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Research Article

AN ECONOMIC ANALYSIS OF CROP PATTERN UNDER RAINFED AND WELL IRRIGATED FARMS IN CAUVERYCOMMAND AREAS OF KARNATAKA

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A B S T R A C T

Groundwater is the major source of irrigation in Karnataka especially in rain fed south-eastern districts of Kolar, Bangalore, Tumkur and Chitradurga. It is the key component in agricultural development in these areas. In this study, the economics of Crop pattern of rain fed and well irrigated cropsis studied in Tumkur district in hard rock areas of Karnataka State. The study area is covered by the Hemavathy river basin. In addition, in parts of the central Dry agro-climatic zone of Karnataka, in the Cauvery basin, the river Hemavathi is put to productive use. This study is a modest attempt towards the economics of Crop pattern of rain fed and well irrigated crops under three situations of recharge in Tipturtaluk, Tumkur district of Karnataka. Here the irrigation wells located under canal command (GWCI) (Gadabanaalli), the irrigation wells located under tank command (GWTI) (Echanur), receiving the Hemavathy river water, with a water spread of 363 acres and another vilallge Kibbanahalli where groundwater wells are located independently (called groundwater under sole irrigation GWSI), which depend only on rainfall source have been considered. The crop pattern in rain fed situation is compared in across the three irrigation tanks GWTI, GWCI and GWSI. The major rain fed crops cultivated by farmers were Ragi, Jowar and Dolichos (Avare).Considering the crop pattern with groundwater irrigation in GWTI, GWCI and GWSI, the major crops grown are Paddy, Coconut, Arecanut, Banana, Tomato, Brinjal and Okra. The major portion of irrigated area was devoted to coconut it is about 44 per cent in GWTI, 55 per cent GWCI and 58 percent in GWSI. Arecanut formed second major irrigated crop in all the three situations. More than 70 percent of the gross cropped area is devoted to perennial crops like Coconut and Arecanut in the study area across the three types of farm situations. This type of cropping pattern dominated by perennial crops in itself is a prima facie indicator of the farmers' coping mechanism to the groundwater scarcity, since perennial crops have greater capacity to withstand scarcity than seasonal and annual crops.

INTRODUCTION

In Karnataka the net irrigated area under different sources of irrigation during was around 24.90 lakh hectares of which the canal irrigation accounted for about 40.70 percent, followed by open well irrigation (19.23 percent), tube wells (18.06 percent), tanks (10.56 percent) and others 11.45 percent. However, groundwater is the major source of irrigation in Karnataka especially in rain fed south-eastern districts of Kolar, Bangalore, Tumkur and Chitradurga. It is the key component in agricultural development in these areas. In this study, the economics of Crop pattern of rain fed and well irrigated cropsis studied in Tumkur district in hard rock areas of Karnataka State.

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The study area is covered by the Hemavathy river basin. In addition, in parts of the central Dry agro-climatic zone of Karnataka, in the Cauvery basin, the river Hemavathi is put to productive use. For example, in the process of getting the crucial and vital drinking water for the city of Tumkur, the riparian areas on either sides of the flow of the river are benefited from groundwater recharge. The river Hemavathy, a tributary of river Cauvery has its origin in BallarayanaDurga in Chikmagalore district of the Western Ghats, at 1,219 metres above MSL. The river flows through Chikkamagaluru, Hassan District and Mysore district before joining the Cauvery near Krishnarajasagara. Flowing a length of 245 kms. The Hemavathy masonry dam is constructed in Gorur in Hassan District which impounds 78 TMC of water assuming 50 percent dependability. The reservoir fills between June and September, during the south west monsoons. and the depletion

period is October to May. The Tumkur branch canal from the Hemavathy left bank canal which brings drinking water to Tumkur city is 240 kilometers long carrying 1429 cusecs of water.

