REVIEW OF RESEARCH
IMPACT FACTOR : 5.7631(UIF) UGC APPROVED JOURNAL NO. 48514 ISSN: 2249-894X
VOLUME - 7 | ISSUE - 12 | SEPTEMBER - 2018

AN ANALYSIS OF RAINWATER HARVESTING STATUS AND ITS IMPACT ON AGRICULTURE DEVELOPMENT IN DHARAWAD DISTRICT

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ABSTRACT:

This paper initiates with demographic profile of sample households and their socio-economic conditions and concludes with subjective results along with objective empirical evidence of RWH implications in Basapur and Ballarwad villages in Navalgund taluk, Jammihal and Tumrikoppa villages in Kalghatagi taluk. This study is based on primary data sources collected from four sample villages. For data analysis has undertaken with the help of simple statistical tools such as percentage, growth rate and associations. Agriculture is the major economic activity in the selected study area. Current study addresses the implications of rain water harvesting in sample villages such as Basapura and Ballarwad in Navalgund taluk which is least developed and low rainfed area in Dharwad district and it is compared with Jammihal and Tumrikoppa villages of Kalghatagi taluk which is more economically developed and having more water resources. The results showed that RWH has benefitted agriculture development and improvement in standard of living of farmers in the study area.

KEYWORDS: *Rain Water Harvesting, Cost and Benefits of RWH, Water Tanks, Catchment Area, Agriculture Development, Irrigation etc.*

1. INTRODUCTION

This paper deals with data analysis and implications of rain water harvesting (RWH) in the selected sample area in Dharwad district of Karnataka state. Agriculture is the major economic activity in the selected study area. Current study addresses the implications of rain water harvesting in sample villages such as Basapura and Ballarwad in Navalgund taluk which is least developed and low rainfed area in Dharwad district and it is compared with Jammihal and Tumrikoppa villages of Kalghatagi taluk which is more economically developed and having more water resources.

2. REVIEW OF LITERATURE:

Jain N.M.D et.al., (2002) provided a detailed explanation and conceptual clarity with regard to various concepts associated with rain-water harvesting namely aquifier, open well, ground water recharge, run-off, water table, artificial recharge structures etc. It also expressed simple calculations for the required quantity of rainwater to be harvested and run-off co-efficients for various surfaces based upon the quantity of rain water received across cities of India. It also provided guidelines on rooftop harvesting technique and design of recharge structures. It also has citied certain case studies where the rain-water harvesting techniques have been incorporated effectively.

Sethi et.al., (2003) analysed the economic feasibility of rain water harvesting and recycling processes in the rainfed region of Kharagpur in West Bengal. They also estimated the cost-benefit ratio of On Farm Reservoirs (OFRs) with the Present Worth Methods. They found that the cost benefit ratio for rice-fish-mustard integration system with the lined OFR was 2.73 for 0 cm; 2.66 for 5 cm and 2.63 for 10 cm weir heights and for the unlined OFR system it was 4.23 for 0 cm, 3.79 for 5 cm and 3.27 for 10 cm weir height. Therefore they concluded that the OFR system is the only alternative to increase the overall productivity of the rainfed ecosystem and integrated farming with the OFRs was found to be cost effective for increasing the agricultural productivity of rain-fed ecosystem in eastern India.

Desai et.al, (2007) found that since Rain Water Harvesting structures namely farm-ponds are expected to have an impact on cropping pattern, productivity, employment and income of the farmers. Therefore they carried a study to examine the impact of farm-ponds on those aspects of the farmers belonging to Sujala watershed development area. It found that the availability of water from water harvesting structures had resulted in diversification of the cropping pattern with / the substitution of more profitable crops. The gross cropped area and the area under double cropping was more in case of with farm pond compared to without farm-pond mainly because of better conservation of residual moisture in the rabi season due to construction of farm-ponds. Therefore, in order to bring fallow land under cultivation and to increase cropping intensity farmers need to be encouraged to follow the adoption of RWHS under watershed technology.

