

# **EQUITY IN DISTRIBUTION OF BENEFITS FROM WATER HARVESTING AND GROUNDWATER RECHARGE – AN ECONOMIC STUDY IN SUJALA WATERSHED PROJECT IN KARNATAKA**

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## **Abstract**

*The paper looks at the impact of water harvesting programs in ground water recharge through the case of the Sujala watershed in Karnataka. On comparison with areas of non sujala watershed and non watershed cases in one normal rainfall and one drought year, it was revealed that Sujala has been successful in recharging groundwater, improving farmers' incomes and increasing crop production. Further the program is inclusive and the benefits were accrued even to the small and marginal farmers. In fact the net return for small and marginal farmers was higher than that for large and medium farmers. The study concluded that there is potential for expansion of Sujala pattern of watershed development program in other parts of Karnataka and India.*

## **1. INTRODUCTION**

Water harvesting for groundwater recharge has been a major objective of Sujala initiated by Government of Karnataka with the assistance of the World Bank. This is a community driven program implemented by Watershed Development Department with tripartite cost-sharing arrangements. The Sujala project is being implemented in 5 districts of Karnataka covering 5.11 lac hectares of land spread over 77 sub-watersheds, 741 micro watersheds and 1270 villages benefiting about four lac beneficiary households including landless spread over three phases during 2002-07. The overall Sujala watershed project cost is Rs. 677.73 crore, of which Rs. 540.83 crore is financed by the World Bank, Rs 72.51 crore is borne by the government of Karnataka and Rs 64.38 crore contributed by the beneficiaries from the watershed communities. This study aims to assess the economic impact of Sujala watershed programme and Non-Sujala watershed in Karnataka on groundwater recharge, agricultural productivity, and equity in distribution of benefits among different classes of farmers.

## **2. REVIEW OF LITERATURE**

Study on appraisal of watershed development program in three agroclimatic regions of Maharashtra conducted by Deshpande and Narayanamoorthy (1999) indicated that there was a definite improvement in fodder, fuel and food availability. Watershed areas with degraded and fragile natural resources would take a long gestation period to recover the natural losses and then the incremental returns follow. Watersheds in assured and moderate rainfall zones perform better than that in low rainfall zones. Farmers had adequate understanding of ongoing watershed activities and all farmers expressed their satisfaction for extension support received (Deshpande and Narayanamoorthy, 1999).

Another study by John Kerr (2001) on watershed project performance in India indicated that participatory watershed projects are successful in protecting upper catchments to promote water harvesting, but this has come at the expense of landless farmers whose livelihoods are dependent on such areas.

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### 3. METHODOLOGY

In this study the contribution or impact of Sujala watershed is quantified explicitly by comparing economic performance with (i) non – sujala watershed program and (ii) non-watershed areas. A sample of 30 farmers each was drawn from Sujala watershed, non-Sujala watershed and non-watershed area, totaling 90 (Table A). The data were collected for two cropping years 2004 and 2005, of which 2004 was a drought year and 2005 was a normal year.

The purpose was to analyze the economic performance of Sujala watershed in normal as well as in drought year. While the economic performance of watershed project in normal year is expected, performance in drought year is crucial and hence the comparison over time. The prices of input and output have almost been uniform for both these cropping years in the study area. Recharge of groundwater is a crucial component of watershed impacts. Therefore the impact on farmers who possess irrigation wells and farmers who don't possess irrigation wells is also discerned along with the overall impact of the watershed program.

Table A: Distribution of sample farmers in Sujala watershed, Non-Sujala watershed and Non-watershed Chitradurga district, 2004-05

Sujala watershed Area		Non-Sujala (DPAP) watershed area		Non-Watershed	
Sample village	No. of sample farmers	Sample village	No. of sample farmers	Sample village	No. of sample farmers
Shivanekatte	7	Srirangapura	12	Nagenahalli	15
Sankainahatti	10	Kalkere	18	Honnekere	15
Yalakappanahatti	11				
Chinnapura	2				
Total	30		30		30

In this study the results for drought year are compared with that of normal year across Sujala, non-Sujala and non-watershed areas (using analysis of variance). In the *Veda* river sub-watershed of Sujala watershed in Hosadurga taluk, one micro watershed Sivanekatte -1 with villages Shivanekatte, Sankainahatti, Yalakappanahatti and Chinnapura were selected for detailed study. For the non-Sujala (DPAP) watershed in Hosdurga taluk, Srirangapura and Kalkere were selected for comparison with Sujala watershed to estimate the differential impact. Another sample of 30 farmers from non watershed area in villages Nagenahalli and Honnekere were selected for comparison all totaling 90 farmers for this study.

In order to measure the impact of water harvesting and groundwater recharge with equity implications, primary data were collected with structured pre-tested schedules both for the drought year 2004-05 and normal rainfall year 2005-06. Secondary data from the NGO as well as from Sujala authorities have been collected regarding expenditure on different activities in the watershed (Table B) and thematic maps. Data were analyzed using weighted averages, ratio measures, percentages and proportions. In order to estimate the impact of watershed program on irrigated and rainfed farms, farmers are classified based on those possessing irrigation wells and those not possessing irrigation wells (classified as rainfed).

### 4. BASIC OUTPUTS

#### 4.1 Per Acre Expenditure of Watershed Program

An investment of Rs.216.84 lac was incurred on the Sujala (veda river bank) sub-watershed during 2002-05 (Table B). Major portion was spent on soil and water conservation (Rs. 156.94 lac or 72.37%) followed by drainage line treatment (Rs.35.33 lac or 16.29%), forestry (Rs.9.8 lakh or 4.51%), livestock (Rs.7.11 lac or

3.28%) and horticulture (Rs. 7.09 lac or 3.27%) and demonstration (Rs. 0.57 lac). The total expenditure was Rs. 45.74 lac in Shivanekatte micro watershed treating the total area of 1028 acres. The amortized cost per acre of treated area per year was Rs. 597 considering the differential life of different structures and a social discount rate of 2%, and this is included while calculating the net contribution of the watershed program. Thus all expenditures crop, non-crop and others on watershed program including the amortized cost of watershed program are considered in costing (Table B).

Table B: Amortized cost of watershed treatment in micro watershed Shivanekatte in Veda river bank sub-watershed, Chitradurga district, 2004-05

Sl.No	Particulars	Expenditure (Rs.)
1	Entry point activity	171806.0
2	Soil and water conservation	2564663.0
3	Drainage line treatment	529234.2
4	Forestry	31089.4
5	Horticulture	148761.0
6	Livestock	283850.0
7	Demonstration	52800.0
8	Common land treatment	167484.9
9	Income generating activity	625000.0
10	Total expenditure (Rs.)	4574689.0
11	Area treated (ha)	415.7
12	Compound cost	5576520.0
13	Total amortized cost	620814.6
14	Amortized cost per treatable area in hectares (Rs.)	1493.4
15	Amortized cost per acre of treated area per acre (Rs.)	597.4

Small and marginal farmers formed 66% of the sample in Sujala watershed, 53% in the non-Sujala watershed (DPAP) and 67% of the sample non-watershed area. Medium farmers formed 33% in the non-Sujala watershed (DPAP) 26% in Sujala watershed, 27% in the non-watershed area. Large farmers formed 13% of the sample in Non-Sujala watershed (DPAP), 6% in both Sujala watershed and non-watershed area. The number of farm equipments was higher in the Sujala watershed compared to Non-watershed area. In the Sujala watershed, the total number of bullock carts, tractors and irrigation pump sets in the sample were 11, 4 and 18, while in the non-Sujala watershed (DPAP) they were 10, 3 and 16 respectively. In the non-watershed area, the total number of bullock carts, tractors and irrigation pumpsets were 17, 0 and 8, respectively.

