AN ECONOMIC ANALYSIS OF TRANSACTION COST IN TANK IRRGATION MANAGEMENT IN KOLAR DISTRICT OF KARNATAKA

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Thesis submitted in part fulfilment of the requirements for the degree of

MASTER OF SCIENCE (AGRICULTURE) IN AGRICULTURAL ECONOMICS

to the Tamil Nadu Agricultural University, Coimbatore-3.

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CERTIFICATE

This is to certify that the thesis entitled "**AN ECONOMIC ANALYSIS OF TRANSACTION COST IN TANK IRRIGATION MANAGEMENT IN KOLAR DISTRICT OF KARNATAKA"** submitted in part fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE) IN AGRICULTURAL ECONOMICS** to the Tamil Nadu Agricultural University, Coimbatore is a record of bonafide research work carried out by **Mr. RANGANATH. L.** under my supervision and guidance and that no part of this thesis has been submitted for the award of any degree, diploma, fellowship or other similar titles and that the work has not been published in part or full in any scientific or popular journal or magazine.

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ABSTRACT

AN ECONOMIC ANALYSIS OF TRANSACTION COST IN TANK IRRIGATION MANAGEMENT IN KOLAR DISTRICT OF KARNATAKA

By

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Realizing the significance of transaction cost in tank irrigation management, the present study makes an attempt to assess the transaction cost in tank irrigation management and the factors influencing the transaction cost under different tank management institutional arrangements in Kolar district of Karnataka state. The overall objective of the study is to assess the functioning, performance of irrigation tanks and transaction cost involved in tank irrigation management under different institutional structures and organisational set up.

Three tanks each representing the type of institutions namely, (i) Formal community based TMI represented by JSYS tank, (ii) informal community based TMI delineated by Damasi tank and (iii) formal centralized TMI represented by minor irrigation tank were selected purposively from Kolar district as case for the study. Total sample comprising of 102 farmers representing 34 from each tank were drawn randomly from the three selected tanks.

The age of the head of the household in majority of cases ranged between 45 to 60 years. majority of the sample respondents were illiterates (54.90%). The stratification of sample respondents based on role they played in tank management activities reveal that 24.51 per cent were supervisory functionaries. Social status of the sample respondents showed that 58.82 per cent belonged to the dominant caste. Small farmers were highest across all three tanks followed by marginal farmers. About 87.25 per cent of sample respondents possessed livestock across all three tanks.

Household’s from Damasi tank with well defined and accepted norm for water sharing had the lowest average time spent in meeting for appropriation (2.04 hr per

meeting), followed by JSYS tank (2.19 hr per meeting) and minor irrigation tank (2.31 hr per meeting). Participation rate in meetings and decision making is lowest in minor irrigation tank as compared to that of other community based tank management institutions. JSYS tank recorded high degree of collective action and decision making which was attributed to it's formal nature of institutional arrangement which facilitated the occurrence of more number of meetings. Damasi functioned with well defined norms was able to express higher degree of water right, equity, efficacy and conflict resolution. All the three study tanks had revenue generated out of fisheries.

Fund mobilization for maintenance and improvement of tank infrastructure in JSYS tank was Rs1474/- per ha, followed by Damasi tank (Rs1238/- per ha) and there was no tank improvement and fund mobilisation activity in minor irrigation department during the reference period. Revenue generation was highest in JSYS tank (Rs.1305/- per ha) followed by Damasi tank (Rs. 524/- per ha) and Minor irrigation tank (Rs. 571/- per ha).

Transaction cost in tank irrigation management is broadly classified into three types namely (i) cost of information and decision making, (ii) contractual and negotiation cost and (iii) monitoring and enforcement cost. Transaction costs incurred in tank irrigation management is incurred through cash paid, value of kind given and cost of time spent. The mean of households transaction cost per hectare was lowest for Damasi tank (Rs.1073/- per ha), followed by JSYS tank (Rs. 1162/- per ha) and minor irrigation tank (Rs.1291/- per ha). Transaction cost at tank level includes cost incurred by the tank Water Users' Association and formal and informal office bearers such as Supervisory Level Functionary. Transaction cost per hectare of gross cropped area at tank level is highest for JSYS tank (Rs.97/- per ha) followed by Damasi tank (Rs.45/- per ha) and Minor irrigation tank (Rs.15/- per ha).

Information and decision making cost is highest in JSYS tank with Rs. 261/- per of ha GIA, lowest in minor irrigation tank Rs. 105/- per of ha GIA and that of Damasi tank is in between with about Rs. 191/-per of ha GIA using tank water. Contractual cost is highest in minor irrigation tank with Rs. 252/- per of ha GIA followed by JSYS tank with Rs. 38/- per of ha GIA and Damasi tank with Rs. 4/ per of ha GIA. Monitoring and Enforcement cost is highest in minor irrigation tank with Rs. 933/- per ha followed by Damasi tank with Rs. 879/- per of ha GIA and JSYS tank with Rs. 862/- per of ha GIA. The analysis of transaction cost per hectare of irrigated area across the farm size category revealed that transaction cost per hectare of GIA is highest for marginal farmers.

Average transaction cost per hectare was 5.99 per cent of average net returns per hectare. The average percentage of transaction cost per Ha to net returns per Ha was highest in minor irrigation tank (6.23%) followed by JSYS tank (6.01%) and Damasi tank (5.70%). The percentage of average transaction cost per hectare was 2.43 per cent to average cost of cultivation. The average percentage of transaction cost per ha to total cost of cultivation is highest in minor irrigation tank (2.57%), followed by JSYS tank (2.48%) and Damasi tank (2.23%).

It was found that transaction cost incurred by farmers in tank irrigation management is positively influenced by education, membership in different organizations and role played by house hold in tank management and type of institutional arrangement. Based on the findings policy for sustainable management of tanks were recommended.