Nagaraj et.al., (2007) evaluated the performance of water harvesting structures with regard to the Sujala watershed in Karnataka and assessed the impact of it on improving groundwater recharge, agricultural productivity, and profitability. They found that the water harvesting structures have facilitated the rejuvenation of failed wells and enhanced the water yield. About 75% of the failed bore wells were rejuvenated as against 66% in the non-watershed. The yield of bore wells were increased by 21% in the watershed where as in non-watershed area the water yield has reduced by 11%. Investment analysis of water harvesting structures indicated that for every rupee of present investment on water harvesting structure there was a return of Rs. 2.79 in farm pond and Rs. 2.19 in recharge pits. Internal Rate of Return was around 14% in farm pond and 56% in recharge pits. They concluded that the productivity of crops has enhanced through protective irrigation at critical stages of crop growth and moisture conservation, which in turn has increased the net returns of the farmer.

Sultana (2007) aimed at providing some guidelines by analyzing the significance of economic rainwater harvesting system, especially for urban areas for specific user groups. These guidelines were formulated through literature review, analysis of some case studies on rainwater harvesting, and, to a certain extent, practical experience of the researcher. Based on these guidelines, a mathematical model was developed to figure out cistern sizes for collection of rainwater. She also utilized programming and visualization to assess the efficacy of the solution and its details. She suggested that making the existing water bodies deeper to increase the storage capacity during the monsoon will not be suitable to areas where the existing water table is very high or all the water bodies are highly arsenic contaminated. Therefore water management projects can be formulated at organizational level including rain water harvesting system andprivate organizations can be engaged with projects to promote, educate, and involve communities for rainwater harvesting practice Then with the help of these organizations, local government can develop cooperative system to maintain, monitor and ensure the aimed benefit of rain water harvesting.

3. RESEARCH OBJECTIVES

- Overview of demographic features in study area
- To know the catchment area of the RWH
- To address the implications of RWH on agriculture development
- To understand the cost of RWH in rural area

4. RESEARCH HYPOTHESIS

- There is no improvement of agriculture performance after installation of RWH

5. RESEARCH METHODOLOGY

The study is based on primary data base that is field survey conducted in Dharwad district where Navalgund and Khalghatagi two taluks are selected based on developed and underdeveloped in terms of economic and irrigation. In each taluk two villages are selected based on irrigated and non-irrigated villages. From Navalgund taluk Basapur and Ballarwad villages are selected whereas Jammihal and Tumrikoppa villages are selected from Kalghatagi taluk. Simple statistical tools like percentage share and composition are utilized for data analysis.

5.1 Demographic profile of the samples

There are one thousand average population numbers in Basapur and Ballarwad villages in Navalgund taluk where scheduled tribes (ST) are more than scheduled caste (SC) but other backward community (OBC) are majority in respect of population and land holdings. Data showed in table 1 highlights the sample size has chosen across various castes and it is selected based on land ownership and cultivation by actual farmers. The selected sample households average age for OBC is 50 years in Basapur and 52 years in Ballarwad while it is 56 years and 46.5 years among SCs respectively. ST community farmers have average 47 years and 47 years in Basapura and Ballarwad villages respectively and they are the young farmers who are following rain water harvesting so far. Moreover, majority of households are having more than three members family size across various castes in both villages. Here, general category people are not accounted who don't have cultivable land.

Table 1: Demographic Profile of Samples in Navalgund Taluk

	Basapura			Ballarwad		
CASTE	OBC	SC	ST	OBC	SC	ST
Total No	40	7	3	41	8	2
Average Age	50.15	56	47.3	52.55	46.5	47.6
Family Size < 3	5	3	0	3	2	0
Family Size > 3	35	4	3	38	6	2

Source: Field survey

Table 2: Demographic Profile of Samples in Kalghatagi Taluk

Jammihal				Tumrikoppa		
CASTE	OBC	SC	ST	OBC	SC	ST
Total No	36	9	5	38	8	4
Average Age	50.5	53.4	46	50.5	44.7	40.9
Family Size < 3	4	3	0	4	1	1
Family Size > 3	32	6	5	34	7	3

