Pond renovation for harvesting and recycling of rain water: an experimental trial in sub Himalayan terai region of India

Abstract

Sub Himalayan Terai region of India falls under heavy rainfall zone. Significant amount of rainfall occurs during Kharif season. Whereas in *rabi* season farmers struggle to cultivated crops due to shortage of water following minimal to no rainfall. To overcome the difficulty, Krishi Vigyan Kendra of this region had taken a initiative in the year 2011 to conserve rain water by renovating ponds so as to harvest and recycle the rain water under the project 'National Initiative on Climate Resilient Agriculture' (NICRA). Information on different aspect of livelihood status of farmers was again collected from same selected farmers in the month of April, 2015 exactly after 5 years of pond renovation following same method. Information collected before initiation and after 5 years of the programme was statistically analyzed separately for pond owners and adjacent land holders to find out whether pond renovation programme has any significant effect in changing the livelihood status of pond owner and adjacent land holders. Analysing different data have revealed that renovation of pond had a significant impact on crop and fish production and farmers net income generation.

Keywords: Krishi Vigyan Kendra, Livelihood, Net income, Pond Renovation, Recycling, Rain water.

Introduction

India is an agrarian country with more than 70 percent of the population relying upon agriculture for maintaining the livelihood status. India is the world's biggest producer of milk, pulses and jute, and ranks as the second greatest producer of rice, wheat, sugarcane, groundnut, vegetables, fruit and cotton. It is additionally one of the leading producers of spices, fish, poultry, farm animals and plantation crops. According to FAO (Access 2019), it is a matter of concern that agriculture of our country is completely dependent on the nature of monsoon because of the fact that only 58.1 m ha of cultivated land is under irrigation. Further with increasing population, growing civilization and intensive agriculture the ground water is being exploited without paying utmost attention to its judicious use resulting in gradual depletion of ground water (Yoshihide *et al.* 2010). So, at present scenario emphasis has to be given on increasing the cultivated area under irrigation with minimum exploitation of ground water resources. The use of irrigation ponds has been a common practice in case of domestic and agricultural purposes (Anjum et al. 2010). In India the irrigation pond supply crops area varies between 1.5 and 50 hectares (Gunnell and Krishnamurth, 2003). The water of agricultural ponds usually comes from rainfall, , the storage of reused water and runoff (Ouyang *et al.* 2017). The irrigation ponds allow farmers to conserve the rain water, store excess water from irrigation channels, and conserve water from other sources (Mushtaqa et al. 2009 and Fuentes-Rodríguez et al. 2013). The irrigation scenario in the district Cooch Behar of West Bengal is very poor as only 62% of cultivated area is under irrigation (Ministry of agriculture, 2019). Although the district experiences high average annual rainfall (higher than 3000 mm) with an uneven distribution as 75% of average annual rainfall is received during the month of May - August whereas minimal or no rainfall is received during the winter months (Biswas *et al.* 2018). Keeping a large area uncultivated during *rabi* season though there remains an ample scope of harvesting rainwater received during the month of May – August. The village Khagribari located at Cooch Behar-II Block of the district Cooch Behar, West Bengal (latitude 26°26.4´ N, longitude 89°21.5´ E) was adopted by Cooch Behar Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya under National Initiative on Climate Resilient Agriculture (NICRA) during the year 2010-11. Before the initiation of the project activities only 32% of total cultivated area of the village was under irrigation mostly by lifting ground water using bore well. Scope of area expansion under irrigation through lifting of underground water by bore well in patches is also limited due to very low water table as well as existence of huge gravels and stones in underground portion. Primary information were collected from villages through participatory survey indicated that numbers of ponds exist in the village are mostly seasonal ponds with 1.5-2.0 meter depth and few having a depth greater than 2.5 meter are annual in nature. Annual ponds are used for year round fish cultivation, jute retting and irrigation to boro crops during December-March whereas seasonal ponds have no utility except for jute retting. Keeping all these in view, Cooch Behar KVK selected and renovated 15 numbers of seasonal ponds of different sizes during March, 2011 in areas of the village where lifting of underground water through bore well is not possible because of very low water table and presence of gravels and stones in different layers of soil. During renovation the depth of renovated ponds were extended upto greater than 2.5 meter and thus all seasonal ponds were converted to annual ponds. Renovated ponds were used for harvesting rain water during heavy rainfall months and utilize the same for irrigation of next boro crops, year round fish cultivation and also for jute retting depending upon size of ponds. The study was conducted during 2011-15. The objective of this study is to find out the effectiveness of pond renovation in changing livelihood status of pond owner and others adjacent farmers to renovated ponds.

