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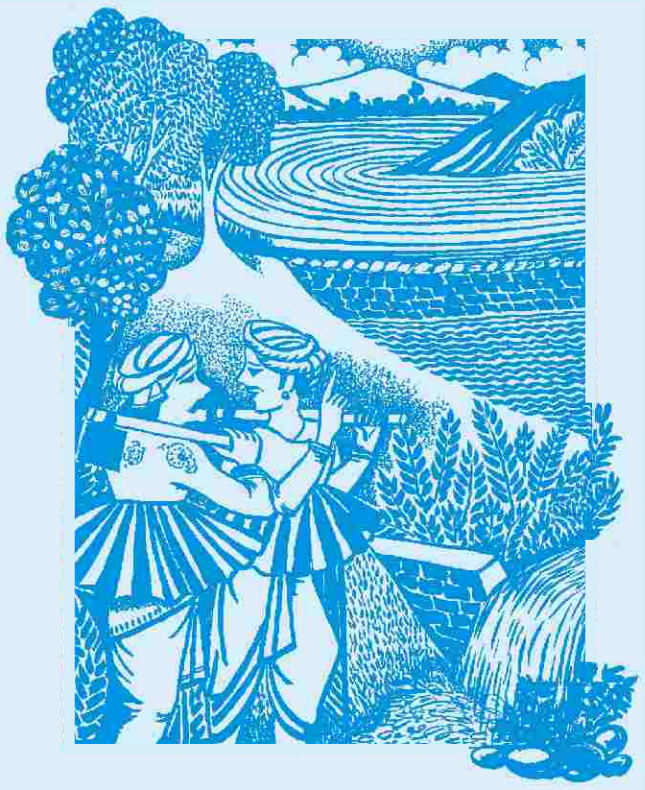
Water Policy Research

Highlight

Small Water Harvesting:
A Sustainable Way for Equity and Income Generation



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Past studies on water harvesting had focused more on the technical efficiency of water harvesting structures, impact of interventions on hydrological regimes, and overall socioeconomic impacts at the village level. The issues of intra-village equity in access to water and efficiency of water use were not well-researched. The received wisdom is that improved local hydrological regimes and increased water use encourage farmers to engage in wasteful practices. A study carried out in Raj Samdhiyala village, which has seen intensive water harvesting shows that there is greater equity in income distribution among the farmers of the village, than that in the control village. Also, the water use efficiency in crop production is enhanced with increased water availability in farm wells.

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Small Water Harvesting: A Sustainable Way for Equity and Income Generation[1]

Research Highlight Based on a Paper with the Same Title

The last decade has seen increased emphasis given by governments and non- governmental organizations of scarcity-hit states on construction of small water harvesting structures. There have been some spirited efforts to capture the essence of available knowledge on rainwater harvesting from the successful initiatives in varied physical and socioeconomic conditions, and scale up. There is a dire need to empirically analyze the impact of such water harvesting initiatives on the farmers before taking up large-scale initiatives. The water harvesting initiatives of Raj Samdhiyala of north-Saurashtra is one of the most admired water-harvesting efforts due to the apparent hydrological gains. In 1986, villagers started building check dams and percolation tanks. Since then, they have completed 45 water harvesting structures over an area of 1090 hectares. The program received the '*Jalkranti Mahaprerak* Award' for the year 1999-2000 from the Saurashtra Jaldhara Trust as the best example of community management of resources. With two more awards on its way, the need for evaluating the impact of water harvesting structures can hardly be over-emphasized.

From a list of all the perceived beneficiaries of water harvesting structures, 60 beneficiaries were selected randomly. Similarly, an equal number of farmers who were deprived of the perceived benefits (non-beneficiaries), were also selected randomly from the nearby villages. The data were collected by survey method for the agricultural year 2001-02 to assess the impact of water harvesting structures on farmers.

Methodology

Cost and Returns

Tabular analysis was extensively used for estimating the costs and returns per hectare over different costs and input-output ratios, using various farm management concepts.

