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Participation in community based tank irrigation system in a rainfed region of India

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ABSTRACT

Tank irrigation is an important source of irrigation in rainfed region and has a less investment structure with few environmental problems. Despite several economic and environmental benefits, the performance of tanks has been poor due to lack of proper management and weak community participation. For effective management, the factors which affect the farmer's participation need to be assessed. The study was undertaken in Andhra Pradesh and required data was collected through primary survey from farmers in Ananthapur and Chittor district for the agricultural year 2016-17. Principal component analysis and regression analysis were employed to analyze the data. The most important factors affecting farmer's participation were farmer's perceptions related to the water management system, tank structure, water accessibility and financial arrangement, explaining 72.8% of farmer's participation in tank irrigation management. Further, level of farmers' participation in tank irrigation management depends on increase in the net sown area, an increase in the need of irrigation water and cultivation of high water requirement crops, absence of membership in other organizations and increase in family size.

Key words: Factors, Farmers, Irrigation, Participation, Tank

The irrigation potential for the country is about 140 million ha with a net irrigated area of 61 million ha. The uneven distribution of rainfall with frequent deviation leading to scarcity of water is a major concern. Among the irrigation sources, tank irrigation is playing very critical role in the sustainable irrigation development in the rainfed region (Jana *et al.* 2012, Sengupta 1985, Shah 2009). The largest concentration of tanks is found in Andhra Pradesh. However, tank as an important source of irrigation in the state, has lost its significance during the last two to three decades. The proportion of net irrigated area under tanks showed a significant decline from 22% in 1985 to 8.3% in 2014. Most of the tanks perform below their actual capacity resulting in 40 to 60% gap between the irrigation potential created and actual irrigated area under tanks. The second Minor Irrigation Census reported that 36.4% of the total numbers of tanks were not in use in the state. Tanks have fewer negative environmental impacts and provide a variety of livelihood options to the rural economy (Narayanmoorthy and Deshpande 2003, Palanasami and Easter 2000, Vaidyanathan 2006) and also serves both as flood moderators in times of heavy rainfall and as drought mitigators in times of long dry spell (Vasimalai 2006). Even though tank irrigation is considered to be a low-cost source, the performance has been poor and has deteriorated over the years (Narayanamoorthy 2007, Vaidyanathan 2006). Most of the tanks have over time degraded into open access resources due to weak property relations (Palanisami 2006) and community participation (Chakravarty *et al.* 2006, ADB 2006, Sreedhar 2007). The tank irrigation system has a special significance to the marginal and small scale farmers. However, it is deteriorated because of negligence of tank management (Nanthakumaran and Palanisami 2010). To mitigate this, Participatory Irrigation Management (PIM) acted as the tool for improving irrigation management for sustainability of the system particularly in water distribution and maintenance of tanks. Water User Associations (WUAs) established in the canal command areas are working fairly well in terms of deciding the cropping pattern, increasing water use efficiency and cost recovery and better water allocation (Kumar 2000). Tank performance is determined by both tank management as well as water management. As community participation is directly influencing the effective management of tanks, which will improve the water use efficiency. Therefore, improving the tank management will enhance tank supplies which in turn will reduce the demand for more number of wells in the tank command area (Palanisami *et al*. 2008). Hence, it is necessary to identify and quantify the factors influencing farmer participation in community-based tank irrigation management.

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MATERIALS AND METHODS

The primary data on various socio-economic features of randomly selected 150 farmers of four mandals (based on maximum concentration of tanks) from Anathapur and Chittor districts of Andhra Pradesh pertaining to 2016-17 was collected.

Principal component analysis (PCA) technique was used to determine the key factors which affect the farmer's participation in tank irrigation management. The analysis provides parsimony of set of variables in the dataset. It was carried out using the Principal component axis model of factoring developed by Hotelling (1933), which was used by Angelucci and conforti (2010), Kumar and Chand (2004) and Anuja *et al*. (2012).

It is expressed as:

$$Zj = aj1\ F1 + aj2\ F2 + aj3\ F3 + \ldots\ldots\ldots\ldots ajq\ Fq \quad (1)$$

where, Zj = Magnitude of the indicator j; i.e. jth principal component or factor in the model, ajq = factor loading of the qth indicator in the jth principal component or factor, Fq =amount of association in magnitude of indicators, the uncorrelated trait measured by factor q which is possessed by the indicator j, j = factor loading with reference to indicators (1, 2, 3…, q), q = set of indicators in the model (1, 2, 3..., q) and ajq Fq = factor coefficient or loading of indicator j on factor q.

