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Economics of irrigation methods for sustainable groundwater use in micro-watershed

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Abstract
The study had analyzed the economics of irrigation methods in micro-watershed areas. In Karnataka, micro-irrigation has received considerable policy focus. In this, Koppal and Raichur district were selected for the study. The partial budgeting technique approach was carried out to focus on the changes in income and expenses that would result from implementing an alternative technology. And micro irrigation is one of the strategies to improve the water use efficiency in micro-watershed areas. The results of the study revealed that the adoption of micro irrigation enhances farmers yield as well as income at farm level. By adopting these methods farmers were profitable for major crops like chilli (₹ 8865.14), sugarcane (₹ 7991.76), in Koppal district and for onion (₹ 3739.56), redgram (₹ 5030.22) in Raichur district. The relatively low spread of micro-irrigation in watersheds with overexploited groundwater needs attention. Overall, there is need to revamp the current micro-irrigation development programmes and capacity building programmes for farmers to create awareness about micro-irrigation technology at farm level.

Keywords: Micro-irrigation, groundwater, micro-watershed, sustainable use

1. Introduction
Groundwater has rapidly emerged to occupy a dominant place in agriculture and food security in the recent years. In the recent years, due to several water-demanding factors like population explosion, spreading urbanization, rapid industrialization, extensive irrigation, the demand has also increased in an unexpected manner. More than half of the irrigation requirements of agriculture are sourced from groundwater, which, in monetary terms, contributed to 9 per cent of India's GDP. Thus, groundwater contributes substantially to the agriculture sector's major share of 28 per cent of the total agriculture GDP. In India, more than 60 per cent of the agricultural output is from irrigated lands. This indicates how crucial is irrigation for the nation's food, economic and nutritional security (Bhende, 2013) [2]. However, the rising importance of groundwater withdrawals in global freshwater supply is well established. Still there exists a large uncertainty on the volumes and spatial distribution of both groundwater recharge and withdrawals (Siebert *et al.,* 2010) [9].
Recently Karnataka has witnessed an explosive increase in the development and use of groundwater. The total annual groundwater draft (9.41 BCM) for irrigation and domestic and industrial use is estimated at 8.59 and 0.28 BCM respectively. Karnataka has already over drafted groundwater by 64 per cent and 6.53 BCM is available for future use (Anon., 2014) [1]. Due to over-exploitation of groundwater resources, more than three lakh dug-wells have dried. Shallow bore wells have failed and yield in deep bore wells are declining. Area irrigated by groundwater extraction structures is decreasing (Chandrakanth, 2009) [3].
Even after substantial promotional efforts by the government and private organizations, the rate of adoption of micro-irrigation technology is still very low compared to the potential. But the adoption of micro-irrigation has resulted in water saving, yield and income enhancement at the farm level. Micro-irrigation (MI), mainly through drip and sprinkler, is considered a strategy to improve water-use efficiency. Impact of irrigation in agricultural development in Karnataka and revealed that irrigation changed the cropping pattern in favor of high value crop.

2. Methodology
The study was conducted in micro-watersheds of Koppal and Raichur districts of Karnataka. Purposive random sampling method was followed for the selection of four micro-watershed areas and the data were collected from the all groundwater irrigated farmers in each micro-

watershed area *viz*., Kavalakeri-4 (16), Ryavanaki-1 (15), Chattar-1 (18), Kumarkhed (16). In this section, impact of different irrigation methods followed by farmers was evaluated using the partial budgeting approach. The technique considers the additional costs involved under different irrigation methods and incremental returns realized by different irrigation methods. The difference indicates the profitability due to particular kind of irrigation method.

Debit	Credit
Increase in cost due to particular irrigation method in the farm = A	Savings due to particular irrigation method in the farm = C
Decrease in gross returns due to particular irrigation method in the farm = B	Increase in gross returns due to particular irrigation method in the farm = D
Total = A+B	Total = C+D
Credit minus debit = Net gain/ loss	

3. Results and Discussion

3.1. Details of irrigation bore wells in different methods of irrigation

It could be observed from the Table 1 that in Koppal district majority of the farmers practicing conventional method of irrigation (62.50%) followed by drip (25.00%), sprinkler (12.50%) with 71.43 percent of area in conventional followed by acres in sprinkler (15.87%) and drip (12.70%) in Kavalakeri-4 micro-watershed. Whereas in Ryavanaki-1 micro-watershed also most of the farmers adopted conventional method (73.34%) followed by drip and sprinkler (13.33%) with area of 82.89 percent in conventional, sprinkler (10.53%) and drip (6.58%).

