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Full Length Research Paper

Sustainable agriculture productivity through restoration of tank irrigation system with stakeholder decision - Case study in rural tank eco system

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The tank irrigation system have provided support for the livelihood of the rural communities and have to be restored and conserved as an economic assets, especially for the poor and marginalized communities in the under developed areas. The tank irrigation system has a special significance to the marginal and small-scale farmers who make a very large number essentially depending on tank irrigation system. Development of tank irrigation system not only increases the storage capacity, it also protects and conserves the environment and contributes to village livelihood security. The objective of the study is to develop a framework for assess the impact and its livelihood improvement for development of tank irrigation eco system. This study is useful to sustainability for livelihoods of the rural and also for improving effectiveness and efficiency of tank ecosystem. The present paper focuses on some case studies; farmers' involvement is excellent in tank irrigation system development programme, and they are getting full benefit from the tank irrigation system and also enhance the livelihood improvement in rural area. Hence this paper concludes that integration of stake holder (government, farmers and technologist) in decision making for Development program for water resources system is very much important for achieving long term sustainability of agriculture productivity and also livelihood improvement in under developed area.

Key words: Stake holder, tank ecosystem, sustainability.

INTRODUCTION

Tank irrigation system contributes significantly to agricultural production in the parts of South and Southeast Asia. Especially in south India and Sri-Lanka. Tank irrigation system has a long history and many currently used tanks were constructed in the past centuries (Palanisamy, 1990). In India, the largest concentration of tanks is found, in the three southern states of Andhra Pradesh, Karnataka and Tamil Nadu and the union territory of Pondicherry, which account for nearly 60% of India's tank-irrigated area (Sakthivadivel et al., 2004). Tank irrigation system are the traditional irrigation common situated in many parts of Indian sub-continent to capture monsoon runoff in the arid and semi arid areas. Tushaar Shah and Raju (1999) have discussed Tank irrigation systems in the Indian context are inextricably linked to the socio-cultural aspects of rural life and have historically been an indispensable part of the village habitat, sustaining its socio-ecological balance. Tank systems, developed ingeniously and maintained over the centuries, have provided insulation from recurring droughts, floods, vagaries of the monsoon, and offered the much needed livelihood security to the poor living in fragile semi-arid regions. (Sivasubramaniyan, 1997) Conserving the tank eco-systems for m Minerals ultiple uses such as irrigation, domestic and livestock use and groundwater recharge is a way to provide a safety net to protect the livelihood of millions in a semi-arid India (Sakthivadivel, 2004). These tanks have many special features.

Tank irrigation system

Surface structures or formations of collecting and storing rainwater, runoff and seepage from the surrounding

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areas are known as tank irrigation system or ponds. Sakthivadivel and Gomathinayagam (2006) have explained Over the centuries, locally built water storage systems (e.g, tanks in South India, Johads in Rajasthan), have acted as insulation against droughts, helped in recharging groundwater, provided crucial irrigation for crop production, functioned as a source of multiple uses for the village community (drinking water, washing, bathing, water for livestock and wildlife, fishing, water for cultural and ritual purposes), and played a role in the maintenance of a good natural environment. Because of these benefits, the Indian kings, Jagirdars, religious bodies and philanthropists built a large number of tanks all over their domains (Tushaar and Vengama, 1999). These rainwater-harvesting structures in various forms were known by different names in different parts of the country, e.g., kere in Karnataka, cheruvu in Andhra Pradesh, Erie in Tamil Nadu, johad and bund in Rajasthan, ahar and pyne in Bihar. Tushaar shah and vengama (2001) explained the tanks were meant not only for agriculture, but also served as a resource-base for many other activities such as the collection of fodder, fuel, the making of bricks, pots, baskets, etc, with women offering their assistance in these processes. Tanks were also part of the socio-religious and economic system in villages. The location of the tank and its physical conditions were a matter of much significance to the people, particularly women, in carrying out their economic activities in carrying out their economic activities. The tank and its surroundings used to be the common property of the village and its people. The maintenance of natural resources through a continuous process of use and conservation meant not merely the assurance of livelihoods to the people of the village, but also the preservation of the ecological balance (Vaidyanathan, A, (2001). While the given social framework might have restricted women's participation in community matters, their role in the conservation and maintenance of natural resources was implicitly acknowledged. The integral role of the tank in the livelihood of a village community is also clear from the fact that in the past the village functionaries received land grants (inam) in the tank's command area, in return for their services.