Regarding the livestock of the sample farmers, the total number of local cows, crossbred cows and she-buffaloes were 15, 13 and 22 in the Sujala watershed and 11, 7 and 32 in non-Sujala watershed (DPAP), while it was 9, 7 and 24 in non-watershed area respectively. In the Sujala watershed the total number of oxen, sheep, poultry and goat were 16, 225, 60 and 30 and in non-Sujala watershed (DPAP) they were 20, 150, 37 and 40 while it was 24, 300, 28 and 45 in non-watershed area

## 4.2 Cropping Pattern

In drought year 2004, Ragi was grown in an area of 49.55 acres in Sujala watershed, 52 acres in non-Sujala and 49.75 acres in non-watershed area, an formed 22.89% of gross cropped area in Sujala watershed and 27.45% in non-watershed area. Sunflower formed 13.16% of gross cropped area in Sujala watershed while it

formed 7.61% and 10.34% in non-Sujala watershed (DPAP) and non-watershed area respectively. Sesamum formed 9.79% of gross cropped area in non-watershed area while it was 3.70 and 5.99 per cent in Sujala watershed and non-Sujala watershed (DPAP) respectively. Groundnut formed 6% of gross cropped area and it was 2.84% and 0.55% in non-Sujala watershed (DPAP) and non-watershed area respectively. Green gram contributed to 4.57% of gross cropped area in non-Sujala (DPAP) watershed and 3.17% in non-watershed area, while it was not grown in Sujala watershed.

In *Rabi*, Jowar formed 1.39% of gross cropped area in Sujala watershed while it was 2.48% in non-watershed area. Total *Rabi* crops formed 2.77% of gross cropped area in Sujala watershed which is lower as compared to 4.87% and 6.34% in non-Sujala (DPAP) and non-watershed area.

Areca nut and coconut were major plantation crops in Sujala watershed and formed 8.41% and 30.72% of gross cropped area and coconut formed 41.02% to GCA in non-Sujala (DPAP) and 25.93% in non-watershed area.

### **4.3 Cropping Pattern fully dependent on Rainfed Agriculture**

The major rainfed crops in the area were ragi, groundnut, sesamum, sunflower and jowar in *Kharif*. The proportion of gross cropped area under ragi was comparable in Sujala watershed (36.49%), non-Sujala watershed (34.72%) and non-watershed area (35.22%). Sunflower was the second major crop after Ragi and formed 21% in Sujala watershed which is higher compared to Non-Sujala watershed (DPAP) (12.52%) and non-watershed area (13.27%). Groundnut formed 9.57% of gross cropped area in Sujala watershed and was higher compared to non-Sujala watershed (DPAP) (4.67%) and non-watershed area (0.71%). The proportion of area under Jowar was uniform across different groups i.e. Sujala (9.02%) and non-Sujala watershed (10.18%) and non-watershed area (9.91%). Green gram formed 7.5% of gross cropped area in non-Sujala watershed and 4.07% in non-watershed area while it was not grown in Sujala watershed.

### **4.4 Watershed Contribution to Groundwater Irrigation**

Considering the crop pattern of sample farmers, with groundwater irrigation, in drought year, 2004 the major share of gross irrigated area was by Coconut with 71.87% in Sujala watershed, 78.57% in non-Sujala and 92.5% in non-watershed area. Areca nut formed 22.55%, while it was not grown in non-Sujala watershed (DPAP) and non-watershed area. Other crops which were grown under groundwater irrigation were sunflower, onion, groundnut and chilli in non-Sujala watershed (DPAP) and were not grown in Sujala and non-watershed area in *Rabi*. In summer, crops like brinjal (0.31%) groundnut (2.48%) tomato (0.31%) leafy vegetables (1.24%) and sunflower (1.24%) were cultivated in Sujala watershed. In non-Sujala watershed (DPAP) Groundnut formed 3.06% of gross irrigated area, followed by cotton at 6.12%, and in non-watershed area, onion (7.5% of gross irrigated area). Cropping pattern on those farms with groundwater irrigation and rainfall in normal year 2005 was almost the same as compared to the previous cropping year drought year 2004.

## **5. RESULTS AND DISCUSSION**

### **5.1 Economics of Crops**

In drought year 2004, among rainfed crops, Sujala farmers realized the highest net returns per acre; 129% higher net returns in Ragi, 110% higher in groundnut, 207% higher in sesamum, 21% in sunflower, 44% higher in green gram and 26% in coconut as compared to non-Sujala watershed (DPAP) farmers while Sujala watershed farmers realized 147% higher net returns in ragi, 288% in groundnut, 327% higher in sesamum, 16% higher in jowar, 211% higher in green gram and 8% higher in coconut compared to non-watershed area farmers. However farmers of non-watershed area realized 30% higher net returns in sunflower from farmers in Sujala watershed area in the cropping year 2004.

Among the irrigated crops in drought year 2004 farmers of Sujala watershed realized higher net returns of 95% in coconut which was almost similar to non-Sujala watershed (DPAP). However, Sujala watershed

Table 1: Economics of crops in watershed programs in Chitradurga district, drought year 2004

(Rs. per Acre)

Crops	Sujala watershed (1)			Non-Sujala watershed (DPAP) (2)			Non-watershed area (3)			Percentage change in Net returns (1 to 2)	Percentage change in Net returns (1 to 3)
	TC	GR	NR	TC	GR	NR	TC	GR	NR		
Rainfed crops											
Ragi	1682	3232	1550	1674	2351	676	2405	3032	628	129.12	147.01
Groundnut	4128	12138	8010	3570	7371	3801	3736	5800	2064	110.72	288.13
Sesamum	1154	7250	6096	2758	4746	1988	2484	3913	1429	206.61	326.72
Sunflower	3216	7472	4256	3045	6571	3525	2682	8729	6047	20.72	-29.62
Jowar	2147	2677	530	1588	2014	426	2049	2505	456	24.29	16.23
Green gram	1820	5000	3180	1821	4022	2201	1535	2558	1024	44.46	210.70
Coconut	3648	6871	3223	3003	5558	2555	3208	6200	2992	26.13	7.69
Irrigated crops											
Groundnut	6725	12083	5359	5593	11392	5799	-	-	-	-7.59	
Cotton	-	-	-	3854	8208	4354					
Coconut	6149	13931	7783	6063	13792	7729	6430	10854	4425	0.69	75.89

Note: TC- Total cost; GR-Gross returns; NR- Net returns

Table 2: Economics of crops in watershed programs in Chitradurga district, normal year 2005

(Rs. per Acre)

Crops	Sujala watershed (1)			Non-Sujala watershed (DPAP) (2)			Non-watershed area (3)			Percentage change in Net returns ( 1 to 2)	Percentage change in Net returns ( 1 to 3)
	TC	GR	NR	TC	GR	NR	TC	GR	NR		
<b>Rainfed crops</b>											
Ragi	1627	4956	3329	1711	3196	1486	2774	3928	1154	124.08	188.48
Groundnut	3299	11323	8025	3591	11329	7738	3858	13800	9942	3.70	-19.28
Sesamum	1391	5474	4082	2654	6347	3692	2554	5513	2959	10.56	37.99
Sunflower	3005	10162	7157	3026	8845	5820	2682	9842	7160	22.98	-0.03
Jowar	2057	3131	1074	2068	2497	429	2217	3071	854	150.27	25.81
Navane	1983	4417	2433	-	-	-	1604	3043	1439		69.06
Horse gram	1865	3077	1212	1383	2308	925	1856	2731	875	31.00	38.53
Green gram	-	-	-	1879	5376	3498	1694	4830	3136		
Coconut	3648	8282	4634	2961	7725	4764	3208	7640	4432	-2.72	4.56
<b>Irrigated crops</b>											
Groundnut	6725	11517	4792	5593	14392	8799	-	-	-	-45.54	
Cotton	-	-	-	3854	10458	6604	-	-	-		
Coconut	6406	16724	10319	6063	13792	7729	6732	12151	5420	33.51	90.39

Note: TC- Total cost; GR-Gross returns; NR- Net returns

farmers realized lower net return per acre by 8% in groundnut. They realized 76% higher net returns in coconut as compared to non-watershed farmers (Table 1).

In normal year 2005, among rainfed crops Sujala watershed farmers realized 124% higher net return per acre in Ragi, 4% higher in groundnut, 11% in sesamum, 23% higher in sunflower, 150% higher in jowar and 31% higher in horse gram. However they realized 3% lower net returns in coconut as compared to non-Sujala watershed (DPAP). They realized 189% higher in ragi, 38% higher in Sesamum, 26% higher in jowar, 69% higher in navane, 39% in horse gram and 4.56% in coconut. However they realized 19% lower in Groundnut as compared to non-watershed area (Table 2).