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CHAPTER I

INTRODUCTION

"What gets measured gets managed" is the widely accepted say of the present world. Any natural resource management involves accounting of various factors or details influencing it. Rightly identifying, analyzing, monitoring and managing these factors decide the outcome of the management. The sustainability of common property resources also depend upon the institutions involved (Rasmussen, 1995). These institutions are the set of formal and informal rules which are responsible for the co-ordination and exercise of management (North, 1990; Haller, 2002). Resource users in common property regime must enter into various kinds of explicit and implicit agreements in order to initiate collective action or agree to exchange or transfer goods or services for their benefit. This involves immediate and costly contributions in the form of negotiation, monitoring and enforcement costs which form the transaction cost (Adhikari, 2001). Transaction costs are unavoidable in functioning of any economic system. Accounting the transaction cost is necessary when evaluating the potential of new institutions as alternatives to existing institutions (Kuperan, *et al.,* 1998).

Tanks are one of the most important common property resources in rural India benefiting the livelihood security to people. It not only is prospective but also necessary to sustainably use tank resources. Studies show that community participation in common property resource management is essential for institutional efficiency and tank management institutions are also no exception (Dick, 2000). The tank management activities categorized mainly as provisioning activities and appropriation activities (Balasubramanian, 2003). The activities carried out to exercise the above activities are termed as 'transactions' and the cost incurred are accounted as 'transaction cost'. Though the transaction activities do not cost much but they do matter for collective action and in turn improve productivity.

1.1 Importance of irrigation including tank irrigation

1.1.1 Irrigation in Karnataka

Karnataka state is the eighth largest state in the country and is located in South India with geographical area of 1, 90,498 sq km which account for 5.81 per cent to total area of the country. A total of 12.18 million hectares of land or 63.99 per cent of the state's total area is cultivated of which 2.5 million hectares are irrigated.

Up to the end of March 2010, total irrigation potential created is 36, 22,921 hectares (including 9, 08,563 hectares of potential from ground water) bringing the percentage of potential irrigated area of total net sown area to 33.85 per cent. This comprises of 17,41,771 hectares under completed and ongoing major and medium irrigation projects with cultivable command area of more than 10000 ha and cultivable command area between 2000 and 10000 ha respectively. About 9,39,566 ha potential was created under completed minor irrigation projects with cultivable command area of from 100 ha to 2000 ha. There were about 40,411 minor irrigation works which comprises of 36,672 tanks with an atchkat of 6.92 lakh ha, 429 lift irrigation schemes with an atchkat of 88,367 ha and 3,427 other minor irrigation works with an atchkat of 1, 20,588 ha and 9,08,563 ha under irrigation from ground water resources.

As per 2008-2009, net irrigated area of Karnataka is 32,37,554 hectares, of which tube well and bore well contribute highest with 35.21 per cent followed by canals with 32.78 per cent, wells with 12.55 per cent, other sources which include streams, ponds etc with 9.58 per cent, tanks with 6.36 per cent and lift irrigation with 3.52 per cent.

1.1.2 Irrigation Tanks in Karnataka

Tanks in rural Karnataka which cater to the water requirement of village communities for irrigation, washing and feeding of livestock, fishing and other domestic needs of the household like drinking, bathing, washing etc. Some of intangible benefits of tanks are insulation from floods and drought and vagaries of monsoon, groundwater recharge and improvement of micro climate around tank ecosystem much of all offer livelihood security to people living in rural areas.

Irrigation is one of the important functions and utility of the multipurpose water harvesting tanks. In Karnataka 6.36 per cent of net irrigated area is irrigated by tanks and that is around 2.06 lakh ha against potential of 6.92 lakh ha. This is only up to 29.78 per cent of their potential (Karnataka at Glance, 2009). Decline in the multipurpose rainwater harvesting structures has its crucial impact not only on the economic scenario of rural Karnataka but have far reaching impacts on socio-cultural and environmental aspects. In spite of the fact that the decline of tank irrigated area is a common phenomenon throughout the country, for Karnataka it assumes greater significance. While the national average irrigated area is around 32 per cent, Karnataka has only 20 per cent of its net cropped area under irrigation. The problem is compounded by the fact that 2/3 of the geographical area of the state is drought-prone compared to only 16 per cent in the country (JSYS Report, year 2003).

Irrigation tanks in Karnataka have cultivable command area varying from less than four ha to more than 2000 ha. Nearly 92 per cent of irrigation tanks in Karnataka have a cultivable command area up to 40 ha and are managed by Zilla panchayath. It consist of 41 per cent of tanks with cultivable command area less than four ha, 42 per cent of tanks with cultivable command area between four ha and 20 ha and 9 per cent of tanks with cultivable command area between 20 ha and 40 ha. Irrigation tank with cultivable command area of more than 40 ha constitute remaining 8 per cent of tanks. This comprises of 7 per cent of irrigation tanks with cultivable command area between 40 ha and 2000 ha which are managed by department of minor irrigation and only one per cent of irrigation tanks have cultivable command area of more than 2000 ha, managed by department of major and medium irrigation.

1.2 Transaction costs and its significance in tank irrigation management

Tank irrigation management is analysed through transaction cost perspective which includes institutional environment and institutions of governance. Institutional environment in tank irrigation management is defined by formal rules such as polity, property rights and laws regarding defining property rights and their enforcement. Institutional environment encompasses the first order economising aspects to get institutional environmental right which is important for economic productivity of the economy (Williamson, 2000 and 2007). The tank irrigation in Karnataka include the Karnataka Irrigation Act, 1957, Karnataka Irrigation Act – 1965 (Levy of Betterment Contribution and Water Rate), The Karnataka Irrigation and Certain Other Law Act - 2000(Amendment), Karnataka State water policy 2002, The Karnataka Panchayat Raj Act - 1993 and Karnataka Societies Registration Act, 1960.

Institutions of governance use rules of game from institutional environment and deal with play of game through second order economising aspect like contracts or alternative modes of governance structure (Williamson, 1998 and 2000).