FRAMEWORK OF DECISION MAKING WITH MULTI STAKE HOLDER FOR TANK RESTORATION

There are many stakeholders in the tank and tank related programs, of which the government agencies, farmers and technologists are important. The government officials, institutions and Farmers should be invited for the meeting to listen to each other's views on the tank systems. The meeting should focus on the status of tanks, tank fed agriculture, tank improvement, tank administration and encroachment. Perspectives of technologist are important one which should get integrated in the decision making to increase farm Productivity (Tang, 1992). Recent technologies have been used to improve the tank irrigation and also they have been used for maximizing tank productivity, ground water recharge and other tank services. Our framework considers the three key areas as equally important. Figure 1, shows the relationship among three key network of active stake holders (the technologist, the government and the farmers), as well as three objectives to be achieved (social equity, economic efficiency and environmental sustainability). The integration of this stakeholder in decision making is very important for achieving all the three objectives. The Tank irrigation is mainly used to surface irrigate by gravity and to recharging surrounding areas in order to increases the water productivity and return to the farmers (Anbumozhil et al., 2001).. Different Stake holders are involved in tank irrigation, so that any decision about tank renovation program should be taken after consultation among different stakeholders. Encroachments and siltation in water spread areas and the supply channels, catchments degradation, deterioration of the traditional irrigation institutions, improper water management at farm level are some of the major problems confront tank irrigation in the State. Restoration program is carried out before understanding the general characteristics about tank system and perspectives of farmers, technologist and the Government. Any restoration program must start with identifying the problems of tank irrigation through perspectives of farmers, improvement of the tank water productivity, ground water recharge and other tank support services which should be collaborated by the perspectives of technologist and finally the government should allocate funds not only for infrastructure development but also for institution building and awareness programs. Integration of stake holder (Government, farmers and technologist) in decision making for rehabilitation /restoration/ renovation, modernization and desilting etc is very important for achieving long term sustainability. Lacking of any one of the stake holder participation, in decision-making may lead to immediate short-term benefit, but it will lead to long term unsustainability. Restoration of irrigation tanks not only increases storage capacity also protects and conserves the environment and contributes to village livelihood security.

CASE STUDY

Impact of tank irrigation system development in Avalur and Puliambakkam villages

Avalur tank, located at Southern side of river Palar, Kancheepuram Block and Puliambakkam tank located on northern side of river Palar, Walajabad block, Kanchipuram district, in the state of Tamil nadu, India. Avalur tank is located 40 km from Chennai and Puliambakkam tank is located around 42 km from

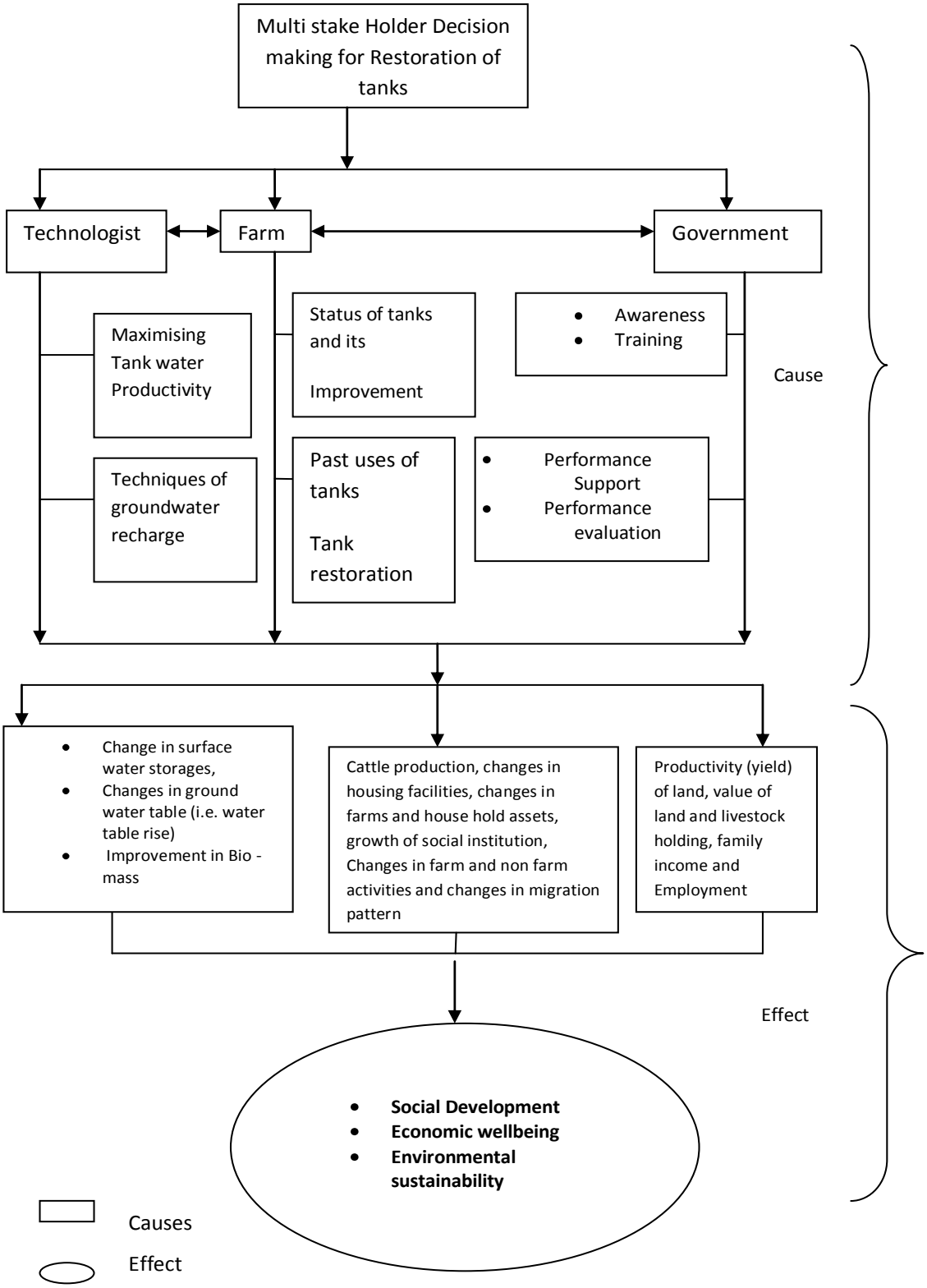

Figure 1. Multi-stake holder decision making framework for tank irrigation system development program.