Materials and Methods

Base line data was collected from 15 pond owners which were seasonal in nature and other 100 land owner farmers adjacent to ponds selected for renovation at the village Khagribari of Cooch Behar, West Bengal (latitude 26°26.4´ N, longitude 89°21.5´ E) just before the initiation of the programme i.e. in the month of March, 2011 through structured schedule by individual contact method. While renovating, depth of 15 selected ponds were extended upto different specified depth viz. 3.7 meter (T_1), 3.4 meter (T_2), 3.1 meter (T_3), 2.8 meter (T_4) and 2.5 meter (T_5), from ground level, having 3 number of ponds under each category and meticulous attention was also paid to make the final volume of 3 number of ponds under each category same through renovation of pond side so that individual pond owner can be treated as replication. 2.5 meter was considered as the minimum depth of renovated ponds because of the fact that all annual ponds existed at village before initiation of the programme were of more than 2.5 meter depth. Volumes of selected ponds were measured before and after renovation. Additional area brought under irrigation and actual amount of water used for irrigation were also recorded. Information on different aspect - volume of water used for irrigation, crop wise area irrigated with pond water, crop wise increase in production and net income, increase in fish production and net income from fish production was collected in 3 consecutive years 2012-13, 2013-14 and 2014-15 from same selected farmers following same method. Information collected before initiation and after 5 consecutive years of the programme was statistically analyzed separately for pond owners and adjacent land holders to find out whether pond renovation programme has any significant effect in changing the livelihood status of pond owner and adjacent land holders.

❖ Results and Discussion

Net increase in volume of ponds due to renovation are shown in table 1 and obviously the magnitude of increase in volume was higher, greater the depth of ponds. The increased volume of pond indicates a net increase in its capacity to harvest that much more amount of rain water with respect to that of its capacity before renovation. Further to be noted that all ponds were filled up with harvested rain water upto its highest level during the month from July to August. Different treatments were studied to find out the efficiency of pond renovation in the village Khagribari. It was found (Table 1) that renovating the pond to a depth of 3.70 m (T_1) which previously had a volume of 1354 cu.m of water from ground level was increased by 1236 cu.m with a total volume of 2590 cu.m after renovation of the pond. Similarly, the lowest was (T_5) obtained in the depth of 2.5 m with an increase in only 590 cu.m volume of water from ground level after renovation. It is noted (Table 2) that due to renovation of pond, irrigated area under potato and wheat has been increased as irrigation was given from the renovated ponds to a volume of 9831 cu.m. during 2014-15. Total irrigated area under potato and wheat during 2014-15 was 13.50 ha and 4.50 ha, respectively. It is observed from the table 2 that T_1 supply more water for irrigation purpose (690 cu.m) followed by T_2 (608 cu.m), T_3 (498 cu.m), T_4 (415 cu.m), and T_5 (329 cu.m). It is further observed from the experiment that area of potato crop irrigation was more in case of T_1 (1.38 ha) followed by T_2 (1.11 ha), T_3 (0.83 ha), T_4 (0.68 ha) and T_5 (0.50 ha). It is found that irrigated area of wheat crop was more in case of T_1 (0.43 ha), followed by T_2 (0.39 ha), T_3 (0.31 ha), T_4 (0.21 ha), and T_5 (0.15 ha).

