

Paddy Yield Enhancement By Water Management-A Study In Sivagangai District Of Tamil Nadu

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Abstract: As population increases that need more food production and other activities like industrialization, power generation etc for which scarce water should be economically utilized. Irrigation is the key input in crop production. Full benefit of crop production technologies such as high yielding varieties, fertilizer use and multiple cropping and plant protection measures can be derived only when adequate supply of water is assured. The irrigation infrastructure that is the backbone of the irrigated areas is in considerable need of modernization and a new paradigm for operations and maintenance. The Irrigated Agriculture Modernization and Water-Bodies Restoration and Management (IAMWARM) project has been formulated converging the roles of all the line departments. The project aims to improve the service delivery and productivity of irrigated agriculture with effective integrated water resources management in a sub-basin framework in Tamil Nadu with the many broad objectives. A study was contemplated to understand the economic impact of irrigation intervention and scope to improve it in Sivagangai district. The main objectives of the study were (i) to assess the impact of water bodies restoration in the study area on water level in open wells, (ii) to assess the impact of water bodies restoration in the study area on water level in bore wells and (iii) to assess the impact of the project on the yield and income. 225 farmers were selected for the study following at five stage sampling procedure, in which random sampling was followed in the last three stages. Impact on groundwater level was 22.84 per cent increase in the open well and 25.06 per cent increase in the bore well. Paddy yield has increased by 5.23 per cent and it was 3.50 per cent for chillies. Net benefit realized by the entire sample respondents by participating in the IAMWARM project was ₹. 2,60,236. Difference in paddy yield between project villages and non project villages was 839.50 Kg./ha in the vaigai system fed tank area. It was 41.68 kg./ha for cotton. Net gain received by the sample respondents for cotton in the project village over non project village was ₹. 1,87,826. In the rainfed tank irrigated farms, difference in paddy yield between project villages and non project villages was 452.30 Kg./ha. It was 41.68 kg./ha for chillies. Net gain received by the sample farmers in the project village over non project village was ₹. 66,214. IAMWARM project had good impact in terms of groundwater recharge, yield and income at arm level.

1. INTRODUCTION

Water is indispensable for human, animal and plant life. It is a major component of all organisms and some of them contain water more than 90 per cent of body weight. Water is a constituent of protoplasm in plant and animal cells. It maintains turgidity of cells which is essential for stomatal opening, expansion of cells and for different physiological processes. About 400 to 500 liters of water is necessary for the production of one kilogram of plant dry matter. As population increases that need more food production and other activities like industrialization, power generation etc for which scarce water should be economically utilized. Irrigation is the key input in crop production. Full benefit of crop production technologies such as high yielding varieties, fertilizer use, multiple cropping and plant protection measures can be derived only when adequate supply of water is assured.

The irrigation infrastructure that is the backbone of the irrigated areas is in considerable need of modernization and a new paradigm for operations and maintenance. This includes rehabilitation of irrigation canal systems restoration and revival of tanks etc. The Irrigated Agriculture Modernization and Water-Bodies Restoration and Management (IAMWARM) project has been formulated converging the roles of all the line departments. The project aims to improve the service delivery and productivity of irrigated agriculture with effective integrated water resources management in a sub-basin framework in Tamil Nadu with the many broad objectives. Thus a study was contemplated to understand the economic impact of irrigation intervention in Sivagangai district. The main objectives of the study were (i) to assess the impact of water bodies restoration in the study area on water level in open wells, (ii) to assess the impact of water bodies restoration in the study area on water level in bore wells and (iii) to assess the impact of the project on the yield and income.

2. METHODOLOGY

In the selection process there were four main stages. The Kottakaraiyar sub basin was selected in the first stage, after that, the Sivagangai district was selected in the second stage based on the maximum number of villages under Kottakaraiyar sub basin. After that, identification of the PWD tanks in Kottakaraiyar sub basin was identified as the third stage.