Due to fractures in hard rock formations, semi confined to confined aquifer systems is formed. Here borewells ranging in depth up to 600 feet, yield around 11000 GHP. In the unconfined aquifers the sustained yield of wells varies from 100 GPH to 1157 GPH in Gubbitaluk, 156 GPH to 1312 GPH in Kunigal, 826 GPH to 2295 GPH in Koratageretaluk, 184 GPH to 431 GPH in Sirataluk, 257 GPH to 588 GPH in Tipturtaluk, 220 GPH to 514 GPH in Tumkurtaluk and 422 GPH to 670 GPH in Turuvekeretaluk. (Groundwater resource in Tumkur district).

This study is a modest attempt towards the economics of Crop pattern of rain fed and well irrigated crops under three situations of recharge in Tipturtaluk, Tumkur district of Karnataka. Here the irrigation wells located under canal command (GWCI) (Gadabanaalli), theirrigation wells located under tank command (GWTI)(Echanur), receiving the Hemavathy river water, with a water spread of 363 acres and another vilallgeKibbanahalli where groundwater wells are located independently (called groundwater under sole irrigation GWSI), which depend only on rainfall source have been considered. The specific objective of the study is to know the Crop pattern under rain fed and well irrigation in Cauvery command area.

METHODOLOGY

The study was conducted in Tumakuru district of Karnataka. The districts in the state were ranked in the descending order of groundwater over-exploitation. Tumkur district has emerged as the most over-exploited district in terms of groundwater extraction and use. Tumkur district comprises 10 taluks and comes under Central Dry Zone of Karnataka. After discussion with the groundwater experts and different institutions, the reconnaissance survey has been conducted in different parts of Tumkur district in order to locate different pockets, which are facing acute groundwater scarcity (groundwater depletion).

Selection of the Sample Villages and Sampling

For identifying the sample villages, the resource persons from department of agriculture, irrigation, biodiversity, forestry (Vanavikasa) cooperative societies and Gram panchayats in the villages were approached. For comparison of the relative performance of the groundwater recharge in Tipturtaluk, Irrigation wells located under Hemavathy canal command (GWCI), the System tank command (Echanoor) (GWTI) and the groundwater wells under sole irrigation (GWSI), where the recharge is largely by rainfall (Kibbanahalli) have been chosen in consonance with study objectives in the Hemavathy river sub-basin of Cauvery river basin as under:

1. Groundwater wells for irrigation located under system tank irrigation command **(GWTI):** here such wells are recharged by system irrigation tank (sample of 35 farmers)
2. Groundwater wells for irrigation located under canal command **(GWCI)**: here such wells are recharged by canal irrigation command (sample of 35 farmers)
3. Groundwater wells for irrigation located independently of tank or canal command **(GWSI)**; here such wells are recharged largely by rainfall and acts as a control situation (sample of 35 farmers).

Sample Size

For this study, only farmers possessing irrigation wells in each of the three scenarios have been chosen. Hence arandomsample of 35 farmers was drawn from each of the three scenarios, thus, totaling 105 for the purpose of this study.

Analytical Frame Work

Measures of Central Tendency and Ratios

Weighted average was computed in respect of cropping pattern, cost of cultivation and returns from crop activities and access to groundwater. Ratios and percentages were employed to analyze the cropping pattern and cropping intensity. Simple averages, ratio measures, percentages and proportions are computed in order to draw meaningful inferences and to facilitate comparison of the average farm situation in Irrigation wells located under tank command (GWTI) i.e., System tank, Irrigation wells located under canal command (GWCI) and Irrigation wells located under sole irrigation, i.e. located neither under tank or canal command (GWSI).

Economics of Irrigation

The cost of cultivation is the summation of amortized cost of irrigation, cost of human labour, bullock labour, machine hours, seeds and fertilizers, application of manure, plant protection measures, bagging, and transporting, cost of irrigation for each crop. The cost of production is the cost of cultivation + interest on variable cost. Gross return for each crop is the value of the output and the by product at the prices realized by farmers.

Net returns from well irrigation are the gross returns from gross irrigated area minus the cost of production of all crops. Notably the cost of cultivation of all crops includes the cost of irrigation.