Source: Field survey

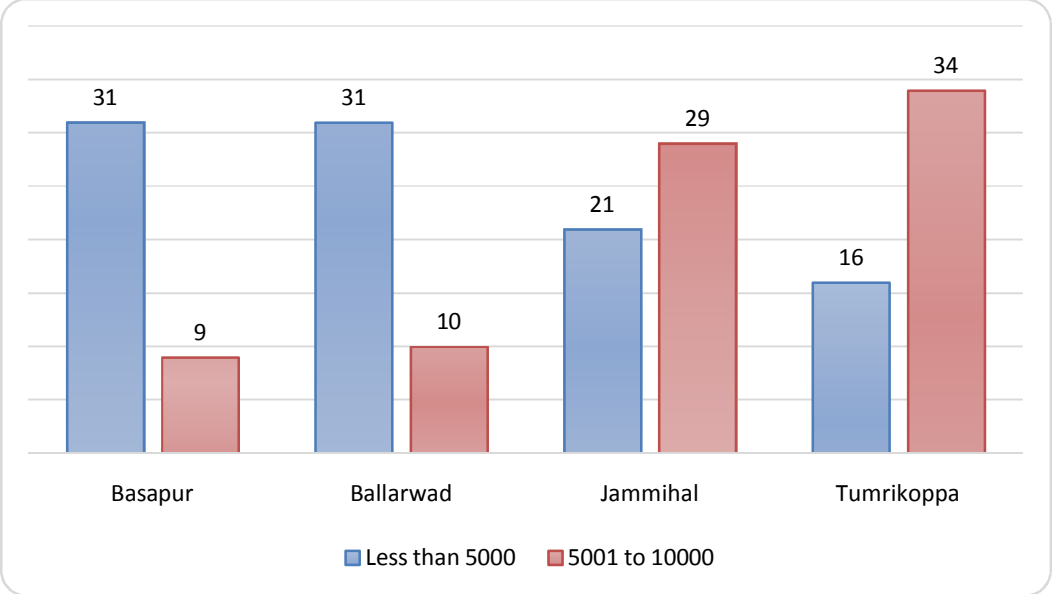
The demographic profile of selected sample villages in Kalghatagi taluk is not much difference compared to Navalgund taluk. Table 2 shows the household size, average age and caste wise samples in Jammihal and Tumarikoppa villages in Kalghatagi taluk. It shows that majority of land owned and adopted rain water harvesting are OBCs followed by SCs and STs. However, scheduled tribes are more than scheduled castes but most of STs don't have land. While general category people also do not have cultivable land. In

these village STs are young farmers than SCs and OBCs. Most of OBC households are from joint family and few households are living below three-member nuclear family groups across all castes.

5.2 Catchment Area of RWH

Roof top area is utilized for collection of rainwater and it can be used for daily utility. Similarly, catchment area of the RWH place can be measured for understanding the size and potential of rain water storage and harvesting. Based on number of available catchment area created in the study area, study classify two size catchments are that are less than 5000 square feet and more than 5000 but less than 10000 square feet area. Majority of rain water harvesting catchment area is less than 500 square feet in Ballarwad and Basapur villages in Navalgund taluk. Figure 1 shows the composition of catchment area of RWH in Navalgund and Kalghatagi taluks. There are 31 household in Basapur and Ballarwad villages own small size catchment area and only 9 and 10 households own large catchment area respectively. Jammihal and Tumrikoppa village's farmers have large size cachment are of RWH. For example, 29 households in Jammihal and 34 households in Tumrikoppa have large size catchment area such as 5000 to 10000 square feet.

Figure 1: Different Size Wise Catchment Area Created by Number of Farmers Under RWH (In Square feet)



Source: Field survey

5.3 RWH and Agriculture Development

Core issue of this study is analyzing the impact of RWH on agriculture development in rural area. Therefore, this study examined the pre and post RWH changes in sample area. Table 3 shows impact of implementation of RWH on agriculture crop area, production, productivity and income in Basapur village. Before implementation of RWH in Basapur village totalcultivated area was 82.5 acres during Kharif period and major crops in this period were cotton, groundnut and mung. Out of these three crops groundnut is the major cropped area which generated Rs 825050 income to farmers followed by mung Rs 89900 and cotton Rs 74000. However, after RWH installation irrigated area has improved to 90.5 acres from 82.5 acres in the previous period. Total production of cotton, groundnut and mung have increased to 496.5 quintal, 52 quintal, 151.5 quintal respectively and revenue generated from each of these crops are Rs 1517100, Rs 144000 and Rs 909000 respectively. Moreover, number of farmers who were not involved in cultivation come down to 3 from 6. Most of farmers what they have produced has not sold their products completely

hence some proportion of the production for domestic use and hoarding and some proportion for money lenders.