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Table 2.1 System, Non System and Rainfed Tanks Details in Kottakaraiyar Sub Basin

Details of Tanks	Project area		Non Project area		Total	
	Nos.	Ayacut Ha.	Nos.	Ayacut Ha.	Nos.	Ayacut Ha.
Vaigai System Tanks	85 (4)	6,188	54 (2)	5,926	139	12,114
Non System Tanks						
> 40 Ha	46	2,818	3	960	49	3,778
< 40 Ha.	80	2274	-	-	80	2,275
Rainfed Tanks	104 (5)	6,142	82 (4)	6259	186	12,402
Total	315	17,424	139	13,145	454	30,569

(Figures in parenthesis indicate 5 % of the total tanks)

Considering the time and other resource constraints faced by the researcher, five per cent of the number of tanks in each category (vaigai system and rainfed) was selected randomly as sample tanks. Following this sampling procedure, 15 tanks were selected to represent each other all the categories. After selecting the sample tanks, 15 villages were selected randomly at the rate of one village per tank. Thus, it was decided to totally select 15 tanks in which project tanks were nine and the non project area tanks were six. The fourth stage was selection of the farmers. In this stage from each village fed by the sample tank, 15 farmers were selected at random. Thus 225 farmers were selected for the study following at five stage sampling procedure, in which random sampling was followed in the last three stages.

3. RESULTS OF THE STUDY

1.1 Impact on the Water level in Open well

In project villages, due to recharge after water bodies restoration, maximum height of water level of open wells in the sample farms had increased by 13.46 per cent from 13.22 feet to 15.00 feet and the mean level has increased by 11.91 per cent from 10.33 feet to 11.56 feet. This has resulted in irrigated area in the sample farms to increase by 14.65 per cent. In vaigai system tank fed villages, average height of water level of open wells in project area was 11.56 feet which was 21.68 per cent more than in non project area (9.50 feet). The maximum height of water level of open wells in the project area was 15.00 feet which was 36.36 per cent more in the non project area (11.00 feet). Average area irrigated by open well in the sample farms had increased by 8.54 per cent in the project area. In rainfed tank fed villages, average height of water level of open wells in project area was 9.00 feet which was 34.93 per cent more than in non project area (6.67 feet). The maximum height of water level of open wells in the project area was 11.33 feet and the same in the non project area was 8.33 feet recording 36.01 per cent increase in the farmer. Average area irrigated by open well in the sample farms had increased by 33.43 per cent in the project area.

Table 3.1 Change in the Water level of Groundwater in Open Wells

		Height of Water level in Open Wells (feet)		Area Irrigated (ha.)
		Average	Maximum	
		Project Villages	Pre - Project	10.33
	Post - Project	11.56 (11.91)	15.00 (13.46)	1.36 (14.65)
Vaigai System tank fed Villages	Non Project Village	9.50	11.00	3.00
	Project Village	11.56 [21.68]	15.00 [36.36]	3.28 [8.54]
Rainfed tank fed Villages	Non Project Village	6.67	8.33	0.90
	Project Village	9.00 [34.93]	11.33 [36.01]	1.40 [33.43]

(Figure in () indicate per cent change over the pre-project values)

(Figure in [] indicate per cent change over the project to non project farms)

1.2 Impact on the Water level in Bore well

In project villages, due to recharge after water bodies restoration, maximum height of water level of bore wells in the sample farms had increased by 32.08 per cent to 211.33 feet and the mean level has increased by 21.03 per cent to 142.00 feet. This has resulted in irrigated area in the sample farms to increase by 14.65 per cent. In vaigai system tank fed project villages, average height of water level of bore wells in project area was 142 feet and the same in non project area was 110 feet. The maximum height of water level of bore wells in the project area was 211.33 feet and the same in the non project area was 203.33 feet. Average area irrigated by bore well in the sample farms had increased by 30.31 per cent in the project area. In rainfed tank fed project villages, average height of water level of bore wells in project area was 121.00 feet. The maximum height of water level of bore wells in the project area was 207.00 feet. In the project area an additional area of 1.30 hectare was brought under irrigation.

Table 3.2 Change in the Water level of Groundwater in Bore Wells

		Height of Water level in Bore Wells (feet)		Area Irrigated (ha.)
		Average	Maximum	
		Project Village	Pre - Project	117.33
	Post - Project	142.00 (21.03)	211.33 (32.08)	1.44 (14.65)
Vaigai System tank fed Village	Non Project Village	110.00	203.33	2.00
	Project Village	142.00 [29.09]	211.33 [3.93]	2.87 [30.31]
Rainfed tank fed Villages	Non Project Village	0.00	0.00	0.00
	Project Village	121.00	207.00	1.30

(Figure in () indicate per cent change over the pre-project values)

(Figure in [] indicate per cent change over the project to non project farms)

1.3 Impact on the Yield

Field visit carried out has revealed conspicuous change in the cropping pattern in the tank irrigated farms of Sivagangai district and hence the data collected were analyzed in that view and the results are presented in Table 3.3, Table 3.4 and Table 3.5.

