FARMER PARTICIPATION ON WATER MANAGEMENT IN THE TANK IRRIGATED SYSTEMS IN TAMIL NADU

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Abstract:

Farmer participation is found to be a solution to arrest the deterioration of the tank irrigation system which is observed in Tamil Nadu state. The study was undertaken with the specific objective of identifying the determinants of farmer participation on water management and its impact on tank performance. The results of the tobit regression model and a production function analysis reveal that the contribution for farmer participation towards water management of Rs 1.00 at the mean level, *ceteris paribus*, would increase the rice yield by 2.7 kg/ha in Tank only typology whereas in Tank with wells typology by 2.2 kg/ha of land. The positive impact of farmer participation towards water management on rice yield indicates the importance of water management institutions in sustaining rice productivity and it has important policy implications for water management in tank commands. The water users association in the tank irrigated systems should be strengthened for water management which leads to better performance of the tanks.

Key words: Farmer participation, Water management, Tank irrigation system

1.0 Introduction

Tank irrigation systems are important sources of irrigation in South India. They account for more than one-third of the total irrigated area in Andhra Pradesh, Karnataka and Tamil Nadu states. The tank irrigation system has a special significance to the marginal and small scale farmers. Many studies in tank irrigation systems revealed that tank irrigation system is deteriorated because of negligence of tank management. Tank performance is determined by both tank management and water management. Water management includes allocation and distribution of water which is mainly done by water man (‘Neerkatti’). Field channel cleaning is also considered as water management activity. As water is the critical input for farming in tank irrigation systems, it is an important need to improve the water availability. Any action towards improvement in tank performance may improve the water availability in the tank command area. As water management directly influencing the tank performance it is necessary to identify the determinants of farmer participation in water management in different situations. Hence the objective of this study is to identify the determinants of farmer participation on water management and its impact on tank performance.

2.0 Materials and Method

2.1 Literature review

Sarma (1992) stated that the objective of increasing the irrigated area and agricultural production could be achieved only through improving the existing systems. Consequently equity and productivity of irrigation systems were thus a function of water distribution. Hence, determinants of water distribution were of primary concern to those interested in project performance; they formulated developmental strategies appropriate for specific agricultural production environment. Over years the area under tank irrigation had been declining and policy makers and planners were exploring the possibilities to revive the tank irrigation, as tank irrigation was the typical example of the water harvesting technique, and were mostly managed by the local communities as common property resource. Budget constraints and poor community participation made the tank performance unsustainable. The immediate solution was to identify the appropriate investment strategies and make the local Panchayat responsible for the operation and maintenance of the tanks. Resource mobilization by the local bodies was very essential (Palanisami and Easter, 2000) Balasubramanian and Selvaraj (2003) tried to understand the main causes for the degradation of tanks and the complex interrelationships among poverty, private coping mechanisms and community coping mechanisms that affected tank performance. Regression models such as a macro model on tank degradation, household-level models on collective action, and a production function incorporating collective action as an input were fitted and found out that poor people are more dependent on tanks for various livelihood needs and hence, they contributed more towards tank management compared to non-poor households. Collective action had a positive and significant impact on rice yields. The tank degradation showed that there had been a decline in the performance of the tanks. Narayanamoorthy (2007) made an attempt a) to study the growth pattern of tank irrigation across different periods both at the national as well as across states level b) to study the nexus between rainfall and area under tank irrigation at a specific state, which has relatively larger area under tank irrigation c) to find out the losers and gainers of tank irrigation among different size of farmers and d) to suggest policy measures to rejuvenate tank irrigation in India. He concluded that the reasons for the decline in area under tank irrigation might be different for different states. Maintenance works could not be carried out in a regular basis due to lack of financial allotment which resulted in an overall reduction in the storage capacity of many tanks. He added that since it was difficult to improve the performance of the tanks without users' participation, state agencies should make effort to revitalize age-old irrigation institutions, which had maintained the systems over centuries.

2.2 Methods

Two districts were purposively selected in Tamil Nadu, wherein Madurai and Sivagangai districts from southern part represent the Tanks only and Tanks with Wells typologies. Tanks are the main source of irrigation in these two districts.

2.2.1 Sampling design

Ten tanks in each selected district were randomly selected for the study using the list of tanks in the districts. Then 25 households in each selected tank were randomly selected using the list of farmers available with the village administrative offices. Thus, the sample for this study consists of 20 tanks and 500 households which represent adequate distribution of sample households among the selected tanks.