Income Inequality

The Gini concentration ratio (GCR) was calculated to measure the inequality in income between beneficiary and non-beneficiary groups of farmers using the formula given below:

$$GCR = 1-\sum_{i=1}^{n} P_i(Q_i+Q_{i-1})$$

Where,

P_i = proportion of number of farmers
Q_i = cumulative proportion of income
Q_{i-1} = preceding cumulative proportion of income

Water Use Efficiency

Water utilization by the crop is generally described in terms of water use efficiency (kg/ha-cm). It is expressed as ratio of crop yield per unit quantity of water used during the entire growth period of crop. Water use efficiency (WUE) is calculated as:

WUE = Yield of the crop/ Effective water application for the crop including the effective rainfall

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[1] The research covered by IWMI-Tata Highlight and Comment is carried out with generous support from Sir Ratan Tata Trust, Mumbai under the IWMI-Tata Water Policy Program. However, this Highlight is based on an invited paper authored by Hiren Tilala and R. L. Shiyani who are associated with the Department of Agricultural Economics, College of Agriculture, Junagadh Agricultural University, Junagadh. We are grateful to authors for allowing us to publish this for wider circulation as an IWMI-Tata Water Policy Research Highlight. The research paper can be downloaded from the IWMI-Tata Website http://www.iwmi.org/iwmi-tata

The data on pump discharge (during each watering), number of irrigations, duration of water application in each irrigation, and length and width of field border were used to estimate the total seasonal irrigation water consumption as

Water application in each irrigation =

(Pump discharge during each watering*duration of water application in each irrigation)/ Area of the border

Effective water application =Sum of water application during different irrigations + (10* Effective rainfall in cm)

The effective rainfall (RF) was estimated using the following model for the Rajkot taluka:

$RF = 0.752\ TRF - LS$

Where,
RF = effective seasonal rainfall in cm
TRF = total seasonal rainfall in cm
LS = losses due to deep percolation and direct evaporation which was taken as 1.0 cm.

In order to nullify the contribution of size of holding in WUE, the net WUE for each crop was calculated using size of holding (ha) as a weight.

Major Findings

Beneficiary farmers alone were able to grow vegetables during summer since they had water available in their wells. Relatively higher gross cropped area was observed in the case of the beneficiary group.

Cropping Pattern

Kharif is the main crop-growing season; more than 74 and 89 percent of the gross cropped area is cultivated during this season by beneficiary and non-beneficiary groups respectively (Table 1). Groundnut is the dominant crop for both groups, and covered highest acreage in kharif. Cotton is the second important crop. In the case of rabi crop, the proportion of area under wheat was maximum, followed by cumin for both groups of farmers. However, beneficiary farmers alone were able to grow vegetables during summer since they had water available in their wells. Relatively higher gross cropped area was observed in the case of the beneficiary group. The average cropping intensities for beneficiary and non-beneficiary groups were 122 and 107 percent respectively.

Table 1: Cropping Pattern of Selected Farmers

Crop	Beneficiary		Non-beneficiary	
	Area	No. of Farmers	Area	No. of farmers
A) Kharif				
Groundnut	110.68 (50.09)	57	105.36 (75.58)	60
Cotton	53.28 (24.11)	43	19.40 (13.92)	24
Sub-total	163.96 (74.20)		124.76 (89.50)	
B) Rabi				
Wheat	37.04 (16.76)	37	13.60 (9.75)	21
Cumin	14.56 (6.60)	14	1.04 (0.75)	2
Sub-total	51.60 (23.36)		14.64 (10.50)	
C) Summer				
Vegetables	5.40 (2.44)	10	0.00 (0.00)	0
Gross Cropped Area (GCA)	220.96 (100.00)		139.40 (100.00)	
Cropping Intensity (%)	122	---	107	—

Note: Figures in parentheses indicate percentage to gross cropped area.

These figures show the positive impact of water harvesting structures on the farmers in the region.

Costs and Returns

Crop yield and returns per hectare were found relatively higher for beneficiaries than those for non-beneficiaries for all the crops.

