

# An Analysis of Conjunctive Water use Plan in Thayagondanahalli Tank in Karnataka, India

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## Abstract

A pilot study was taken up in the tank command area of Thayagondanahalli tank of Madhugiri taluk, Tumkur district of Karnataka with the objective of preparing the crop plans in different seasons considering the conjunctive use of surface and ground water available in the command area. The study was taken up using farmers participatory approach. The study also aimed at educating and motivating the farmers on conjunctive water use. Keeping the point of efficient water balance and utilization of available water resources had been analyzed and based on this, the crop plan had been prepared. The results of the study revealed that the cropping pattern had shifted from higher water consumptive crops to lower water consumptive and high value crops such as vegetables, flowers and Mulberry than paddy alone as in the case of traditional crops. It was also observed that the cost-benefit ratio of field crops, vegetable crops, flower and Mulberry showed significant improvement due to intervention initiated in the tank command. This has resulted higher economic returns and improved the socio-economic status of farmers of the area.

**Keywords:** Ground Water, Surface Water, Conjunctive Water Use, Crop Plan, Water Use Efficiency

## I. INTRODUCTION

The total water resources comprise surface and ground water which are being used for agriculture, industries, drinking and other uses. Surface water resources were primarily being used for irrigation as it was easy to exploit them. The resources to ground water were taken in areas where surface water was not available. All big and small irrigation projects were planned on surface water system[1]. Such large scale uses of surface water without giving any attention to the ground water resulted in water logging and turning the fertile land in to banner. Thus, to prevent and rectify the problem, the conjunctive use of surface and ground water is of utmost important[2]. The concept of treating surface and ground water independently should now give place to their being considered in an integrated manure to achieve to optimal utilization of the water resources and maximize the agriculture production per unit of water. With this background, a pilot study 'to prepare work plan for conjunctive use of tank and ground water through farmers participatory technique' was taken up during 2002 by University of Agricultural Sciences, Bangalore in its consultancy project namely, Karnataka Community Based Tank Management Project funded by the World Bank.

### A. Advantages of Conjunctive Water Use

Meeting the water requirement of crops timely supply of ground water in adequate quantities is essential for a good crop yield. It is all the more necessary in case of high yielding varieties. Surface water schemes do not sufficient flexibilities and so the roster of the operating channels cannot be adjusted to provide timely irrigation in the command areas for various crops with different base and critical periods. The needs cannot also be economically met from ground water alone on account of pumping. Thus conjunctive use can help to meet the requirements both in respect of quantity and time[3].

## II. MATERIAL AND METHODS

The conjunctive water use plan was prepared tank wise depending upon the crop plans initiated in the tank command. The borewell discharge and availability of water in the corresponding year was considered for taking up this cropping pattern. Keeping the number of borewells in the command, borewell owners and neighbouring farmers demand for water based on the crops taken was analyzed. Further availability of water from outside borewells and drawing/ sharing water to the command areas by the farmers were also worked out. Keeping these points, the total water available from the borewells both from within the command and outside the command areas was considered for sharing and growing the crops in these commands by owners of the wells as and neighbouring farmers with an mutual understanding between them to share the excess water at the time of critical stages of crop growth. The maximum evaporation during the season made to go for frequent irrigation as soil moisture was depleted in short period of time. Out of 13 running borewells in the command 273.35 ha-cm was shared by 16 farmers for 4.1 ha crop area. The crops grown were Marigold, Ragi, Sunflower, Vegetable and Paddy. Borewell-1, Borewell-2, Borewell-4 and Borewell-12 farmers were agreed to share 273.35 ha-cm of ground water for neighbouring farmers after utilizing 1064.75 ha-cm for their crops in the command area. In this way the conjunctive water use plan was worked out and initiated in the tank.

Along with Tank Management Institution (TMI) members, season wise work plan for conjunctive water use plan for the tank was developed and implemented with the help of technical staff. While initiating the plan, the status of rain fall, evaporation and ground water exploitation through borewells and openwells in the command area was considered. Based on the experiences gained in the TMI and with the help of Jala Samvardhane Yojane Sangha (JSYS) the field staff was influenced the additional coverage area with Suitable short duration crops like vegetables, flowers & other arable crops by providing critical inputs from the project to help in educating the community for effective utilization of conjunctive water use plan to get higher and additional income.