Table 3: Agriculture Crop's Production Performance During Kharif Period in Basapura -Navalgund Taluk

	Before Implementation of RWH				After Implementation of RWH			
Crops	Cotton	Groundnut	Mung/Green Gram	No Production	Cotton	Groundnut	Mung/Green Gram	No Production
Farmers No	3	38	6	6	28	4	18	3
Area hr	4.5	68	10	0	56.5	6.5	27.5	0
Production in Qnt	27	302.5	38.5	0	496.5	52	151.5	0
Average Rate in Rs	4983.3	5026	4867.3	0	7051.6	6515.35	7163.4	0
Income Generated	74000	825050	89900	0	1517100	144000	909000	0
Quantity Sold in Market	26	236	30	0	468	48	150	0

Source: Field survey

Table 4 shows the implication results of RWH on agriculture development in Basapur village during Rabi period. Major crops were grown during Rabi period in Basapur village are Jowar and Wheat. Total area cropped before implementation of RWH during Rabi period is 5 acres and total production of Jowar crop was 24.5 quintal and 9.5 quintal of Wheat where each crop generated total income Rs 19800 and Rs 11000 respectively. After implementation of RWH total area of cultivation increased to 51 acres while production of Jowar and Wheat increased to 103 quintal and 77.5 quintal respectively with these production total income from respective crops also increased to Rs 125900 and Rs 72300. Earlier 45 households have not cultivated during rabi period but after implementation of RWH method number of farmers without cultivation reduced to 16. Hence RWH has improved standard of living in Basapur village.

Table 4: Agriculture Crop's Production Performance During Rabi Period in Basapura -Navalgund Taluk

	Before Implementation of RWH			After Implementation of RWH		
Crops	Jowar	Wheat	No Production	Jowar	Wheat	No Production
Farmers No	3	2	45	17	19	16
Area hector	3.5	1.5	0	29	22	0
Production in Quintal	24.5	9.5	0	103	77.5	0
Average Rate in Rs	1800	1950	0	1882.35	2013.15	0
Income Generated	19800	11000	0	125900	72300	0
Quantity Sold in Market	12	2	0	55	27.5	0

Source: Field survey

Table 5 shows impact of implementation of RWH on agriculture crop area, production, productivity and income during Kharif period in Ballarwad village. Major crops of Kharif are cotton, groundnut and mung while groundnut is cropped higher than other crops during pre-RWH. Total revenue generated from cotton, groundnut and mung production were Rs 48000, Rs 1331600 and Rs 204400 respectively. However, after

implementation of RWH method for agriculture in Ballarwad, total area, production and income have improved. Similarly, during Rabi period Jowar and Wheat are the major food crops cultivated and their total area of cultivation during pre RWH was 5 acres which has increased to 69 acres during post RWH period. Total production of Jowar increased to nine times and Wheat production to four times during post RWH period which is showed in table 6. Number of cultivators also increased to 31 from 9 which is really commendable changes.

Table 5: Agriculture Crop's Production Performance during Kharif Period in Ballarwad -Navalgund Taluk

	Before Implementation of RWH				After Implementation of RWH			
Crops	Cotton	Groundnut	Mung/Green Gram	No Production	Cotton	Groundnut	Mung/Green Gram	No Production
Farmers No	1	38	8	3	32	3	3	12
Area hr	4	97.5	17	0	89	3	6	22
Production in Qunt	18	447	72	0	793.5	22	21	107.5
Average Rate in Rs	5000	4799.4	4775	0	5123.43	4900	14000	12041.6
Income Generated	48000	1331600	204400	0	2449550	57000	122000	811000
Quantity Sold in Market	18	427	68	0	702	19	19.5	95.5

Source: Field survey

Table 6: Agriculture Crop's Production Performance During Rabi Period in Ballarwad -Navalgund Taluk

	Before Implementation of RWH			**After Implementation of RWH**		
Crops	Jowar	Wheat	No Production	Jowar	Wheat	No Production
Farmers No	6	3	41	19	12	19
Area hr	2.5	2.5	0	46.5	22.5	0
Production in Qunt	20.5	15.5	0	178.5	66.5	0
Average Rate in Rs	2000	1950	0	1836.84	1958.3	0
Income Generated	20800	18000	0	265900	88000	0
Quantity Sold in Market	8	4	0	105	33	0