The gross cropped area (GCA) is calculated as, the sum of area under crops in all the three seasons (Kharif, Rabi and summer) +2 times the area under perennials such as coconut and arecanut. The net cropped area (NCA) is calculated as, the sum of area under crops for a season (Kharif) +one time area under perennials.

Gross irrigated area (GIA) is the sum of irrigated area under all crops in all the three seasons + 2 times the area under perennials. Net irrigated area (NIA) is the irrigated area under all crops in kharif season + 1 time the area under perennials.

Cropping intensity (CI)=(gross cropped area / net cropped area)*100
Irrigation intensity (II)=(gross irrigated area / net irrigated area)*100

Gross Returns for each crop is total value of the output at the prices realized by farmers. Net returns from well irrigated area = Gross Returns from gross irrigated area minus the cost of production of all crops (for the year 2008).

RESULTS AND DISCUSSION

Cropping pattern fully dependent on rain fed agriculture in the study area

The major rain fed crops grown are Ragi + Avare mixed crop and Jowar. In 2008 Ragi + Avare was grown in 1.68 acres per

farm in GWTI, 1.36 acres per farm in GWCI and 2.69 acres per farm in GWSI, and formed 78.57 per cent of gross cropped in GWTI, 76.67 per cent GWCI and 85.10 percent in GWSI. Jowar was grown in 0.46 acres per farm in GWTI, 0.41 acres per farm in GWCI and 0.47 acres per farm in GWSI. It amounts to 21.46, 23.33 and 14.90 per cent of gross cropped area in GWTI, GWCI and GWSI respectively. Thus, Ragi was the predominant crop occupying the rainfed area across the three types of sample farms followed by Jowar and Dolichos (Avare) *(Table 1)*.

Table 1 Crop pattern fully dependent on rain fall among sample farmers in GWTI, GWCI and GWSI in Tumakuru

Crops	GWTI,		GWCI		GWSI	
	Avg. Area (acre)	Proportion to GCA	Avg. Area (acre)	Proportion to GCA	Avg. Area (acre)	Proportion to GCA
Ragi + Avare	1.68	78.57	1.36	76.67	2.69	85.10
Jowar	0.46	21.46	0.41	23.33	0.47	14.90
GCA	2.13	100	1.78	100	3.16	100
NCA	2.13		1.78		3.16	
Cropping intensity	100		100		100	

Note: *GCA- Gross cropped; NCA- Net cropped area* GWTI: Groundwater use under System percolation tank, GWCI: Groundwater use under Canal irrigation, GWSI: Groundwater use under sole irrigation, dependent only on rainfall for recharge

Crop pattern dependent on groundwater (Bore well) irrigation in the study area

The major ground water irrigation crops in the study were Coconut, Paddy Arecanut, Arecanut+Coconut, Banana, Tomato, Brinjal and Okra. Among all these crops, the gross irrigated area was highest for Coconut. It amounts to 44.59 per cent in GWTI, 54.94 per cent in GWCI and 58.46 per cent in GWSI *(Table 3)*. Paddy formed 14.65 per cent in GWTI, 10.55 per cent in GWCI and 4.40 percent in GWSI. Arecanut was grown in 11.28 per cent in GWTI, 10.46 per cent in GWCI and 16.34 per cent in GWSI. The percentage of gross irrigated area covered by coconut and Arecanut alone was 73.84 per cent in GWTI, 79.84 per cent in GWCI and 89.04 per cent in GWSI. Other crops which were grown under GWTI were Banana (3.54 per cent), Tomato (2.50), Brinjal (4.16 per cent) and Okra (1.31 per cent). In GWCI, Banana (1.53 per cent), Tomato (3.37 per cent)), Brinjal (2.90 per cent) and Okra (2.62 per cent) and in GWSI, Banana (2.25 per cent), Tomato (1.69 percent), Brinjal (1.31) and Okra (1.31 per cent) (*Table 3*). The net irrigated area per farm was higher in GWCI (6.38 acres) followed by GWTI (4.97 acres) and GWSI (4.23 acres). The irrigation intensity was highest in GWTI (219.25) followed by GWCI (189.94) and GWSI (180.24). Thus, more than 70 percent of the gross cropped area is devoted to perennial crops like Coconut and Arecanut in the study area across the three types of farm situations. This type of cropping pattern dominated by perennial crops in itself is a prima facie indicator of the farmers' coping mechanism to the groundwater scarcity, since perennial crops have greater capacity to withstand scarcity than seasonal and annual crops. In addition, by cultivating perennial crops which are not water intensive, the farmers in the study area have not only exerted less pressure on water, but also put the land to better use (Table 2)