The farmers involved in the study were convinced to save water upto 25-30 percent by giving irrigation once in 3 days instead of daily irrigation. Based on crop need and after ascertaining moisture status and only during critical stages of crop growth water was given. Alternate furrow irrigation was given to mulberry crop. The IPM practices were also adopted especially in tomato crop for controlling insects pests and diseases by way of reducing chemical sprays. This has helped farmers to understand and to go for use of trap crops, pheromone traps, Panchagavya, Trichoderma and NSKE.

### III. RESULTS AND DISCUSSION

During kharif 2005 the quantity of irrigation water shared was quite less as there was a good distribution of rainfall during the season. Similarly, the tank had surplused several times. So rain water and tank water was utilized effectively by the farmers for land preparation and crop irrigation. The ground water was exploited for fulfilling crop requirement at initial months of the year (summer crops of previous year) and also during kharif season.

During kharif 2005, the tank water over flowed on several occasions from August to September and collected 1010 ha-cm of water. In addition, about 0.5 cusec of water was continuously flowing from sluice due to a small hole below the sluice inlet. The channel work in the command was not complete. Owing to this situation, paddy was planned in the head and mid reach of tank command. The water flowing through waste weir was utilized for agriculture by diverting the same into the farmers fields in small streams. In tail end, groundnut and ragi were planned and were sown well before the tank filling. Out of 1697 ha-cm of runoff water, 697 ha-cm was surplused. With the remaining 1010 ha-cm of tank water 599 ha-cm of water was utilized for kharif crops

#### A. Ground Water

There was no much exploitation of ground water was observed during kharif 2005 (Table-1). Out of total exploitation of 84.82 ha-cm, only 60.68 ha-cm of water was utilized in the command area and outside command area. There was no demand created for ground water by non borewell farmers. So only 3.15 ha-cm of ground water was shared by five farmers for 0.71 ha of paddy and areca nut (Table-2). Only two outside borewell owners were agreed to share the ground water for other farmers with water rate of 1/3<sup>rd</sup> of the produce.

Table – 1  
Water use efficiency of crops of Thayagondanahalli tank command during kharif- 2005

Sl. No	Crops	Area (ha)	Water utilization (ha-cm)				Average Yield (q/ha)	WUE (kg/ha-cm)	C:B
			Effective Rainfall	Bore well water	Tank water	Total			
<i>Command area 14.09 ha</i>									
	Ragi	3.16	127.33	-	-	127.33	29.0	72.0	1.8
	Paddy	6.02	427.54	2.0	93.32	522.0	47.5	54.8	2.0
	Groundnut	1.24	49.78	-	-	49.78	16.25	40.5	2.2
	Napier	0.28	10.70	6.10	-	16.8	565.0	941.0	3.5
	Mulberry	0.18	12.89	-	-	12.89	490	773.7	2.5
	<b>Total</b>	<b>10.88</b>	<b>628.24</b>	<b>8.10</b>	<b>93.32</b>	<b>728.8</b>			

Table - 2  
Conjunctive water use of borewell irrigation during 2005-06

Season	Borewell farmers		Sharing farmers		No. of farmers
	Crop area (ha)	Water used	Crop area (ha)	Water used (ha-cm)	
Kharif	1.49	57.53	0.17	3.15	5
Rabi/summer	1.42	102.59	1.87	20.61	13
<b>Total</b>	<b>2.91</b>	<b>160.12</b>	<b>2.58</b>	<b>23.76</b>	<b>18</b>

#### B. Conjunctive Water use of Thayagondanahalli Tank Command during Rabi/summer 2005-06

With the water reserved in the tank and from borewell water conjunctive water use plan was discussed in TMI and implemented in the command. Out of 411 ha-cm of tank water 300.75 ha-cm was utilized for paddy crop (2.55 ha). Totally 4.23 ha of crop area was existed during this season. The tank water was utilized by the head reach and mid reach farmers as there was good conveyance system existed. There was no proper conveyance for tail end of command area during 2005.

