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Economics of Water used in Arecanut under Drip, Sprinkler and Flood Irrigation Method in Arecanut Growing areas of Chitradurga District of Karnataka, India

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ABSTRACT: The study on Economics of water used in Arecanut under drip, sprinkler and flood irrigation methods in Arecanut growing areas of Chitradurga district of Karnataka during 2018-2019. Chitradurga district is a basic hard rock area that has a total geographical area of 8388 sq.kms. It receives low to moderate rainfall and is one of the drought-prone districts in the state. Normal annual rainfall in the district based on 30 years data is 574 mm. However, in the last decade, the district received an average annual rainfall of 631.10 mm varies between 668 mm in Holalkere in the western part and 457 in Challakere in the north eastern part. The farmers of the Chitradurga district were growing Arecanut in 23,697 ha. Among six taluks, Holalkere (13305 ha), Chitradurga (4559 ha), Hiriyur (2993 ha) and Challakere (610 ha) are the leading in area and production of Arecanut. Arecanut is a water intensive crop which requires about 16-20 litres of water per tree per day. But nowadays the water availability was drastically decreased. In such conditions lack awareness about their own bore well yield and how much quantity of water required irrigating their crops and how to manage the available water in an efficient manner. By simple random sampling of 40 respondents from 3 taluks (Chitradurga, Hiriyur, and Holalkere) of Chitradurga district. The results shown that cost of cultivation of drip irrigation (Rs. 98,868.94/acre) sprinkler irrigation (Rs. 1,04,544.16/acre) and flood irrigation (Rs. 98,247.23/acre). Net returns from drip irrigation is found to be as highest of (Rs. 2,14,151.06/acre), (Rs. 1,75,216.84/acre) in sprinkler and (Rs. 1,71,472.77/acre) in flood irrigation method. The water use efficiency was in drip irrigation is found to be as highest (9.81 ltr/acre) followed by sprinkler (13.15 ltr/acre) and flood irrigation method (19.18 ltr/acre). High economic efficiency will be observed in drip irrigation is Rs. 5.87 (net returns per acre rupee of irrigation cost) and sprinkler irrigation Rs. 4.58, flood irrigation is Rs. 3.89. The average Arecanut yield obtained per acre under drip, sprinkler and flood irrigation was 9.62 quintal, 8.56 quintal and 8.22 quintal respectively.

Keywords: Water use efficiency, Economic efficiency, Net returns,

INTRODUCTION

Agriculture is an important sector with most of the rural population in developing countries depending on it. This sector faces significant challenges in enhancing production because of the dwindling natural resources becoming scanty. The scarcity of irrigation water is a major problem in modern agriculture. Even though irrigation includes a network of major and minor canals from rivers, groundwater wells and an enormous number of irrigation projects for agricultural activities, ground water is the primary source of irrigation for Indian agriculture. But Groundwater depletion is a major concern, and irrigation efficiency is very low in our country due to loss of irrigation water during conveyance and field application. To achieve higher efficiency in agriculture and efficient utilization of water needs an attention in the present contest. This could be possible if irrigation water is managed judiciously by using suitable irrigation methods.

Irrigation is a basic determinant of agriculture because its inadequacy is the most powerful constraint on the increase of agricultural production. At present 70.00 per cent of fresh water was used for agriculture and about 500.00 billion cubic meter of fresh water out of total available fresh water used in industries and 30.00 billion cubic meters is used for refrigeration purpose which lead to the quantity of water available for irrigation is declining drastically (Anonymous, 2014). The intensification of agriculture along with increased demand for water from other sectors *viz.*, industrial and household sectors has put tremendous pressure on the limited water resources in recent years in India.

Arecanut is water intensive crop which requires about 16-20 liters of water per tree per day. But nowadays the water availability was drastically decreased. In such conditions lack of awareness about their own bore well yield and how much quantity of water required irrigating their crops and how to manage the available water in an efficient manner needs to known by the

farmers.

Since the study was carried out by the student researcher there was limitation of time, funds and other resources at the disposal. Thus, the study was confined to a limited area of one district and a sample size of 120. Therefore, the findings have to be viewed in the specific context of the conditions prevailing in the area of the study and cannot be generalized for a wider geographical area. However, these findings can be applied wherever similar conditions exist.