Table 2 Crop pattern with well Irrigation among sample farmers in GWTI, GWCI and GWSI

Sl. No.	Crops	GWTI		GWCI		GWSI	
		Avg. Area (acre)	Proportion to GIA	Avg. Area (acre)	Proportion to GIA	Avg. Area (acre)	Proportion to GIA
1	Coconut	4.86	44.59	6.66	54.94	4.46	58.46
2	Arecanut	1.23	11.28	1.27	10.46	1.25	16.34
3	Mixed crop Coconut +Areca	1.96	17.97	1.75	14.44	1.09	14.24
4	**Total (1+2+3)**	**8.05**	**73.84**	**9.68**	**79.84**	**6.79**	**89.04**
5	Paddy	1.60	14.65	1.28	10.55	0.34	4.40
6	Banana	0.39	3.54	0.19	1.53	0.17	2.25
7	Tomato	0.27	2.50	0.41	3.37	0.13	1.69
8	Brinjal	0.45	4.16	0.25	2.09	0.10	1.31
9	Okra	0.14	1.31	0.32	2.62	0.10	1.31
10	**GIA**	**10.89**	**100**	**12.13**	**100**	**7.62**	**100**
11	**NIA**	**4.97**		**6.38**		**4.23**	
12	**Irrigation intensity**	**219.25**		**189.94**		**180.24**	

Note: *GCA- Gross cropped area ; NCA- Net cropped area* GWTI: Groundwater use under System percolation tank, GWCI: Groundwater use under Canal irrigation, GWSI: Groundwater use under sole irrigation, dependent only on rainfall for recharge

The crop pattern in rain fed situation is compared in across the three irrigation tanks GWTI, GWCI and GWSI. The major rain fed crops cultivated by farmers were Ragi, Jowar and Dolichos (Avare). More than 60 per cent of the rain fed area was devoted to Ragi in all the three situations, a major food crop of the area, and the second was Jowar which covered 21 per cent of the rain fed area in GWTI, 23 per cent in GWCI and 15 per cent in GWSI. The third major rain fed crop was Avare which covered about 10 per cent of the rain fed area in GWTI, 18 per cent in GWCI and 12 per cent in GWSI. The total area under rain fed crops was 75 acres in GWTI, 62 acres in GWCI and 111 acres in GWSI. Due to improved access to ground water, farmers of GWTI and GWCI devoted most of the land for commercial crops like coconut and Arecanut. The cropping intensity in all the three situations was 100 per cent for rain fed crops. Coconut and Arecanut were major plantation crops in all the three situations. Cropping pattern dependent on rainfall is almost the same in all the three situations. *(Table 2)*.

Costs and Returns

Among Rainfed crops, GWTI farmers realized the highest net returns per acre followed by GWCI and GWSI farmers. 24.31 per cent higher net reruns in Ragi+Avare was realised by GWTI farmers compared to GWSI farmers.While GWCI farmers realized 21.31 per cent higher net returns in Ragi+Avare as compared to GWSI farmers. The GWTI farmers realized 2.47 per cent higher in Ragi+Avare and 2.75 percent higher in Sorghum as compared to GWCI farmers *(Table 3)*.

