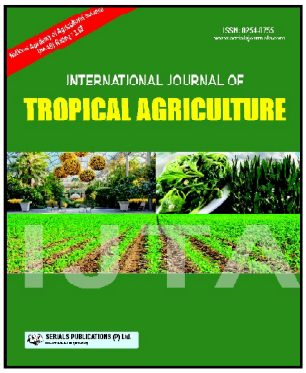

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Welfare Implications of Irrigation Tanks and Canals on Crop Yield and Income Generation in Hard Rock Areas of Karnataka

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Abstract: The efforts to impound surface water through watershed development programs, Tank desiltation, Tank rehabilitation, Construction of percolation ponds are continuing unabated in Southern India, with Karnataka being no exception. Thus the Ecological services of irrigation tanks and canals in groundwater recharge and welfare Implications in Hard Rock Areas of Tiptur, India are studied. Primary data from 35 farmers each from (i) farmers owning irrigation wells in system irrigation tank (GWTI), (ii) farmers owning irrigation wells in canal irrigation (GWCI), and (iii) farmers owning irrigation wells in areas not served by tanks and canals or farmers under sole irrigation (GWSI). About 33% are small farmers (< 5 acres), 50% medium (5-10 acres) and 17% large farmers (>10). More than 70 per cent of cropped area is under Coconut /Arecanut, the coping mechanism due to groundwater scarcity. Surface water recharge from tank and canal had reduced economic cost of groundwater and improved net farm income. This study is a modest attempt to know the Welfare implications of irrigation tanks and canals on crop yield and income generation in hard rock areas of Karnataka under three situations of recharge in Tiptur taluk, Tumkur district of Karnataka.

Key words: Groundwater, recharge, irrigation wells, hard rock area, Net return.

INTRODUCTION

In the regions without perennial rivers, groundwater recharge suffers as in the Deccan plateau, unlike the Indo–Gangetic plains which receive both snow melt water from the Himalayas as well as the rainwater. Thus, efforts to impound surface water through

watershed development programs, Tank desiltation, Tank rehabilitation, Construction of percolation ponds are continuing unabated in Southern India, with Karnataka being no exception. Increased groundwater table through recharge is one of the important impacts of Tank Rehabilitation. Both irrigation and drinking water wells are benefited through rehabilitation. Wells in and around get recharged due to tank rehabilitation and supplement tank irrigation and, in some cases, even act as the main source of irrigation during lean period. Thus, the augmented recharge directly benefits the land owning farmers and indirectly benefits the poor and landless through an increase in employment days.

In this study, the economics of groundwater recharge is studied in Tumkur district 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, The Hemavathy masonry dam is constructed in Gorur in Hassan District which impounds 78 TMC of water assuming 50 per cent 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.

This study is a modest attempt to know the Welfare implications of irrigation tanks and canals on crop yield and income generation in hard rock areas of Karnataka under three situations of recharge in Tiptur taluk, 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 without canal or tank irrigation command (called groundwater under sole irrigation GWSI), which depend only on rainfall source have been considered.

METHODOLOGY

Tumkur district has emerged as the most over-exploited district in terms of groundwater extraction and use in Karnataka. 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 (ground-water depletion).

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 Tiptur taluk, 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 a random sample of 35 farmers was drawn from each of the three scenarios, thus, totaling 105 farms were selected for the purpose of this study.

Data Base

The schedule prepared for this study was used to elicit primary data from the sample farmers through personal interviews. The information elicited included

1. general information regarding the socioeconomic features of the respondents
2. cropping pattern
3. land holdings
4. Sources of irrigation
5. investment on irrigation wells
6. Costs and returns from crops grown under well irrigation and
7. volume of water used.

Analytical Frame Work

Weighted average was computed in respect of socio-economic features, 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).

RESULTS AND DISCUSSION

The results of the study on Welfare implications of irrigation tanks and canals on crop yield and income generation in hard rock areas of Karnataka pertaining to the sample farmers owning irrigation wells in different situations such as System Tank *i.e.*, Irrigation wells located under tank command (GWTI), Irrigation wells located under canal command (GWCI) and Irrigation wells not located under tank or canal command (GWSI) are presented in detail.