Among irrigated crops in normal year 2005, Sujala watershed farmers realized higher net return of 90% in coconut as compared to non-watershed; and 33% in coconut as compared to non-Sujala watershed (DPAP) farmers. However they realized lower net return per acre by 45% in groundnut. Non-Sujala watershed (DPAP) farmers realized net return per acre of Rs. 6,604 from cotton, which was not cultivated in Sujala watershed and non-watershed area (Table 2).

## 5.2 Well Irrigation Benefits

It was observed that 11 farmers (37%) owned irrigation wells in Sujala watershed, 10 farmers (33%) in non-Sujala watershed (DPAP) and eight farmers (27%) in non-watershed area.

The net irrigated area of sample farmers was higher in non-Sujala watershed (DPAP) (57.5 acres) by 21% as compared to Sujala watershed (45.35 acres) and the same was higher by 111% compared to non-watershed area. Gross irrigated area among sample farmers was higher in non-watershed area (96 acres, 13%) as compared to Sujala watershed (83.45 acres, 109%) and non-watershed area (40 acres). However the gross irrigated area per farm was lower in Sujala watershed (4.64 acres), lower by 23% as compared to non-Sujala watershed (DPAP) (6.0 acres) and 7% as compared to non-watershed area (5.0 acres).

Groundwater pumping per well in Sujala watershed was 50.08 acre-inch, lower by 21% compared to Non-Sujala watershed (DPAP) (69.94 acre inch) and higher by 4% when compared to non-watershed area (53 acre-inch). Net return per rupee of irrigation cost was Rs. 3.9 in Sujala watershed lower by 2% as compared to Non-Sujala watershed (DPAP) (Rs. 3.98). It was higher by 1.2% as compared to non-watershed area (Table 3). Amortized cost per well was lower by 6.5% in Sujala watershed (Rs. 6,818) and is almost the same in non-watershed area (Rs. 6,856). However amortized cost per functioning well in Sujala watershed (Rs. 9,470) was lower by 5.5% as compared to non-Sujala watershed (DPAP) (Rs. 10,027) and lower by 15% as compared to non-watershed area (Rs. 11,140). The annual externality cost was lower by 38% in Sujala watershed (Rs. 2,654) compared to Non-watershed area (Rs. 4,285) and lower by 3% as compared to non-Sujala (DPAP) watershed (Rs. 2,735) (Table 3).

### 5.2.1 Irrigation benefit for farmers not possessing irrigation wells but having water harvesting structures

Out of 19 sample farmers, small and marginal farmers (< 5 acres) formed 89.5%; medium farmers (5 to 10 acres) formed 10.5% of the total sample in Sujala watershed. Total expenditure per farm was higher for medium farmers (Rs. 14,948) compared to small and marginal farmers (Rs. 8,149). However, the total expenditure per acre of gross cropped area was higher for small and marginal farmers (Rs. 2,796) compared to medium farmers (Rs. 1,708). Considering the net return from rainfed crops, medium farmers realized higher net returns per farm (Rs. 41,386) compared to small and marginal farmers (Rs. 7,948). The net return per acre of gross cropped area was higher for medium farmers (Rs. 4,730) compared to small and marginal farmers (Rs. 2,727). However, incremental net return per rupee of public investment is higher for small and marginal farmers (Rs. 2.52) compared to medium farmers (Rs. 0.47). The overall net return per rupee of public investment worked to be Rs. 1.95 (Table 4).

### 5.2.2 Distribution of benefits among land holding classes

In Sujala watershed, small and marginal farmers formed 27.3%, medium farmers formed 54.5% and large farmers formed 18.2% of the farmers possessing irrigation wells and watershed structures. Total

Table 3: Particulars of groundwater resources in watershed programs in Chitradurga district, normal year 2005

Sl. No	Particulars	Sujala watershed	Non-Sujala watershed (DPAP)	Non-watershed area	Percentage change (Sujala to Non-Sujala watershed (DPAP))	Percentage change (Sujala to Non-watershed area)
1	Groundwater extracted per farm (acre-inch)	90.12	111.43	52.99	-19.12	70.06
2	Groundwater extracted per well (acre-inch)	55.08	69.64	52.99	-20.92	3.93
3	Number of sample farmers owning wells	11	10	8	10	37.50
4	Per cent of farmers owning wells	36.67	33.33	26.67	10	37.50
5	Number of functioning wells	18	16	8	12.5	125.00
6	Net irrigated area (acre)	45.35	57.50	21.50	-21.13	110.93
7	Net irrigated area per functioning well (acre)	2.52	3.59	2.69	-29.89	-6.25
8	Gross irrigated area (acre)	83.45	96.00	40.00	-13.07	108.63
9	Gross irrigated area per functioning well (acre)	4.64	6.00	5.00	-22.73	-7.28
10	Gross irrigated area per farm (acre)	7.59	9.60	5.00	-20.98	51.73
11	Irrigation intensity (per cent)	184	167	186	10.22	-1.09
12	Groundwater used per acre of gross irrigated area (acre inch)	11.88	11.61	10.60	2.35	12.08
13	Irrigation cost per acre inch of groundwater used (Rs.)	125	117	138	7.48	-8.98
14	Net returns per farm (Rs.)	44265	51992	28246	-14.86	56.71
15	Net returns per acre inch of groundwater used (Rs.)	491	466	533	5.27	-7.85
16	Net returns per acre of gross irrigated area (Rs.)	5834	5415	5649	7.74	3.28
17	Net returns per acre of net irrigated area (Rs.)	10737	9042	10510	18.74	2.16
18	Net returns per rupee of irrigation cost (ratio)	3.90	3.98	3.85	-2.06	1.24
19	Amortized cost per well (Rs.)	6818	7292	6856	-6.50	-0.54
20	Amortized cost per functioning well (Rs.)	9470	10027	11140	-5.55	-14.99
21	Annual externality cost (Rs.)	2652	2735	4285	-3.04	-38.11
22	Amortized cost per well (Rs.)	6818	7292	6856	-6.50	-0.54

Note: Net returns per rupee of irrigation cost was derived to compare the net return per acre-inch of groundwater used with irrigation cost per acre-inch of groundwater (net return per acre-inch of groundwater used/ irrigation cost per acre-inch of groundwater)



expenditure on Sujala watershed structures per farm is higher for large farms (Rs. 3, 02,221) compared to small and marginal farms (Rs. 9,596) and medium farms (Rs. 19,650). However, expenditure per gross cropped area is higher for small farms (Rs. 1,745) compared to medium farms (Rs. 1,456) and large farms (Rs. 836).

Table 4: Benefits accrued to sample Sujala farmers not possessing irrigation wells but having water harvesting structures in Chitradurga district, normal year 2005

Sl. No	Particulars	Small and marginal farmers	Medium Farmers	Overall
1.	No. of farmers in each category	17	2	19
2.	Size of holding per farm (acre)	2.7	8.5	3.3
3.	No. of water harvest structures per farm	1.6	2.0	1.7
4.	Water harvest structures constructed on the farm	Earthen bund, boulder outlet, boulder bund, farm pond, strengthening of existing bund, boulder bund repair	Earthen bund, boulder outlet, boulder bund, farm pond,	Earthen Bund, boulder outlet, boulder bund, farm pond, strengthening of existing bund, boulder bund repair
5.	Total expenditure on water harvest structure on sample farms (Rs)	138532	29895	168427
6.	Sujala Expenditure per farm (Rs)	8149	14948	8865
7.	Sujala expenditure per water harvest structure (Rs)	4948	7474	5263
8.	Sujala Expenditure per acre of gross cropped area (Rs)	2796	1708	2512
9.	Gross cropped area per farm (acre)	2.91	8.75	3.53
10.	Net return from rainfed crops per farm (Rs)	7948	41386	11468
11.	Net return from rainfed crops per acre of Sujala Gross cropped area (Rs)	2727	4730	3250
12.	Incremental net return per acre of gross cropped area in Sujala over non-watershed area (Rs)	7048	796	4907
13.	Net return per rupee of Sujala expenditure(12/8) (Rs)	2.52	0.47	1.95

Medium farms realized higher net return from irrigation per farm (Rs. 84,777) compared to large farms (Rs. 65,156) and small and marginal farms (Rs. 12,153). Net returns per acre of gross irrigated area was higher for medium farms (Rs. 6,280) compared to small and marginal farmers (Rs. 2,210) and medium farmers (Rs. 1,802). Considering the net return per rupee of amortized cost of irrigation, medium farmers realized higher net returns (Rs. 8.8) and were same for small and large farms (Rs 2.5). The net return from irrigation per rupee of Sujala expenditure on watershed structure was higher in medium farms (Rs.4.3) than small farms (Rs.1.3) and large farms (Rs.2.2). Considering the incremental net return per rupee of expenditure on watershed structures, medium farmers (Rs. 3.7) realized higher net return compared to large farms (Rs. 2.6) and small and marginal farms (Rs. 1.5) (Table 5).