Among the irrigated crops grown during the study area, farmers of GWTI realized higher net returns of 44 per cent in Paddy, 38 per cent in Coconut, 17 per cent in Aracanut, 29 percent in Arecanut+Coconut, 10 percent in Banana, 47 percent in Tomato, 10 percent in Brinjal and 17 per cent in Okra as compared to GWSI farmers *(Table 5)*.

The farmers of GWCI realized higher net returns of 31 per cent in paddy, 45 per cent in Coconut, 21 per cent in Aracanut, 42 percent in Arecanut + coconut, 60 percent in tomato, 09 percent in Brinjal and 14 per cent in Okra as compared to GWSI farmers. The farmers of GWTI realized higher net returns of 10 per cent in paddy, 14 percent in Banana, 54 percent in Tomato, and 3 per cent in Okra as compared to GWCI farmers *(Table 5)*. Thus, Considering both Rainfed and irrigated crops, the net returns per acre are higher in GWTI and

GWCI situations compared to GWSI situations. This shows the role of system irrigation tank in the crop and farm economy.

A comparison of net returns per acre from rain fed crops in GWTI, GWCI and GWSI; GWTI and GWCI, indicated that farmers realized the highest net returns per acre in Ragi, and Avare in GWTI and GWCI, it may be due to moisture conservation in these lands because of percolation of water from channel and tank. Similar results were indicated by Rajput (1996) andSarin and Ryan (1983).The net return for sorghum is almost equal in all the three situations because most of the farmers in GWTI and GWCI grew sorghum in newly established coconut gardens as intercrop and the shade and moisture effect was common across the two situations.

perennial crops which are not water intensive, the farmers in the study area have not only exerted less pressure on water, but also put the land to better use (Table 3)

Net returns per acre from irrigated crops

Among irrigated crops, Coconut and Arecanut are the main commercial crops in the study area. The net return per acre was higher for GWTI farmers compared to GWSI farmers by 38 per cent and 17 per cent in Coconut and Arecanut respectively. However GWTI farmers realized lower net return per acre by 5 per cent and 3 per cent in coconut and Arecanut respectively as compared GWCI farmers.

Table 3 Economics of rain fed crops in GWTI, GWCI and GWSI(Rs. Per acre)

Crops	GWTI			GWCI			GWSI			Percentage change (1 over 3)	Percentage Change (2 over3)	Percentage change (1 over 2)
	1			2			3					
	TC	GR	NR	TC	GR	NR	TC	GR	NR			
Ragi +Avare	3497	5732	2234	3478	5658	2180	3398	5194	1797	24.31	21.31	2.47
Sorghum	3375	6400	3025	3034	5979	2944	3303	6388	3085	-1.94	-4.57	2.75

GWTI: Groundwater use under System percolation tank, GWCI: Groundwater use under Canal irrigation, GWSI: Groundwater use under sole irrigation, dependent only on rainfall for recharge, TC: Total cost, GR: Grass return, NR: Net return

Table 4 Economics of well irrigated crops in GWTI, GWCI and GWSI(Rs. Per acre)

Crops	GWTI			GWCI			GWSI			Percentage Change in net returns (1 over 3)	Percentage Change in net returns (2 over 3)	Percentage Change in net returns (1 over 2)
	1			2			3					
	TC	GR	NR	TC	GR	NR	TC	GR	NR			
Paddy	8404	19432	11028	8620	18679	10059	8200	18117	7659	43.99	31.34	9.63
Coconut	13503	23888	10385	13851	24811	10961	16025	23571	7546	37.62	45.25	-5.25
Arecanut	40684	82544	41861	43037	86261	43225	43369	79105	35736	17.14	20.96	-3.16
Coco+areca	43900	60823	16923	42627	61265	18638	47639	60761	13121	28.98	42.04	-9.20
Banana	51647	123737	72090	55366	118531	63164	52335	117942	65607	9.88	-3.72	14.13
Tomato	30650	55152	24502	28695	44573	15878	26887	36800	9913	147.16	60.16	54.32
Brijal	21659	47415	25755	22324	47748	25424	18676	42000	23324	10.42	9.00	1.30
Okra	7710	20000	12290	7844	19820	11976	7033	17500	10467	17.42	14.42	2.62