Before renovation of pond (2011-12) in the village, the total potato and wheat production under irrigated area was only 1931.07 t and 63.38 t, respectively (table 3). As area under irrigation was increased (2014-15) due to renovation of the pond in the village, potato and wheat production has also increased drastically to a tune of 3399.31 t and 140.61 t, respectively (Table 3). Potato and Wheat production in the village has been increased to a substantial amount as compared to the production obtained before renovation of the ponds which lead to a rise in the net income of Rs. 347224 and Rs. 46671 for potato and wheat respectively (2014-15) as compared to Rs. 210828 and Rs. 17965 for potato and wheat respectively (2011-12) before renovating the ponds (Table 3). Renovation of ponds (Table 3) in the village also provided an opportunity for the farmers of the village to increase fish production on the renovated ponds which led to an increase in approximately double the fish production as compared to before renovating the ponds. Fish production to a tune of 60.68q increasing net income from fish production of Rs. 38410 (2014-15) as earlier before renovating it was only 34.85q of fish production giving total net income from fish production of Rs. 10336 (2011-12). The finding is line with the results found by Chawla *et al.* (2002), Desai *et al.* (2007) and Prabha (2014), . It is revealed from the study (Table 3 and figure 1, 2 and 3) that T_1 (Pond depth 3.7 m) is more sustainable in case of crop and fish production and farmers net income generation followed by T_2 (Pond depth 3.4 m), T_3, (Pond depth 3.1 m), T_4 (Pond depth 2.8 m) and T_5 (Pond depth 2.5 m).

Photograph 1: Experimental centre for wheat and potato

❖ Conclusion

The study explores that after renovating the seasonal ponds to annual ponds, potato and wheat production was increased immensely which might be the result of timely and regular supply of water from the ponds to various parts of the village where cultivation was possible due to availability of life saving irrigations during the months of December - March. Apart from this, it can also be seen from the study that farmers were getting additional income throughout the year by cultivating fish in those renovated ponds. From the above cases, it may be concluded that pond renovation had a potential impact on agriculture and allied sectors. Crop production, productivity, net farm income and area of irrigation may increase through construction and renovation of pond and recycling of rain water. Different national and international organisation may disseminate this technology to the farmers for recycling and harvesting of rain water which may help to increasing global agriculture and fish production thus uplifting the socio-economic conditions of the farmers. It is concluded from the study that treatment 1 (Pond depth 3.7 meter) might be adopted by the farmers for harvesting and recycling of rain water in sub Himalayan terai region of India. It is further concluded from the study that treatment 1 is more sustainable in case crop production and farmers net income generation in sub Himalayan terai region of India.

References

Anjum, S.A.; Wang, L.C.; Xue, L.; Saleem, M.F.; Wang, G.X.; Zou, C.M. (2010). Desertification in Pakistan: Causes, impacts and management. *J. Food Agric. Environ*., 8: 1203–1208.

Biswas, S., Das, G., Rahman, F.H., Sarkar, S., Sarkar, S., Saha, S., Das, S. K., Saha, A. & Roy, B. (2018). Impact of NICRA project through analysis of different success point, *International Journal of Agriculture Sciences,* 10(8): 5863-5866.

Chawla, J. K., Khepar S.D. and Siag M. (2002). Economic Feasibility of Renovation of Village Ponds for Irrigation in Kandi Area of Punjab, Ind. in. of Agri. Econ. , 57 (1): 91-98.

Desai, R., Patil B. L., Kunnal L. B., Jayashree, H. and Basavaraj, H. (2007). Impact Assessment of Farm Ponds in Dharawad District. *Karnataka J. of Agric. Sci*. 20 (2):426-427.

FAO (2019), AQUASTAT - FAO's Global Information System on Water and Agriculture, http://www.fao.org/aquastat/en/geospatial-information/global-maps-irrigated-areas/irrigation-by-country/country/IND. Date accessed: 15.11.2019.

Fuentes-Rodríguez, F.; Juan, M.; Gallego, I.; Lusi, M.; Fenoy, E.; León, D.; Peñalver, P.; Toja, J.; Casas, J.J. (2013). Diversity in Mediterranean farm ponds: Trade-offs and synergies between irrigation modernisation and biodiversity conservation. *Freshw. Biol*., 58: 63–78.