REVIEW OF LITERATURE

Anand (2012) in his study on Farmer's perception of drip irrigation efficiency in grapes in Bangalore district of Karnataka reported that there was about an 8.00 percent increase in gross returns under drip irrigation and there was a significant increase in net profit to the extent of Rs.6, 575 under drip irrigation, which was 16.13 per cent more compared to surface irrigation probably duet o considerable saving of Rs. 1,682 per hectare in the cost of production under surface irrigation. The benefit to cost ratio for drip and surface irrigation was 3.44:1 and 2.94:1, respectively. Thus, there was an additional income of Rs. 0.50 for every rupee invested under the drip method of irrigation.

Shivakumar *et al.,* (2000) conducted a study on economic analysis of drip irrigation system in sun flower. A field experiment was held at the main research station, the University of Agriculture Science, Bangalore. The results of the study revealed that the average establishment cost of drip layout under regular and paired row planting was Rs. 35, 000/ha and Rs. 17, 500 / ha, respectively. Under paired row method of planting (45 × 90cm) discounted B:C ratio (1.82) and positive net present value (Rs. 14,285) with the shortest payback period of 0.49 years was noticed.

Kiran and Chandrakanth (2016) conducted a study on irrigation efficiency and crop water planning in Karnataka. Field data were collected from 30 sample farmers each (1) following drip irrigation for narrowly spaced crops; (2) following drip irrigation for broad spaced crops; (3) sharing their groundwater well with their brothers; (4) who have recharged their bore well and (5) control farmers from water-scarce Eastern and Central Dry agro-climatic Zones of Karnataka. The economic efficiency reflected in terms of net returns per rupee of irrigation water cost was the highest among farmers who shared their groundwater among their relatives [sharing institution (Rs. 10.83)] followed by farmers with bore well recharge technology (Rs.8.17).

MATERIAL AND METHOD

Ex-post-facto research design was used in the study. The researcher had no scope to manipulate the independent as well as dependent variables. Inferences on the relationship between independent and dependent variables have to be drawn based on effects already manifested. The investigation was conducted in the Chitradurga district of Karnataka state. Chitradurga, Holalkere and Hiriyur taluks coming under Chitradurga district were selected purposively based on the highest area under Arecanut production and practicing different irrigation methods. The samples were randomly selected. the 40 drip irrigation adopted farmers,40 sprinkler irrigation adopted farmers and remaining 40 who was following flood irrigation in Arecanut cultivation were selected. Thus the total sample size for the study was 120 respondents.

A. Economics of water use under different irrigation methods in Arecanut

Cost of ground water irrigation. The cost of ground water is calculated by amortizing investment on drilling and casing of bore well over their average life plus the operation and maintenance cost of the bore well.

Amortized investment on irrigation pump sets, pump house, electrification charges, storage structure (constructed if any), conveyance structures, drip structure, sprinkler structure. The obtained total cost is regarded as total annual cost of irrigation. To obtain cost of water per acre inch, total annual cost of irrigation was divided by total water extracted in the year.

Cost of irrigate on per acre inch = [Total annual cost of irrigation] ⁄ [volume of water used for the crop in ac inches of ground water used].

Annual cost of irrigation = (Amortized cost of bore well +Amortized cost of pump set+ Amortized cost of conveyance +Amortized cost of over ground structure + Amortized cost of Micro Irrigation Structure (MIS) + Annual repairs and maintenance cost of pump set and accessories).

Procedure followed in estimation of annual cost of irrigation is detailed below

1. Amortized cost of BW

$$= \text{CC of BW} * \frac{(1+\text{i})^{AL} \times (\text{i})}{(1+\text{i})^{AL} - (1)}$$

Calculated:

CC of BW = Historical investment on Bore well X $(1+\text{i})^{\text{Reference year – year of drilling}}$

Where,

AL = Average life, i = Interest rate.