GWTI: Groundwater use under System percolation tank, GWCI: Groundwater use under Canal irrigation, GWSI: Groundwater use under sole irrigation, dependent only on rainfall for recharge, TC: Total cost, GR: Grass return, NR: Net return

Crop pattern dependent on groundwater irrigation

Considering the crop pattern with groundwater irrigation in GWTI, GWCI and GWSI, the major crops grown are Paddy, Coconut, Arecanut, Banana, Tomato, Brinjal and Okra. The major portion of irrigated area was devoted to coconut it is about 44 per cent in GWTI, 55 per cent GWCI and 58 percent in GWSI. Arecanut formed second major irrigated crop in all the three situations. The total area under Coconut and Arecanut was 74 per cent in GWTI, 80 per cent GWCI and 89 percent in GWSI. (by treating one acre of coconut and Arecanut =2 acres). Paddy and vegetables were the other ground water irrigated crops in GWTI and GWCI but not in GWSI. This is one of the basic impacts of channel water to the ground water irrigated farms. The irrigation intensity is higher for GWTI and GWCI as compared to GWSI due to better access to ground water and yield of bore wells. Similar results were indicated in the studies of Karam Singh *et al*.(1991), Karunakaran and Palanisami (1998). Thus, more than 70 percent of the gross cropped area is devoted to perennial crops like Coconut and Arecanut in the study area across the three types of farm situations. This type of cropping pattern dominated by perennial crops in itself is a prima facie indicator of the farmers' coping mechanism to the groundwater scarcity, since perennial crops have greater capacity to withstand scarcity than seasonal and annual crops. In addition, by cultivating

The net return per acre in Coconut + Arecanut (mixed crop) garden for GWTI farmers was lower by 9 per cent as compared to GWCI farmers. However they realized higher net return per acre in other ground water irrigated crops. Thus, considering both Rainfed and irrigated crops, the net returns per acre are higher in GWTI and GWCI situations compared to GWSI. This shows the role of system irrigation tank in the crop and farm economy. These results are in conformity with the results of studies by Tyagi (1982).

CONCLUSIONS

Ragi was the predominant crop occupying the rainfed area across the three types of sample farms followed by Jowar and Dolichos (Avare). Ragi was grown in 51.25 acres in GWTI, 36.78 acres in GWCI and 81 acres in GWSI, and formed 69 per cent of gross cropped in GWTI, 59 per cent GWCI and 73 percent in GWSI.

The major ground water irrigation crops in the study were Coconut, Paddy Arecanut, Arecanut+Coconut (mixed crop), Banana, Tomato, Brinjal and Okra. Among all these crops, the gross irrigated was highest for Coconut. It amounts to 44.29 per cent in GWTI, 54.94 per cent in GWCI and 58.46 per cent in GWSI.

More than 70 percent of the gross cropped area is devoted to perennial crops like Coconut and Arecanut in the study area across the three types of farm situations. This type of cropping

pattern dominated by perennial crops in itself is a prima facie indicator of the farmers' coping mechanism to the groundwater scarcity, since perennial crops have greater capacity to withstand scarcity than seasonal and annual crops.

Hemavathy canal project provides irrigation water for Right Bank Canal command. In rainy season, this area is fully flooded with water and at the same time the farmers of Left Bank Canal command are struggling to get drinking water. Thus, water needs to be put to productive and efficient use by linking this water in all low level areas where ever possible. It will increase ground water recharge and improve socioeconomic status of the farmers besides protecting the ground water table.

The Irrigation Department needs to examine the possibilities of linking most of the tanks in Hemavathy command area through channels from Hemavathy reservoir. This will ensure water availability throughout the year for farmers to cultivate perennial crops since these crops are low water users compared to annual and seasonal crops.

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