.40, Rs. 4,03,109.80 and Rs. 3,33,476.02 per ha. under drip cum plastic mulch, drip and conventional irrigation systems respectively. Out of total cost 57.54 per cent, 60.97 per cent and 73.00 per cent were incurred towards variable inputs such as labour, seed, fertilizers, machinery etc. under the drip cum plastic mulch, drip and conventional irrigation systems respectively.

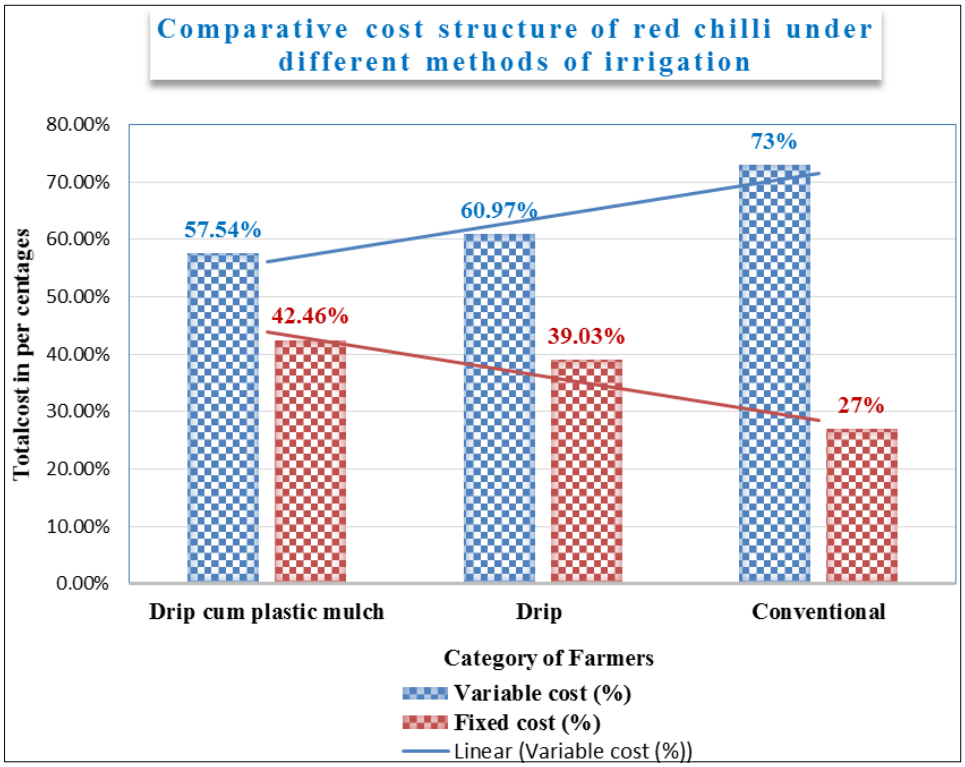

Fig 3.1: Comparative cost structure of different methods of irrigation systems in Red chilli (per ha.)

Table 3.1: Cost structure under different methods of irrigation systems in red chilli (per ha.)