Table 5: Benefits accrued to Sujala sample farmers possessing irrigation wells and water harvesting structures in Chitradurga district, normal year 2005

Sl. No	Particulars	Small and marginal farmers	Medium farmers	Large farmers	overall
1.	Number of farmers in each category	3	6	2	11
2.	Total number of wells	6	10	9	25
3.	Number of functioning wells	3	8	8	19
4.	Number of non functioning wells	3	2	1	6
5.	Size of holding per farm (acre)	4.7	8.5	23.0	10.1
6.	Number water harvesting structures per farm	1.7	2.2	3.0	2.2
7.	Total expenditure on water harvest structure (Rs.)	28789	117898	60442	207129
8.	Expenditure per farm (Rs.)	9596	19650	30221	18830
9.	Expenditure per water harvest structure (Rs.)	5758	9069	10074	8630
10.	Expenditure per acre of gross cropped area (Rs.)	1745	1456	836	1220
11.	Gross cropped area per farm (acre)	5.5	13.5	36.2	15.4
12.	Net returns from irrigated crops per farm (Rs.)	12153	84777	65156	61403
13.	Net returns from irrigated per acre of Gross irrigated area (Rs.)	2210	6280	1802	3978
14.	Net return per acre inch of groundwater (Rs.)	783	1504	215	681
15.	Net return per rupee of amortized groundwater irrigation cost (Rs.) (= NRs per Rupee of private investment)	2.5	8.8	2.5	5.4
16.	Net returns from irrigation per rupee of expenditure on water harvesting structures (Rs.) (=NRs per rupee of public or Sujala investment)	1.3	4.3	2.2	3.3
17.	Net returns from rainfed crops per farm (Rs.)	7201	34930	83582	36213
18.	Net returns from rainfed crops per acre of Gross cropped area (Rs.)	1309	2587	2312	2346
19.	Incremental net returns per acre of gross cropped in Sujala over non-watershed area (Rs.)	2640	5407	2159	3808
20.	Synergistic role of Sujala WDP (=19-18)	1331	2820	-153	1462
21.	Net returns per rupee of expenditure on all watershed structure (Rs.) = (19 /10)	1.5	3.7	2.6	3.1

Note: Synergistic role of Sujala WDP = Incremental net returns per acre of gross cropped area over non-watershed area (Rs.) - Net returns from rainfed crops per acre of gross cropped area (Rs.)

*Net returns per rupee of expenditure on all watershed structures* = Incremental net returns per acre of gross cropped area in Sujala over non-watershed area (Rs.) - Expenditure per acre of gross cropped area in Sujala (Rs.); *NR*: Net returns

### 5.3 Incremental Net Return due to Sujala Watershed in Drought Year, 2004

This analysis on incremental net return due to Sujala watershed pertains to a drought year. With this backdrop, the incremental return in Sujala watershed has been positive for the sample farmers who do not possess irrigation wells. However, barring the medium farmers, for all sample farmers possessing irrigation

wells, the incremental net return per acre is negative. This is because, in Sujala watershed, arecanut is still in establishment stage. Once arecanut crop begins bearing, this difference would be positive. When the incremental net return is computed between Sujala watershed and non watershed area, it turns out to be positive for sample farmers possessing irrigation wells as well as for those who are totally dependent on rainfall. Here too, the incremental returns are relatively higher for farmers not possessing irrigation wells than for farmers not possessing irrigation wells. This reiterates that Sujala watershed program has contributed substantially for farmers who are totally dependent on rainfall compared with those farmers who are dependent on irrigation wells (Table 6).

Table 6: Incremental net returns due to Sujala watershed over Non- Sujala watershed area and Non-watershed area in Chitradurga District, drought year 2004

Type of farm	Sujala WDP over Non -Sujala (DPAP) WDP = Rs. 8375 -Rs. 5689 = Rs. 2686		Sujala WDP over Non-watershed area = Rs. 8375 – Rs. 5309 = Rs. 3066	
	For sample farmers possessing irrigation wells	For sample farmers not possessing irrigation wells	For sample farmers possessing not possessing	For sample farmers irrigation wells irrigation wells
Small and marginal farmers	-3782	5863	3618	7714
Medium farmers	2184	7765	3461	6739
Large farmers	-1672	NA	1195	NA
Overall	-65	7798	614	7354

Note: NA: There were no large farmers in the sample not possessing irrigation wells

Incremental net return in Sujala over Non-Sujala watershed = net return per acre from all sources in Sujala minus that in Non-Sujala watershed  
Incremental net return in Sujala over Non- watershed = net return per acre from all sources in Sujala minus that in non-watershed area

#### 5.4 Net Return per Farm from Different Sources in Normal Year, 2005

Considering net returns per acre of net cropped area realized from all the sources in normal year 2005, in Sujala watershed, small and marginal farmers and medium farmers with irrigation wells realized higher return of Rs. 8,693 and Rs. 13,081 respectively as compared to large farmers (Rs. 7,536). Small and marginal farmers without irrigation wells realized a net return (Rs. 12,922) higher than medium farmers (Rs. 9,848). The overall net return per acre of net cropped area for sample farmers without irrigation wells (Rs. 12,203) was higher than that of sample farmers with irrigation wells (Rs. 7,199) (Table 9), since Sujala program amply supported these farmers through wage employment to a large extent and through income generating activity to some extent. The wage employment was the single largest contributor forming 38% of the net return per farm here (Table 7).

Those farmers not possessing irrigation wells in Non-watershed area in normal year 2005 are realizing a net return of Rs. 6,094 per acre while those possessing irrigation wells are realizing a net return of Rs. 5,370. Farmers not possessing irrigation wells realized 52% of their income from wage employment and livestock while those possessing irrigation wells realized only 13% of their income from livestock and wage employment. They realized the remaining 87% from agriculture and horticulture (Table 9).

#### 5.5 Incremental Net Return due to Sujala Watershed in Normal Year, 2005

The incremental net return due to Sujala watershed in good rainfall year (normal year 2005) was positive for the sample farmers who should not possess irrigation wells in comparison to non-Sujala watershed (DPAP).

In the Non-Sujala (DPAP) watershed in good rainfall year (normal year 2005), the overall net return per acre for sample farmers possessing irrigation wells was Rs. 10,787 per acre it is higher than that obtained by sample farmers not possessing irrigation wells being Rs. 5,245 per acre. The contribution of wage employment in DPAP is substantial being 31% for sample farmers without irrigation wells. For the farmers with irrigation, 93% of their net return was from agriculture and horticulture. Medium farmers realized lower net return per acre (Rs. 8,018) as compared to small and marginal farmers (Rs. 13,438) and large farmers (Rs. 10,998). Similar results were observed for farmers without irrigation wells, wherein small and marginal farmers realized Rs. 8,629 which is higher than that obtained by medium farmers (Rs. 3,179) (Table8).