Table 3.3 Change in Cropping Pattern in the Sample Farms in Project Area

Crop	Pre – Project		Post – Project		Yield (Kgs/ha.)		
	Area (ha.)	% Share	Area (ha.)	% Share	Pre - Project	Post - Project	% Change
Paddy	137.74	94.12	136.38	87.43	4217.78	4494.63	5.23
Chillies	8.60	5.88	8.80	5.64	6960.53	7203.95	3.50
Cotton	0.00	0.00	5.00	3.21	0.00	1142.85	0.00
Sugar cane	0.00	0.00	3.00	1.92	0.00	82500.00	0.00
Groundnut	0.00	0.00	2.80	1.80	0.00	2828.58	0.00
Total	146.34	100.00	155.98	100.00			

From the table it is clear that, after implementation of the scheme, crops such as cotton, sugarcane and groundnut were newly introduced in the cropping system. This resulted in reduction in area under paddy and chillies, which are the major crops in the study area. Area under paddy had decreased in such a way that share of the crop in the total cultivated area had decreased from 137.74 to 136.38 hectares for the entire sample. Impact on the yield of crops has also shown perceptible change. To site a few examples, yield of paddy has substantially increased by 5.23 per cent and yield of chillies by 3.50 per cent. From the table it is clear that, the implementation of project had brought new crops under cultivation (chillies and sugarcane) which generates additional benefits to the farmers. Paddy area was more (55.58 ha.) in the project villages than in the non project villages (17.40 ha.). However share of paddy in total cultivated area had marginally lower (82.24 per cent) compared to 93.55 per cent in the non project area. Cotton area was more (5.00 ha.) in the project villages than in the non project villages (1.20 ha.). However share of cotton in total cultivated area had marginally high (7.40 per cent) compared to 6.45 per cent in the non project area. Yield of the existing crops also found increased in the project implemented area. Difference in yield of paddy between project area and non project area was 839.50 Kgs./ha which was statistically significant at 5 % level. In case of cotton the yield difference was 41.68 Kgs./ha, which was also statistically non significant. New crops chillies and sugarcane were brought under cultivation in project area, which had provided the additional yield of 7,555.50 Kgs./ha and 82,500 Kgs./ha respectively. The major reason for improvement of yield was the adequate and timely to supply of water the beneficiary villages of the project.

Table 3.4 Difference in Cropping Pattern between Project and Non Project Villages in the

Sample Farms in System Tanks

S. No	Crop	Project Villages (2010-11)		Non -Project Villages (2010-11)		Yield (Kgs/ha.)		
		Area (ha.)	% Share	Area (ha.)	% Share	Project Villages (2010-11)	Non - Project Villages (10-11)	"t" value
1	Paddy	55.58	82.24	17.40	93.55	4,788.25	3,948.75	839.50* (11.11)
2	Chillies	4.00	5.92	0.00	0.00	7,555.50	0.00	0.00
3	Cotton	5.00	7.40	6.45	6.45	1,000.00	958.33	41.68NS (1.00)
4	Sugar cane	3.00	4.44	0.00	0.00	82,500.00	0.00	
	Total	67.58	100.00	18.60	100.00	-	-	-

(Figure in the parenthesis denote 't' statistics)

* - 5 % level of significance NS – Non Significance

From the table it is clear that, the implementation of project had brought groundnut as new crop under cultivation to which generates additional benefits to the farmers. Paddy area was more (80.00 ha.) in the project villages than in the non project villages (43.00 ha.). However share of paddy in total cultivated area had marginally high (90.91 per cent) compared to 90.00 per cent in the non project area. Yield of the existing crops also found increase in the project implemented area. Difference in yield of paddy between project area and non project area was 452.30 Kgs./ha, which was statistically significant at 5 % level. In case of chillies the yield difference was 912.50 Kgs./ha, which was also statistically significant at 5 % level. New crop of groundnut had provided the additional yield of 2,828.60 Kgs./ha respectively. The major reason for improvement of yield was the frequent supply of water in required quantity due to the implementation of project.