There were more failed bore well under conventional irrigation as compared to other irrigation in Koppal district. The possible reasons are non-adoption of improved methods of irrigation, poor knowledge of groundwater importance and small size of holding. Hence, they followed the traditional conventional method of irrigation.

Similarly in case of Raichur district, majority of the farmers followed conventional method (72.23%) followed by drip (16.66%), sprinkler (11.11%) with total area of 74.36 percent in conventional, sprinkler (14.10%) and drip (11.54%) in Chattar-1 micro-watershed. Whereas in case of Kumarkhed micro-watershed area majority of the farmers were adopted conventional (68.75%) followed by sprinkler (18.75%) and drip (12.50%) with total area of 76.47 percent, 15.29 percent, 8.24 percent respectively. Overall it was found that most of the farmers followed conventional (70.59%) compared to drip and sprinkler (14.71%) with total area of 75.46 percent, 9.82 percent and 14.72 percent respectively (Table 2).

It was evident from the Table 2 that information of number of borewells, method of irrigation in micro-watersheds of Raichur district was observed. In Chattar-1 micro-watershed, the total number of borewells drilled was 35 out of which 21 borewells were functioning under conventional method followed by drip irrigation (4) and sprinkler irrigation (2).

3.2. Economics of different methods of irrigation

To find out the profitability of different irrigation methods, common crops grown in each selected micro-watershed were considered with average per acre costs and returns. Similarly, the net gain or loss was worked out from the used technology.

In Koppal district, the increased in cost due to drip irrigation method use was the sum difference between costs of marketing and installation cost incurred by drip method use over conventional method in chilli crop. The additional costs incurred by farmers in drip method were ₹ 4895 per acre. Reduced return forgone due to drip use was zero. Savings due to drip was the sum of costs saved due to the reduction of costs of human labour, bullock labour, seeds, fertilizer, plant protection chemicals, and irrigation which accounted to ₹ 8360. Increase in returns due to drip was the sum difference between the gross returns obtained by drip and conventional method. The total additional returns realized by farmers in were ₹ 5400. Hence the total savings realized in chilli crop were ₹ 13760.14 per acre. Thus, the profitability of drip method accounted to ₹ 8865.14 per acre per year over conventional irrigation method (Table 3).

In case of sugarcane also it was found that the additional cost incurred by drip method was by marketing and installation cost was ₹ 5201 per acre and reduced returns forgone due to drip adoption was zero. Savings due to drip was the sum of costs saved due to the reduction of costs of human labour, bullock labour, seeds, fertilizer, plant protection chemicals, and irrigation which accounted to ₹ 10768. Increase in returns due to drip was about ₹ 2430. Hence, total savings to the extent of ₹ 13198.8 per acre in sugarcane crop. Thus, the profitability of drip method accounted to ₹ 7991.96 per acre per year over conventional irrigation method (Table 3). Sugarcane cultivation showed that the drip method of irrigation not only enhanced the productivity and income of the sugarcane but also increased the water use efficiency. Comparable results were observed in the study conducted by Kumar and Palanisami (2010) [4], Mundinamani *et al.* (2006) [5].

Similarly, major crop was onion crop in Raichur district the result showed that in Table 4. It was observed that by using sprinkler method additional costs incurred by farmers were ₹ 4415 per acre and decrease in returns due to sprinkler was zero. Savings by adopting sprinkler was by reduction of costs of human labour, bullock labour, fertilizer, plant protection chemicals, and irrigation which was ₹ 4312.20. And increase in returns due to sprinkler method was about ₹ 1985. Hence the total savings realized per acre was ₹ 6297.20. Thus, the profitability of sprinkler method accounted to ₹ 1882.12 per acre per year over conventional irrigation method

In case of redgram crop also showed that by adopting sprinkler method of irrigation the additional costs incurred were by marketing and installation cost was ₹ 4500 and reduced returns forgone to zero. Due to this method savings observed was by reduction of costs of human labour, bullock labour, fertilizer, plant protection chemicals, and irrigation which was ₹ 4533.22 per acre and increase in returns due to sprinkler method was ₹ 5047 per acre. Hence, total savings to the extent of ₹ 9580.22 per acre. And the profitability of sprinkler method accounted to ₹ 5030.22 per acre per year over conventional irrigation method (Table 4). The similar findings were on par with Muthuchamy *et al.* (2001) [12] in Coimbatore district of Tamil Nadu.