In case of tank irrigation, the institution of environment refers to policy and laws at state level and informal rules at operational level adopted and adapted by governance structure within its operational limits. Governance structure includes agency or any organisation involved or entrusted in tank irrigation management it includes government department, formal water users associations and informal water users associations (Kiser and Ostrom 1982; Ostrom *et al*,. 1994; Shah 2005).

In tank irrigation management, we can predominantly see two different kinds of governance structure: collective action sector and public sector. Collective action sector includes all tanks in which the farmers have direct responsibility for managing the system as well as water distribution. This includes all Zillah Panchayath tanks managed by informal WUA and JSYS tanks which are managed by formal WUA. Public sector includes tanks which are owned and managed by state but responsibility for water distribution is still vested with the farmers. This includes tanks under Minor Irrigation Department where minor irrigation department is responsible for the system management, including the major repairs of the tank structures.

In this study we have compared the three different institutions: JSYS tank management institution, Damasi system of tank management and Minor Irrigation system of tank management. The JSYS tank management institution is a registered community based tank management institution where as Damasi system tank management institution is an informal community based tank management and Minor Irrigation tank management institution is a public sector with formal and centralised management.

1.3 Need for Taking up the Study

Several studies have emphasized that people's participation in irrigation management programs is essential for its success and increase in productivity. This has triggered the devolving of management responsibility of irrigation from the state to users by creating institutions involving farmers in the management. The increase of users participation and transaction cost which was sidelined all through the years has gained importance. Transaction cost influences institutional change, collective action, role played by different actors of the institution and incentive structure (Bhattarai, 2010). This has emphasised the need for the study of the transaction cost involved in tank irrigation management.

Realising the significance of transaction costs in tank irrigation management, the present study makes an attempt to assess the transactions costs in tank irrigation management and the factors influencing the transaction costs under different tank management institutional arrangements in Kolar district, Karnataka State. The institutional regimes include: JSYS tank management institution – Formal community based tank management institution (ii) Damasi tank management institution – Informal community based tank management and (iii) Minor Irrigation institution – Formal centralized tank management

The present study mainly focuses on identifying, defining and quantifying the components of transaction cost in tank irrigation management under different institutions. The factors influencing the transaction cost and the impact of transaction cost on incentive structure of the household are analyzed across different institutions.

1.4 Objectives of the Study

The overall objective of the study is to analyse the functioning, performance of irrigation tanks and quantify the transaction costs involved in tank irrigation management under different institutional structures. The specific objectives include:

1) To study the functioning and performance of tank irrigation institutions under different institutional arrangements,
2) To identify and quantify the transaction costs involved in tank irrigation management under different institutional arrangements in tank irrigation management,
3) To examine factors which affect transaction cost and
4) To suggest policy measures to improve functioning of institutions, and achieve sustainability in tank irrigation management.

1.5 Hypothesis of the Study

The review of issues relating to tank irrigation and discussion with different stakeholders in Karnataka state led to the formulation of following hypothesis:

1. The performance of tank management institutions varies across institutional arrangements
2. Transaction cost is lower in community based tank irrigation management system when compared to that of state managed tank irrigation systems and
3. The transaction cost incurred by the farm households in tank irrigation management is influenced by various socio-economic and institutional factors.

1.6 Scope of Study

The study is aimed to identify the various components of transactions cost and factors influencing the transaction cost in tank management. An effort has been made to study the existing institutional arrangement and environment and to know the functioning of tank management institutions at operational level based on existing, collective choice and constitutional choice rules. In this study, it has been tried to operationalize and compute the institutional performance index based on the designed principles illustrated by long enduring CPR institutions as identified by (Ostrom, 1990). Study also tries to assess the major components of transaction costs incurred by households and institutions both at tank and household level in tank irrigation management. The relative share of the transaction costs as compared to production cost and net returns in different tank irrigation management institutions has also been assessed. Present study will help to evaluate role of transaction costs and institutional performance on production.

1.7 Limitation of the Study

The information was collected from the respondents from their memory and experience. The recall error and the inbuilt bias of the farmers towards particular variables and information may cause problems in obtaining data with maximum accuracy. Further, this is a micro level study based on a small sample of 102 farmers from three tanks functioning in different institutional arrangements. Therefore, the results of the study cannot be generalized fully and should have to be used with caution in case of application in other related areas. The reports from State government of Karnataka regarding irrigation in Kolar district do not reflect ground reality of irrigation in Kolar district. Even though Kolar is rich in irrigation tank not all tanks provide irrigation annually and no secondary data was available on number of tanks that provide irrigation in Kolar district. So, tanks were purposively selected for the study based on information given by officials of concerned government department and farmers. Respondents were suspicious and are reluctant to furnish data regarding rent seeking which form part of transaction cost in tank irrigation management.

1.8 Organization of the Thesis

The presentation of this study is organized under the following chapters:

Chapter I- Introduction

This part of the thesis deals with the importance of credit and technology in increasing farm income, problem focus, hypotheses, objectives, scope and limitations of the study.

Chapter II- Concepts and Review

In this chapter, an attempt has been made to review the concepts and the past studies which hold relevance to the current problem.

Chapter III – Design of the Study

The sampling method and the analytical tools used to study the stated objectives of the present study are explained in this chapter.

Chapter IV- Description of Study Area

The distinct physical, geographical, agricultural, climatic and infrastructural characters of the study region are described in this part of the study.

Chapter V – Results and Discussion

The results obtained using the analytical tools described in chapter III are presented in this chapter and their relevance and significance are discussed.

Chapter VI- Summary and Conclusion

The study results are summarized and conclusions are drawn to make necessary policy suggestion.

CHAPTER II

CONCEPTS AND REVIEW

A review of concepts, theories and methodologies used in earlier studies helps the researcher to adopt, modify and improve the conceptual framework and provide a link with the past approaches. Therefore, an attempt was made to review the concepts and theories, methodological approaches followed in earlier studies and empirical research findings. The comprehensive review is presented here under the following major heads.