CC of BW=compared cost of bore well

2. Amortized cost of pump set (PS)

$$\text{Amortized cost of PS} = \text{CC of PS} \times \frac{(1+\text{i})^{10}\ \text{X}\ (\text{i})}{(1+\text{i})^{10} - (1)}$$

CC of PS = Historical investment on pump set X $(1+\text{i})^{\text{Reference year – year of drilling}}$

CC of PS=compared cost of pump set

3. Amortized cost of conveyance structure (CS)

$$\text{Amortized cost of CS} = \text{CC of CS} \times \frac{(1+\text{i})^{10}\ \text{X}\ (\text{i})}{(1+\text{i})^{10} - (1)}$$

CC of CS = Historical investment on CS × $(1+\text{i})^{\text{Reference year – year of drilling}}$

CC of CS=compared cost of Conveyance structure

4. Amortized cost of over Ground Structure (OGS)

Amortized Cost of OGS

$$= \text{CC of OGS} \times \frac{(1+\text{i})^{10}\ \text{X}\ (\text{i})}{(1+\text{i})^{10} - (1)}$$

CC of OGS = Historical investment on OGS X $(1+\text{i})^{\text{Reference year – year of drilling}}$

CC = compared cost of bore well. OGS includes storage structures like ponds, drums, etc.

6. Amortized cost of Micro irrigation structure (MIS)

$$\text{Amortized Cost of MIS} = \text{CC of MIS} \times \frac{(1+\text{i})^{10} \times (\text{i})}{(1+\text{i})^{10} - (1)}$$

CC of MIS = Historical investment on MIS X $(1+\text{i})^{\text{Reference year – year of drilling}}$

Choice of discount rate. In the previous study made by Kiran Kumar Patil, (2016), the investment on earliest well (IEW) and the investment on latest well (ILW) was compared using the formula IEW $(1+\text{i})^{n} =$ ILW and interest rate 'i' was solved to obtain discount. In their study the appropriate rate established cost 2 per cent and was considered as social discount rate. The present study was same discount rate for amortization of investment approximately two per cent. Accordingly, a two per cent discount rate was used.

B. Quantification of irrigation water from different irrigation methods

Drip irrigation method

Water yield from bore well=

$$\frac{\text{No. of drips in cropped area} \times \text{discharge per drip (liters per hour)} \times \text{Number of hours pump put on to irrigate across all seasons and crops in a year}}{4.54 \times 22611}$$

Flood irrigation method:

Water yield from bore =

$$\frac{\text{No. of sprinklers in cropped area} \times \text{discharge per sprinkler (liters per hour)} \times \text{Numb of hours pump put on to irrigate across all seasons and crops in a year}}{4.54 \times 22611}$$

Water yield from bore Well =

$$\frac{\text{Water discharge by the well in GPH across all season's} \times \text{Number of hours pump put on across all seasons}}{2261}$$

RESULT AND DISSCUSSION

The data represented in Table 1 indicates the cost of cultivation of Arecanut under different irrigation methods. It was evident from the table 1 that the cost of maintenance of Arecanut was found to be higher in sprinkler irrigation followed by flood irrigation and drip irrigation method. The cost of human labour was found to be higher in the flood irrigation (Rs. 31, 000.00) and sprinkler irrigation (Rs. 28, 750.00) compared to drip irrigation (Rs. 24, 250.00) method. The cost of machine labour was found to be higher drip irrigation (Rs. 6, 160.00) followed by sprinkler irrigation (Rs. 6,052.00) and flood irrigation (Rs. 5, 000.00) method respectively. Material cost in drip irrigation was found to be high *i.e.*, Rs. 23, 880.00 followed by sprinkler (Rs. 23,679.00) and flood (Rs. 15, 880.00) irrigation method respectively.

Irrigation cost in drip, sprinkler and flood irrigation method was Rs. 43, 178.94, Rs. 43, 862.16 and Rs. 45,367.23, respectively. But the total maintenance cost was found to be higher in sprinkler irrigation (Rs. 1, 03,343.16) followed by drip (Rs. 98,969.94) and flood irrigation (Rs. 98,247.23) method, respectively.