Table 3.5 Difference in Cropping Pattern between Project and Non Project Villages in the

Sample Farms in Rainfed Tanks

S. No	Crop	Project Villages (2010-11)		Non -Project Villages (2010-11)		Yield (Kgs/ha.)		
		Area (ha.)	% Share	Area (ha.)	% Share	Project Villages (2010-11)	Non - Project Villages (10-11)	"t" value
1	Paddy	80	90.91	43	90.00	4,246.80	3,794.50	452.30* (8.72)
2	Chillies	5	5.68	5	10.00	6,887.50	5,975.00	912.50* (15.44)
3	Groundnut	3	3.41	0	0.00	2,828.60	0.00	0.00
	Total	88	100.00	48	100.00	-	-	-

(Figure in the parenthesis denote 't' statistics)

* - 5 % level of significance

1.4 Impact on the Income

Water bodies restoration is expected to affect the net income received by the farmers as reflected through changes in the quantity and type of resources used is farming as well as the yield level and prices of farmers

produce. Hence changes observed in the income received and cost of cultivation of major crops cultivated was analyzed and the results are presented in Table 3.6, Table 3.8 and Table 3.10.

Table 3.6 Change in the Cost – Returns in the Sample Farms in Project Area (₹. / ha.)

S. No	Crop	Gross income		Cost of cultivation		Net income	
		Before	After	Before	After	Before	After
1	Paddy	22769	27053 (18.81)	16084	17282 (7.45)	6685	9771.11 (46.16)
2	Chillies	20676	22523 (8.93)	13895	14763 (6.25)	6782	7760.00 (14.43)
3	Cotton	0	14414 (0)	0	6250 (0)	0	8164.29 (0)
4	Sugar cane	0	49500 (0)	0	36714 (0)	0	12785.71 (0)
5	Ground nut	0	24614 (0)	0	15786 (0)	0	8828.57 (0)

(Figures in parenthesis indicate % change over the before values)

Combining the results presented in Table 5.4 and 5.5, net gain realized by the sample farmers out of IAMWARM project is summarized as below:

Table 3.7 Additional Income Received in the Sample Farms in Project Area

Crop	Area (ha)	Net income added (₹. / ha.)	Net income added (₹. / ha.)
Chillies	0.2	2,446.05	489.21
Cotton	5.0	20,410.73	1,02,053.70
Sugarcane	3.0	31,964.28	95,892.84
Groundnut	2.8	22,071.43	61,800.00
Total			2,60,235.70
Income loss			
Paddy	1.3	7,714.80	10,492.13
Net gain received			2,49,743.57

Gross income had increased, after the water bodies restoration structures were constructed, in all major crops grown in the district. To be specific, gross income from crops such as paddy and chillies had increased by 18.81 and 8.93 percentages respectively. Correspondingly, cost of cultivation per acre of the paddy had increased by 7.45 per cent and chillies had increased by 6.25 per cent. Due to these changes, net income received from paddy increased by 46.16 per cent and chillies had increased by 14.43 per cent respectively. Net benefit realised by the entire sample respondents by participating in the IAMWARM project was ₹ 2,60,236.

Table 3.8 Change in the Cost – Returns in the Sample Farms in System Tanks (₹. / ha.)

S.No	Crop	Gross Income		Cost of Cultivation	
		Project (2010-11)	Non -Project (2010-11)	Project (2010-11)	Non -Project (2010-11)
1	Paddy	71,354.18	53,495.83 (25.03)	43,833.33	43,416.68 (0.95)
2	Chillies	58,400.00	0.00	35,416.68	0
3	Cotton	36,035.70	30,600.00 (15.08)	15,833.33	15,833.33 (14.77)
4	Sugarcane	1,23,750.00	0.00	91,785.70	0.00

(Figures in parenthesis indicate % change value over the project to non project farms)

S. No	Crop	Net Income (₹. / ha.)		Difference
		Project (2010-11)	Non -Project (2010-11)	
1	Paddy	27,937.50	9,662.50	18,275.00* (11.32)
2	Chillies	22,983.33	0.00	
3	Cotton	20,410.70	15,833.33	4,577.37** (2.80)
4	Sugarcane	31,964.28	0.00	