Chennai (Capital of Tamilnadu). Figure 2 shows the location of Map for Avalur and Puliambakkam Tanks and Table 1 shows the tank components of Avalur and Puliambakkam tank.

Figure 2. Location maps of Avalur and Puliambakkam villages in Tamilnadu.

Table 1. Tank components in Avalur and Puliampakkam.

S/No	Tank components		Avalur tank	Puliambakkam tank
1	Hydrology	Surface water	No	Yes(Due to de-silting)
		Ground water	Moderate	Good
2	Tank Condition	Number of sluices	3	2
		De-silted	No	Yes
3	Command area	Area in hectare	140	75
		Crops	Paddy	Paddy, Vegetables
4	Flood disposal structures	Surplus weir	Yes	Yes
5	PeopleParticipation	Women Participation	Yes	No
		Leadership	Yes	Yes

Groundwater recharge in the command area wells

Avalur tank is a system tank which has two channels. They are Mettukkal and pallakkal channel. The availability of water in the tank is coming from the palar river through these two channels. There is no rain in past of some years. Hence water is not coming through the channel from the river in to the tank. The water table level in the command area wells is very low even some of the wells are dry also. One of the stake holders of the Farmers are decided, channel desilting is enough to irrigate the crop in both seasons. So Village block officers give the NREGA Scheme fund to channel desilting work to avalur panchayat. The Restoration work taken under NREGA scheme on 2008 in Avalur tank, in which, Pallakkal and Mettukkal channel desilting have been done on April 2008 and July2008 as shown in Figure 3.The tank has a sluice, which is used by in two ways, one way of the sluice is used for water entering into the tank and other way if the tank has full of water the sluice is used for water going away from the tank to the command area. But it is not in practice during little water is coming from the river through the channel. Since the water level has not attained full level of the tank. They

Figure 3. Execution of desilitng of channel work in the Avalur Village.

have closed the way of water entry sluice. After channel desilting the water did not allow for entering into the tank, and then the channel water is directly used by farmers in the command area. There are number of open wells in the Avalur tank there was a significant improvement of the water level in most of wells after channel desilting, particularly those wells located nearer almost around the channel. Due to additional recharge in the command area wells to irrigated crop area were increased during the cropping season 2008/2009. Again one more restoration work of partial desilting of tank has been done on nearer deepest sluice on November 2008. Water levels in the wells are rise between 2 to 4 ft. This will prove to the restoration work will help to improve the groundwater recharge as well as increased irrigated crop area and also economic improvement in the rural village.

The farmer community under the leadership of councilor undertook the desilting a small portion of the tank during the year 2004.Water stored in the desilted area which had helped the farmers to recharge their wells located in the command area and also which has increased in command area water table level significantly. Even in peak summer, these wells are having water to a level about 7 feet which was completely dry before partially desilting this tank with this encouraging experience. The farmers from Puliambakkam village prepared a proposal and received a total fund of Rs.6.4 lakhs from National Rural Employment Guarantee Scheme (NREGA) then the partial desilting has done again in the Puliambakkam tank nearer deeper sluice with 416 pits (each pit size is 10 × 3 × 0.3 m) on July 2008 and also one more partial desilting has been done on the same place on 11th month of 2008 received a fund from NREGA .The water stored in the two desilted portions i.e. combined portions of first and second desilted area of the tank in Figure 4. It is helped to recharge the Command area wells, so the command area wells are always having water in all the season. In Rainy season well water level are raised ranges between 3 to 4 ft. One more desilting of channel was done with fund received from NREGA scheme. This will prove that during rainy season; it is helped to easily receive the water from the river through the channel to the tank by doing desilting work and also the impact on groundwater recharge through desilting of tank particularly in partial desilting of tank.

Production of crop yield

The development of irrigation tank system has effectively brought to some additional areas irrigating under crops in both the Kharif and Rabi seasons. The improved crop production for restoration data were collected from the sample farmers as indicated in the Table 2. Paddy is the main crop grown in for both seasons in Avalur tank and Paddy along with some vegetables has grown for in both seasons in Puliambakkam. The following analysis reveals that significant improvement in the yield rate of paddy crop in the restored irrigation tanks. The yield of bags per hectare (1 bag = 75 kg) of paddy crop cultivated in the irrigation tanks and percentage deviation in the yield rate for before and after implementation of restoration was calculated and presented in table 2 the result of the yield rate is higher in after restoration of irrigation tanks. It is observed from the result is given in table 2. In Avalur village the changes in crop yield rate for restoration of irrigation tank in both seasons was significantly high as shown in Figure 5. The changes in crop yield rate in terms of percentage in the first season were 5, 4 and 5% for small farmer, middle farmer and large farmers respectively The changes in increased yield rate in the second season were 4, 5, 8 and 11% for small farmer, large farmers, marginal farmers and middle farmers

Figure 4 Water stored Portions (Combined portion for first and second desilting) of Puliambakkam tank after desilting

Table 2. Changes in production of yield for restoration.