As compared to previous season, 20.61 ha-cm of ground water was shared among 13 farmers in the command area. It was 2.58 ha area covered under conjunctive water use during summer season. The ground water was utilized directly from borewell to crop field through the channels and through rubber pipes. Channels were kept clean and repaired so as to check the conveyance losses. The increase in the water sharing mechanism was mainly due to the awareness on water utilization and capacity building on

conjunctive water use plan. So there was 1.76 ha of area increased under cultivation as compared to rabi/summer 2004-05. The details of conjunctive water use for borewell irrigation are given in Table-3.

Table – 3  
Water use efficiency of crops of Thayagondanahalli tank command during rabi/summer 2005-06

Sl. No	Crops	Area (ha)	Water utilization (ha-cm)				Average Yield (q/ha)	WUE (kg/ha-cm)	C:B
			Effective Rainfall	Bore well water	Tank water	Total			
Command area 14.09 ha									
	Paddy	2.55	61.84	20.6	127.0	210	49.25	59.8	2.92
	Groundnut	0.17	4.12	2.63	-	6.75	18.9	47.6	1.75
	Areca nut	0.60	14.55	32.70	-	47.25	10.9	13.84	2.75
	Mulberry	0.18	4.37	7.76	-	12.13	519.7	771.2	3.0
	Napier	0.04	0.37	2.03	-	2.4	590.0	983.3	4.0
	Fodder maize	0.10	3.43	2.57	-	6.0	712	1186.0	4.0
	Total	3.64	88.28	66.91	127.0	284.53			

### C. Conjunctive Water use of Thayagondanahalli Tank Command during during kharif- 2006

It was uneven distribution of rainfall recorded in the year 2006. There was no runoff occurred in the catchment. So no water was collected in the tank during this period. Rainfall was utilized for land preparation in command area. But subsequent rains failed for further crop production activities. The total area sown during kharif season was very less due to poor rainfall distribution.

The WUE of transplanted paddy was 60.97 kg/ha-cm and for Ragi it was 75.12 kg/ha-cm. There was improvement in WUE in Paddy, Ragi, Mulberry and Napier crops compared to previous year (54.8 and 72.0, 773.7, 941.6 respectively). It was due to good water management practices adopted by the farmers. (Table-4).

Table – 4  
Water use efficiency of crops of Thayagondanahalli tank command during kharif- 2006

Sl. No	Crops	Area (ha)	Water utilization (ha-cm)				Average Yield (q/ha)	WUE (kg/ha-cm)	C:B
			Effective Rainfall	Bore well water	Tank water	Total			
	Paddy	1.77	57.08	82.3	2.86	142.24	49.0	60.97	2.47
	Ragi	1.20	38.70	9.64	-	48.34	30.3	75.12	1.88
	Fodder maize	1.67	53.86	0.97	30.00	84.83	710.0	1397.74	4.33
	Areca nut	0.60	19.35	13.15	-	42.5	11.2	15.81	2.6
	Mulberry	0.18	5.81	5.19	-	11.0	517.3	846.41	2.75
	Napier	0.04	1.29	1.21	-	2.5	601.0	961.60	3.66
	Total	5.46	176.09	111.56	32.86	331.41			

### D. Cost Benefit Ratio

The C: B ratio was maximum for the Fodder Maize (4.33) followed by Napier (3.66), Mulberry (2.75), Arecanut (2.6), Paddy (2.47) and ragi (1.88) in that order.

### E. Conjunctive water use of Thayagondanahalli tank command during Rabi/summer 2006-07

The conjunctive water use plan was prepared for *summer* season for Thayagondanahally tank command considering groundwater availability. There was no alternate source of water for irrigation. It was recorded that the borewell yield was declining during the period. So the availability was not much as in previous year. Seven borewells were working in the command area and 767.89 ha-cm of ground water was expected. Out of which 235.4 ha-cm of water was planned for command area crops. Remaining 532.49 ha-cm of water was planned for crops of outside command area. The total crop area planned was 3.95 ha only. Further increase in area was not feasible due to poor allocation of inputs by the command area farmers where the number of marginal farmer were more compared to other category. The groundwater sharing was planned to 0.91 ha of 8 farmers for 68.4 ha-cm of water. The water used by the borewell farmers was estimated to 167 ha-cm (Table-5).