As there were no tanks without wells, the 20 tanks selected randomly were categorized into two different typologies based on the farm households depending upon the source of water supplies, *viz*., Tank only and Tank with wells. Thus this categorization was primarily based on the percentages of households depending on the type of water source. If more than 80 per cent of the household in a tank, use tank as the only source for irrigation, then those tanks were categorized as typology I (Tank only situation) and the rest were grouped into typology II (Tank with wells situation). In the study area, eight tanks in Madurai district were categorized under typology I (*i.e.,* Tank only situation). It consists of 173 households using tanks as the only source of water for irrigation. There were 27 households under those particular tanks who use tanks with wells as the source of water for irrigation. Likewise 12 tanks in which 10 tanks in Sivagangai and two tanks in Madurai districts were categorized under typology II (*i.e.,* Tank with wells). It consists of 246 households using tank with wells as the source of water for irrigation. However, there were 54 households in the typology II who use only the tanks as the source of water for irrigation. Finally 27 households in the typology I and 54 households in the typology II were excluded from the analysis because these households could not fit into the above typologies due to their field locations and conflicts with other neighboring farmers in sharing the available water from tanks and wells. This exclusion was made to draw the conclusions and recommendations based on the results obtained under each typology. The details of the sample are given in Table 3.1

Table 3.1 Sample household distribution in the study area

Typology	Tank only	Tank with wells	Total
Tank only	173 (34.60)	27 (5.40)	200 (40.00)
Tank with wells	54 (10.80)	246 (49.20)	300 (60.00)
Total	227 (45.40)	273 (54.60)	500 (100.00)

Figures in parentheses indicate percentage to the total

The field data from the sample respondents relating to agriculture year 2006-07 were collected with the help of pre-tested interview schedule through personal interview. The information regarding the age, education, occupation, family details, source of irrigation for wet and dry lands, well irrigation, water purchase and sales details, annual pumping hours, level of water in the wells, investment on wells, cost of cultivation details of crops under cultivation, household income, participation in tank and water management activities were obtained from sample respondents. Further the tank level information of the selected tanks like tank characteristics such as storage level, command area; number of wells in the tank command area, details of total extent of crops cultivated in each tank, details of livestock, tree resource in the tank bund was collected from the records maintained in the taluk offices for analysis. In addition to this, the block level data such as rainfall, geographical area, number of wells present were obtained from official records.

3.0 Theory

3.1 Tobit regression

Tobit model was used for identifying the determinants of farmer participation towards water management. The independent variables for the analysis were selected after a careful review of literature on factors affecting farmer participation. Group size is an important factor determining the extent of cooperation in the commons. Small groups are considered to be conducive for the emergence and stability of cooperative behavior in view of lower heterogeneity and transaction cost associated with organizing group action (Wade, 1988). As data is not available on the exact number of farmers in each of the sample tanks, tank size (command area) is used as a proxy for group size. Given the fact that the size of land owned under tanks does not show much variation across tanks, tank size provides a good proxy for group size. Participation in meetings is considered as the strength of that traditional organization and its effectiveness in its activities. It is hypothesized that it captures the extent of farmer participation (collective action) for water management. Thus, a dummy variable for institutional effectiveness that represents the active participation or not on water management is used.

Farm size, education as years of schooling of the household head are used as independent variables in this model. Number of wells included as a variable and it is hypothesized to have negative effects on farmer participation. Share of non farm income and age were also included in the model. The dependent variable is the total value of farmer participation (collective effort), which is calculated by summing up the monetary value of labor, materials such as gunny bags and money contributed for collective work. Since there was no contribution by some of the sample farmers, the dependent variable takes a zero value for all these observations and others take value more than zero. In view of the truncated nature of the dependent variable, the tobit regression was chosen and specified as follows:

The tobit model originally developed by Tobin is of the following form.

$$Y_i = \beta_1 + \beta_2 X_i + \varepsilon_i \quad \text{If RHS>0}$$

=0 otherwise

where RHS is right hand side. Additional X variables can be easily added to the model.

The model used in this study was modified from Balasubramaniam and Selvaraj (2003) to find out the amount of money contributed by way of farmer participation to tank and water management in relation to other socio economic and tank variables.

3.1.1 Tank only situation:

$Fpart = \beta_0 + \beta_1 Age + \beta_2 Yschl + \beta_3 WUA + \beta_4 Fsize + \beta_5 Tksize + \beta_6 NFIshare + \varepsilon$

3.1.2 Tank with wells situation:

$Fpart = \beta_0 + \beta_1 Age + \beta_2 Yschl + \beta_3 WUA + \beta_4 Wellden + \beta_5 Fsize + \beta_6 Tksize + \beta_7 NFIshare + \varepsilon$

Where,

Fpart	=	Farmer participation measured by contribution of money value (Rs / ha)
Age	=	Measured as number of years of household head
Yschl	=	Education measured as years of schooling of household head
WUA	=	Dummy for active participation in WUA meetings as a proxy for effectiveness of local institutional mechanism (1 if the WUA is active and 0 otherwise)
Wellden	=	Number of wells available/ ha.
Fsize	=	Farm size in ha.
Tksize	=	Command area of the tank in ha.
NFIshare	=	Share of non-farm income in the total household income
$\beta_0, \beta_1 \ldots \beta_7$	=	Coefficients
ε	=	Error term

3.2 Multiple regression analysis

The Cobb-Douglas model was fitted to capture the impact of farmer participation on rice yield in different scenarios of tank irrigation. As this study has two different typologies of tank irrigation for paddy, the regression models were specified separately as follows.