S/No	Name of Villages	Type of Season	Farmer category	Paddy yield per hectare (Bags)		Changes in yield	
				Before	After	Bags	%
1	Avalur	I Season	Large	78	82	4	5
			Middle	74	77	3	4
			Small	85	88	3	3.5
			Marginal	94	99	5	5
			Total	84	87	3	3.5
		II Season	Large	78	82	4	5
			Middle	74	82	8	11
			Small	83	87	3	4
			Marginal	94	101	7	8
			Total	80	84	4	5
		I Season	Large				
			Middle	81	86	5	6
			Small	79	84	5	6
			Marginal	88	91	3	3.5
			Total	81	86	5	6
		II Season	Large				
			Middle	82	89	7	8.5
			Small	77	82	5	6
			Marginal	94	99	5	5
			Total	82	95	13	16

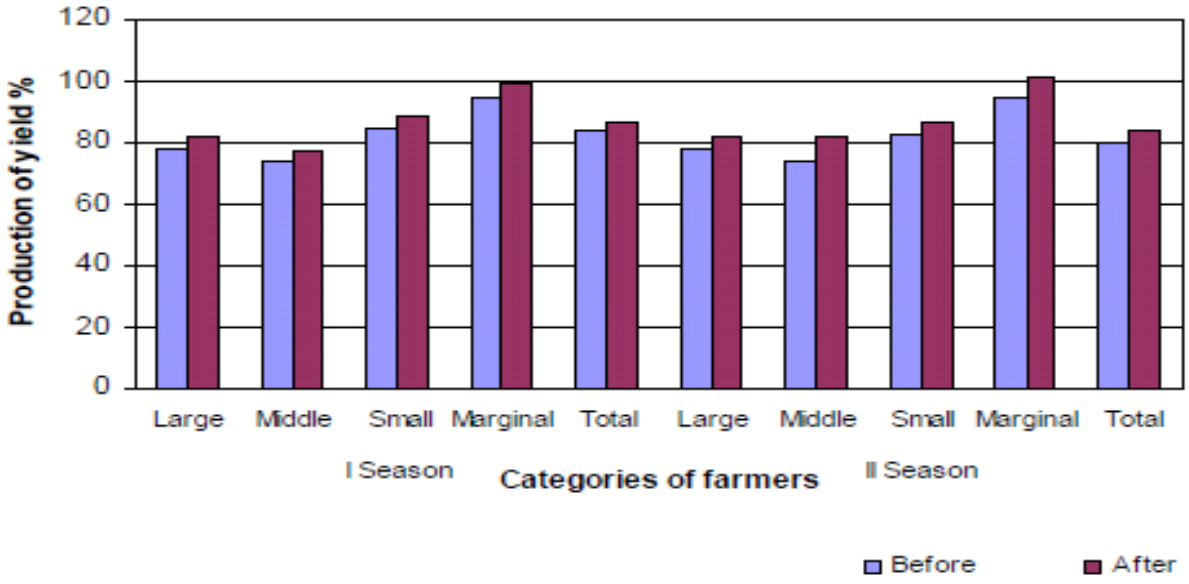

Figure 5. Changes in production of crop yield for restoration in Avalur.

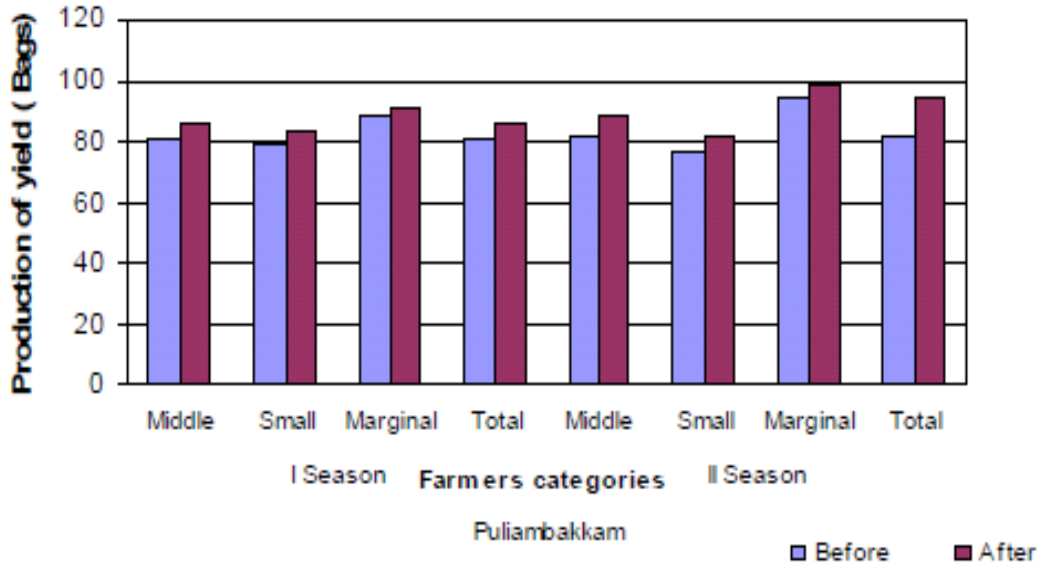

Figure 6. Changes in production of crop yield for restoration in Puliambakkam.

respectively. The over all changes in yield in the first season is from 84 to 87 bags and in the second season is from 80 to 84 bags and in the second season is from 80 to 84 bags. The changes in yield rate in percentage term were 5 and 8% for second which it is higher than that in the first season.