Table – 5  
Conjunctive water use under borewell irrigation during 2006-07

Season	Borewell farmers		Sharing farmers		
	Crop area (ha)	Water used (ha-cm)	Crop area (ha)	Water used (ha-cm)	No. of farmers
Kharif	1.46	167.15	1.65	34.15	13
Rabi/summer	3.04	167.00	0.91	68.40	8
Total	5.50	334.15	2.56	102.53	15

Table – 6  
Water use efficiency of crops of Thayagondanahalli tank command during Rabi/Summer- 2006-07

Sl. No	Crops	Area (ha)	Water utilization (ha-cm)				Average Yield (q/ha)	WUE (kg/ha-cm)	C:B
			Effective Rainfall	Bore well water	Tank water	Total			

	Groundnut	1.00	18.16	16.10	10.44	44.7	19.2	42.95	2.01
	Areca nut	0.60	10.90	13.60	20.33	44.83	11.2	14.98	2.34
	Mulberry	0.18	1.33	9.50	-	10.83	523.00	869.25	2.5
	Napier	0.12	6.75	0.75	-	7.5	597.00	955.20	3.8
	Fodder maize	0.50	13.58	16.87	-	30.45	729.0	1197.04	4.2
	Paddy	2.15	39.04	46.25	102.6	180.89	50.25	59.73	2.2
	Total	4.55	82.63	103.07	133.37	319.2			

The WUE was maximum for Fodder maize 1197.04 kg/ha-cm and for Napier it was 955.20 kg/ha-cm. Table-6. There was improvement in WUE in all the crops compared to previous years. It was due to good water management practices adopted by the farmers.

#### F. Cost benefit ratio

The C: B ratio was maximum for the Fodder Maize (4.2) followed by Napier (3.8), Mulberry (2.5), Arecanut (2.34), Paddy (2.2) and groundnut (2.01).

#### G. Participatory Technology Development

Conventional paddy consumes highest water (120 ha-cm) than any other field crops. This was also true with respect to per day water consumption of water to produce one kg of grain. During kharif 2005 and 2006, paddy was the only crop in Thayagondanahally tank command area grown maintaining a standious water of 5-10 cm in the paddy fields.

Instead of daily irrigation to transplanted paddy it was decided to irrigate once in three days. This was decided in consultation with the farmers. To begin with, this was demonstrated on two farmers fields (0.4 ha). This technology was referred as 'On and off' method of irrigation. The farmers were of the opinion that the water could be saved upto 20 per cent by this method. Farmers appreciated this technology and followed in kharif 2006 also.

#### H. Conjunctive water use of Thayagondanahalli tank command during Kharif 2007

Rainfall was fairly good during 2007 and runoff occurred in the catchment and hence, water was collected in the tank. But rainwater was utilized for land preparation in command area. Subsequent rains occurred for further crop production activities. The total area sown during kharif season was very less due to good rainfall distribution.

Out of total command area of 14.09 ha the net cropped area during kharif was only 7.22 ha. Which was under paddy, ragi, maize and Arecanut. The ground water exploited from six borewells during kharif. The water sharing farmers hired borewell water at the cost of 1/3<sup>rd</sup> portion of crop produce. Major portion of ground water was shared from adjacent borewell only because, there was only one borewell existed in the command area. Efforts were made to fix unit cost of irrigation water used by sharing farmers. The average cost per ha-cm was estimated was Rs 550. The improved irrigation practices helped in saving water which was utilized for other crops and extension of area.

#### I. Water use Efficiency

Water use efficiency of crops grown during kharif recorded for five crops and are given in Table-7. Among food crops, maize gave higher water use efficiency (94.0 kg/ha-cm) followed by Ragi (80.53 kg/ha-cm). The water use efficiency of paddy was higher compare to the previous season (60.41 kg/ha-cm). The arecanut had water use efficiency of 4.79 kg/ha-cm. In case of Napier fodder crop, highest water use efficiency (992.0 kg/ha-cm) was recorded. The improved water use efficiency could be attributed to improved package of practice and awareness on water management.