The formula of factor loading in the final loading matrix by using the following standard- error (Harman 1967):

$$\sigma a = ½\ [(3/r – 2 – 5r + 4r2) / N\ ]^{0.5} \quad (2)$$

where, σa = Standard-error of factor loadings, r = Average value in correlation matrix or factor loadings, and N = number of observations.

Ordinary Least Squares (OLS) is used to explain the variation in the factors of farmer's participation in tank irrigation management.

Factor i = Constant + β1 NETAREA + β2 PNIRRLAD + β3 PNAMNGCA + β4 DBORO + β5 FSIZE + β6 DEDUHEAD + β7 OTHERIRR + β8 DORG + β9 OFFFARM + β10 DVEG + β11 AGE + error.

RESULTS AND DISCUSSION

Socio-economic profile of respondents

Socio-economic characteristics of selected farmers in the tank command area is presented in Table 1. Among different category of farmers, marginal famers (36%) dominated in the sampling area, while small farmers and medium farmers constituted 23% each. Majority of the farming area under study (78.26%) was irrigated with tank irrigation as the major source (63%) of irrigation. Age and farming experience were not found to be associated with farm size, whereas level of education was more in case of large farmers. Medium and large farmers were having more membership in the SHGs, cooperatives and other organisations than marginal and small farmers in the command area.

Table 1 Socio-economic profile of respondents in the command area (2016-17)

Particular	Marginal	Small	Medium	Large	All
No. of farms	54	35	35	26	150
Age of the head of the family (Years)	47 (1.45)	47 (1.63)	44 (1.71)	46 (1.93)	46 (0.82)
Family size (no.)	6.00 (0.27)	7.00 (0.37)	6.00 (0.34)	6.00 (0.30)	6.00 (0.16)
Farm size (ha)	1.43 (0.34)	2.05 (0.48)	3.29 (0.41)	5.85 (0.80)	2.77 (0.39)
Experience of the head (Years)	23 (1.47)	23 (1.46)	21 (1.64)	24 (1.77)	23 (0.79)
Irrigation (Per cent)	75.96 (0.23)	81.47 (0.33)	84.34 (0.35)	73.31 (0.65)	78.26 (0.29)
Tank irrigation (Per cent)	48.83 (0.11)	76.75 (0.18)	74.82 (0.34)	51.54 (0.33)	63.07 (0.18)
Membership in any organization (Per cent)	40.74	48.57	65.71	65.38	52.67
Literacy (Per cent)					
Illiterate	40.00	30.00	16.67	13.33	20.00
Primary	37.21	23.26	27.91	11.63	28.67
Secondary	38.89	24.07	22.22	14.81	36.00
Graduation	21.74	13.04	26.09	39.13	15.33

Figures in parenthesis indicates standard error. Source: Author's calculation from primary survey (2016-17).

Factors influencing farmer's participation

To study the key factors which affect the farmer's participation in tank irrigation management, the information regarding perception on the functioning of irrigation tanks has been recorded. Principal component analysis technique is employed to analyze the twelve indicators of farmer's participation (Jana and Lise 2013). The result of all the factors with Eigen values, extraction sum of square loading, percentage of variance to each factor, and the cumulative variance of the entire factor and over all cumulative variance of all the four key factors are presented in Table 2. The first four factors explain 76% of the total variance. This value corresponds to a relative high representation of the variables by four factor model.

The first factor explained 46% of the total variance, 61.45% of overall cumulative variance among the other factors, represent most important key factor for farmers' participation in tank irrigation management (Table 2). However, this factor had highest positive loading for Suez system (0.83) which benefit in terms of monitoring the flow of water with proper lock gates, followed by water entry/exit system (0.73), channel lining between tank and land (0.68), control of water use according to need (0.66) and water sharing system (0.64) and all factors had strong positive association with each other (Table 3).