Table 7: Net returns per farm from different sources in Sujala Watershed in Chitradurga district, normal year 2005 (Rupees)

Sources of net returns	Sample total								NR per NCA	per farm
	Agriculture	Horticulture	Livestock	Income Generating Activities	Wage employment	Sum of net returns	NCA			
For sample farmers possessing irrigation wells										
Small and marginal farmers (3)	58062 (46)	0 (0)	23180 (18)	4800 (4)	40000 (32)	126042	14.5	8693	42014	
Medium farmers (6)	547125 (67)	171117 (21)	64800 (8)	0 (0)	28000 (3)	811042	62	13081	135174	
Large farmers (2)	169352 (41)	108123 (26)	13490 (3)	125000 (30)	0 (0)	415965	55.2	7536	217983	
Overall (11)	774540 (56)	299240 (22)	101470 (7)	129800 (9)	68000 (5)	1373050	131.7	10426	124823	
For sample farmers not possessing irrigation wells										
Small and marginal farmers (17)	119799 (20)	15317 (3)	166270 (28)	55200 (9)	241680 (40)	598266	46.3	12922	35192	
Medium farmers (2)	78392 (66)	4379 (4)	6020 (5)	0 (0)	30000 (25)	118791	16.5	7199	59396	
Overall (19)	198192 (28)	19696 (3)	172290 (24)	55200 (8)	271680 (38)	717057	62.8	11418	37740	
Overall Net returns per acre from all sources considering irrigated and rainfed condition from agriculture, horticulture, livestock and wage employment and income generating activities in Sujala watershed= (1373050+717057)/(131.7+62.8)=10746										

Note: NCA: Gross cropped area, NR: Net returns, Figures in the parentheses indicate percentage to the respective total

Table 8: Net returns per farm from different sources in Non- Sujala Watershed in Chitradurga district, normal year 2005 (Rupees)

Sources of net returns	Sample total							NR per NCA	per farm
	Agriculture	Horticulture	Livestock	Income Generating Activities	Wage employment	Sum of net returns	NCA		
For sample farmers possessing irrigation wells									
Small and marginal farmers (3)	137368 (68)	42999 (21)	21200 (11)	0 (0)	0 (0)	201567	15	13438	67189
Medium farmers (3)	62922 (38)	77351 (47)	24100 (15)	0 (0)	0 (0)	164373	20.5	8018	54791
Large farmers (4)	662079 (75)	177214 (20)	46030 (5)	0 (0)	0 (0)	885323	80.5	10998	221331
Overall (10)	862369 (69)	297564 (24)	91330 (7)	0 (0)	0 (0)	1251263	116	10787	124975
For sample farmers not possessing irrigation wells									
Small and marginal farmers (13)	83478 (26)	20721 (6)	58540 (18)	0 (0)	158700 (49)	321439	37.25	8629	24726
Medium farmers (7)	124376 (64)	36447 (19)	25900 (13)	7200 (4)	0 (0)	193922	61	3179	29132
Overall (20)	207853 (40)	57168 (11)	84440 (16)	7200 (1)	158700 (31)	515361	98.25	5245	26268
Overall net returns per acre from all sources considering Irrigated and Rainfed condition from agriculture, horticulture, livestock wage employment and income generating activities in Non-Sujala watershed (DPAP)= (1251263+515361)/116+98.25)=8246									

Note: NCA: Gross cropped area, NR: Net returns, Figures in the parentheses indicate percentage to the respective total

Table 9: Net returns per farm from different sources in Non- Watershed area in Chitradurga district, normal year, 2005 (Rupees)

Sources of net returns	Sample total							NR per NCA	per farm
	Agriculture	Horticulture	Livestock	Income Generating Activities	Wage employment	Sum of net returns	NCA		
For sample farmers possessing irrigation wells									
Small and marginal farmers (1)	20860 (64)	5483 (17)	6150 (19)	0 (0)	0 (0)	32493	5.5	5908	32493
Medium farmers (5)	147244 (61)	60241 (25)	34330 (14)	0 (0)	0 (0)	241815	41	5898	48363
Large farmers (2)	70158 (61)	34538 (30)	10330 (9)	0 (0)	0 (0)	115026	26	4424	57513
Overall (8)	238261 (61)	100262 (26)	50810 (13)	0 (0)	0 (0)	389334	72.5	5370	48667
For sample farmers not possessing irrigation wells									
Small and marginal farmers (19)	176257 (44)	15610 (4)	104470 (26)	0 (0)	104470 (26)	400807	75.75	5291	24081
Medium farmers (3)	77126 (66)	6552 (6)	23170 (20)	0 (0)	10000 (9)	116847	18.5	6316	38949
Overall (22)	253382 (44)	22162 (4)	127640 (22)	0 (0)	171200 (30)	574384	94.25	6094	26108
Overall Net returns per acre from all sources considering Irrigated and Rainfed condition from agriculture, horticulture, livestock wage employment and income generating activities in Non watershed= $(389334+574384)/(72.5+94.25)=5779$									

Note: NCA: Gross cropped area, NR: Net returns, Figures in the parentheses indicate percentage to the respective total

When the incremental net return was computed between Sujala watershed and non-watershed area, it turns to be positive for sample farmers possessing irrigation wells as well as for those who are totally dependent on rainfall. Here too, the incremental returns were relatively higher for farmers possessing irrigation wells (Rs.5, 326) than for farmers not possessing irrigation wells (Rs. 5,056). This reiterates that Sujala watershed program has contributed substantially for farmers who are totally dependent on rainfall as compared to those farmers who are dependent on irrigation wells (Table10).

Table 10: Incremental net returns in Sujala watershed over Non- Sujala (DPAP) watershed area and Non-watershed area in Chitradurga District, normal year, 2005

Type of farm	Sujala WDP over Non -Sujala (DPAP) WDP = Rs. 10746 –Rs. 8246 = Rs. 2500		Sujala WDP over Non-watershed area = Rs. 10746 –Rs. 5779 = Rs. 4967	
	sample farmers possessing irrigation wells	sample farmers not possessing irrigation wells	sample farmers possessing not possessing	sample farmers irrigation wells irrigation wells
Small and marginal farmers	-4745	4292	2785	7630
Medium farmers	5063	4020	7183	883
Large farmers	-3462	NA	3112	NA
Overall	-361	6173	5056	5326

NA: There were no large farmers in the sample not possessing irrigation wells

### 5.6 Contribution of Watershed Program for Farmers not Possessing Irrigation Wells

Farmers who are totally dependent on rainfall and not possessing irrigation wells form an important class of beneficiaries in a watershed program. They are far more exposed to the vagaries of weather and market uncertainties. The contribution of Sujala watershed program for these farmers totally dependent on rainfall is thus a serious equity issue, since these farmers with relatively low endowment, will have been benefited the most, compared with farmers who have irrigation wells. The contribution of Sujala and non-Sujala (DPAP) watershed in a drought year (2004) as well as in a normal rainfall year (2005) for these farmers was therefore estimated using the net returns (as enunciated in Table11).

The estimated contribution of watershed institutions and community participation in the drought year (2004) as well as in normal rainfall year (2005) for farmers totally dependent on rainfed agriculture was Rs. 7,798 and Rs. 6,173 respectively. The overall contribution of Sujala watershed program to farmers totally dependent was Rs. 7,354 in the drought year (2004) and Rs. 5,324 in the normal rainfall year (2005). Thus, Sujala watershed program has greatly benefited the farmers dependent on rainfall.

In corroboration of these findings, the ANOVA performed by comparing the net returns per acre for farmers dependent on rainfall in a drought year (2004) as well as in normal rainfall year (2005) in Sujala watershed, non-Sujala watershed and non-watershed were, indicated that the net returns per acre from all sources for farmers totally dependent on rainfall in Sujala watershed were significantly higher than those in non-Sujala (DPAP) watershed and in non-watershed area. Thus, the contribution of Sujala watershed to farmers totally dependent on rainfall is both statistically and economically significant.