Concepts and theory

Institutions

Collective action, Common property resources, and property rights

Tank irrigation management and performance

Transaction, Transaction costs and Factors affecting transaction costs

Transaction Cost Economics

Transaction costs and tank management

Empirical research

Transaction costs

Tank management performance

Functioning of tank WUAs

Concept and theory

Institutions

Commons (1968) defined institutions, by viewing them as the particular regime or body of working rules. Together, these rules indicate what 'individuals must or must not do (compulsion or duty), what they may do without interference from other individuals (permission or liberty), what they can do with the aid of collective power (capacity or right), and what they cannot expect the collective power to do on their behalf (incapacity or exposure).

Ostrom (1987) defined institutions as the sets of working rules that are used to determine who is eligible to make decision in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions.

Bromley (1986) defined institutions as “rules and conventions of society that facilitate coordination among people regarding their behaviour”. Since institutions define the choice sets of individuals and groups and define relationships among individuals and groups, they are at the core of choice and behaviour institutions – viewed either as ‘working rules’ or as the ‘set of ordered relationships’ – together determine the economic conditions or the action situations. Later, he also provided a broad description of institutions in terms of two categories of convection and entitlements. Conventions are regularities in human behaviour in which everyone prefers to conform to R on expectation that all others will also conform to R. Convection is a structured set of expectation about behaviour and ultimate outcome as opposed to the means by which that outcome is achieved.

An example of a convention is that of driving motor vehicles on particular side of a road. There is strong preferred outcome for vehicles to be driven uniformly on one side of the road and the means by which vehicle drivers are persuaded to comply with a determination of one side of the road or the other are relatively unimportant. Entitlements are socially recognised and sanctioned set of expectations on the part of everyone in society with regard to de jure or de facto legal relations that define the choice sets of individuals with respect to the choice set of others”. An example for ownership of object ownership implies an expectation on the part of the owner of the object that he can maintain possession of the object and can use the objects in certain ways without interference by other individuals (Bromley, 1989).

North (1990) in his definition excluded organisations from institutions by defining “institutions are the rules of the game, organizations are the players of the game”. Organizations constitute of groups of individuals engaged in goal-directed activity. The constraints imposed by the institutional framework (together with the other constraints) on organisation define the opportunity set and therefore the kind of organizations that will come into existence. Given the objective function of the organization-- maximizing profit, winning elections, regulating businesses, educating students--the firm, the political party, the regulatory agency, the school or college will engage in acquiring skills and knowledge that will enhance its survival possibilities in the context of ubiquitous competition. The kinds of skills and knowledge that will pay off will be a function of the incentive structure inherent in the institutional matrix. If the highest rates of return in a society are to piracy, then organizations will invest in knowledge and skills that will make them better pirates; if the pay offs are highest for firms and other organizations to increase productivity then they will invest in skills and knowledge to achieve that objective. Organizations not only will directly invest in acquiring skills and knowledge but will indirectly (via the political process) induce public investment in those kinds of knowledge that they believe will enhance their survival prospects.

Knight (1992) stated that it is necessity that “rules” to become an institution must be widely known, shared and followed. In the process of institutional change, Knight proposed to take as an indicator for change that a certain percentage rate of people has to be given, who know and follow the “rule”. Before this percentage is reached, we cannot yet speak of an institution.

Williamson (1998) described institutions at two levels viz., institutional environment and institutional arrangements. The institutional environment is the legal, social and political rules that determine the context in which economic activity takes place while institutional arrangements are the governance structures which structure transactor interaction (markets, regulation and hierarchies). Additionally institutions are often described as something relatively stable. Only then they reduce uncertainty and allow predicting the behaviour of others in a particular situation (Williamson, 2000).

Aoki (2001) defined institution as endogenously-appearing and self enforcing rules that are the equilibrium of a repeating game. Here institutions are assumed to be a solution supported by everybody, not ‘forced’ by the state, or any other third party. The ‘institutions-as-equilibria’ position, however, looks at institutions as a result of spontaneous emergence; “a convention of behaviour (that) establishes itself without third-party enforcement or conscious design”. It understands institutions as the result of spontaneous ‘games’ without any conscious design or third party enforcement. This approach is more suited in case of simple institution like contract enforcement.

According to Ostrom (2005), institutions are “the prescriptions that humans use to organize all forms of repetitive and structured interactions including those within families, neighbourhoods, markets, firms, sports leagues, churches, private associations, and governments at all scales. Individuals interacting within rule-structured situations face choices regarding the actions and strategies they take, leading to consequences for themselves and for others”

Vatn (2006) defined that institutions are the conventions, norms and legal rules of a society that provides expectations, stability and meaning essential to human existence and coordination. Institutions regularize life, support values and protect and produce interests.” Norms are usually understood as non-state involving institution (West, 1997; Vatn, 2005)

According to Crawford and Ostrom (1995) the central pieces of an institution are strategies, norms and rules, which can be distinguished by their grammatical texture.

Ostrom (1990) Distinguish three levels of institutional arrangements that cumulatively affect the action taken and outcomes obtained in using Common Property Resources (CPRs): operational rules, collective choice rules and constitutional rules. The operational rules directly affect the use of the resource: who can participate, what the participants may, must and must not do (permit, require, and forbid), and how they are rewarded and punished. Rules can be either formal or informal shared understandings. Process of provision, monitoring and enforcement occur at the operational level. The collective choice rules indirectly affect operational choices these are the rules that are used by appropriators, their official or external authority in making policy operational rules about how a CPR should be managed and give guidelines for formulating, changing and enforcing operational rules. Process of policy making, management and adjudication of policy decision occur at the collective–choice level. The constitutional rules affect operational activities and results through their effect in determining who is eligible and determining the specific rules to be used in crafting the set of collective-choice rules that in turn affect set of operational rules. Formulation, governance, adjudication, and modification of constitutional decision occur at the constitutional level.