Gunnell, Y.; Krishnamurthy, A. (2003). Past and present status of runoff harvesting systems in dryland peninsular India: A critical review. *Ambio*, 32, 320–324.

Ministry of Agriculture (2019), agricoop.nic.in/sites/default/files/WB.pptx.Date accessed: 20.12.2020.

Mushtaqa, S.; Khana, S.; Hafeezb, M. (2009). Evaluating the impact of ponds in sustaining crop production: A case of Zhanghe irrigation system in China. *Water Policy*, 11: 236–249.

Ouyang, Y.; Paz, J.O.; Feng, G.; Read, J.J.; Adeli, A.; Jenkins, J.N. (2017). A Model to Estimate Hydrological Processes and Water Budget in an Irrigation Farm Pond. *Water Resour. Manag.* 31: 2225–2241.

Prabha. U L. (2014). Impact of Farm Ponds on Cropping Pattern – A Case Study on Vembedu Village in Tamilnadu , *International Journal of Innovative Research in Advanced Engineering (IJIRAE)*, 1(4):50-52.

Yoshihide W. 0., Ludovicus, P. H. Van Beek, Cheryl M. Van Kempen , Josef W.T.M. Reckman, Slavek Vasak, Marc F.P. Bierkens, (2010). Global depletion of ground water resources, *Geophysical Research Letters,* 37(20):1-5.

Table.1. Farmer wise details about pond volume before and after renovation (cu.m)

Treatment	Replication	Initial volume (cum)	Final volume (cum)	Increase
T_1	F_1	1409	2590	
	F_2	1307	2590	
	F_3	1345	2590	
	Mean	1354	2590	1236
T_2	F_1	1278	2380	
	F_2	1292	2380	
	F_3	1265	2380	
	Mean	1279	2380	1101
T_3	F_1	1236	2170	
	F_2	1222	2170	
	F_3	1314	2170	
	Mean	1257	2170	913
T_4	F_1	1198	1960	
	F_2	1225	1960	
	F_3	1161	1960	
	Mean	1195	1960	765
T_5	F_1	1119	1750	
	F_2	1195	1750	

	F_3	1166	1750	
	Mean	1160	1750	590
Total		23817	41650	

Table 2: Mean effect of pond renovation on irrigation coverage area during the year from 2012-13 to 2014-15

Treatment Number	Replication	Pond water used for irrigation (cu.m)	Area irrigated (ha)		
			Potato	Wheat	Total
T_1	F_1	670	1.31	0.36	1.67
	F_2	702	1.44	0.50	1.94
	F_3	698	1.39	0.44	1.83
	Mean	690	1.38	0.43	1.81
T_2	F_1	624	1.21	0.37	1.58
	F_2	606	1.06	0.45	1.51
	F_3	594	1.06	0.36	1.42
	Mean	608	1.11	0.39	1.50
T_3	F_1	486	0.79	0.27	1.06
	F_2	526	0.88	0.30	1.18
	F_3	482	0.82	0.36	1.18
	Mean	498	0.83	0.31	1.14
T_4	F_1	418	0.7	0.21	0.91
	F_2	385	0.59	0.15	0.74
	F_3	442	0.75	0.27	1.02
	Mean	415	0.68	0.21	0.89
T_5	F_1	359	0.59	0.2	0.79

	F_2	296	0.43	0.12	0.55
	F_3	332	0.48	0.14	0.62
	Mean	329	0.50	0.15	0.65
Total		9831	13.50	4.50	18.00

Table 3: Mean effect of pond renovation on Production and Net income from crop and fish under irrigated area during during the year from 2012-13 to 2014-15