For meaningful comparison and logical inference on superiority of irrigation system using partial budgeting technique only those crops being grown under different methods of irrigation considered and the results were showed that due to modern method of irrigation (like drip and sprinkler method) savings and increase in returns observed and also by adopting these methods farmers are profitable for major crops as compared to conventional method of irrigation in each districts it might be because of the government has

been investing on irrigation and giving priority to the development of irrigational facilities in each district and Karnataka state in general. As a result, the area under irrigation has increased in the districts there has been a tremendous change in the agricultural economy.

Table 1: Details of irrigation borewells in different methods of irrigation in Koppal district

Sl. No.	Particulars	Kavalakeri-4 (MW) (n=16)			Ryavanaki-1 (MW) (n=15)		
		Conventional Irrigation	Drip irrigation	Sprinkler irrigation	Conventional irrigation	Drip Irrigation	Sprinkler irrigation
1	No. of farmers	10 (62.50)	4 (25.00)	2 (12.50)	11 (73.34)	2 (13.33)	2 (13.33)
2	Total area (acres)	45 (71.43)	8 (12.70)	10 (15.87)	63 (82.89)	5 (6.58)	8 (10.53)
3	No. of functioning borewells	24 (80.00)	4 (13.34)	2 (6.66)	24 (85.72)	2(7.14)	2 (7.14)
4	No. of failed borewells	10 (83.34)	2 (16.66)	0 (0.00)	30 (96.78)	1 (3.22)	0 (0.00)
5	Total number of borewells	34 (80.96)	6 (14.28)	2 (4.76)	54 (91.53)	3 (5.08)	2 (3.39)

Table 2: Details of irrigation borewells in different methods of irrigation in Raichur district

Sl. No.	Particulars	Chattar-1 (MW) (n=18)			Kumarkhed (MW) (n=16)		
		Conventional irrigation	Drip irrigation	Sprinkler irrigation	Conventional irrigation	Drip Irrigation	Sprinkler irrigation
1	No. of farmers	13 (72.23)	3 (16.66)	2 (11.11)	11 (68.75)	2 (12.50)	3 (18.75)
2	Total area (acres)	58 (74.36)	9 (11.54)	11 (14.10)	65 (76.47)	7 (8.24)	13 (15.29)
2	No. of functioning borewells	21 (80.77)	3 (11.54)	2 (7.69)	22 (81.48)	2 (7.40)	3 (11.12)
3	No. of failed borewells	9 (100.00)	0 (0.00)	0 (0.00)	11(91.66)	1 (8.34)	0 (0.00)
4	Total number of borewells	30 (85.71)	3 (8.58)	2 (5.71)	35 (85.36)	3 (7.32)	3 (7.32)

Note: Figures in parentheses indicate percentage to total

Table 3: Comparative economics of drip over conventional method of irrigation in Koppal district (₹/acre) Crop: Chilli (Seed production)

Debit	Amount (₹)	Credit	Amount (₹)
A) Increase in cost		**B) Decrease in cost**	
Marketing cost	95.00	Human labour cost	4030.75
Amortized installation cost	4800.00	Bullock labour cost	434.39
		Seeds	38.00
		Fertilizer	2459.50
		PPC	452.50
		Irrigation cost	945.00
C) Decrease in returns		**D) Increase in returns**	
Decrease in Gross returns	0	Increase in Gross returns	5400.00
Total Expenses (A+C)	4895.00	Total Savings (B+D)	13760.14
Net Gain = Total Savings (₹13760.14) - Total Expenses (₹4895.00) = ₹ 8865.14			
Crop: Sugarcane			
Debit	Amount (₹)	Credit	Amount (₹)
A) Increase in cost		**B) Decrease in cost**	
Marketing cost	207.00	Human labour cost	4478.50
Amortized installation cost	5000.00	Bullock labour cost	975.00
		Seeds	1716.00
		Fertilizer	1609.06
		PPC	283.00
		Irrigation cost	1707.20
C) Decrease in returns		**D) Increase in returns**	
Decrease in Gross returns	0	Increase in Gross returns	2430.00
Total Expenses (A+C)	5207.00	Total Savings (B+D)	13198.80
Net Gain = Total Savings (₹13198.80) - Total Expenses (₹5207.00) = ₹ 7991.76			

Table 4: Comparative economics of sprinkler over conventional method of irrigation in Raichur district (₹/acre) Crop: Onion

Debit	Amount (₹)	Credit	Amount (₹)
A) Increase in cost		**B) Decrease in cost**	
Marketing cost	90.00	Human labour cost	2046.00
Amortized installation cost	4325.00	Bullock labour cost	315.00
		Fertilizer	1028.20
		PPC	53.82
		Irrigation cost	869.00
C) Decrease in returns		**D) Increase in returns**	
Decrease in Gross returns	0	Increase in Gross returns	1985.00
Total Expenses (A+C)	4415.00	Total Savings (B+D)	6297.20
Net Gain = Total Savings (₹6297.20) - Total Expenses (₹4415.00) = ₹ 1882.02			