Source: Field survey

Agriculture is better improved in Kalghatagi taluk compared to Navalgund taluk. Table 7 shows the agriculture performance in Jammihal village during pre and post RWH. Major crops have been grown in Jammihal during Kharif season are groundnut, mung, soybean and maze. Majority of area of crops covered by maize and total 166-acre land was cultivated and total 16 quintal groundnut, 7 quintal mung, 121 quintal soybean, 640 quintal maize produced during Kharif period but after RWH implementation agriculture production has improved considerably inJammihal village. But introduction of RWH has changed cropping pattern in Jammihal where cotton, wheat, maize and soybean are the primary crops during Kharif season. Total area of cultivation is not improved much during post RWH but total production has improved and revenue from each crop increased especially soybean cultivation generated highest revenue to farmers Rs 1532800 followed by maize Rs 533000, cotton Rs 124800 and Wheat Rs 27300.

Table 7: Agriculture Crop's Production Performance During Kharif Period in Jammihal -Kalghatagi Taluk

	Before Implementation of RWH				After Implementation of RWH			
Crops	Groundnut	Mung/Green Gram	Soybean	Maize	Cotton	Wheat	Maize	Soybean
Farmers No	3	2	13	32	3	2	14	31
Area hr	5.5	4	45	101	6.5	5	30	123
Production in Qunt	16	7	121	640	24	21	410	479
Average Rate in Rs	4200	4800	3300	1270	5200	1300	1300	3200
Income Generated	67200	33600	399800	812800	124800	27300	533000	1532800
Quantity Sold in Market	14	6	38	1008	20	19	360	470

Source: Field survey

Agriculture production and productivity have improved during Rabi season during post RWH period which is illustrated in table 8 and major crops cultivated during pre-RWH period were cotton, groundnut, maize and soybean. Revenue generated from each crop during post RWH is higher than pre-RWH. Groundnut and soybean crops cultivation area have increased to 19 acres and 94 acres respectively from 5 acres and 36 acres during pre and post RWH period. Revenue generated from groundnut has doubled whereas soybean income increased seven times after implementation of RWH in Jammihal village during Rabi season. Totally area of cultivation and production have improved noticeably in Jammihal village and all farmers have cultivated in both periods.

Table 8: Agriculture Crop's Production Performance During Rabi Period in Jammihal -Kalghatagi Taluk

	Before Implementation of RWH				After Implementation of RWH		
Crops	Cotton	Groundnut	Maize	Soybean	Cotton	Groundnut	soybean
Farmers No	4	2	31	13	2	13	35
Area hr	8	5	68	36	6	19	94
Production in Qunt	39	40	245	389	23	98	1232
Average Rate in Rs	2829	3890	3400	3400	5000	1300	2026.9
Income Generated	121000	65000	833000	132200	115000	130000	918000
Quantity Sold in Market	38	39	230	380	20	46	1153

Source: Field survey

Table 9 shows the agriculture performance in Tumrikoppa village during pre and post RWH. It shows that before installation of RWH in farm lands, farmers in Tumrikoppa were growing only Jowar in the Kharif season and generated Rs 819165 revenue and after installation of RWH Jowar along with vegetables are grown and revenue generated from both crops are Rs 1066560 and Rs 91000 respectively. Vegetables need more water and nearby market for better profit margin which is better accessed by Tumrikoppa village. During Rabi season maize and wheat were major crops cultivated in Tumrikoppa village while after

installation of RWH cropping pattern changed and maize and vegetables were becoming more income generating source for farmers. Table 10 highlights the pre and post RWH agriculture performance in Tumrikoppa village. Area of cultivation has not changed much while productivity of crops improved after RWH installation consequence total revenue generated from agriculture production benefitted farmers. For example, revenue generated from maize increased to Rs 1424000 from Rs 907700 during pre and post RWH period respectively. Cultivation of wheat crop discontinued after RWH installation and shifted same area for vegetable production which generated total income Rs 40800. It shows that irrigation has positively contributed on agriculture production and cropping pattern change in Kalghatagi taluk compared to Navalgund taluk and in nutshell RWH has directly benefitted farmers in case of better production and more income generation in recent years.