3.2.1 For Tank only typology:

$lnRiceyd = \beta_0 + \beta_1 lnSeed + \beta_2 lnFert + \beta_3 lnLabour + \beta_4 Npcide + \beta_5 lnFpart + \varepsilon$

3.2.2 For Tank with wells typology:

$lnRiceyd = \beta_0 + \beta_1 lnSeed + \beta_2 lnFert + \beta 3Labour + \beta_4 Npcide + \beta_5 Swirri + \beta_6 Fpart + \varepsilon$

Where,

Riceyd	=	Rice yield (kg/ha)
Seed	=	Value of Seeds used (Rs/ha)
Fert	=	Value of fertilizer NPK used (Rs/ha)
Labour	=	Value of human labor used (Rs/ha)
Npcide	=	Number of pesticides spray/ha

Swirri = Number of supplemental irrigations/ha

Fpart = Monetary value of farmer participation for collective action (Rs/ha)

$\beta_0, \beta_1 \ldots B_6$ = Coefficients

ε = Error term

4.0 Results

The mean values of the variables used and the results of the regression analysis for identifying the determinants of farmers' participation in water management are presented in the Tables 4.1 and 4.2 respectively.

Table 4.1: Description and mean values of determinants of farmer participation on water management in Tank only and Tank with wells typology

Variables	Description	Mean values of Tank only typology	Mean values of Tank with wells typology
Age	Number of years of the household head	48.54	49.68
Yshcl	Education measured as years of schooling of household head	6.97	7.81
WUA	Dummy for active participation in WUA meetings as a proxy for effectiveness of local institutional mechanism	-	-
Fsize	Farm size in ha.	0.83	1.22
Wellden	Well density number/ha		0.27
Tksize	Command area of the tank in ha	147.76	214.76
NFIshare	Share of non-farm income in the total household income	0.27	0.24

Table 4.2. Determinants of farmer participation on water management in Tank only and Tank with wells typologies

	Tank only typology		Tank with wells typology	
Variable	Coefficient	Standard error	Coefficient	Standard error
Constant	-184.37	56.45	-15.18	48.22
Age	0.3263	0.8126	0.297	0.734
Yschl	4.998*	2.697	5.272*	2.55
WUA	161.71***	0.0316	105.34***	16.36
Fsize	153.91***	22.82	25.78**	9.81
Wellden			-45.34***	8.246

Tksize	-0.146***	11.74	-0.085***	2.028
NFIshare	-63.47	31.82	-275.53***	81.03
Log likelihood function	-706.08		-563.71	
Sigma	78.57	4.901	66.1	4.99
Sample size	171		184	

***, ** indicate significance at one and five per cent level

Table 4.3. Description and mean values of variables used in rice production function analysis for water management in Tank only and Tank with wells typologies

Variable	Description	Mean values of Tank only typology	Mean values of Tank with wells typology
Riceyd	Rice yield (Kg/ha)	4,123	4,789
Seed	Value of seeds (Rs/ha)	1,208	1,239
Fert	Value of fertilizer (Rs/ha)	3,645	3,875
Labor	Value of labor (Rs/ha)	6,178	6,278
Swirri	Number of supplemental irrigation	-	1.50
Npcide	Number of pesticides spray	1.40	2.50
Fpart	Farmer participation (Rs/ha of command area)	478	352

Table 4.4 Impact of farmer participation on rice yield through water management in Tank only and Tank with wells typologies

	Tank only typology		Tank with wells typology	
Variable	**Coefficient**	**Std.Error**	**Coefficient**	**Std.Error**
Constant	1.73	0.643	3.787	0.666
Seed	0.143*	0.086	0.11*	0.0518
Fert	.399***	0.082	0.155**	0.053
Labor	0.145***	0.037	0.23***	0.014
Npcide	0.037	0.023	0.0038	0.0171
Swirri	-	-	.129**	0.0348
Fpart	0.202***	0.033	0.053**	0.0188

Adjusted R^2	0.54	0.91
F-value	41.006	191.86

***, **, * indicate significance at one, five and 10 per cent level

5.0 Discussion

5.1 Determinants of farmers' participation on water management

From the Table 4.2 the coefficients of farm size and water users association were highly significant and positively contributing for farmer participation towards water management while tank size is negatively contributing for farmer participation and years of schooling positively contributing for farmer participation at 10 per cent significance level in Tank only situation whereas in Tank with wells situation the variables *viz.*, tank size, well density and non-farm income share showed negative contribution in farmer participation towards water management with one per cent significant level while years of schooling, farm size and water users' organization showed positive contribution in the extent of farmer participation towards water management. It could be interpreted that an increase in the well density by one from the mean level, *ceteris paribus,* would reduce the farmers' participation in water management by Rs. 45 per ha (Table 4.2). This result provides stronger evidence to the hypothesis which states that the increase in density of private wells in the tank command reduces the farmers' participation towards water management.