The average cost of cultivation of groundnut (Cost C_2) for beneficiary and non-beneficiary groups was Rs. 24492/ha and Rs. 20199/ha respectively. The share of operating cost was about 65 percent for both groups. Human labor, seed, bullock labor, manure, chemical fertilizers, and irrigation cost were the major items of expenditure in groundnut cultivation for both the groups. Cost C_2 for cotton and wheat was respectively Rs. 29982/ha and Rs. 19172/ha for beneficiary farmers, while the corresponding figures for the non-beneficiary group were Rs. 23711/ha and Rs. 16873/ha.

In the case of cotton, the beneficiary group spent more on irrigation (Rs. 2884/ha) compared to the non-beneficiary group (Rs. 1853/ha) since the former used more water for obtaining higher yields. About 10 percent of the total cost of cultivation went towards protecting the cotton crop against heavy attacks of bollworm during the season. However, in the case of wheat, irrigation charges were relatively higher for the non-beneficiary group as compared to the beneficiary group because of higher cost of lifting unit volume of water from the wells.

Crop yield and returns per hectare were found relatively higher for beneficiaries than those for non-beneficiaries for all the crops. In the case of beneficiaries of water harvesting, the yield per hectare was higher by about 42, 45, and 31 percent for groundnut, cotton and wheat respectively (Table 2). Similarly, net income over Cost C_1 was higher by about 216, 137, and 77 percent for groundnut, cotton and wheat respectively. Farm income figures for the respective crops were found 76, 95 and 77 percent higher in the case of beneficiaries. The input-output ratio over cost C_2 for all crops were found relatively higher in the case of beneficiaries.

Income Inequality

Income is more evenly distributed in the case of the beneficiary group than in the non-beneficiary group.

The share of the top 25 percent beneficiary households to total income in the village was nearly 55 percent (Table 3). The share of the non-beneficiary group of farmers was only 8.33 percent, which contributed nearly 27 percent of the total income.

Income distribution was further investigated by estimating the Gini concentration ratios and standard deviation of logarithms of income (Table 4). The Gini concentration ratio was found lower in the case of beneficiary farmers (0.4640). This indicates that income is more evenly distributed in the case of the beneficiary group than in the non-beneficiary group, which is further supported by the Lorenz curve (Figure 1).

Water Use Efficiency

Water use efficiency refers to how efficiently farmers use the available water to maximize their returns in terms of yield and net income. About 72 percent of the area covered by beneficiary farmers has WUE greater than 50 kg/ha-cm, whereas the corresponding figure for non-beneficiary farmers is only 23 percent (Table 5). Similar is the situation for cotton which is attributed to availability of water in the area of water harvesting structures, which enable beneficiary farmers to provide life saving irrigation to cotton. In the case of wheat, 60 percent of the area covered by beneficiary farmers has obtained WUE greater than 70 kg/ha-cm as against only 29 percent in the case of non-beneficiary farmers. This implies that beneficiaries could give enough supplemental irrigation to wheat crop compared to non-beneficiaries.

Table 2: Yield and Returns per Hectare of Different Crops

Items	Unit	Beneficiary			Non-beneficiary			% increase in beneficiary		
		Groundnut	Cotton	Wheat	Groundnut	Cotton	Wheat	Groundnut	Cotton	Wheat
Yield										
A) Main product	Ql	21.01	14.50	33.97	14.75	10.03	25.91	42.44	44.56	31.11
B) By-product farm harvest price (FHP)	Ql	23.97		30.51	21.26		24.93	12.75		22.38
A) FHP of main product	Rs/ql	1196.80	1937	724	1163.00	1926	718	2.90	0.57	0.83
B) Income from by-product	Rs.	3465		3048	3215		2494	7.74		22.21
Gross return	Rs.	28610	28086	27642	20370	19318	21097	40.45	45.38	31.02
Farm business income	Rs.	12810	8335	16138	7248	4267	11242	76.74	95.33	43.55
Family labor income	Rs.	7961	3349	11491	3700	858	7721	115.16	290.33	48.82
Net income over Cost-C_1	Rs.	6344	829	10213	2007	-2238	5758	216.09	137.04	77.37
Net income over Cost-C_2	Rs.	4118	–1896	8470	171	-4393	4224	2308.19	56.84	100.52
Input-output ratios over										
Cost-A	Rs.	1: 1.81	1: 1.42	1: 2.40	1: 1.55	1: 1.28	1: 2.14			
Cost-B	Rs.	1: 1.39	1: 1.13	1: 1.67	1: 1.22	1: 1.05	1: 1.57			
Cost-C_1	Rs.	1: 1.28	1: 1.03	1: 1.58	1: 1.11	1: 0.90	1: 1.37			
Cost-C_2	Rs.	1: 1.16	1: 0.93	1: 1.44	1: 1.01	1: 0.81	1: 1.25			