Table 2 Total variance explained

Component	Initial Eigen values			Extraction sums of squared loadings			
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)	Overall Cumulative (%)
Water management	5.61	46.72	46.72	5.61	46.72	46.72	61.45
Tank structure	1.48	12.34	59.06	1.48	12.34	59.06	16.23
Water accessibility	1.34	11.19	70.25	1.34	11.19	70.25	14.72
Financial arrangement	0.69	5.78	76.03	0.69	5.78	76.03	7.60

Extraction method: Principal component analysis

Table 3 Analysis of farmer's participation in tank irrigation management

Particular	Components/Dimensions			
	Water management	Tank structure	Water accessibility	Financial arrangement
Suez system (lock gate)	0.83	-0.07	0.13	-0.08
Water entry / exit system	0.73	0.45	0.32	0.01
Channel lining between tank and land	0.68	0.20	0.29	0.08
Control of water use	0.66	0.46	0.13	0.27
Water sharing system	0.64	0.48	0.09	0.12
Maintenance of tank bund	0.15	0.81	-0.02	0.03
Role of the panchayat in tank development	0.35	0.80	0.21	0.05
Maintenance of tank (desiltation etc.)	0.06	0.76	0.37	0.33
Certainty of getting water	0.22	-0.02	0.87	0.04
Adequacy of tank water	0.10	0.23	0.83	0.29
Maintenance of channel	0.38	0.26	0.66	0.08
Fund availability for tank	0.06	0.14	0.22	0.94

These high loading have relative high correlation between each other. The factor 'water management' represented through the above indicators benefit the farmers in terms of better water allocation which would avoid the conflict, minimize the losses and improve water use efficiency and better management of irrigation. The second factor explained 12.33% of the total variance and 16.23% of total cumulative variance (Table 3) with positive factor loading on maintenance of tank bund (0.81) which would benefit to withstand the flood and generate additional income by planting horticulture and other fuel trees. The active role of panchayat in tank development (0.80) and maintenance of tank (0.76) in terms of desiltation which will give strength to tank bund had positive loading and it could be identified as 'tank structure'. A better condition of tank structure leads to increase in water availability in the tank, provide additional income by silt application to dry land and cultivation of crops in all the season. The third factor explain 11.19% of total variance with highest positive factor loading values for certainty of getting water (0.87) and adequacy of tank water (0.83) represent the 'water accessibility' in the tank and the fourth factor with factor loading values for fund availability for tank management (0.94) could be represent as 'financial arrangement'. Hence various indicators are grouped under four major factors, viz. water management, tank structure, water accessibility and financial arrangement. Findings of the study were consistent with the results obtained by the Jana and Lise (2013).

Note: Extraction method: Principal component analysis. Rotation converged in 6 iterations.

The result of regression analysis (Table 4) showed most of the variables except education and off worker in the family are significant for at least once in explaining the variation in participation. Increase in net area sown and percentage of irrigated land would lead to a higher level of participation. However, when the proportion of non-aman paddy in gross cropped area increases and farmers grow boro paddy, then it leads to worsen the situation in case of tank irrigation due to limited availability of water and conflict in sharing. Further, family size had a positive impact on level participation. When other irrigation sources are available, there may be lower participation of farmers. However, due to cultivation of water intensive crops, there is a higher level of participation because farmers considering the tank water is one of the important sources for irrigation even though other alternatives sources are available. These findings were consistent with the study conducted by Jana and Lise (2013).

The most critical factors contributing to farmers' participation in tank irrigation management include water management system, tank structure, water accessibility and financial arrangement for the tank maintenance. These

Table 4 Multiple regression analysis to explain variation in farmer's participation

Particular	Code	Water management	Tank structure	Water accessibility	Financial arrangement
Intercept		4.98** (2.45)	3.56** (1.80)	5.62*** (1.59)	3.44*** (0.80)
Net area sown	NETAREA	0.14* (0.08)	0.001 (0.05)	0.09** (0.04)	0.04* (0.02)
Percentage of irrigated land	PNIRRLAD	0.04** (0.02)	0.02* (0.01)	0.002 (0.01)	0.001 (0.01)
Percentage of non aman paddy in GCA	PNAMNGCA	-2.45 (2.63)	-3.91* (2.04)	0.88 (1.79)	1.78** (0.90)
Boro paddy dummy	DBORO	-0.98 (0.36)	-0.90* (0.54)	-0.80* (0.49)	-0.21 (0.25)
Family size	FSIZE	0.36** (0.16)	0.21* (0.11)	0.21** (0.10)	0.06 (0.05)
Education of head of the family	DEDUHEAD	-0.13 (0.32)	0.13 (0.23)	0.001 (0.20)	0.03 (0.10)
Other irrigation sources	OTHERIRR	0.01 (0.70)	0.84 (0.53)	0.76* (0.45)	0.41* (0.23)
Membership in any organization	DORG	-0.45 (0.67)	0.62 (0.53)	-1.00** (0.33)	-0.12 (0.23)
Off farm worker in the family	OFFFARM	-0.18 (0.53)	-0.46 (0.38)	0.21 (0.44)	0.04 (0.17)
Vegetable dummy	DVEG	1.26* (0.67)	0.4 (0.49)	0.73* (0.02)	0.07 (0.22)
Age	AGE	0.02 (0.03)	0.001 (0.02)	0.01 (0.02)	-0.02* (0.01)
R2 adjusted		0.13	0.14	0.15	0.07
F- statistic		2.5	2.7	2.76	1.74