(Figures in parenthesis denote 't' statistics)

* - 5 % level of significance ** - 1 % level of significance

Combining the results presented in tables 5.13 and 5.14, net gain realized by the sample farmers out of IAMWARM project is summarized as below:

Table 3.9 Additional Income Received in the Sample Farms in System Tanks

Crop	Area (ha.)	Net Income Added (₹. / ha.)	Net Income Added (₹. / ha.)
Chillies	4.0	22,983.33	91,933.32
Sugarcane	3.0	31,964.28	95,892.84
Total			1,87,826.16
Net gain received			1,87,826.16

From the table it is clear that, the implementation of project had brought new crops under cultivation (chillies and sugarcane), which generates additional income to the farmers. Gross income and net income of the existing crops also found increased. In project area gross income of paddy was 25.03 per cent more compared to non project area and in case of cotton the improvement was 15.08 per cent. Difference in net income of paddy between project area and non project area was ₹ 18,275.00 which was statistically significant at 5 % level. In case of cotton the income difference was ₹ 4,577.37, which was also statistically significant at 1 % level. New crops chilly and sugarcane provides the additional net income of ₹ 22,983.33 and ₹ 31,964.28 per hectares respectively. Net gain received by the sample farmers in the project village over non project village was ₹ 1,87,826.

Table 3.10 Change in the Cost – Returns in the Sample Farms in Rainfed Tanks (₹. / ha.)

S. No	Crop	Gross Income		Cost of Cultivation	
		Project (2010-11)	Non - Project (2010-11)	Project (2010-11)	Non - Project (2010-11)
1	Paddy	65,536.68	51,629.18 (3.91)	43,916.68	43,033.33 (2.01)
2	Chillies	54,425.00	43,350.00 (20.35)	38,625.00	38,250.00 (0.97)
3	Groundnut	61,535.73	0.00	39,464.28	0.00

(Figures in parenthesis indicate % change value over the project to non project farms)

S.No	Crop	Net Income (₹. / ha.)		Difference
		Project (2010-11)	Non -Project (2010-11)	
1	Paddy	21,620.00	7,712.50	13,907.50* (9.22)
2	Chillies	16,175.00	4,725.00	11,450.00** (8.02)
3	Groundnut	22,071.43	0.00	

(Figures in parenthesis denote 't' statistics)

* - 5 % level of significance

Combining the results presented in Tables 5.22 and 5.23, net gain realized by the sample farmers out of IAMWARM project is summarized as below:

Table 3.11 Additional Income Received in the Sample Farms in Rainfed Tanks

Crop	Area (ha.)	Net Income Added (₹. / ha.)	Net Income Added (₹. / ha.)
Groundnut	3.0	22,071.43	66,214.29
Total			66,214.29
Net gain received			66,214.29

From the table it is clear that, the implementation of project had increased the gross income and net income of the existing crops of paddy and chillies. In project area gross income of paddy was 3.91 per cent more compared to non project area and in case of chillies the improvement was 20.35 per cent. Difference in net income per hectare of paddy between project area and non project area was ₹ 13,907.50 which was statistically significant at 5 % level. In case of chillies the income difference was ₹ 11,450.00, which was also statistically significant at 5 % level. New crop groundnut provides the additional net income of ₹ 22,071.43 per hectare. Net gain received by the sample farmers in the project village over non project village was ₹ 66,214.

4. CONCLUSION

It could be concluded from the above analysis that,

- Impact on groundwater level - 22.84 per cent increase in the open well and 25.06 per cent increase in the bore well.
- Paddy yield has increased by 5.23 per cent and it was 3.50 per cent for chillies.
- Net benefit realized by the entire sample respondents by participating in the IAMWARM project was ₹. 2,60,236.

- Difference in paddy yield between project villages and non project villages was 839.50 Kg./ha in the vaigai system fed tank area. It was 41.68 kg./ha for cotton.
- Net gain received by the sample respondents for cotton in the project village over non project village was ₹. 1,87,826.
- In the rainfed tank irrigated farms, difference in paddy yield between project villages and non project villages was 452.30 Kg./ha. It was 41.68 kg./ha for chillies.
- Net gain received by the sample farmers in the project village over non project village was ₹. 66,214.
- IAMWARM project had good impact in terms of groundwater recharge, yield and income at arm level.
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