The above results may be attributable to regular maintenance of sprinklers during warm weather months, sometimes improper maintenance leads to wastage of water due to leaky valves and pipes, irrigation is affected by high winds, and the nozzle is easily blocked by sediment. Difficult to perform inter-cultivation in the field. So, the operational and maintenance cost of the pump and field found to be high in sprinkler irrigation. Maintenance cost was found to be low in drip irrigation may be due to less human labour requirement, a lesser requirement of weedicides and fungicides, water conservation and higher water use efficiency may reduce the cost of maintenance in drip irrigation.

Researcher during data collection at Chitradurga district.

Table 1: Cost of cultivation of Arecanut under different irrigation methods (Rs/acre).

Sr. No.	Particulars	DIM (Rs.)			SIM(Rs.)			FIM (Rs.)		
		Qty	Rate	Value	Qty	Rate	Value	Qty	Rate	Value
1	Human labour (man days)									
	a) Men	50	300.00	15,000.00	65	300.00	19,500.00	70	300.00	21,000.00
	b) Women	37	250.00	9,250.00	37	250.00	9,250.00	38	250.00	10,000.00
	Total Human labour			24,250.00			28,750.00			31,000.00
2	Machine labour (hr)									
	a) Intercultivation	04	600.00	2,400.00	05	600.00	3,000.00	04	600.00	2,400.00
	b) Sprayer	08	50.00	400.00	08	50.00	400.00	10	50.00	500.00
	c) Dehusking	08	420.00	3,360.00	06	420.00	2,652.00	05	420.00	2,100.00
	Total machine labour			6,160.00			6,052.00			5,000.00
3	Materials									
	a) FYM(tonnes)	04	2250.00	9,000.00	04	2250.00	9,000.00	04	2250.00	9,00.00
	b) Red earth/silt (tonnes)	18	165.00	2,970.00	18	160.00	2,880.00	18	160.00	2,880.00
	c) fertilizers (quintals)	04	2400.00	9,600.00	4.5	2400.00	9,600.00	01	24000.00	2,400.00
	d) Plant protection chemicals (ltrs)	02	450.00	900.00	02	450.00	900.00	01	450.00	450.00
	e) electricity charges			290.00			276.00			150.00
	f) Kalipak			170.00			170.00			170.00
	g) Fuel wood			950.00			853.00			830.00
	Total material cost			23,880.00			23,679.00			15,880.00
4	Irrigation cost			43178.94			43862.16			45367.23
5	Annual repairs			1,500.00			1,000.00			1,000.00
6	**Total variable cost(Maintenance cost)**			**98,968.94**			**1,03,343.16**			**98,247.23**

DIM = Drip Irrigation Method **SIM** = Sprinkler Irrigation Method **FIM** = Flood Irrigation Method

Table 2: Returns from Arecanut cultivation under different irrigation methods (Rs/acre).

Sr. No.	Particulars	DIM			SIM			FIM		
		Yield (Qtl/acre)	Price (Rs.)	Value	Yield (Qtl/acre	Price (Rs.)	Value	Yield (Qtl/acre	Price (Rs.)	Value
1	Rasi	9.00	33,000.00	2,97,000.00	8.00	33,000.00	2,64,000.00	8.00	33,000.00	2,64,000.00
2	Gorabalu	0.62	26,000.00	16,120.00	0.56	26,000.00	14,560.00	0.22	26,000.00	5,720.00
	Total Yield	9.62			8.56			8.22		
3	Gross returns/acre			3,13,120.00			2,78,560.00			2,69,720.00
4	Total cost / acre			98,968.94			1,03,343.16			98,247.23
5	Net returns/ acre			2,14,151.06			1,75,216.84			1,71,472.77
6	Gross returns per quintal			32,548.85			32,542.05			32,816.65
7	Net returns per quintal			22,261.02			20,469.25			20,864.43
8	Total cost /quintal			10,287.83			12,072.79			11,952.21

DIM = Drip Irrigation Method, **SIM**= Sprinkler Irrigation Method, **FIM**= Flood Irrigation Method

Table 3: Water use efficiency of different irrigation methods in Arecanut.