Changes in the increased yield rate for restoration in Puliambakkam tank are also appreciably high for both seasons as shown in Figure 6. The changes in crop yield rate is from 81 to 86 bags for middle farmer, 79 to 84 bags for small farmers and 88 to 91 bags for marginal farmers in the first season. The changes in the crop yield rate for second season is from 82 to 89 bags for middle farmers, 77 to 82 bags for small farmers and 94 to 99 bags for marginal farmers were 5% for marginal farmer, 6% for small farmer and 16% for large farmer. The overall percentage changes in crop yield rate were from 81 to 86 bags in the first season and from 82 to 95 bags in the second season. The changes in yield rate in percentage terms are 6% in first season and 16% in second season. This is proving to appreciable impact on crop yield rate (Table 2) due to restoration of irrigation tank under

Table 3. Changes in Production of cropping pattern for restoration.

S/No	Name of Villages	Details of cultivation land		Cropping pattern (Ha)	
				Before	After
1	Avalur	Total cultivated land by tank irrigation	Paddy	64.35	86.00
			Vegetable	-	-
			Total	64.35	86.00
		Total cultivated land by tank and Well irrigation	Paddy	32.78	51.40
			Vegetable	-	-
			Total	32.78	51.40
		Total cultivated land		97.13	137.40
		Total Existing irrigated land		140	140
		Not cultivated land		42.87	2.60
2	Puliam bakkam	Total cultivated land by tank irrigation	Paddy	33.18	46.94
			Vegetable	6.88	8.50
			Total	40.06	55.44
		Total cultivated land by tank and Well irrigation	Paddy	11.74	15.38
			Vegetable	1.62	2.02
			Total	13.35	17.40
		Total cultivated land		53.42	72.84
		Total existing irrigated land		75	75
		Not cultivated land		21.58	2.16

NREGA.

Cropping pattern and cropping intensity

The cropping pattern changes have taken place both in additional area brought under well irrigation from the fallow lands and in area under rain fed cultivation. In Avalur village, the changes in cropping pattern of Paddy and vegetables by Tank and well irrigation for restoration were analysed and presented in Table 4. The major effect of restoration measures is reflected by improvement in cropping intensity and cropping pattern are given in Figure 5. It could be seen that the restoration impact on cropping pattern of paddy by tank irrigation is increased from 64.35 to 86 ha and by tank and well irrigation is increased from 32.78 to 51.40 ha. Before restoration a lot of land was fallow land (not cultivated) but it will be changed after restoration which is reduced from 42.87 to 2.60 ha.

Irrigated land use pattern

The changes in the land use pattern by tank irrigation and Well irrigation for desilting of Avalur and Puliambakkam tank were analysed and presented in Table 3. The major effect of desiltation measures is reflected in improvements to cropping intensity and cropping pattern. It could be seen that in Avalur village, the impact of desilting of tank on cropping pattern by tank irrigation is increased from 64.35 to 86 ha and cropping pattern by tank and well irrigation is increased from 32.78 to 51.40 hectare as shown in Figure 7. It also discusses the cropping intensity of cultivated land among these households in their operated area.

In Puliambakkam village, the restoration impact on cropping pattern of paddy and vegetable by tank irrigation and well and tank irrigation is presented in Table 3.The improved cropping pattern by tank irrigation for restoration to paddy is increased from 33.18 to 46.94 ha and vegetables is from 6.88 to 8.52 ha. Cropping pattern by tank and well irrigation is changed for restoration in the paddy is increased from 11.74 to 15.38 ha and in the vegetables is increased from 1.62 to 2.02 ha. Fallow pattern (Not cultivated) cropping pattern has reduced after restoration which is reduced from 21.58 to 2.16 ha. It is proved in cropping pattern has been improved due to desilting of supply channel and desilting of tank. Changes in cropping pattern restoration in Puliambakkam are shown in Figure 8.

In Avalur village, cropping intensity has improved during post implementation period as shown in Figure 9a and b and General changes in cropping intensity are presented in table Cropping intensity of paddy by tank irrigation is increased from 46 to 61% and by tank and well irrigation is increased from 23 to 37%. Increase in cropping intensity indicates improvement production

Table 4. Changes in farmer income for restoration.

S/No	Name of villages	Type of season	Farmer category	No of Farmers	Total income per farm household(Rs)		Changes in income	
					Before	After	Rs	%
1	Avalur	I Season	Large	1	94540	106700	12160	13
			Middle	19	38200	58210	20010	52
			Small	47	30540	44730	14190	46
			Marginal	44	27700	29750	2050	7
			Total	111	31310	41660	10350	33
		II Season	Large	1	94540	106700	12160	13
			Middle	19	42190	54590	12400	29
			Small	47	20940	31620	10680	51
			Marginal	44	7080	11030	3950	56
			Total	111	19490	27680	8190	42
2	Puliam bakkam	I Season	Large					
			Middle	11	20732	29055	8323	40
			Small	39	21780	33115	11335	52
			Marginal	29	18940	25070	16130	180
			Total	79	16920	29600	12680	75
		II Season	Large					
			Middle	11	22231	32336	10015	45
			Small	39	14252	15613	1361	10
			Marginal	29	4585	18930	14345	313
			Total	79	11850	18400	6550	55