S. No.	Cost components	Drip cum plastic mulch irrigation system	Drip irrigation system	Conventional irrigation system
		Value (Rs.)	Value (Rs.)	Value (Rs.)
A.	**Variable costs**			
1.	Human labour	48529.17 (12.05)	64739.58 (17.67)	77542.50 (25.58)
	Hired	33709.17 (8.37)	43118.75 (11.77)	56852.08 (18.75)
	Owned	14820.00 (3.68)	21620.83 (5.90)	20690.42 (6.82)
2.	Bullock labour	1350.00 (0.34)	1450.00 (0.40)	1550.00 (0.51)
	Hired	1000.00 (0.25)	1050.00 (0.29)	1100.00 (0.36)
	Owned	350.00 (0.09)	400.00 (0.11)	450.00 (0.15)
3.	Machine labour	9200.00 (2.28)	7000.00 (1.91)	6220.00 (2.05)
	Hired	6320.00 (1.57)	3850.00 (1.05)	3000.00 (0.99)
	Owned	2880.00 (0.71)	3150.00 (0.86)	3220.00 (1.06)
4.	Seeds	17687.00 (4.39)	18200.00 (4.97)	19475.00 (6.42)
5.	Organic manure	2572.92 (0.64)	2456.25 (0.67)	2032.92 (0.67)
6.	Chemical fertilizers	54112.50 (13.43)	53250.00 (14.53)	35713.75 (11.78)
7.	Pesticides	46727.08 (11.60)	54344.17 (14.83)	58429.17 (19.27)
8.	Plastic mulch	31075.00 (7.71)		0.00
9.	Weedicides	0.00	3681.67 (1.00)	3743.75 (1.23)
11.	Gunny bags	6591.00 (2.79)	5325.00 (2.67)	4262.00 (1.41)
12.	Interest on working capital 7%	13985.63 (3.47)	12969.31 (3.54)	12922.61 (4.26)
	Sub total	231830.30 (57.54)	223415.97 (60.97)	221891.69 (73.19)
B.	Fixed costs			
1.	Land revenue	250.00 (0.06)	250.00 (0.07)	250.00 (0.08)
2.	Rental value of owned land	151250.00(37.54)	122291.70 (33.37)	79458.33 (26.21)
3.	Depreciation of farm assets	2159.43 (0.54)	1607.53 (0.44)	1418.18 (0.47)
4.	Depreciation of drip system	17188.33 (4.27)	18737.50 (5.11)	0.00
5.	Interest on fixed capital 10%	215.94 (0.05)	160.75 (0.04)	141.82 (0.05)
6.	Sub total	171063.70 (42.46)	143047.49 (39.03)	81268.33 (26.81)
	Total	402894.00 (100.00)	366463.46 (100.00)	303160.02 (100.00)

Source: Estimated from primary data
Note: Figures in the parenthesis are per cent to total cost

The results indicate that three major variable inputs i.e. human labour, fertilizers and pesticides together consume near half of the total cost in red chilli cultivation irrespective of the irrigation system. It is known fact that red chilli being cash crop and highly liquidative was required heavy cash requirements. Farmers used extremely high quantity of fertilizers, pesticides indiscriminately which was much higher than the recommended levels. Therefore cost of cultivation was highest in red chilli than many other crops in the study area.

The human labour cost was higher in conventional method among the three methods of irrigation systems. The basic reasons were reduced the need of labour by advanced technology in drip cum plastic mulch and drip irrigation methods in furrow making, weeding, irrigation and fertilizers application.

The share of bullock labour cost was remarkably low in drip cum plastic mulch and drip compared to conventionally irrigated red chilli.

The estimated costs difference among three systems of irrigation in red chilli cultivation (drip cum plastic mulch, drip and conventional) is observed as the value of depreciation, machinery charges, organic manure, rental value of owned land and interest on working capital were found higher in drip cum plastic mulch and drip irrigated farms. Seeds cost was found higher in conventional method over drip cum plastic mulch and drip irrigated farms. The probable reason was in gap filling operation mostly done in conventional farms than drip cum plastic mulch and drip irrigated farms.

As a whole adoption of drip cum plastic mulch and drip irrigation system was found to be expensive (Rs. 4, 43,183.40 and Rs. 4, 03,109.80). Total cost of cultivation for drip cum plastic mulch was nearly 24.75 per cent higher than the conventional red chilli, primarily an account of depreciation on drip and purchase of plastic mulch.

Table 3.2: Yield level, farm harvest price and gross income (per hectare)

S. No.	Particulars	Drip cum plastic mulch	Drip	Conventional
1.	Yield (q per ha)	65.91	49.5	39.62
2.	Avg. Farm harvest price(Rs. per q)	12316.67	11010.09	11005.80
3.	Value of gross output (Rs. per q.)	811791.72	544999.50	436049.80
4.	Cost of production (based on Cost C)	6,724.07	8,143.63	8,312.92

Source: Estimated from primary data

The yield was 65.91 q/ha. under drip cum plastic mulch irrigation technology, while that under the drip and conventional irrigation methods was only 49.50 q/ha. and 39.62 q/ha. respectively.