Table 3: Distribution of Income among Beneficiary and Non-beneficiary Group of Farmers

Income Range (Rs.)	Beneficiary						Non-beneficiary					
	No.of farmers	% of farmers	Cumu-lative %	Income (Rs.)	% of Income	Cumu-lative %	No.of farmers	% of farmers	Cumu-lative %	Income (Rs.)	% of Income	Cumu-lative %
Up to 20000	0	0	0	0	0	0	10	16.67	16.67	128808	4.15	4.15
20001– 40000	4	6.67	6.67	127816	1.96	1.96	25	41.67	58.34	721553	23.22	27.37
40001 – 60000	19	31.66	38.33	976686	14.97	16.93	8	13.33	71.67	418134	13.46	40.83
60001 – 80000	11	18.33	56.66	775928	11.89	28.82	7	11.66	83.33	503532	16.21	57.04
80001–100000	7	11.66	68.32	620503	9.51	38.33	2	3.33	86.66	166452	5.36	62.4
100001–120000	4	6.67	74.99	441239	6.76	45.09	3	5	91.66	328716	10.58	72.98
120001–140000	3	5	79.99	371581	5.7	50.79	3	5	96.66	385003	12.39	85.37
140001–160000	4	6.67	86.66	610528	9.36	60.15	1	1.67	98.33	140632	4.52	89.89
160001–180000	4	6.67	93.33	679549	10.42	70.57	0	0	98.33	0	0	89.89
Above 180000	4	6.67	100	1919718	29.43	100	1	1.67	100	314384	10.11	100
Total	60	100		6523548	100		60	100		3107214	100	

Table 4: Concentration of Income among Beneficiary and Non-beneficiary Farmers

Particulars	Beneficiary	Non-beneficiary
Gini concentration ratio	0.4640	0.4817
Standard deviation of logarithms of income	0.6339	0.8245

Figure 1: Distribution of Total Income Between Beneficiary and Non-beneficiary Groups of Farmers