Governance is defined as ‘the institutional framework broadly consisting of markets, hierarchies, and hybrids through which a transaction is channelled’. (Commons, 1934, cited in Williamson, 1993)

Sehring (2009) defined water governance as the governance of water in particular can be said to be made up of the range of political, social, economic and administrative systems that are in place, which directly or indirectly affect the use, development and management of water resources and the delivery of water services at different levels of society. Governance systems determine who gets what water, when and how and decide who has the right to water and related services and benefits (UNESCO, 2006).

Path dependence

According to North (1990), path dependence implies limited scope for sudden and radical changes. Although most institutional change is gradual and continuous, discontinuous institutional changes through conquest or revolution are also possible. However, institutional change through conquest and revolution affects only the formal rules. The informal rules derived from the previous formal rules change far more slowly than their formal counterparts and linger on with little change. He also points out that “the informal constraints that are culturally derived will not change immediately in reaction to changes in the formal rules. As a result the tension between altered formal rules and the persisting informal constraints produces outcomes that have important implications for the way economies change.

Setterfield (1993) has suggested a model of institutional hysteresis characterised by the short-term exogeneity and long-term endogeneity of institutions. In the short-term, due to a degree of inertia in institutions, the institutional environment guides economic activities. In the long-run, institutional changes are the results of the sequential, short-term patterns of economic activity which lay the groundwork for them--patterns of activity that are themselves influenced by the previously existing institutions. In other words, long-run institutional changes are path-dependent. Economic pressures for institutional change may arise continuously, but they are counter balanced to some extent by forces of institutional inertia.

Arthur (1988) included positive feedbacks and increasing returns among the factors explaining technological change; the increasing returns economy is seen as characterised by multiple equilibria, possible inefficiencies, lock-in, and path dependence, while four generic sources of self-reinforcing mechanisms were identified: large setup or fixed costs; learning effects; coordination effects; and adaptive expectations.

Institutional Performance

Ostrom argues that collective action for CPR management will be long enduring and successful under conditions of well defined boundaries, congruence between appropriation and provision rules, effective monitoring, graduated sanctions, efficient conflict-resolution mechanisms and minimal recognition of rights to organize (Ostrom, 1990)

Recent literature on common property resource management indicates that sustaining the environmental resource is not dependent on a particular structure of property rights regime. Rather it depends on a well-specified property rights regime and a congruence of that regime with its ecological and social context (Hanna and Munasinghe, 1995)

Success of the property rights regime requires: congruence of ecosystem and governance boundaries, specification and representation of interests, matching of governance structure to ecosystem characteristics, containment of transaction costs, and establishment of monitoring, enforcement and adoption processes at the appropriate scale (Eggertsson, 1990; Ostrom, 1990; Bromley, 1991; Hanna and Munasinghe, 1995)

Collective Action, Common Property Resources and Property Rights

Collective Action

Olson (1965) defined collective action as if members of a group have a common interest or objective, and if they would all be better off if that objectives were achieved, it has been thought to follow logically that the individuals in that group would, if they were rational and self-interested, act to achieve that objective. Unless the number of individuals is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational, self-interested individuals will not act to achieve their common or group interests.

According to Baland and Plateau (1996) small size of a user group, location close to the resource, homogeneity among group members, effective enforcement mechanism, external aid, past leadership and past experiences of cooperation contribute significantly to achieve collective action.

Athula and Karunanayake (2006) stated that in any collective action context, decisions on whether to participate and adopting the action at community-level and individual household level depends on the transaction cost structure and benefits associated with a given institutional arrangement.

Kumar (2011) studied how the devolutionary policies ensure collective action in watershed management. The analysis of factors that influence ongoing maintenance of watershed structures indicates that collective action emerges when user groups are small and homogenous and communities are dependent on a large number of wells. Further, greater success is likely where user groups have more knowledge and control over funds available for maintenance activities after the state withdraws.

Collective action in this study is defined as “all actions such as contributions in the form of physical labour, monetary contribution and self commitment to tank management institutions complied by members of tank user group for provision and appropriation of water for irrigation collectively either by working altogether in group or organised work in rotation or independently.”

Common property Resources

Magrath (1989) has broadly defined Common Property Resources (CPRs) as those resources in which a group of people have co-equal use rights, specifically rights that exclude the use of those resources by other people Individual membership in the group of co-owners is typically conferred by membership in some or other group, such as village or tribe etc.

Berkes and Farer (1988) defined common-property resources as ‘a class of resources for which exclusion is difficult and joint use involves subs tractability. Hence, they share the first attribute with pure public goods; the second attribute, with pure private goods.

Bromley (1991) argues that a common property regime (res communes) represents private property for the group of co-owners (since all others are excluded from use and decision making) and individuals have rights (and duties) with respect to the resource in question. Common property is said to be similar to private property in a sense that there is exclusion of non-owners. The property-owning group may vary in nature, size, and internal structure across a broad spectrum, but it is a social unit with definite membership and boundaries, with certain common interests, with at least some interaction among members, with some common cultural norms, and often their own endogenous authority system (Bromley 1991). The management group (the "owners") have the right to exclude non-members, and non-members have a duty to abide by exclusion. Individual members of the management group (the "co-owners") have both rights and duties with respect to use rates and maintenance of the property owned (Bromley 1991)

Feeny *et al*., (1998) defines common property resource as the resource held by an identifiable community of interdependent users in which these users exclude outsiders while regulating use by members of the local community. Within the community, rights to the resources are unlikely to be either exclusive or transferable; they are often rights of equal access and use the rights of the group may be legally recognised or in some cases it may be de facto rights (Feeny *et al*., 1998).

Pressure on the resource because of human population growth, technological change, or economic change, including new market opportunities, may contribute to the breakdown of communal-property mechanisms for exclusion (Feeny *et al*., 1998)

The social and political characteristics of the users of the resource and how they relate to the larger political system affects the ability of local groups to organize and manage communal property (Ostrom, 1987).