Crop: Redgram

Debit	Amount (₹)	Credit	Amount (₹)
A) Increase in cost		**B) Decrease in cost**	
Marketing cost	100.00	Human labour cost	1129.38
Amortized installation cost	4500.00	Bullock labour cost	380.00
		Fertilizer	2122.00
		PPC	610.84
		Irrigation cost	291.00
C) Decrease in returns		**D) Increase in returns**	
Decrease in Gross returns	0	Increase in Gross returns	5047.00
Total Expenses (A+C)	4550.00	Total Savings (B+D)	9580.22
Net Gain = Total Savings (₹9580.22) - Total Expenses (₹4550.00) = ₹ 5030.22			

4. Conclusion and recommendations

The study brings out some insights. The adoption of micro-irrigation has resulted in water saving, yield and income enhancement at the farm level. Micro-irrigation (MI), mainly through drip and sprinkler, is considered a strategy to improve water-use efficiency. There are several other associated benefits as well, including better land productivity, energy and labour savings, higher fertilizer use efficiency, and higher farm income through reorientation of cropping pattern to more profitable crops (Kumar & Palanisami, 2010; Pfeiffer & Lin, 2014) [4, 8]. Impact of irrigation in agricultural development in Karnataka and revealed that irrigation changed the cropping pattern in favor of high value crop. Overall, there is need to revamp the MI development strategy to promote water use efficiency. Still there is a huge scope for micro irrigation, the subsidy for micro irrigation should be continue till a major area of groundwater irrigation is covered by micro irrigation. In addition, the procedure to avail the micro irrigation subsidy should be simplified in availing the benefits by the farmers. And also, farmers need to be educated and motivated to invest on low water consumption technologies like drip irrigation and sprinkler irrigation for conservation of groundwater.

5. References

1. Anonymous. Ministry of Water Resources, River Development and Ganga Rejuvenation. GOI; c2014.
2. Bhende MJ. Agricultural profile of Karnataka state agricultural development and rural transformation centre. Inst. Soc. and Econ. Change, Bangalore; c2013. p. 18-20.
3. Chandrakanth MG. Karnataka state water sector reform: Current status, emerging issues and needed strategies. International Water Management Institute (IWMI); c2009.
4. Kumar SD, Palanisami K. Impact of Drip Irrigation on Farming System: Evidence from Southern India. Agricultural Economics Research Review. 2010;23:265-272.
5. Mundinamani SM, Dasag GS, Naik BK, Jahagirdar SV, Udagatti GS, Prakath R. Impact of Irrigation Infrastructure on Water use Efficiency in the Tank Commands of Northern Karnataka: A Case Study of Drip Irrigation in Sugarcane Cultivation. Indian Journal of Agricultural Economics. 2006;61(3):542.
6. Pandey R, Chaurey R, Solanki ERHK, Kumar S, Singh RM. Groundwater prospectus mapping using well points based on remote sensing and GIS techniques in a micro-watershed. Int. J Geogr Geol. Environ. 2022;4(1):145-153.
7. Palanisami K, Kadiri M, Kakumanu KR, Raman S. Spread and Economics of Micro-irrigation in India: Evidence from Nine States. Economic & Political Weekly. 2011;46(26):81-86.
8. Pfeiffer L, Lin CY. Does efficient irrigation technology lead to reduced groundwater extraction? Empirical evidence, Journal of Environmental Economics and Management, Volume. 2014;67(2):189-208.
9. Siebert S, Burke J, Faures JM, Frenken K, Hoogeveen J, Doll PD, *et al*. Groundwater use for irrigation – a global inventory. Hydrology and Earth System Sciences. 2010;14:1863-1880.
10. Srivastava SK, Kumar Ranjit, Singh RP. Extent of Ground water extraction and irrigation efficiency on farms under different water-market regimes in Central Uttar Pradesh. Agricultural Economics Research Review. 2009;22:87-97.
11. Suresh A, Aditya KS, Jha G, Pal S. Micro-irrigation development in India: an analysis of distributional pattern and potential correlates. International Journal of Water Resources Development; c2018.
12. Muthuchamy I, Senhivel S, Mohanmmedali A, Kannan B, Subramanian K. Subsurface drip irrigation for coconut. Kisan World. 2001;28(2):15.