Table 11: Estimated contribution of Sujala watershed development program exclusively for farmers who totally depend on rainfed agriculture (and not possessing irrigation wells) in Veda river bank in Chitradurga district, 2004-05 (Rs per acre)

Sl.No	Particulars	Drought year (2004)	Normal rainfall year (2005)
1	Contribution of (Non-Sujala) DPAP Watershed program (= net returns in Non-Sujala WDP minus net returns in Non-watershed area)	(= 4405 - 4849) = - 444	(= 5245- 6094) = - 849
2	Contribution of Watershed institutions and community participation (= net returns in Sujala minus Net returns in Non-Sujala WDP)	(=12203- 4405) = 7798	(=11418- 5245) = 6173
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non- watershed area)= (1) + (2)	(= 12203- 4849) = 7354	(=11418-6094) = 5324

### 5.7 Contribution of Watershed Program for Farmers Possessing Irrigation Wells

Considering the contribution of watershed program for farmers possessing irrigation wells, the results indicated that the contribution of Non-Sujala (DPAP) watershed on the farmers possessing irrigation wells is Rs. 680 in a drought year (2004) while it rose to Rs. 5,417 in a normal rainfall year (2005). However, the role of Sujala watershed institutions and community participation in watershed program is negative in 2004 and 2005 indicating that the institutions have to have different and better strategies exclusively for farmers possessing irrigation wells. This does not mean that watershed institutions and community participation haven't performed well. The watershed institutions and community participation in watershed program have done their best in augmenting incomes of those depending totally on rainfed farming. Their role in augmenting incomes of those having wells has to improve. Discerning the contribution of Sujala watershed program, it is apparent that the overall contribution of Sujala watershed program to farmers possessing irrigation wells is Rs. 614 per acre in a drought year (2004) and Rs. 5,056 per acre in normal rainfall year. Thus, the contribution of Sujala watershed as well as non-Sujala (DPAP) watershed is uniform for the farmers possessing irrigation wells (Table12).

While considering whether the net returns per acre for farmers possessing irrigation wells in Sujala and non-Sujala watershed are different from that of the control area through ANOVA, it was found that these net returns per acre are not statistically significantly different. However, this result is not true for the farmers totally dependent on rainfall as already discussed. Thus, while the contribution of Sujala watershed program is statistically significant for farmers not possessing irrigation wells, it is not statistically significant for farmers possessing irrigation wells.

Table 12: Estimated contribution of Sujala watershed development program exclusively for farmers who are possessing irrigation wells in Veda river bank in Chitradurga district, 2004-05 (Rs per acre)

Sl.No	Particulars	Drought year (2004)	Normal rainfall year (2005)
1	Contribution of (Non-Sujala) DPAP Watershed program (= net returns in Non-Sujala WDP minus net returns in Non-watershed area)	(= 6615- 5935) = 680	(= 10787- 5370) = 5417
2	Contribution of Watershed institutions and community participation (= net returns in Sujala minus Net returns in Non-Sujala WDP)	(=6549- 6615) = -66	(=10426 - 10787) = -361
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non- watershed area)= (1) + (2)	(= 6549- 5935) = 614	(=10426 -5370) = 5056



## 5.8 Overall Contribution of Watershed Program for Farmers Dependent on Rainfall as well as for Farmers Possessing Irrigation Wells

Considering the overall contribution of non-Sujala (DPAP) watershed on farmers possessing irrigation wells and those not possessing irrigation wells was Rs. 380 per acre in a drought year (2004) and Rs. 2,467 per acre in a normal rainfall year (2005). The contributions of the Sujala watershed institutions and the community in a drought year was Rs. 2686 per acre and in a good year was Rs. 2500 per acre. For farmers, the contribution of watershed institutions and the community was not only uniform irrespective of the agro-climatic conditions, but also higher than the contributions of non-Sujala (DPAP) watershed program (Table 13).

Table 13: Estimated contribution of Sujala watershed development program in Veda riverbank in Chitradurga district, 2004-05 (Rs per acre)

Sl.No	Particulars	Drought year (2004)	Normal rainfall year (2005)
1	Contribution of (Non-Sujala) DPAP Watershed program (= net returns in Non-Sujala WDP minus net returns in Non-watershed area)	(= 5689- 5309) = 380	(= 8246-5779) = 2467
2	Contribution of Watershed institutions and community participation (= net returns in Sujala minus Net returns in Non-Sujala WDP)	(=8375-5689) = 2686	(=10746-8246) = 2500
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non- watershed area)= (1) + (2)	(=8375-5309) = 3066	(=10746-5779) = 4967

The contribution of Sujala watershed program in a normal rainfall year (2005) was Rs. 4967/acre. This is higher than the contribution of Sujala watershed program in a drought year (2004) (Rs. 3066/acre). Thus, the contributions of Sujala watershed program in both good and drought years are higher than the contributions of Non-Sujala (DPAP) watershed as well as the contributions of Sujala watershed institutions and community participation. Upon performing ANOVA, it was found that the net returns per acre from all sources in Sujala watershed is significantly different from that in non-watershed area in a drought year (2004) as well as in a good year (2005). Thus, the overall contribution of Sujala watershed program to farmers not possessing irrigation wells as well as farmers possessing irrigation wells is statistically significant.

## 5.9 Contribution of Watershed Program for Farmers Possessing Irrigation Wells

The economic contribution in terms of incremental net returns per acre, which is exclusive of income from wage employment and which considers watershed expenditure in (i) Sujala over non-watershed area (in drought year, normal year) to be as contribution of Sujala watershed is Rs. 1726, Rs. 3650; (ii) Sujala over non-Sujala (DPAP) watershed to be equal to the contribution of Sujala watershed institutions and community participation is Rs. 1067, Rs. 898; (iii) Non Sujala (DPAP) over non-watershed area, as contribution of Non-Sujala or DPAP watershed was Rs. 133 and Rs. 2226. This indicates the economic supremacy of Sujala watershed program (Table 14).

The economic contribution in terms of incremental net returns per acre without deducting watershed expenditure, including wage income in (i) Sujala over non-watershed area in drought year, normal year was Rs. 3066 and Rs. 4967 respectively; (ii) Sujala over non-Sujala (DPAP) watershed is Rs. 2686 and Rs.2500; (iii) Non Sujala (DPAP) over non-watershed area was Rs. 380 and Rs. 2467) (Table 15).

The economic contribution in terms of incremental net returns per acre after adding watershed expenditure, adding wage income in (i) Sujala over non-watershed area (in drought year, normal year) is Rs. 2469 and Rs. 4370; (ii) Sujala over non-Sujala (DPAP) watershed is Rs. 2089 and Rs. 1903; (iii) Non Sujala (DPAP) over non-watershed area was Rs. 146 and Rs. 1941 (Table 16).

The economic contribution in terms of incremental net returns per acre excluding income from wage employment, exclusive of watershed expenditure in (i) Sujala over non-watershed area (in drought year, normal year) was Rs. 2323 and Rs. 4247; (ii) Sujala over non-Sujala (DPAP) watershed was Rs. 1664 and Rs. 1495; (iii) Non Sujala (DPAP) over non-watershed area was Rs. 659, Rs. 2752 (Table 17).

Table 14: Estimated contribution of watershed development program in Chitradurga district, 2004-05 (Excluding income from wage employment and adding watershed expenditure) (Rs per acre)

Sl. No	Particulars	Drought year 2004	Normal year 2005
1	Contribution of (Non-Sujala) DPAP Watershed program(= net returns in Non-Sujala WDP minus net returns in Non-watershed area)	(= 4877 - 526- 4218) = 133	(= 7505 - 526 - 4753) = 2226
2	Contribution of Watershed institution and community participation (=net returns in Sujala minus NRs in Non-Sujala WDP)	(=6541 - 597 - 4877) = 1067	(=9000 - 597-7505) = 898
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non-watershed area)= (1) + (2)	(=6541 - 597 -4218) = 1726	(=9000 - 597 -4753) = 3650
4	Effect of rainfall on (Non-Sujala) Watershed program =(contribution of NS watershed in normal year 2005 minus contribution of NS watershed in drought year 2004)	(=2226 - 133) = 2093	
5	Effect of rainfall on Watershed institution and community participation (=contribution of watershed institution and community participation in normal year 2005 minus contribution of watershed institution and community participation in drought year 2004)	(=898 - 1067) = -169	
6	Effect of rainfall on Sujala Watershed (= contribution of Sujala watershed in normal year 2005 minus contribution of Sujala watershed in drought year 2004 is also equal to (4) + (5)	(=3650 - 1726) = 1924	
7	Net contribution of non Sujala (DPAP) watershed	= 2226 - 2093= Rs. 133	
8	Net contribution of Sujala watershed	Rs. 3650 - Rs. 1924 = Rs. 1726	

Table 15: Contribution of Sujala watershed development program, in Veda river bank in Chitradurga district, 2004-05 (Without deducting watershed expenditure, adding wage income) (Rs per acre)