Property right

A property right is an enforceable authority to undertake particular actions in a specific domain. Property rights define actions that individuals can take in relation to other individuals regarding some 'thing'. If one individual has a right, someone else has a commensurate duty to observe that right (Commons, 1968).

Bromley (1989) viewed property right as, however, a social relation. It is a relationship between the rights holder and the rights retarders under a specific authority structure like the state granting legitimacy and security to a specific resource or benefit stream. Hence, rights run from the collective to the individual level. They have to be defined and defended through socio-political processes.

Schalger and Ostrom (1992) highlight that the benefit stream accruing to a right holder depends on the package of access, withdraw, management, exclusion and alienation rights held by authorised users, claimants, proprietors and owners of a good. They identified five property rights that are most relevant for the use of common-pool resources, including access, withdrawal, management, exclusion, and alienation. Access: the right to enter a defined physical area and enjoy non-subtractive benefits (for example, hike, canoe, sit in the sun). Withdrawal: the right to obtain resource units or products of a resource system (for example, catch fish, divert water). Management: the right to regulate internal use patterns and transform the resource by making improvements. Exclusion: the right to determine who will have access rights and withdrawal rights and how those rights may be transferred. Alienation: the right to sell or lease management.

Barzel (1997) viewed property rights in the economic and legal perspective. The former is a right which enables the right holder to enjoy a piece of property or to consume a good or services from an asset directly or indirectly through exchange. The latter is the protection of the former from the state which is essential for individuals to realise the economic benefits from assets (through enforcement).

Challen (2000) defined property rights are a "subset of (formal) institutions for regulation of behaviour and social interactions with respect to objects of value. In institutional context property refer to the rules of behaviour rather than object. Property right are the constraints and permission that enable such discrimination to occur in a manner that is consistent, predictable and socially acceptable.

Tank irrigation management and performance

Tank Irrigation Management

Jayaraman, (1981) stated that farmer's participation in surface irrigation management essentially consists of maintenance of the terminal level of the system, distribution of water and resolution of disputes which helps in running of system.

Kajisa, *et al*. (2004) noted that management in traditionally managed tank systems by an informal local body or water users' organization (WUO) include (a) de-silting the water storage area, (b) cleaning the water supply channels, and (c) arranging water distribution among users by mobilizes community labour to perform these tasks.

Balasubramanian and Selvaraj (2003) stated that tank management problems tend to fall into two distinct categories: the problem of provision and the problem of appropriation. The provision problem relates to problems associated with bringing adequate water to the tank and making it available for use at the outlet. It involves multiple tasks such as conservation of the catchments, maintenance of supply channels, removal and prevention of encroachment into tank water spread areas, de-silting, maintenance and repair of the bunds, surplus weir and sluices. Appropriation problems, on the other hand, relate to sharing of various benefits from tanks such as water for agriculture and non-agricultural purposes, fishes and trees grown in tanks, silt collected from the tank bed, and grasses and other minor benefits from tanks.

According to Rao and Rao (2005), the core tasks assigned to WUAs include: (a) procurement of water from the irrigation department and the distribution of it among members, (b) operation and maintenance of irrigation systems under their jurisdiction, (c) collection of water charges from members, (d) settlement of water disputes among members, (e) maintenance of office and meetings records, and (f) the conducting of executive committee and general body meetings.

Bassi *et al.* (2010) studied the efficacy and performance of WUAs. The core tasks assigned to WUAs include: (a) procurement of water from the irrigation department and the distribution of it among members, (b) operation and maintenance of irrigation systems under their jurisdiction, (c) collection of water charges from members, (d) settlement of water disputes among members, (e) maintenance of office and meetings records, and (f) the conducting of executive committee and general body meetings.

Performance of Tank

Palanisami (1997) measure performance of Tank performance is generally measured as the ratio of actual area irrigated by the tank to the total command area. This definition, however, does not accurately reflect the actual tank performance since the wells in the tank command also contribute to tank performance, both as a supplemental irrigation source in the wet season and as a sole source of irrigation during the dry season. Tank performance was redefined by excluding the probable area accounted for by those numbers of wells which are above the threshold number of wells (sample mean) in the tank command and the adjusted tank performance was calculated for each tank. Here, only for those tanks having the well density above the threshold level, the actual area irrigated by the tanks has been calculated by subtracting the area irrigated by the number of wells above the threshold number, from the total area irrigated in the tank command.

If well density is higher than the sample mean well density

$$\text{ATP} = \frac{\text{Total area irrigated in the tank command} - \text{Area irrigated by those number of well above threshhold nunber}}{\text{Total command area of the tank}}$$

If well density is less than the sample means well density

$$\text{ATP} = \frac{\text{Total area irrigated in the tank command}}{\text{Total command area of the tank}}$$

Palanisami (2001) defined the Overall Tank Performance by use share (OTPUS). This is a simple average of the performance of all the multiple uses will give one measure of overall tank performance. But in practice, all multiple uses do not occur in every tank in every year, and the probability of occurrence may vary for each use. In addition, the villagers' perceptions regarding the importance of each use may also vary. Hence taking a simple average to compute performance may be subject to aggregation bias. To avoid this problem, a weighted average measure of performance is used. Accordingly, the Overall Tank Performance by use share (OTPUS) is defined as follows:

$$\text{OTP}_{\text{US}} = \left[\frac{\sum_{i=1}^{m}[\text{PF}_i][\text{PR}_i]\left[\frac{\text{AC}_i}{\text{PO}_i}\right] + \sum_{i=m+1}^{m}[\text{PF}_i][\text{PR}_i]\left[\frac{\text{CN}_i}{\text{PC}_i}\right]}{n\sum_{i=1}^{n}[\text{PF}_i]}\right] * 100$$

PF_i = Scoring given based on the villagers' perceptions regarding the preference for the i^{th} multiple use