Table 9: Agriculture Crop's Production Performance During Kharif Period in Tumrikoppa -Kalghatagi Taluk

	Before Implementation of RWH		**After Implementation of RWH**		
Crops	Jowar	No Production	Jowar	Vegetables	No Production
Farmers No	45	5	33	15	2
Area hr	132	0	108.5	14	0
Production in Qunt	563	0	711	70	0
Average Rate in Rs	1455	0	1500	1300	0
Income Generated	819165	0	1066560	91000	0
Quantity Sold in Market	505	0	420	289	0

Source: Field survey

Table 10: Agriculture Crop's Production Performance During Rabi Period in Tumrikoppa -Kalghatagi Taluk

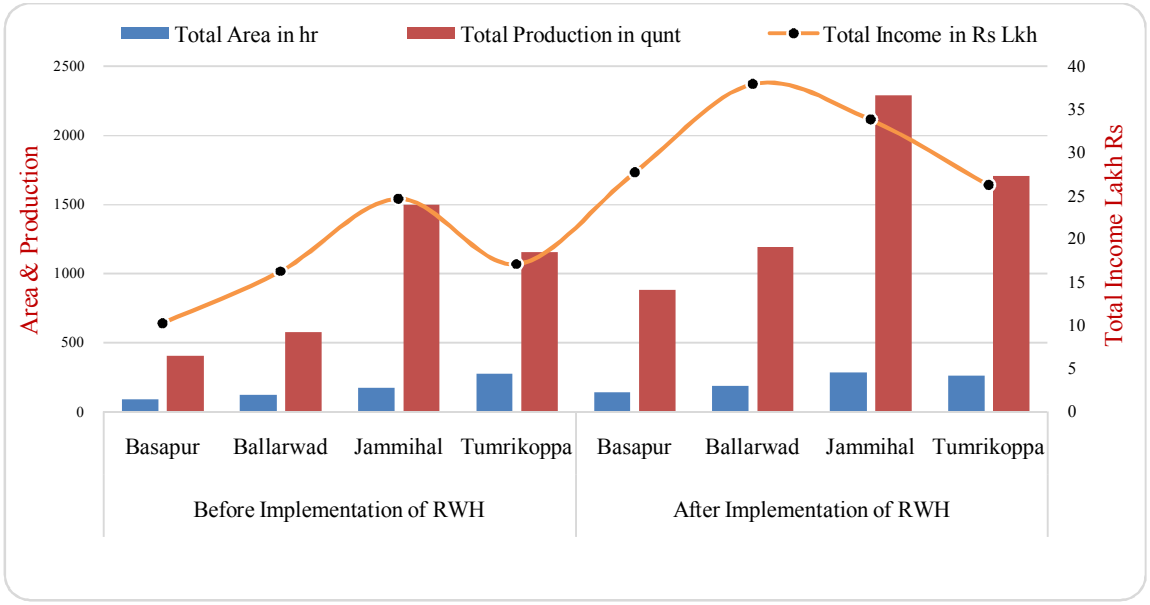
	Before Implementation of RWH			After Implementation of RWH		
Crops	Maize	Wheat	No Production	Maize	Vegetables	No Production
Farmers No	32	9	9	30	16	4
Area hr	138	3	0	118	19	0
Production in Qunt	580	12.5	0	890	34	0
Average Rate in Rs	1565	1900	0	1600	1200	0
Income Generated	907700	23750	0	1424000	40800	0
Quantity Sold in Market	523	10	0	800	30	0

Source: Field survey

Different crops were cultivated in different villages in the study area. Cropping pattern and productivity are changing after installation of RWH. Figure 2 illustrates the total area, production and income generated during pre and post RWH in Navalgund and Kalghatagi taluk. The results showed that area of cultivation has improved greater extent in Navalgund taluk than Kalghatagi taluk after installation of RWH. For example before implementation of RWH in Basapur and Ballarwad village, total area of cultivation were 87.5 hectares and 123.5 hectares respectively which are increased to 141.5 and 189 hectares after implementation of RWH that is almost 61 percentage and 53 percentage respectively whereas in Jammihal village net area of cultivation increased to 112 hectares but area of cultivation reduced by 13.5 hectares in Tumrikoppa which is due to increase of dairy and other subsidiary activities of agriculture. Moreover, total production has increased at greater extent in all villages after implementation of RWH.