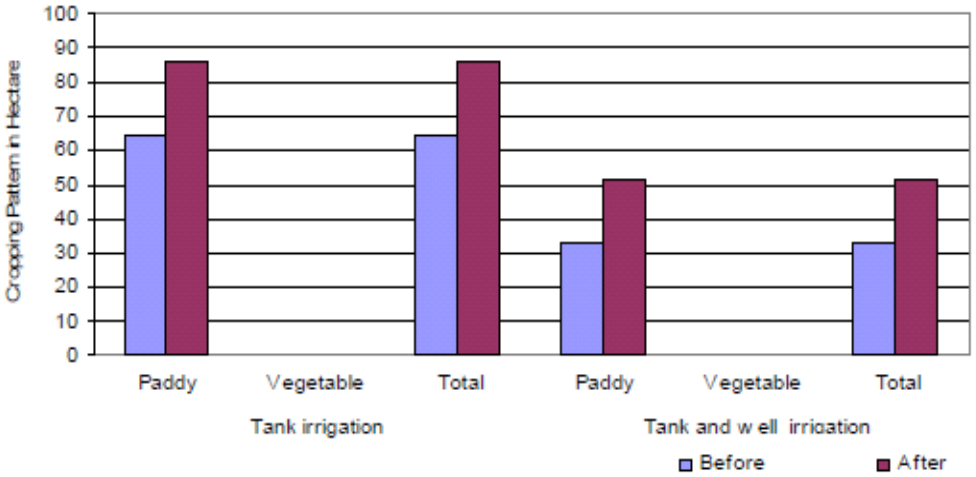

Figure 7. Changes in production of cropping pattern for restoration in Avalur tank.

capability of land. Cropping intensity not cultivated land is reduced from 31 to 2%. In Puliambakkam village, cropping intensity has improved during post implementation period. Cropping intensity of Area under cultivation of tank irrigation increased from 53 to 74% and cultivation of well and tank irrigation increased from 18 to

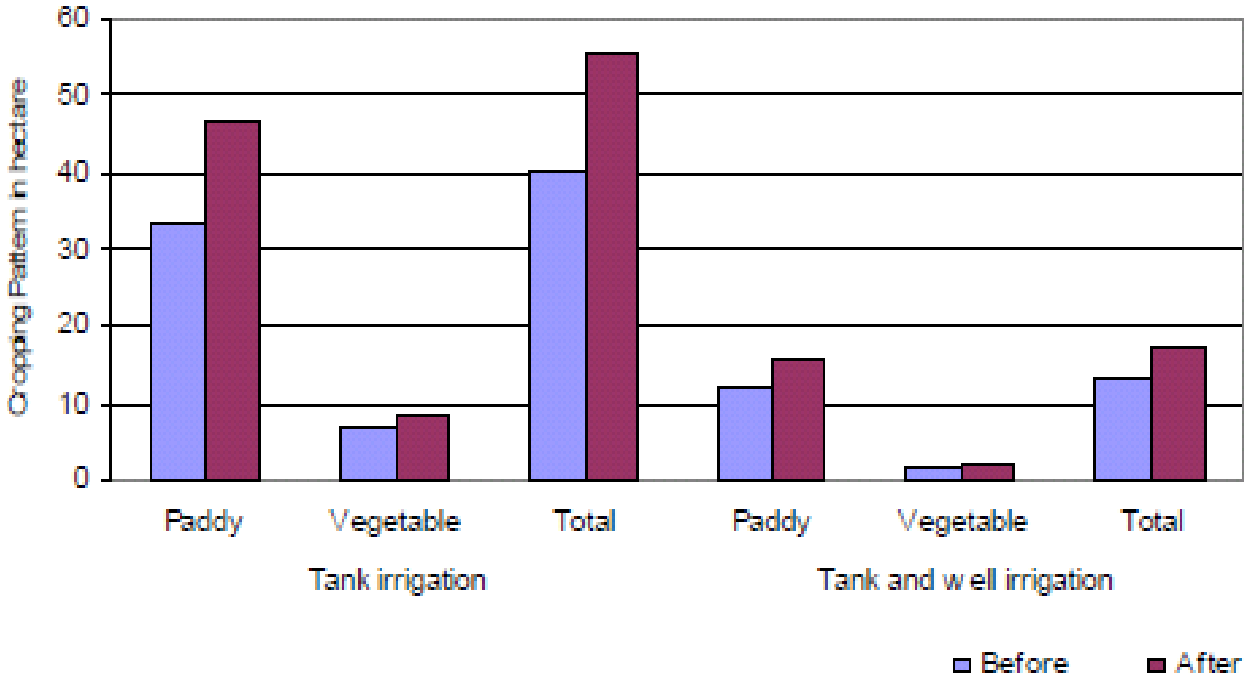

Figure 8. Changes in production of cropping pattern for restoration in Puliambakkam tank.