PR_i = Probability of occurrence of i^{th} multiple use

AC_i = Mean Actual use units occurred in a tank, for the i^{th} multiple use

PO_i = Potential use units possible in a tank, for the i^{th} multiple use

CN_i = Mean capacity used by the villagers with regard to the i^{th} multiple use

PC_i = Potential capacity available for the villagers of the tank command with regard to the i^{th} multiple use

i = 1 to m Number of multiple uses (agricultural and other productive uses, excluding livestock)

i = (m + 1) to n Number of multiples uses (domestic and livestock uses)

The overall performance of the tanks is likely to be closely related to tank maintenance. This in turn depends on the revenue from its users that is ploughed back to the tank management (PU, PWD *etc*.), and the efficiency of its appropriation (Palanisami, 2001). The receipt at the tank level is through formal and informal payments.

$$OTP_{RT} = \sum_{i=1}^{N} RT_i$$

Where RTi = revenue receipts (taxes, fees) at tank level in Rs/ha from the i^{th} use. This includes both official charges collected by government agencies, as well as resources collected by non-formal local groups, from user fees or penalties.

Transaction, Transaction Cost and factors affecting transaction costs

Transaction

Commons (1934) defined transaction is a transfer of property rights.

Williamson (1985) notes that ‘a transaction occurs when a good or a service is transferred across a technologically separable interface’.

Schmid (2004) viewed transaction is a change in social relationships that may or may not result in a movement of physical objects. It is the change in individual rights and mutual obligations which constitutes a transaction in this perspective.

McCann *et al*., (2005) stated that the “transaction” could be thought of as the enactment of legislation or a court ruling. However, there may be a number of transactions prior to and subsequent to the primary one. For instance, a policy that establishes tradable permits will entail transactions for years after the policy is established. It may be appropriate, in the case of public policies, to focus on stages of development of policy instruments, rather than trying to define specific transactions.

Transaction Cost

Coase (1937) in his work “nature of firm” tried to explain reason for the existence of firm, if markets are cost-less to run? His answer was that market transactions are costly in some situations, though he never used the term transaction costs but the idea was certainly that of economizing such type of costs. In some situations, it is less costly to use command within the firm than to operate with exchange within markets. Later, Coase (1960) stated transaction cost as the cost of carrying out market transactions. Here transaction cost refers to administrative cost due to interaction between the firm or between the firms and individuals to resolve externality, which comes about within a firm or by government regulations.

Randall (1972) defined the ‘transaction cost’ as the cost of making and enforcing decisions. It includes the cost of obtaining information, establishing one’s bargaining position, bargaining and arriving at a group decision and enforcing the decision made. Any method of modifying externalities will involve some transaction costs. The size and type of transaction services are likely to vary with the use of different types of solution methods and with the actual solution obtained. Transaction costs may be so large that they become major factors in the selection of an efficient method of solution of any particular externality problem.

Dahlman (1979) separates transaction costs into (a) search and information costs, (b) bargaining and decision costs, and (c) policing and enforcement costs and then states that all of these costs “represent resource losses due to lack of information”. Transaction costs are a real and unavoidable aspect of any economic system. It is not even possible to eliminate transactions costs by prohibiting all transactions because such a decree would have to be deliberated and enforced and other institutions would emerge to replace banned markets.

Williamson (1979) argues that “if transaction costs are negligible, the organization of economic activity is irrelevant, since any advantages of one mode of organization appears to hold over another will simply be eliminated by costless transaction”.

Maynard *et. al.* (1982) stated that transaction cost is an explanation for the existence of externality. The externalities are resulting from divergence between private and social costs, which may complicate the allocation of resources. The divergence is mainly attributed to the absence of contractual arrangements between the user groups. This “un-contracted effect” is a market failure to achieve the optimum allocation of resources and hence the government intervention is necessary in the form of tax against the producers of harmful effect.

Mathews (1986) described transaction costs as the costs of arranging a contract ex- ante and monitoring and enforcing that contract ex-post. Transaction costs typically occur as goods and services, travel costs, labour and time expended in a transaction.

Alchian and Woodward (1998) argued that there are two distinct traditions in transaction-cost analysis: one is measurement-cost view and the other is asset-specificity view. 'One emphasizes the administering, directing, negotiating, and monitoring of the joint productive team work in a firm. The other emphasizes assuring the quality or performance of contractual agreements. The basic notion of the measurement-cost approach is that it is often costly to measure the quality and sometimes even the quantity of the output of a stage of production.

Allen (1991) viewed "transaction costs are the resources used to establish and maintain property rights". It includes the resource used to protect and capture (appropriate without permission) property rights, plus any deadweight costs that result from potential or real in protecting and capturing. This definition is well suited to environmental and natural resource policies as market failure is an issue here because of incomplete property rights.

Some researchers viewed that transaction costs arise because of information uncertainty and as a result of the actions that transactors must take to manage for this uncertainty. Transaction cost generating actions include searching for contract partners, gaining knowledge of materials and production, negotiating and concluding contracts and monitoring and enforcing contracts over time (Bromley, 1991; Kasper,1998),

Damodaran (1994) indicated that 'transaction cost' is a significant segment of the centralized project implementation and can be substantially reduced with more local-based schemes. Minimization of transaction cost not only raises the rate of returns from public investment, but also ensures better conservation of natural resources.

Transaction costs are "the costs of resolving situations where involved parties have conflicting interests including the costs to each party of gathering information, determining their position and strategy; the costs of the bargaining, negotiation, arbitration, judicial or any other process by which an agreement is reached and the costs of enforcing the agreement is made" (Randall (1975 cited in Colby, 1995).

Carlsson (1996) reported that exploitation of forest resources are generally more costly for a common forest than a private forest company. These high transaction costs are associated with the exercise of property rights. Similarly, one would expect it to be more expensive to regulate the exploitation of the forest resources. One way of reducing transaction cost is by gathering information about rules, regulations, markets, competitors and forestry technology. Transaction costs have been defined as all the costs that are not directly related to the production of that product (Nilsson and Sundqvist, 2007).