The average farm harvest price was Rs. 12,316.67 /q under drip cum plastic mulch irrigation technology, while that under the drip and conventional irrigation methods, it was only Rs. 11,010.00 /q and Rs. 11,005.80 /q respectively.

The value of gross output was Rs. 8, 11,791.72 /ha. under drip cum plastic mulch irrigation technology, while under the drip and conventional irrigation methods it was only Rs. 5,44,999.50/ha. and Rs. 4,36,049.80 /ha. respectively.

The Cost of production was Rs. 6,724.07/q under drip cum plastic mulch irrigation technology, while under the drip and conventional irrigation methods was only Rs. 8,143.63/q and Rs. 8,312.92/q respectively. Cost of production was nearly 19.11 per cent less in drip cum plastic mulch, compared to conventional system due to higher yield with marginal increase in the cost under drip cum plastic mulch system.

3.3 Estimates of different cost concepts of three methods of irrigation systems in red chilli

Estimates of different cost concepts between drip cum plastic mulch, drip and conventional methods such as Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3 were calculated and presented in Table 3.3.

Table 3.3: Estimates of different cost concepts of red chilli cultivation under drip cum plastic mulch, drip and conventional methods (per ha.)

S. No.	Particulars	Category of farmers		
		Drip cum plastic mulch	Drip	Conventional
		Value (Rs.)	Value (Rs.)	Value (Rs.)
1.	Cost A_1	236608.06	222390.18	202869.45
2.	Cost A_2	387858.06	344681.88	282327.78
3.	Cost B_1	236824.00	222550.93	203011.27
4.	Cost B_2	388074.00	344842.63	282469.60
5.	Cost C_1	251644.00	244171.76	223701.69
6.	Cost C_2	402894.00	366463.46	303160.02
7.	Cost C_3	443183.40	403109.80	333476.02

Source: Estimated from primary data

Cost C_3 was estimated by adding 10 per cent of Cost C_2 to the Cost C_2. It can be depicted from the data given in Table 3.3 that the average total cost (Cost C_3) per hectare in drip cum plastic mulch, drip and conventional methods was Rs. 4, 43,183.40, Rs. 4,03,109.80, Rs. 3,33,476.02 respectively. Cost A_1, Cost A_2, Cost B_1 and Cost B_2, Cost C_1, Cost C_2 were higher in drip cum plastic mulch irrigation system. This was mainly because of farmers incurred higher relative cost on inputs like organic manure, plastic mulch, machinery charges, interest on working capital, rental value of owned land and depreciation on farm assets and drip system as well as related materials. And drip cum plastic mulch adopted red chilli growers were also using costly chemical fertilizers for fertigation.

3.4 Estimates of different Income measures between drip cum plastic mulch, drip and conventional methods (per ha.)

The various income measures were estimated to understand the returns over cash expenditure (Cost A_1) and net returns over Cost C_3 to understand the extent of actual profits received from the red chilli cultivation. Table 3.4. present that the adopters of drip cum plastic mulch irrigation system received Rs. 5,75,183.66 as farm business income, which was actual income received by the farmer after recovering cash expenditure (Cost A_1). If it is assumed that rental value of owned land is to be paid, actual income comes down by 26.29 per cent.

Table 3.4: Different Income measures between drip cum plastic mulch, drip and conventional methods (per ha.)

S. No.	Particulars	Category of farmers		
		Drip cum plastic mulch	Drip	Conventional
		Value (Rs.)	Value (Rs.)	Value (Rs.)
1.	Net returns	368608.32	141889.70	102573.78
2.	Farm business income	575183.66	322609.32	233180.35
3.	Family labour income	423717.72	200156.87	153580.20
4.	Farm investment income	560363.66	300988.49	212489.93