Treatment	Farmers	Crop Production in irrigated area (t)			Net income (Rs.) from crop production in irrigated area			Fish Production (q)	Net income from fish Production (Rs.)
		Potato	Wheat	Total	Potato	Wheat	Total		
T_1	F_1	331.43	11.96	343.39	34322	4515	38837	4.56	2886
	F_2	357.12	15.09	372.21	34848	4599	39447	4.30	2722
	F_3	360.01	14.36	374.37	39754	5238	44992	4.93	3121
	Mean	349.52	13.80	363.32	36308.00	4784.00	41092.00	4.60	2909.67
T_2	F_1	304.92	12.22	317.14	31218	4567	35785	4.96	3140
	F_2	271.36	13.34	284.70	29044	3872	32916	4.43	2804
	F_3	262.88	11.34	274.22	25652	3834	29486	4.05	2564
	Mean	279.72	12.30	292.02	28638.00	4091.00	32729.00	4.48	2836.00
T_3	F_1	194.34	8.06	202.40	18486	2382	20868	3.82	2418
	F_2	223.52	9.59	233.11	23408	3350	26758	4.11	2602
	F_3	205.00	11.56	216.56	20500	4072	24572	4.39	2779
	Mean	207.62	9.74	217.36	20798.00	3268.00	24066.00	4.11	2599.67
T_4	F_1	179.90	6.43	186.33	19460	2029	21489	4.11	2602
	F_2	148.09	4.89	152.98	14986	1779	16765	3.73	2361

	F_3	188.25	7.85	196.10	19050	2151	21201	3.41	2159
	Mean	172.08	6.39	178.47	17832.00	1986.33	19818.33	3.75	2374.00
T_5	F_1	145.14	5.74	150.88	13806	1510	15316	3.04	1924
	F_2	108.79	3.88	112.67	11266	1390	12656	3.41	2159
	F_3	118.56	4.31	122.87	11424	1383	12807	3.43	2171
	Mean	124.16	4.64	128.81	12165.33	1427.67	13593.00	3.29	2084.67
Total	2014-15	3399.31	140.61	3539.92	347224	46671	393895	60.68	38410
	2011-12	1931.07	63.38	1994.45	210828	17965	228793	34.85	10336