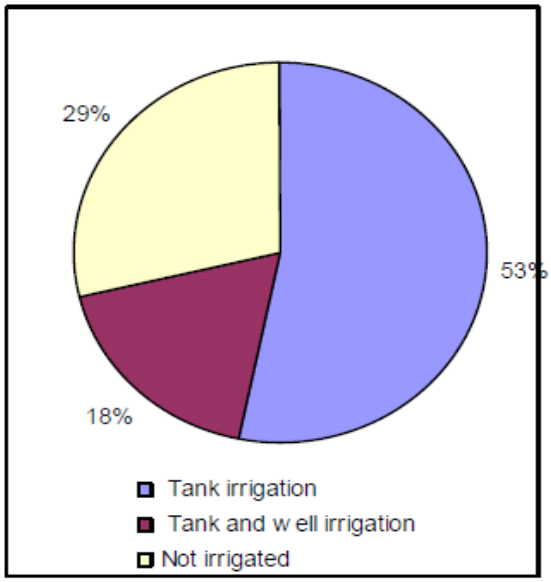

Figure 9a. Cropping intensity of Avalur Before restoration.

23%. Increasing in cropping intensity indicates the improvement in production capability of land. Cropping intensity of not cultivated land has changed due to restoration it is reduced from 29 to 3%. It is proved that restoration impact on cropping intensity in the village. The above detail is clearly shown in Figure 10a and b.

Employment generation

Restoration work under NREGA scheme has made a significant contribution on employment and income generation in the villages of Avalur and Puliambakkam. In Avalur village a minimum of 100 people were employed

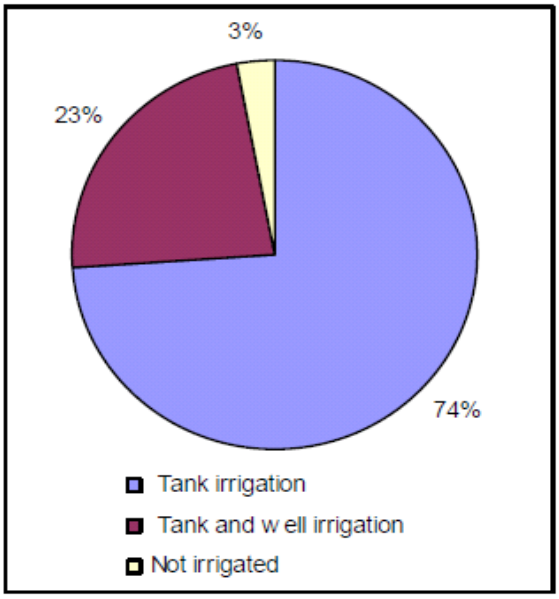

Figure 9b. Cropping intensity of Avalur after restoration.

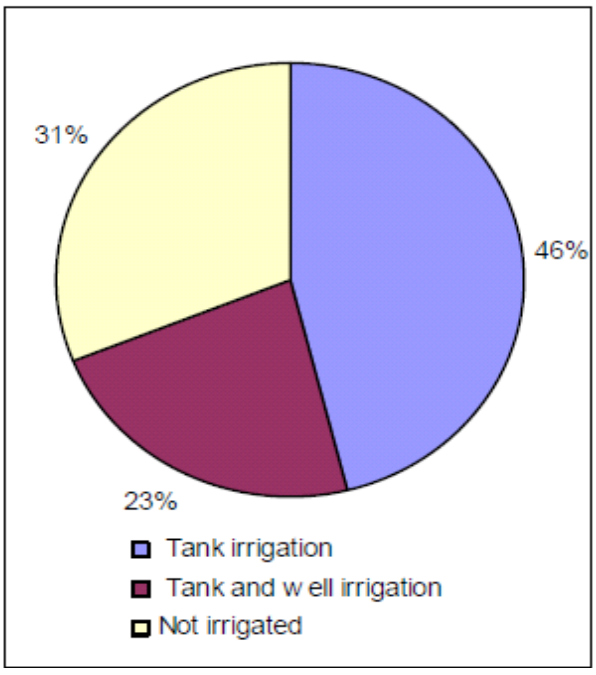

Figure 10a. Cropping intensity of Puliambakkam before restoration.

in this project during the implementation of restoration work like channel desilting, jungle clearance work and tank desilting work. That is in restoration work 16% of men, 70% of women and 14% of old people were employed at an average daily wages of Rs 80 /person /day during the period of work. In puliambakkam village at least 230 people were employed on restoration under NREGA scheme which is 37% men, 47% women and 16% old people were people employed at an average daily wages of Rs 80 per person per day during that

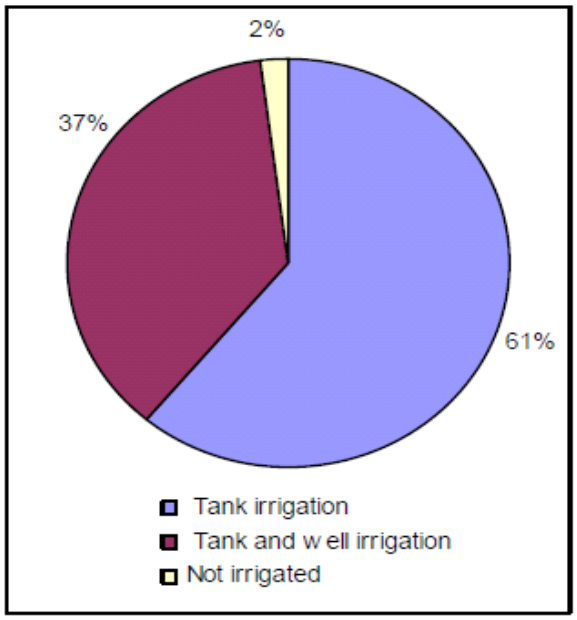

Figure 10b. Cropping intensity of Puliambakkam after restoration.

period.