Table – 7  
Water use efficiency of crops of Thayagondahalli tank command during kharif- 2007

Sl. No.	Crop	Area (ha)	Water utilization (ha-cm)				Average Yield (q/ha)	WUE (kg/ha-cm)	C:B
			Effective Rainfall	Borewell water	Tank water	Total			
	Paddy	3.11	58.41	23.0	177.28	258.69	50.25	60.41	1.8
	Ragi	1.95	36.62	3.0	39.08	78.7	32.5	80.53	1.5
	Maize	0.81	15.21	19.49	5.8	40.5	47.0	94.00	2.6
	Napier	0.04	0.75	1.15	0.6	2.5	620.0	992.00	2.1
	Areca nut	1.31	24.60	13.46	31.44	69.5	11.65	21.95	2.7
	Total	7.22	135.59	332.7	254.2	449.89			

#### J. Cost benefit ratio

The economics of crops were worked out and are given in Table-9. There was no much difference in C:B of kharif crops than previous year. Among all the crops Arecanut had highest returns with 4.2 followed by maize with 2.6 and Napier with 2.1 C:B ratio.

### K. Conjunctive water use plan for rabi/summer 2007

There was no alternate source of water available for irrigation. It was recorded that the borewell yield was declining in that period and availability was not much as in previous year. Six borewells are working in the command adjacent area expecting 797.81ha-cm of ground water. Out of which 246.2 ha-cm of water was planned for borewell owner crops and remaining 296.25 ha-cm of water was shared among 20 farmers in 4.28 ha. The total cropped area planned was 7.1 ha only. The details are given in Table-8

Table – 8

Conjunctive water use under borewell irrigation

Season	Borewell farmers		Sharing farmers		
	Crop area (ha)	Water used (ha-cm)	Crop area (ha)	Water used (ha-cm)	No. of farmers
Kharif	1.47	50.3	2.26	197.63	10
Rabi/summer	3.16	246.2	4.28	296.25	20
Total	4.63	296.5	6.54	493.88	30

### L. Cost Benefit Ratio of Crops

The net returns were worked out for crops of Thayagondanahally tank command area from *kharif* 2005 to *kharif* 2007 and are given below (Table-9). The net returns during *kharif* 2007 was Rs. 26676.96 per hectare with C:B of 2.88. The increase in C:B was Rs. 0.22 The reason for it was increase in area and yield and good distribution of rainfall during the crop period. But as compared to *kharif* 2005 the net return was increased up to Rs. 6749 per hectare.

### M. On and off method of irrigation

In paddy crop, instead of daily irrigation to transplanted paddy it was decided to irrigate once in three days. This was decided in consultation with the farmers. To begin with, this was demonstrated on two farmers fields (0.4 ha). This technology is referred as 'On and off' method. The farmers had the opinion that the water savings could be up to 20 per cent by this method. Farmers appreciated this technology and followed in *kharif* 2007 also.

Table – 9

Economics of Thayagondanahally tank command (Command area -14.05 ha)

Season	2005				2006				2007			
	Area	Cost	Returns	C:B	Area	Cost	Returns	C:B	Area	Cost	Returns	C:B
	(ha)	(Rs /ha)	(Rs /ha)		(ha)	(Rs /ha)	(Rs/ha)		(ha)	(Rs /ha)	(Rs /ha)	
Kharif	11.48	5757.8	10204	1.8	6.05	7641	19927	2.6	7.12	9578	27677	2.9
Rabi/ summer	4.23	12202	36115	2.9	2.8	15000	38000	2.5	-	-	-	-

## IV. CONCLUSION

The conjunctive use of water is one of the best ways to conserve the natural resources available and to improve the water use efficiencies for overall productivity and production of land based activities. The study revealed that the cropping pattern had shifted from higher water consumptive crops to lower water consumptive and high value crops such as vegetables, flowers and mulberry than paddy alone as in the case of traditional crops. It is also observed that the cost-benefit ratio of field crops, vegetable crops, flower and mulberry has shown significant improvement due to intervention initiated in the study areas. This had resulted higher economic returns and improved the socio-economic status of farmers of the area.

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