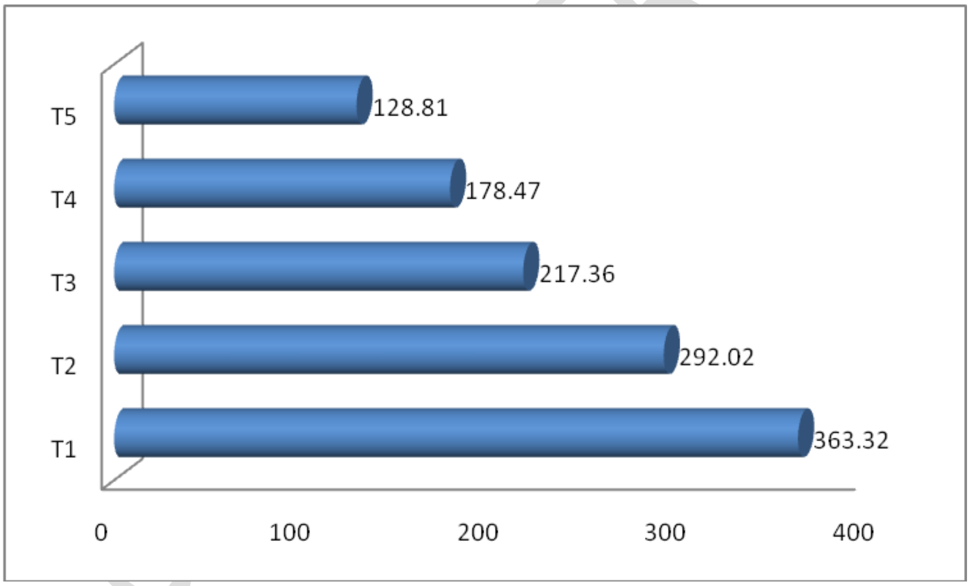

Figure 1 : Compare the sustainability of crop production from the experiment

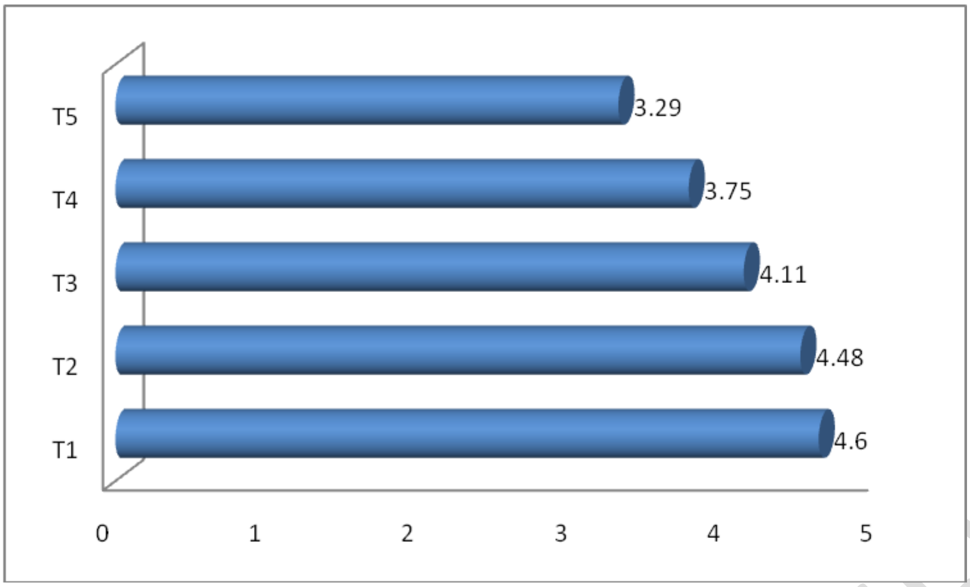

Figure 2 : Compare the sustainability of fish production from the experiment

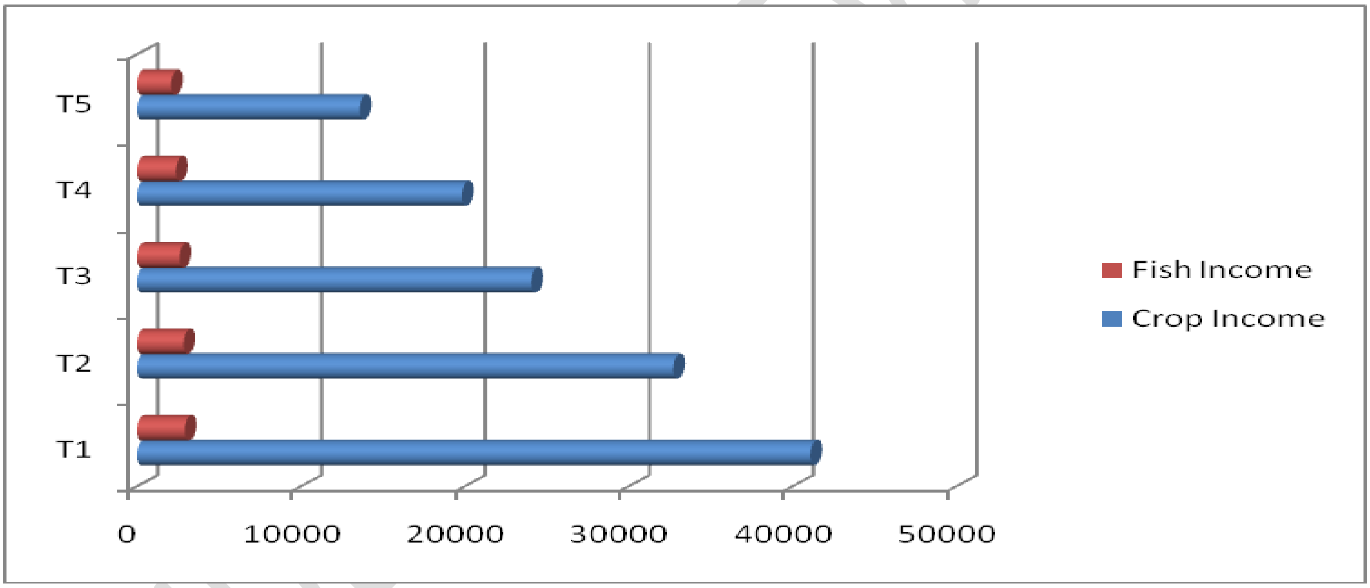

Figure 3 : Compare the sustainability of income generation from the experiment