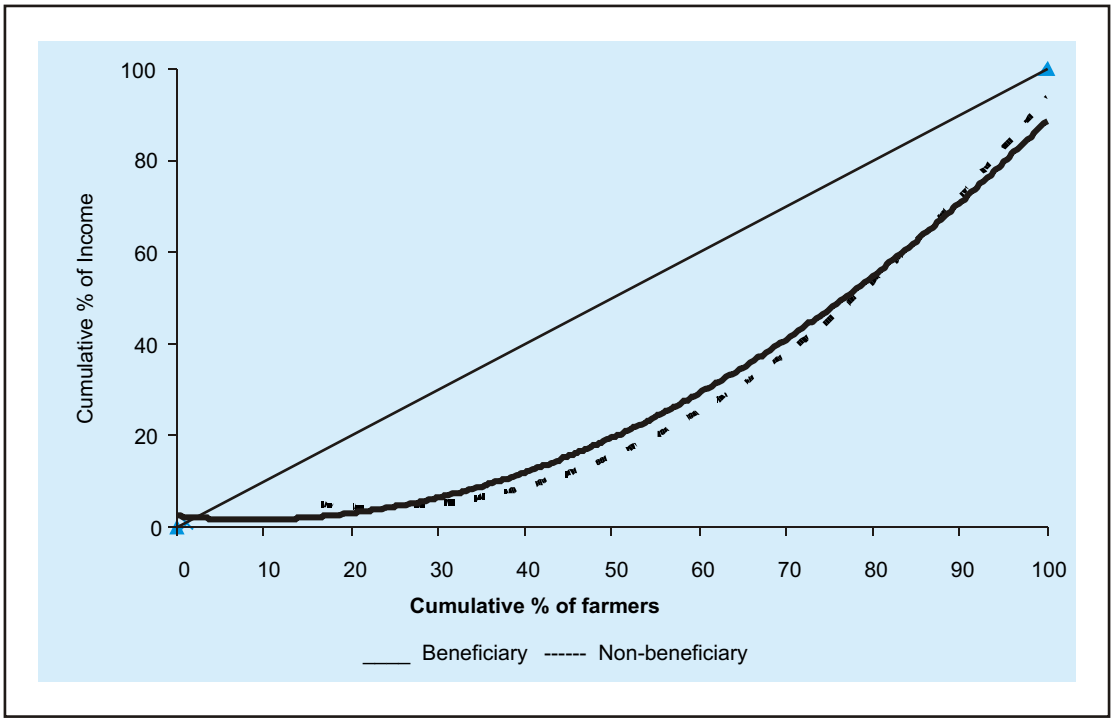

Table 5: Distribution of WUE over Percentage Area Covered in Different Crops by Beneficiary and Non-beneficiary Group of Farmers

Groundnut			Cotton			Wheat		
WUE (kg/ ha-cm)	% of total area		WUE (kg/ha-cm)	% of total area		WUE (kg/ ha-cm)	% of total area	
	B	NB		B	NB		B	NB
20-30	0	4.93	Upto 10	4.28	21.44	40-50	16.41	3.53
30-40	17.20	35.62	10-20	45.80	30.52	50-60	8.00	23.53
40-50	11.13	36.14	20-30	22.07	30.31	60-70	15.12	43.53
50-60	42.57	18.15	30-40	20.12	9.48	70-80	21.38	24.70
60-70	29.10	5.16	40-50	7.73	8.25	80-90	39.09	4.71
Total	100.00	100.00	Total	100.00	100.00	Total	100.00	100.00

Note: B—Beneficiary; NB---Non-beneficiary

Table 6: Net Water Use Efficiency (kg/ha-cm) of Different Crops

Crop	Beneficiary	Non-beneficiary	% Change
Groundnut	54.13	43.26	25.13
Cotton	23.33	20.25	15.21
Wheat	71.37	67.52	5.70

We compared net water use efficiency (NWUE) of all major crops to nullify the contribution of size of holding in WUE. NWUE of all the major crops grown by beneficiary farmers was higher compared to non beneficiaries in the region (Table 6).

Conclusion

Our findings suggest that water harvesting structures provide multiple benefits to beneficiaries. Increase in yield and net income from various crops, reduction in unit cost of production, efficient utilization of resources, and higher labor productivity are some of the benefits, which many previous studies on water harvesting also brought out. The findings of this study with regard to decline in income inequality and improvement in water use efficiency are important from the policy perspective. If increased water availability also leads to enhancing water use efficiency in crop production, it has significant implications for managing the demand for water in agriculture, especially during years of drought. The finding of the study is quite contrary to the concern raised by many researchers about the potential negative implications of increased water availability with water harvesting/watershed management efforts on farmers' incentive to use water efficiently. These visible gains will help further increase awareness among the people about the benefits of water harvesting structures, and enhance their willingness to get actively involved in decentralized water harvesting and management. Other dry land areas can replicate the success of Raj Samdhiyala to grow the right kind of crops and share water equitably. An ever-green revolution, as envisaged by Dr. M. S. Swaminathan, is possible only by managing local resources such as water.

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IWMI-Tata Water Policy Program

The IWMI-Tata Water Policy Program was launched in 2000 with the support of Sir Ratan Tata Trust, Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations.

Through this program, IWMI collaborates with a range of partners across India to identify, analyse and document relevant water-management approaches and current practices. These practices are assessed and synthesised for maximum policy impact in the series on Water Policy Research Highlights and IWMI-Tata Comments.

The policy program's website promotes the exchange of knowledge on water-resources management, within the research community and between researchers and policy makers in India.

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