Incremental income

The general changes in house hold income for restoration is presented in Table 4. The tank irrigation system intervention was found to help the rural farm households in enhancing their income level. The household income in Avalur village before initiation of restoration of irrigation tanks under NREGA was computed in the first season was at Rs 94540, Rs 38200, Rs 30540 and Rs 27700 for large farmers, middle farmers, small farmers and middle farmers which is increased to Rs 106700, Rs 58210, Rs 44730 and Rs 29750. In percentage terms, the corresponding increased income in the first season was 13, 52, 46 and 7%. Changes in the agriculture income in the second season was from Rs 94540 to 106700, Rs 42190 to 54590, Rs 20940 to 31620 and Rs 7080 to 11030 for large farmers, middle farmers, small farmers and marginal farmers and changes in income in percentage terms was 13, 29, 51 and 56%. On overall, before restoration of irrigation tank, the average agriculture income in the first season is Rs 31310 which shot up appreciably to Rs 41660, that is 33% after the execution of these works and in the second season is Rs 19490 which turns up appreciably to Rs 27680 that is 42%. It is prove that impact of restoration program under NREGA in Avalur tank on Farmer income is increased in 33% in the first season and 42% in the second season as shown in Figure 7. It is raised appreciably in both the first season and second season after restoration in Avalur tank. In Puliambakkam village, the increased agriculture income per household for restoration in Puliambakkam tank in the first season is Rs 8323, Rs 11335 and Rs 16130 for middle farmer, small farmer and marginal farmer and the increase income in percentage terms is 40, 52 and 180%. Incremental income for restoration in Puliambakkam tank in the second season is Rs 10015, Rs 1361 and Rs 14345 for middle farmer, small farmer and marginal farmers and in percentage terms is 45, 10 and 313%. The over all incremental income in terms of percentage in the first season is 75% and second season is 55%. Marginal farmers highly benefited for restoration because their lands are situated nearer desilting portion because their cultivated land are increased highly. Over all the income has raised in Both season after restoration in Puliambakkam tank as shown in Figure 8 Thus restoration program in the tanks helped to raise farmers' income in both the villages of Avalur and Puliambakkam.

Rate of return of estimates

Financial and economic feasibility for restoration in irrigation tanks system like desilting of tanks, desilting of channel, jungle clearance, bund strengthening etc. To conduct this analysis, various data related to yield per hectare and input use per hectare of each irrigation system was collected from sample households in conjunction with secondary data from relevant offices in the study areas.

Tank irrigation system development activities can be assessed by using key indicators such as net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR) (Amarnath and Karthick, 2006). To simplify the analysis the following basic assumptions were made in the calculations of costs and benefits and these are discussed below. The result of the financial cost benefit analysis for restoration in Avalur tank has indicted that the net present value at 10% rate of interest in the first season was found to be Rs 41.04 lakhs per season and in second season was found to be Rs 30.44 lakhs per season.

The Benefit Cost Ratio was found to be 2.5 and 3.4 in first and second season respectively. The Internal Rate of Return was 42 and 34% in first and second season respectively. Thus the study confirmed that investment in restoration of Avalur tank was found to be financially viable. The result of the financial cost benefit analysis for restoration in Puliambakkam tank has indicted that the net present value at 10% rate of interest in the first season was found to be Rs 19.04 lakhs per season and in second season was found to be Rs 38 lakhs per season. The Benefit Cost Ratio was found to be and in first and second season respectively. The Internal Rate of Return was 36 and 24% in first and second season respectively. Thus the study confirmed that investment in restoration of irrigation tank was found to be financially

viable. The Overall, the result of the financial cost benefit analysis of this research illustrated that investment restoration under NREGA scheme was commercially profitable.

FUTURE DIRECTIONS

Tank irrigation system development programmes not only protect and conserve the environment, but also contribute to livelihood security. All the stakeholders should be involved at various stages of project activities, planning and implementation with the ultimate objective of sustainability.

In addition, strengthening of community organizations within the Tank irrigation system, implementation of the planned Tank irrigation system management activities, encouraging linkages with other institutions and initiating groups towards formation of apex bodies will help motivate the people and make it a peoples' movement.

CONCLUSION

Today tank irrigation system management has become the main intervention for water resource management and rural development due to sustainable agriculture crop production. Tank irrigation system development program not only protect and conserve the environment, but also contribute to livelihood security. Tank irrigation development activities have significant impact on groundwater recharge, access to groundwater and hence the expansion in irrigated area. Tank irrigation development activities have been found to alter crop pattern, increase crop yields and crop diversification and thereby provide enhanced employment and farm income.

Therefore, alternative farming system combining agricultural crops, trees and livestock components with comparable profit should be evolved and demonstrated to the farmers. Once the groundwater is available, high water-intensive crops may be introduced. Hence, appropriate water saving technologies like drip is introduced without affecting farmers' choice of crops. Convergence of various rural development programmes in around the tank irrigation could be ensured to promote holistic development of tank irrigation system. For its continued success, the programme should be economically efficient, financially viable, technically feasible and socially acceptable while ensuring equity. For, sustainable development, regular and routine monitoring of environmental parameters is important as environmental enhancement increases the credibility and acceptability of the programme.

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