An increase in tank size by 100 ha from the mean level, *ceteris paribus,* would result in a reduction of farmer participation in water management by Rs. 14.60 whereas in Tank with wells typology by Rs. 8.50. In many cases these tanks serve more than one village thus increasing heterogeneity that discourages the cooperative action among the tank farmers. An increase in farm size by one ha from the mean level, *ceteris paribus,* would increase the farmer participation on water management by Rs. 154 in Tank only situation whereas in Tank with wells situation by Rs. 26. It indicates that even though the farmers own wells in Tank with wells situation they understand the importance of water management. An increase in the years of schooling by one year from the mean level, *ceteris paribus*, would result in an increase of farmer participation by Rs. 5.00 in Tank only situation and Rs. 5.20 in Tank with wells situations. This implies that the educated farmers understand the importance of water management on tank performance. By changing the attitude from poor participation to active participation in WUA's meetings keeping all other variables constant, contributes Rs. 161 for water management in Tank only typology whereas Rs. 105 in Tank with wells typology. An increase in non-farm income share by one, keeping all other variables constant, would reduce the farmer participation by Rs. 63 in Tank only typology whereas by Rs. 275 in Tank with wells typology.

5.2 Impact of farmer participation on water management

The R^2 value of 0.54 and 0.91 in Tank only and Tank with wells typologies (Table 4.4) indicated that about 54 per cent of the variation in the rice yield was explained by the independent variables (*viz.*, seed, fertilizer, labor, pesticide spray and farmer participation) selected for the analysis in Tank only typology whereas in Tank with wells typology, about 91 per cent of the variation in the rice yield was explained by the independent variables (*viz.*, seed, fertilizer, labor, pesticide spray, supplemental well irrigation and farmer participation) involved in this analysis.

The results shown in Table 4.4 indicate that all the independent variables included in the analysis showed positive impact on rice yield. Fertilizer, labor and the extent of farmer participation towards water management are statistically significant at one per cent level while seed is at 10 per cent significant level in Tank only typology whereas in Tank with wells typology labor was found to be highly significant in influencing the yield while the numbers of supplemental well irrigation from private wells, extent of farmer participation and fertilizer were significant at five per cent level. The positive impact of extent of farmer participation towards water management on rice yield indicates the importance of water management institutions in sustaining rice productivity. The significance of both the number of supplemental well irrigation and the extent of farmer participation in increasing rice productivity has important policy implications for water management and the regulation of private wells in tank commands.

The coefficients of farmer participation were 0.202 and .053 in Tank only and Tank with wells typologies (Table 4.4), could be interpreted that for one per cent increase in farmer participation towards water management from the mean level, *ceteris paribus,* would increase the rice yield by 0.202 per cent in Tank only typology whereas in Tank with wells typology one per cent increase in farmer participation towards water management from the mean level, *ceteris paribus,* would increase the rice yield by 0.053 per cent. It can be translated that for the contribution of Rs. 3.00 by farmer participation towards water management from the mean level, *ceteris paribus*, would increase the rice yield by 8.2 kg in Tank only typology whereas in Tank with wells typology Rs 1.12 increase from the mean level of contribution of farmer participation towards water management, *ceteris paribus*, would increase the rice yield by 2.25 kg. It can further be translated that for the contribution of Rs 1.00 at the mean level, *ceteris paribus,* would increase the rice yield by 2.7 kg in Tank only typology whereas in Tank with wells typology by 2.2 kg per ha of land. It indicates that the return to water management by farmers participation is more in Tank only typology than in Tank with wells typology. One per cent increase in supplemental irrigation from the mean level, *ceteris paribus*, would increase the rice yield by 0.129 per cent per ha in Tank with wells typology. It can be translated that an increase in supplemental irrigation by 0.025 from the mean level, *ceteris paribus*, would increase the rice yield by 6.17kg per ha which is same as that the increase the number of supplemental irrigation by one from the mean level, *ceteris paribus,* would increase the rice yield by 243 kg per ha of land in Tank with wells typology.

6.0 Conclusion

As water users association has significant role in farmer participation towards water management which in turn will increase the return from water management, action should be taken to strengthen the activities of water users association. Both capacity building initiatives and strengthening the social capital in the tanks are highly needed. Adequate efforts should be taken in this direction by the village panchayats and NGOs in the regions

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