Total agriculture production during pre-RWH in the study area is followed as 402 quintals in Basapur, 573 quintals in Ballarwad, 1497 quintals in Jammihal and 1155.5 quintals in Tumrikoppa villages and their production level further reached to 880.2 quintal, 1189 quintal, 2287 quintal and 1705 quintal respectively during post RWH. Combinedly total production in Navalgund taluk has increased to 112 percentage whereas it is 50 percentage in Kalghatagi taluk. In terms of revenue generation, after implementation of RWH total income of farmers increased 2.7 times in Basapur village, 2.1 times in Ballarwad village, 1.5 times each in Jammihal and Tumrikoppa villages respectively. These results showed that in terms of percentage, total production and total revenue generated is high in Kalghatagi taluk compared to Navalgund taluk. Therefore, null hypothesis of the study is rejected and accepted alternative hypothesis as there is considerable improvement of agriculture after implementation of Rain Water Harvesting in farmlands.

Figure 2: RWH Effect on Agriculture Area, Production and Income in Navalgund & Kalghatagi Taluks



Source: Field survey

5.4 Source of Investment and Maintenance Cost of RWH

Investment on RWH is burden on farmers who don't have sufficient resources. Many of farmers invested money on RWH with the help of bank loan and subsidies while few has managed to invest from their internal source of income. Table 11 shows that total investment, source of investment and average maintenance cost incurred by farmers across social groups. Average investment on installation of RWH by OBCs is Rs 65437, SCs Rs 64203 and STs Rs 63812 in Basapur village whereas in Ballarwad OBC and SC had spent average Rs 64000 but STs spent little lower Rs 57676. In both villages 90 percentage of farmers had taken bank loan for construction of rain water tanks and average maintenance cost is around Rs 2000. Table 11 highlights the average investment and maintenance cost incurred by social groups in Navalgund taluk. It is clear that there is no much difference in average investment by from across various social groups but STs are spending less due to poverty and lack of internal income sources.

Table 11: Source of Investment and maintenance Cost of RWH

	Basapura			Ballarwad		
	OBC	SC	ST	OBC	SC	ST
Average Investment on RWH in Rs	65437	64203.61	63812	64534.22	64001.75	57676.6
Bank Loan in No	36	5	3	37	5	3
Own Investment in No	4	2	0	4	2	0
Average maintenance Cost of RWH in Rs	2182.5	2131.91	2118	2146.6	2124.74	1900

Source: Field survey

Table 12 shows total investment, source of investment and average maintenance cost incurred by farmers across social groups in Jammihal and Tumrikoppa villages of Kalghatagi taluk. OBCs are investing more amount on installation of RWH than SC and STs in Jammihal village compared to Tumrikoppa village. Majority of farmers had taken bank loan for constructing rain water tanks and other expenses of RWH while half of OBC farmers in Jammihal village are invested with their own internal resources and rest of farmers dependent on bank loan.

Table 12: Source of Investment and maintenance Cost of RWH in Kalghatagi taluk

	Jammihal			Tumrikoppa		
	OBC	SC	ST	OBC	SC	ST
Average Investment on RWH in Rs	65437	45800	39870	64534.22	64001.75	57676.6
Average Maintenance Cost of RWH in Rs	2137.5	1828.5	2533	2155	2071.4	2333.3
Bank Loan in No	26	5	3	37	5	3
Own Investment in No	24	2	0	4	2	0

Source: Field survey

6. CONCLUSION

RWH explores the water tank potential and catchment area, deficit of water under constructed water tanks. Further it analysed the impact of RWH on cropping patter, agriculture development, improvement in area of cultivation, production, income generation and cost and benefits of RWH, average investment on RWH installation and maintenance. The comparison of results between pre and post RWH impact in Navalgund and Kalghatagi taluks clearly showed that there is considerable changes in production and productivity in one side and another way it has improved the standard of living people and made agriculture more remunerative for farmers. All sections of people in the study area are benefitted from RWH but majority of sample households are OBC category while few SC and STs have land and are struggling for leading their descent life due to lack of other internal resources.

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