Socio-economic Features of Sample Farmers in the Study Area

Out of 105 sample farmers, 35 farmers each from System Tank *i.e.*, Irrigation wells located under tank command (GWTI), Irrigation wells located under canal command (GWCI) and Irrigation wells not located under tank or canal command (GWSI) formed the total sample. The average size of the family was higher in GWTI (6.29 No.) as compared to GWSI (5.69 No.) and GWCI (5.06 No). Considering the educational status, literacy rate was higher in GWCI and GWSI (63 per cent each) compared to GWTI (60 per cent). Small farmers formed 37 per cent of the sample in GWTI, 23 per cent in the GWCI and 43 per cent in GWSI. Medium farmers formed 51 per cent in the GWTI, 54 per cent in GWCI and 40 per cent in the GWSI. Large farmers formed 11 per cent of the sample in GWTI, 23 per cent in GWCI and 17 per cent GWSI. (Table 1) The average size of the holding was higher in GWCI (7.33 acres) than GWTI (6.58 acres) and GWSI (6.31 acres). Rainfed area was slightly higher in GWSI (2.51 acres) followed by GWTI (1.76 acres) and GWCI (1.00 acres).

Groundwater irrigated area owned by sample farmers was 6.38 acres per farm in the GWCI while it was 4.97 acres in GWTI and 3.87 acre in GWSI. The number of farm equipments was lower in the GWSI compared to GWTI and GWCI. In the GWTI, the total number of bullock carts, tractors and irrigation pump sets in the sample were 11, 5 and 48, while in the GWCI they were 7, 8 and 60 respectively. In the GWSI, the total number of bullock carts, tractors and irrigation pump sets were 11, 3 and 43 respectively. Regarding the livestock of

the sample farmers, the total number of local cows, crossbred cows and she-buffaloes were 9, 32 and 37 in the GWTI and 9, 22 and 27 in GWCI, while it was 10, 14 and 23 in GWSI respectively. In the GWTI the total number of drought animals, sheep, poultry and calves were 28, 25, 10 and 21 and they were 18, 0, 0 and 20 in GWCI and 38, 30, 12 and 13 in GWSI respectively (Table 1).

Table 1
Socio-economic features of sample farmers in GWTI, GWCI and GWSI in Tiptur.

Sl. No.	*Particulars*	*GWTI*	*GWCI*	*GWSI*
1.	*Demographic features*			
	Number of Sample farmers	35	35	35
	Family size (No. of members)	6.29	5.06	5.69
	Experience in farming	33.60	28.51	32.54
2.	*Educational status in the sample (Number and percentage)*			
	Primary	10 (28.57)	9 (25.71)	9 (25.71)
	High school	7 (20.00)	4 (11.43)	9 (25.71)
	College	4 (11.43)	7 (20.00)	2 (5.71)
	Degree	0 (0.00)	2 (5.71)	2 (5.71)
	Illiterate	14 (40.00)	13 (37.14)	13 (37.14)
3.	*Land holding details of farmers (Number and percentage)*			
	(a) Small farmer (< 5 acres)	13 (37.14)	8 (23)	15 (43)
	(b) Medium farmers (5 to 10 acres)	18 (51.43)	19 (54)	14 (40)
	(c) Large farmers (> 10 acres)	4 (11.43)	8 (23)	6 (17)
4.	No. of farmers with ground-water irrigation wells	35 (100)	35 (100)	35 (100)
5.	Average Size of holding (acres)	6.58	7.33	6.31
6.	Rain fed (acres)	1.76	1.00	2.51
7.	Net Groundwater irrigated per farm (acres)	4.97	6.38	3.87
8.	*Farm equipment among sample farms*			
	No. of bullock carts in the sample	11	7	11
	No. of tractors in the sample	5	8	3
	No. of irrigation pump sets in sample	48	59	43
9.	*Livestock among sample farms*			
	Local cow	9	9	10
	Cross breed cow	32	22	14
	She buffaloe	37	27	23
	Drought animals	28	18	38
	Sheep	25	0	30
	Poultry	10	0	12
	Calves and heifers	21	20	13

Note: Figures in the parentheses indicate percentage to the respective total.

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.

Experience in farming is a crucial factor influencing the decision making process. The average experience in farming of the sample farmers was around 30 years indicating that the sample farmers were in the middle age. The size of the farm family and literacy was higher in GWTI and GWCI than in GWSI. The literacy rate indicates that the farmers in these areas are not deprived of basic education. The average size of the holding per farm was relatively higher in GWTI (6.58 acres) and GWCI (7.33 acres) than GWSI (6.31 acres). Thus on an average in all the three types of irrigation tanks, the large farmers are a rule than an exception. The rain fed area was lower in GWTI (1.76 acres) and GWCI (1.00 acre) as compared to GWSI (2.51 acres). Thus the rainfed area formed 27 per cent of the size of the holding in GWTI,