Sr. No.	Particulars	DIM	SIM	FIM
	Physical efficiency			
1	Yield per acre(qtl)	9.62	8.56	8.22
2	Water used (in acre inch)	9.81	13.15	19.18
3	Yield per acre-inch(qtl)	1.03	0.63	0.44
	Economic efficiency			
4	Irrigation cost per acre-inch (Rs.)	4,703.58	3,327.93	23,65.34
5	Gross returns per acre-inch (Rs.)	33,679.06	21,215.05	13,827.95
6	Net returns per acre-inch (Rs.)	23,665.63	13,621.05	8,891.04
7	Gross returns per rupee of irrigation cost (Rs.)	8.38	7.13	6.05
8	Net returns per rupee of irrigation cost (Rs.)	5.87	4.58	3.89

DIM = Drip Irrigation Method, **SIM=** Sprinkler Irrigation Method, **FIM=** Flood Irrigation Method

A. Returns from Arecanut cultivation under different irrigation methods (Rs/acre)

It is evident from Table 2 that the yield of Arecanut is higher in the drip irrigation method (9.62qtl/acre) compared to sprinkler (8.56qtl/acre) and flood (8.22 qtl/ acre) irrigation method.

The probable reason may be the drip irrigation method provides the limited amount of water to the plants or cops directly to their root zone which makes a difference in crop yield by making better utilization of available water at root zone. In case of sprinkler irrigation, the water use efficiency is less compared to drip due to high wind currents which may causes the less returns than drip. In flood irrigation there is a maximum water loss by evaporation and this method requires high labour than any other methods which becomes ultimate reason for less returns in flood irrigation method. The findings are in line with the outcomes of Chandrakanth *et al.*, (2013).

B. Water use efficiency of different irrigation methods in Arecanut

The information presented in Table 3 depicts the Physical and economic efficiency of different irrigation methods in Arecanut. It shows that physical and economic efficiency was found to be higher in the drip irrigation method compared to sprinkler and flood irrigation methods. Physical efficiency of water used was measured interms of Yield per acre inch of water used. Water used under drip, sprinkler and flood irrigation method was 9.81, 13.15 and19.18 liters per acre inch, respectively. Yield per acre inch under drip irrigation was 1.03 quintals followed by sprinkler irrigation (0.63 quintals) and flood (0.44 quintals) irrigation method respectively. Economic efficiency was measured in terms of gross returns per acre inch of water, Net returns per acre inch of water, Gross returns per rupee of irrigation cost and Net returns per rupee of irrigation cost. Across all the measures of economic efficiency, the drip irrigation method was found to be efficient compared to sprinkler and flood irrigation method. Irrigation cost per acre inch was found to be highest in case of drip irrigation method (Rs. 4,703.58), followed by sprinkler (Rs. 3,327.93) and flood (Rs. 2,365.34) methods of irrigation respectively. Net returns per acre inch were found to be higher in the drip irrigation method (Rs. 23,665.63) followed by sprinkler (Rs. 13,621.05) and lower in flood (Rs. 8,891.04) method. Similarly, net returns per acre inch of irrigation cost also found to be higher in drip irrigation (Rs. 5.87) followed by sprinkler (Rs. 4.58) and flood (Rs. 3.89) irrigation methods, respectively.

IMPLICATIONS

There is a need to conduct capacity building programmes in order to increase the farmers' skills about operational aspects of different irrigation methods. There is a need to educate the farmers to adopt water budgeting for efficient utilization of water. The farmers need to utilize of solar power for bore wells in order to overcome the poor timely availability electricity. Incentivization of economically efficient irrigation method and rainwater harvesting for recharging of bore wells by using runoff water on an individual farm basis.

FUTURE LINE OF WORK

To study the farmer's attitude and knowledge about different irrigation methods. The research must be conducted on the same sampled farmers after capacity building about operational aspects of different irrigation methods in order to estimate the impact. The research must be conducted on other plantation crops to know the water use efficiency and economics of different irrigation methods.

CONCLUSION

The study affirms that as the farmers of Chitradurga district growing Arecanut under different irrigation methods have to shift towards drip irrigation which had a high productivity and high water use efficiency. At the same time in drip irrigation also used in sustainable manner by concentrate on other low quantity of water demanding crops other than Arecanut in order t maintain and save the underground water for future.

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