Sl. No	Particulars	Drought year 2004	Normal year 2005
1	Contribution of (Non-Sujala) DPAP Watershed program(= net returns in Non-Sujala or DPAP WDP minus net returns in Non-watershed area)	(= 5689- 5309) = 380	(= 8246-5779) = 2467
2	Contribution of Watershed institution and community participation (=net returns in Sujala minus NRs in Non-Sujala WDP)	(=8375-5689) = 2686	(=10746-8246) = 2500
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non- watershed area) = (1) + (2)	(=8375-5309) = 3066	(=10746-5779) = 4967
4	Effect of rainfall on (Non-Sujala or DPAP) Watershed program = (contribution of NS watershed in normal year minus contribution of NS watershed in drought year)	(=2467 - 380) = 2087	
5	Effect of rainfall on Watershed institution and community participation (=contribution of watershed institution and community participation in normal year minus contribution of watershed institution and community participation in drought year)	(=2500- 2686) = -186	
6	Effective of rainfall on Sujala Watershed (= contribution of Sujala watershed in normal year minus contribution of Sujala watershed in drought year, is also equal to (4) + (5)	(=4967- 3066) = 1901	
7	Net contribution of non Sujala (DPAP) watershed	= 2467-2087 = Rs.380	
8	Net contribution of Sujala watershed	(4967 – 1901) = 3066	

Table 16: Estimated contribution of watershed, institutions and rainfall in Veda river bank in Chitradurga district, 2004-05 (after adding watershed expenditure, adding wage income) (Rs per acre).

Sl. No	Particulars	Drought year 2004	Normal year 2005
1	Contribution of (non-Sujala) or DPAP Watershed program (= net returns in Non-Sujala WDP minus net returns in Non-watershed area)	(5689 - 526-5309) = -146	(=8246 -526 -5779) = 1941
2	Contribution of Watershed institution and community participation (=net returns in Sujala minus NRs in Non -Sujala or DPAP WDP)	(=8375-597-5689) = 2089	(=10746-597-8246) = 1903
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non- watershed area)= (1) + (2)	(=8375-597-5309) = 2469	(=10746-597-5779) = 4370
4	Effect of rainfall on (Non-Sujala) Watershed program = (contribution of NS watershed in 2005 minus contribution of NS watershed in 2004)		= [1941-(- 146)] = 2087
5	Effect of rainfall on Watershed institution and community participation (=contribution of watershed institution and community participation in 2005 minus contribution of watershed institution and community participation in 2004)		(= 1903 - 2089) = - 186
6	Effect of rainfall on Sujala Watershed (= contribution of sujala watershed in 2005 minus contribution of sujala watershed in 2004 is also equal to (4) + (5)		(= 4370 - 2467) = 1901

*Note: 2004 - drought year. 2005 - good rainfall year; Expenditure in Sujala watershed programme = Rs 597 per acre; Expenditure in Non-Sujala (DPAP) watershed programme = Rs 526 per acre, ;*

Table 17: Estimated contribution of watershed development program in Chitradurga district, 2004-05  
(Excluding income from wage employment and without deducting watershed expenditure) (Rs. per acre)

Sl. No	Particulars	Drought year 2004	Normal year 2005
1	Contribution of Non-Sujala (DPAP) Watershed program (= net returns in Non-Sujala (DPAP) WDP minus net returns in Non-watershed area)	(= 4877- 4218) = 659	(= 7505-4753) = 2752
2	Contribution of Watershed institution and community participation (=net returns in Sujala minus NRs in Non-Sujala (DPAP) WDP)	(=6541-4877) = 1664	(=9000-7505) = 1495
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non- watershed area) = (1) + (2)	(=6541-4218) = 2323	(=9000-4753) = 4247
4	Effect of rainfall on (Non-Sujala) Watershed program = (contribution of NS watershed in normal year 2005 minus contribution of NS watershed in drought year 2004)	(=2752 - 659) = 2093	
5	Effect of rainfall on Watershed institution and community participation (=contribution of watershed institution and community participation in normal year 2005 minus contribution of watershed institution and community participation in drought year 2004)	(=1495- 1664)= -169	
6	Effect of rainfall on Sujala Watershed (= contribution of Sujala watershed in normal year 2005 minus contribution of Sujala watershed in drought year 2004 is also equal to (4) + (5)	(=4247- 2323) = 1924	
7	Net contribution of non Sujala (DPAP) watershed	= 2752-2093 = 659	
8	Net contribution of Sujala watershed	(4247-1924) = 2323	

The net return per acre is hypothesized to reflect the quintessence of farm efficiency in using the resources and opportunities optimally. Considering small and marginal, medium and large farmers together, the net return in Sujala is Rs. 10,426 per acre. For small and marginal farmers, net return is Rs. 8,693 and for medium farmers, net return is Rs.13, 081. For Large farmers, net return is Rs 7,536 per acre. These are the direct impacts of Sujala on farmers possessing irrigation wells. For these farmers, 56% of the net return was obtained from the cultivation of crops or agriculture, 22% from horticulture, and 9% from income generating activities, 7% from livestock and 5% from wage employment.

### 5.10 Economic Impact on Rainfed Farmers

For farmers who are totally dependent on rainfall, small, marginal and medium farmers together in Sujala, the net return per acre was estimated to be Rs. 11418. For small and marginal farmers, the net return was Rs. 12922 and medium farmers Rs.7199. Considering both rainfed and irrigated condition the overall net return

per acre from all the sources was Rs. 10746. For rainfed farmers, 28% of the net returns were from cultivation of field crops, 3% from horticulture, 24% from livestock, 8% from income generating activities and 38% from wage income.

Considering small and marginal, medium and large farmers with irrigation in non watershed area, the net return per acre was Rs.5370 per acre, for small and marginal farmers net return was Rs. 5908 and medium farmers Rs.5898 and for large farmers it was Rs 4424. Here farmers realized 61% net returns from agriculture, 26% from horticulture and 13% from livestock.

Considering small, marginal and medium farmers under rainfed conditions in non watershed area, the net was Rs. 6094. For small and marginal farmers net return was Rs. 5291 and medium farmers Rs.6316. Here farmers realized 44% of the net returns from agriculture, 4% from horticulture, 22% from livestock and 33% from wage employment. Considering both rainfed and irrigated condition the overall net return per acre from all the sources was Rs. 5779.

### **5.11 Economics of Groundwater Recharge**

Economics of groundwater recharge for small and marginal farmers is measured as the difference in the net returns between farmers with irrigation wells in Sujala and farmers with wells outside Sujala. Accordingly, farmers with irrigation wells in Sujala realized a net return of Rs. 10,426 while those outside the watershed realized Rs. 5,370 per acre as net return. Thus, the overall contribution of groundwater recharge because of Sujala is Rs. 5,056 per acre, which is 94% higher than net returns outside the watershed. Thus, the recharge contribution of Sujala watershed through groundwater recharge was Rs. 5056 per acre to which agriculture, horticulture and livestock contribute substantially.

### **5.12 Assessment of Equity in Benefits**

There is equity in distribution of benefits in Sujala for farmers possessing irrigation wells. Here large farmers realized net returns of Rs. 7,536 per acre while small and marginal farmers realized net return of Rs. 8,693 and Rs. 13,081. Small and marginal farmers constitute around 80% in the Sujala watershed and as they realized 15% higher net return than large farmers it points towards equity in the distribution of benefits.

Under rainfed category, the net returns obtained by small and marginal farmers (Rs. 12,922) are 80% higher than the return obtained by medium farmers (Rs. 7,199). Here, rainfed small and marginal farmers enjoy two types of equity. First, the net return of small and marginal farmers under rainfed condition (Rs. 12,922) is almost 50% higher than the net return of small and marginal farmers with irrigation (Rs. 8,693). Second, the net return of small and marginal farmers (Rs. 12,922) under rainfed is 80% higher than medium farmers (Rs. 7,199).

### **5.13 Sustainability**

The equity impacts of watershed program on rainfed farmers are largely owing to incremental wage employment offered by Sujala which is contributing to 40% of net returns. Thus, after the Sujala project rainfed farmers are deprived of wage employment, they will lose this net return. Hence, incomes for farmers possessing irrigation wells in Sujala will be more sustainable than farmers without irrigation wells. The rainfed farmers in Sujala received Rs. 7019 per acre while the irrigated farmers in Sujala received Rs. 10,426, this is 48% higher than the net returns realized by Sujala rainfed farmers. Thus, the overall contribution of Sujala to groundwater recharge is 48% on sustainable basis (Tables 11 and 12).