***, **,*Significant at 1, 5 and 10% level of significance, respectively. Source: Author's calculation from primary survey (2016-17).

factors are considered to be most critical and explain 76% of farmer's participation in tank management. Study also reveals the variation in the role of farmer's participation in tank irrigation management. Better condition of the land, family size, need for irrigation water, lack of other alternative irrigation sources and absence of membership in other organizations lead to increase in the level of participation in tank irrigation management. By considering the need and scarcity of water, the farmer's participation in tank irrigation management is necessary and need to be improved. Therefore, while designing the policy to improve farmers' participation in tank irrigation management above factors need to be taken into account.

REFERENCES

Angelucci F and Conforti P. 2010. Risk management and finance along value chains of small island developing states. Evidence from the Caribbean and the Pacific. *Food Policy* **35**(6): 565–75.

Anuja A R, Kar A, Mathur V C and Jha G K. 2012. Input delivery, processing and marketing of natural rubber: The role of producers' cooperatives in Kerala. *Agricultural Economics Research Review* **25**: 379–86.

ADB. 2006. Rehabilitation and management of tanks in India: A study of select states. Asian Development Bank, Philippines.

Chakravarty K K, Badam G L and Paranjpye V. 2006. Traditional water management systems of India. Aryan Books International, New Delhi.

Jana S K, Palanisami K and Das A. 2012. Prospect of sustainable tank irrigation option in the dry zones of West Bengal. *Indian Journal of Agricultural Economics* **67**(2): 225–37.

Jana S K and Lise W. 2013. Participation in tank irrigation management in dry zones of India. *European Water* **42**: 35–50.

Kumar M D. 2000. Institutional framework for managing groundwater: A case study of community organisations in Gujarat, India. *Water Policy* **2**(6): 423–32.

Kumar S and Chand P. 2004. Prevailing practices and dimensions of contract wheat seed production in Haryana state. *Agricultural Economics Research Review* **17**(2): 149–61.

Nanthakumaran A and Palanisami K. 2010. Farmer participation on water management in the tank irrigated systems in Tamil Nadu. *Proceedings of International Conference on Sustainable Built Environments (ICSBE-2010)*. 13-14 December 2010, Kandy, Sri Lanka, pp 90-98.

Narayanmoorthy A and Deshpande R S. 2003. Where water seeps! towards a new phase in India's irrigation reforms, Academic Foundation, New Delhi.

Narayanamoorthy M A. 2007. Tank irrigation in India: A time series analysis. *Water Policy* **9**(2): 193–216.

Palanisami K and Easter K W. 2000. *Tank Irrigation in the 21st Century*. Discovery Publishing House, New Delhi.

Palanisami K. 2006. Sustainable management of tank irrigation systems in India. Water Technology Centre, Tamil Nadu Agricultural University, India.

Palanisami K, Gemma M and Ranganathan C R. 2008. Stabilization value around water in tank irrigation systems. *Indian Journal of Agricultural Economics* **63**(1): 126–34.

Sakthivadivel R. 2005. Two decades of tank rehabilitation in India: Investment institutional and policy issues. IWMI, Tata water policy research program, and annual partners meet, Anand.

Sengupta N. 1985. Irrigation-traditional vs. modern. *Economic and Political Weekly* **20(**45), (46) and (47): 1919-38.

Shah M. 2009. Participatory watershed development: An institutional framework. (*In*) *Making Water Everybody's*

Business. Agarwal A, Khurana I and Narain S (Eds). Centre for Science and Environment, New Delhi.

Sreedhar G. 2007. Tank irrigation management in the peril– Emerging issues and challenge. (*In*) Irrigation Development– Issues and Challenges. Narsimha Rao P (Ed). Discovery Publishing House, New Delhi.

Vaidyanathan A. 2006. *India's Water Resources: Contemporary Issues of Irrigation*. Oxford University Press, New Delhi.

Vasimalai M P. 2006. Shaping stakeholders perspectives survival of the common traditional tanks in South India. International Association of Study of Common Property (IASCP), Bali, Indonesia.