Source: Estimated from primary data

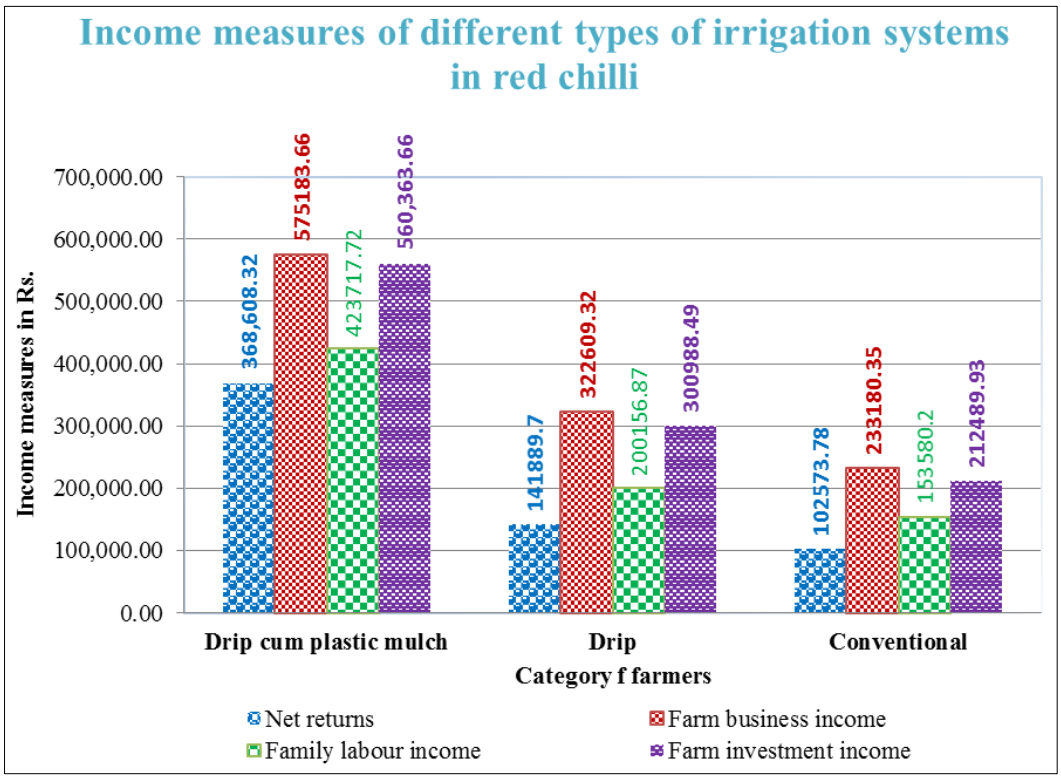

Fig 3.4: Different Income measures between drip cum plastic mulch, drip and conventional methods (per ha.)

The overall farm business income, family labour income, farm investment income and net profit for drip cum plastic mulch, drip and conventional farms are presented in Table 3.4.

It is apparently clear from the results that red chilli grower fetches the higher net benefit as, farm business income (Rs. 575183.66), family labour income (Rs. 423717.72) and farm investment income (Rs. 560363.66) from drip cum plastic mulch irrigation system compared to farm business income (Rs. 233180.35), family labour income (Rs. 153580.20) and farm investment income (Rs. 212489.93) of conventionally cultivated red chilli.

The net profit per hectare was about Rs. 368608.32 on drip cum plastic mulch red chilli farms whereas; it was about Rs. 141889.70 on drip and about Rs. 102573.78 on conventional farms. Thus, per hectare net profit was also higher in drip cum plastic mulch method as compared to drip and conventional methods of red chilli cultivation. This was due to reduced use of important resources (human and bullock labour, seeds etc.), higher yield and high price obtained due to the high quality of produce under drip cum plastic mulch red chilli cultivation.

5. Conclusions

The cost of cultivation was significantly high in drip cum plastic mulch irrigation system. But they receive high net benefits, high price, high yield compared to drip and conventioanal red chilli farms. It is apparently clear from the results that red chilli cultivation has vast potential of generating employment and income for farmers.

Policy Implications

The implications arising out of the findings are need to provide institutional credit (term loan) to the farmers for adopting drip system and small and marginal farmers are to be provided with drip system at capacity building in the use of drip system

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