### **5.14 Estimation of Synergies**

The economic benefit owing to synergistic roles of technical support by Sujala authorities, watershed structures, NGOs, SHGs, watershed *sanghas*, area group, executive committee and the participating farmers was estimated by deducting net return obtained in non-Sujala watershed (DPAP) from the net return obtained in

Sujala watershed. This works out to Rs. 2500 per acre, which forms 50% of the total contribution of Sujala watershed. Thus, the synergistic benefits contribute around 50%. The synergistic effect here was computed to reflect the interaction effects of technical support (Table 18).

### 5.15 Policy Implications for Sustainability of Sujala

Considering the synergistic contribution of 50% in the success of Sujala watershed program, the role NGO improvement, peoples' participation and the private property rights for watershed structures, would continue to contribute towards the sustainability of the Sujala watershed program. Hence, the transaction cost of erecting watershed institution and evolving community participation needs to be either borne by farmers themselves or subsidized in part or full by the government. Thus, Sujala pattern of watershed development program holds promise for future Watershed Development program in the country and has potential for emulation in other parts of Karnataka and India. While this paper was being written, already the World Bank approved extension of Sujala program to other five districts of Karnataka.

Table 18: Economic benefits due to synergistic role of surface water bodies, in situ conservation efforts and institutional innovations (*Rs per Acre*)

Sl.No	Particulars	Contribution / Effects in 2005
1.	Contribution of (Non-Sujala) DPAP Watershed program (= net returns in Non-Sujala WDP minus net returns in Non-watershed area)	(= 8246-5779) = 2467
2	Synergistic effect (=net returns in Sujala minus NRs in Non-Sujala WDP)	(=10746-8246) = 2500
3	Contribution of Sujala Watershed (= net returns in Sujala minus Net returns in Non- watershed area)= (1) + (2)	(=.2467 + 2500) = 4967

The results and findings along with objectives and methodology are summarized in Table 19.

Table 19: Conclusions

Sl No	Objective	Hypothesis	Methodology	Results and Findings
1	To evaluate the impact of watershed development on cropping pattern, income, and employment.	Net returns from watershed induced cropping pattern have resulted in economic drought proofing.	Net returns per acre in Sujala minus net returns per acre in non watershed area in drought year	<p>1. For farmers possessing wells: Rs. 614</p> <p>2. For farmers not possessing wells: Rs. 7354</p> <p>3. For pooled sample: Rs. 3066</p> <p>Findings:</p> <p>1. Sujala watershed program has not induced major change in crop pattern in this micro-watershed</p> <p>2. The positive net returns above indicate the extent of drought proofing offered by Sujala watershed program</p>
		Watershed Development Program has improved household level income.	Net returns per acre from livestock, wage employment and income generating activities in Sujala minus Non watershed area	<p>1. In drought year, household income per acre in Sujala minus that in non watershed area is Rs. 3997 – Rs. 2231 = Rs. 1766</p> <p>2. In normal year, household income in sujala minus that in non watershed area is Rs. 4105 – Rs. 2097 = Rs. 2008</p> <p>Findings: Due to Sujala, the household income per acre has increased by Rs. 1766 in drought year, and by Rs. 2008 in normal year.</p>
		Watershed Development Program has resulted in additional employment generation	Employment generation in Sujala minus employment generation outside Sujala	<p>1. In drought year, in Sujala employment generation is 2244 man days per household, while outside watershed, employment generation is 112 man days per household</p> <p>2. In normal year, in Sujala, employment generation is 2264 mandays per household, while outside watershed, employment generation is 114 man days per household.</p> <p>Findings: Watershed development program has resulted in additional employment generation to the tune of around 2244 man days in drought year and 2264 man days in normal year</p>



SI No	Objective	Hypothesis	Methodology	Results and Findings
2	To assess the distribution of economic benefits across different categories of farmers	Watershed Development Program has brought fair distribution of income across different classes of farmers.	Incremental net returns due to Sujala over non-water-shed area in drought year and in normal year for the three classes of farmers	<ol style="list-style-type: none"> <li>1. In drought year, for class of farmers with irrigation wells, small and marginal farmers realized Rs. 3618 per acre; medium farmers realized Rs. 3461 per acre and large farmers realized Rs. 1195 per acre.</li> <li>2. In drought year, for class of farmers without irrigation wells, small and marginal farmers realized Rs. 7,714 per acre, medium farmers realized Rs. 6,739 per acre, (and there were no large farmers in this class)</li> <li>3. In normal year, for class of farmers with irrigation wells, small and marginal farmers realized Rs. 2,785 per acre; medium farmers realized Rs. 7,183 per acre and large farmers realized Rs. 5,056 per acre.</li> <li>4. In normal year, for class of farmers without irrigation wells, small and marginal farmers realized Rs. 7,630 per acre, medium farmers realized Rs. 883 per acre, (and there were no large farmers in this class)</li> <li>5. In normal year, among farmers possessing wells, the small and marginal farmers realized incremental net returns of Rs. 2,640, while medium farmers realized incremental net returns of Rs. 5,407 per acre and large farmers realized Rs. 2,159 even though the Sujala expenditure per acre was Rs. 1,745 on small and marginal farmers and Rs. 1,456 per acre in medium farmers and for large farmers Rs.836</li> </ol>

SI No	Objective	Hypothesis	Methodology	Results and Findings
				<p>6. In normal year, among farmers without wells, the small and marginal farmers realized incremental net returns of Rs. 7048, while medium farmers realized incremental net returns of Rs. 796 per acre, even though the Sujala expenditure per acre was Rs. 2796 on small and marginal farmers and Rs. 1708 per acre in medium farmers</p> <p>Findings: In drought and normal year, small and marginal farmers have performed economically better than medium / large farmers. Hence Sujala watershed program has favored small and marginal farmers more than large farmers, despite the fact that small and marginal farmers received lower Sujala expenditure per acre. Hence small and marginal farmers have exhibited higher economic efficiency in utilizing both public and private resources than medium and large farmers.</p>

## 6. SUMMARY AND CONCLUSION

In this study, economic impact of water harvesting and groundwater recharging was analyzed in the context of Sujala watershed equity and efficiency in the distribution of benefits in Chitradurga district, Karnataka. Field data for 2004-05 (drought year) and 2005-06 (normal year) from 30 sample farmers in Sujala watershed form the data base for the study. Another sample of 30 farmers from Non-Sujala (or DPAP) watershed, and 30 from outside watershed area form the control. Farmers were further classified as: (i) those who had bore well irrigation; and (ii) those who had no borewell irrigation in order to assess the impact of watershed.

It was found that the amortized cost per functioning well and cost per acre inch of groundwater in Sujala watershed is lower than that in non-Sujala watershed and non-watershed area. The economic contribution in terms of incremental net returns per acre in (i) Sujala over non-watershed area (in drought year, normal year) as the contribution of Sujala watershed are Rs. 1726 and Rs. 3650; (ii) Sujala over Non-Sujala (DPAP) watershed (as the contribution of Sujala watershed institutions) is Rs. 1067 and Rs. 898; (iii) Non Sujala (DPAP) over non-watershed area (equal to contribution to Non-Sujala or DPAP watershed) is Rs. 133 and Rs. 2226. These indicate economic supremacy of Sujala watershed program.

The incremental net returns of Sujala over non-watershed area in drought year and in normal year for farmers possessing irrigation wells were Rs. 614 and Rs. 5056 respectively; for farmers not possessing irrigation wells is Rs. 7354 and Rs. 5326; for all classes of farmers is Rs. 3066 and Rs. 4967 are the prima facie indicators of economic contributions of Sujala watershed program. The negative externality per well per year in Sujala was Rs 2652, in Non-Sujala watershed was Rs. 2735, and in non-watershed area was Rs. 4285. It shows that the negative externality in groundwater irrigation has reduced by 38% in Sujala over non-watershed area.

Sujala watershed program had a higher expenditure as compared to non-sujala watershed. Still the B-C ratios were higher in Sujala watershed during both drought and normal year.

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