14 per cent in GWCI and 40 per cent in GWSI. The gross irrigated area per farm of sample farmers was 10.89 acres in GWTI, 12.13 acres in the GWCI while it was 7.62 acres in GWSI. Considering that 1 acre of coconut = 2 acres, 1 acre of Arecanut = 2 acres for the purpose of calculating the gross cropped area, this indicates an appreciable increase in access to irrigation water in GWTI and GWCI. These results are in conformity with the results of by other research studies (Chandrashekar and Bhat (1992), Kolavalli and Atheeq, (1993). Considering the livestock numbers in the study area, the total number of local cows, crossbred cows, she-buffaloes and Drought animals were 9, 32, 37 and 28 in the GWTI and 9, 22, 27 and 18 in GWCI, while it was 10, 14, 23 and 38 in GWSI respectively. This revealed that the channel water linkage was not only resulted in area expansion, but also lead to increase in livestock per farm.

Crop Pattern with Well Irrigation Among Sample Farmers

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 44.29 per cent in GWTI, 54.94 per cent in GWCI and 58.46 per cent in GWSI (Table 2). Paddy formed 14.65 per cent in GWTI, 10.55 per cent in GWCI and 4.40 per cent 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)

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

		GWTI		*GWCI*		*GWSI*	
Sl. No.	*Crops*	*Area (acre)*	*Proportion to GIA*	*Area (acre)*	*Proportion to GIA*	*Area (acre)*	*Proportion to GIA*
1	Coconut	170	44.29	233.20	54.94	156	58.46
2	Arecanut	43.00	11.28	44.40	10.46	43.6	16.34
3	Mixed crop Coconut +Areca	68.50	17.97	61.28	14.44	38.00	14.24
4	Total (1 + 2 + 3)	281.50	73.84	338.88	79.84	237.6	89.04
5	Paddy	55.86	14.65	44.76	10.55	11.75	4.40
6	Banana	13.5	3.54	6.50	1.53	6.00	2.25
7	Tomato	9.53	2.50	14.32	3.37	4.50	1.69
8	Brinjal	15.86	4.16	8.88	2.90	3.50	1.31
9	Okra	5	1.31	11.10	2.62	3.50	1.31
10	GIA	381.25	100	424.44	100	266.85	100
11	NIA	173.89		223.46		148.05	
12	Irrigation intensity	211.22		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.*

and in GWSI, Banana (2.25 per cent), Tomato (1.69 per cent), Brinjal (1.31) and Okra (1.31 per cent) (*Table 2*). 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 per cent 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 (Table 2).

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 which is about 44 per cent in GWTI, 55 per cent in GWCI and 58 per cent 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 per cent 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 Katar Singh (1991), Karunakaran and Palanisami (1998). Thus, more than 70 per cent 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).

Costs and Returns

In the study area 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 realized 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 per cent higher in Sorghum as compared to GWCI farmers (Table 3).

Net Returns Per Acre from Irrigated Crops

Among the irrigated crops grown in the study area, farmers of GWTI realized higher net returns of 44 per cent in Paddy, 38 per cent in Coconut, 17 per

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

	GWTI			*GWCI*			*GWSI*					
	1			*2*			*3*					
Crops	*TC*	*GR*	*NR*	*TC*	*GR*	*NR*	*TC*	*GR*	*NR*	*Percentage change (1 over 3)*	*Percentage change (2 over 3)*	*Percentage change (1 over 2)*
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.

cent in Aracanut, 29 per cent in Arecanut+Coconut, 10 per cent in Banana, 47 per cent in Tomato, 10 per cent in Brinjal and 17 per cent in Okra as compared to GWSI farmers (Table 4).

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 per cent in Arecanut + coconut, 60 per cent in tomato, 09 per cent 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 per cent in Banana, 54 per cent in Tomato, and 3 per cent in Okra as compared to GWCI farmers (Table 4). 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.

Among irrigated crops in the study area, coconut and Arecanut are the main commercial crops. 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. 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

- More than 70 per cent 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

Table 4
Economics of well irrigated crops in GWTI, GWCI and GWSI, 2007-08 (Rs. Per acre)

	GWTI			*GWCI*			*GWSI*					
	1			*2*			*3*					
Crops	*TC*	*GR*	*NR*	*TC*	*GR*	*NR*	*TC*	*GR*	*NR*	*Percentage change in net returns (1 over 3)*	*Percentage change in net returns (2 over 3)*	*Percentage change in net returns (1 over 2)*
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

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.

- 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.
- This study apparently is a pointer towards the role of channel water linkage in promoting ground water recharge. The farms served by System Tank (GWTI) and Canal command (GWCI) have registered the highest net returns compared with farms in GWSI. This indicates the supremacy of the performance of GWTI and GWCI in heralding agricultural development due to recharge from irrigation tank and canal commands.

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