McCann and Easter (1999) developed a model for estimating transaction cost, which is an improvement over Thompson's institutional transaction cost (ITC) framework. In this model, Transaction cost (T) included research, information gathering and analysis (R), enactment of legislation including lobbying costs (E), design and implementation of the policy (D), support and administration of the on-going programs (S), monitoring or detection (M), and prosecution or inducement costs (P). The magnitude of transaction costs associated with an environmental policy is thus represented by the sum of these costs.

$$Ti = \sum \beta_t (R_{it} + E_{it} + D_{it} + S_{it} + M_{it} + P_{it})$$

Where, β = discount factor

i = policy

t = time period

Challen (2000) extends scope of transaction cost analysis for institutional choice by considering both static and dynamic dimension of these costs. Static transaction costs are the costs of decision making for resource allocation within a given institutional structure. It mainly arises through costs of administering an institutional structure and cost of decision making for resource allocation under that structure. Costs of administering an institutional structure arises through use of resources in maintaining and administering the institutions such as management of records of property rights and changes in ownership of the rights, and in policing and enforcement. These costs may be borne by different parties with in an institutional hierarchy and effects on resource allocation will differ accordingly. Costs of decision making for resource allocation with in an institutional structure arise largely through costs of obtaining information. Dynamic transaction costs are the costs that give rise to the irreversibility's and path-dependencies in institutional development.

Crase *et al*. (2000) identifies two distinct definitions of transaction cost. The first regards transaction cost as an actor's opportunity costs of establishing and maintaining internal control of resources. That is they are the costs of measurement and enforcement incurred to protect values both in voluntary exchange and against voluntary exchange. The second and border conceptualization of transaction cost is that they include all costs associated with creation, use and change of institutions or organisations.

McCann *et al.,* (2005) viewed transaction costs are the cost of resources used to define, establish, maintain and transfer property rights.

Factors affecting transaction costs

The transaction costs of contracting emerge due to the characteristics of the transaction and the nature/behaviour of transactors (Williamson, 1996, 1998).

Williamson (1998) found that the transaction characteristics influence transaction costs. They include (i) asset specificity (ii) timing/frequency or duration of the transaction and (iii) uncertainty about the transaction.

Transaction cost economics

An economic analysis should always include transaction cost along with transformation cost, which otherwise becomes incomplete. Transaction costs are substantial in many economic transactions and it is necessary to take transaction costs into account for policy choice, policy design and compare alternatives. Some policies with low transformation cost have high transaction cost for functioning and some policies with high transformation cost have low transaction cost for functioning (McCann, 2005). So, it's essential to look at trade off between transaction cost and transformation cost for functioning. Transaction costs must be considered in the context of what cost would have been incurred in the absence of governance or policy being evaluated but not just transaction cost itself. This helps in thinking of alternate policies and coming up with the most optimum policy applicable under the context.

Transaction cost economics (TCE) is an interdisciplinary field of study which elaborates ideas from law, economics and organisation theory. TCE mainly focuses on the governance of ongoing contractual relations (Williamson, 2007). TCE is concerned with economising transaction cost and hence increase economic efficiency of transaction. TE subscribes to the idea that transaction is the basic unit of analysis. TCE tries to look economics as a science of contract rather than as science of choice as in neoclassical economics (Moe 1984, 1990; Williamson, 1998, 2000). TCE is a product of two recent and complementary fields of economic research, the new institutional economics and the new economics of organisation.

The new institutional economics comprised of two parts, institutional environment and institutions of governance. The institutional environment (the rules of the game) originates with Ronald Coase's 1960 paper on "The Problem of Social Cost." It opens opportunity for first order economising behaviour by providing formal rules of the game like constitution, policy, property rights, laws defining and enforcing property rights and contract laws (Williamson, 2000). Institutional environment encompasses all aspects to get institutional environmental rights, which is important for productivity of the economy. The institution of governance (play of the game) traces its origin to Coase's 1937 paper on "The Nature of the Firm". It provides governance structure rights for enforcing rules of the game by aligning the governance structures with transactions. Institutions of governance use rules of game from institutional environment and deals with play of game through second order economising aspects like contracts or alternative modes of organisation (private sector, collective action sector and public sector). Institutions of governance are the means to enforce order so that we can mitigate conflict and realise mutual gains (Williamson, 2000).

The analysis in transaction cost economics is mostly comparative intuitional analysis where several alternative modes of governance such as private sector, collective action sector and public sector are compared for efficiency. TCE regards firm as a governance structure (organisational construction) but not as production function (technological construction) (Moe 1984, 1990; Williamson, 1998). TCE considers that each mode of governance is reinforced and supported by distinctive form of contract law and also by adaptation both autonomous and cooperative kind. TCE invokes the discriminating alignment hypothesis according to which transactions which differ in attribute are aligned with governance structure thereby affecting the transaction cost economising result.

Transaction costs and tank management

Athula and Karunanayake (2006) identified that transaction cost involved in community based aquaculture irrigation tank management. They include search and information cost for accessing scientific methods and species for culture; collective decision making cost for organizing meetings; reaching agreements and coordinating with authorities; enforcement and monitoring compliances cost for organization of tank preparation actions, stocking, etc., prevention of free rider activity cost for protection from poaching and distribution of benefits cost for organizing harvesting and monitoring the distribution of benefits.

Bhattarai (2010) classified the transaction cost in Farmers Managed Irrigation System (FMIS) into two broad categories based on the time at which they incur viz., ex-ante cost and ex-post cost. These transaction costs are further grouped into five broad activities : (i) watching, waiting and negotiating, (ii) meeting, (iii) conflict resolution, (iv) communication and (v) formation cost. Among the above transaction costs watching, waiting and negotiating cost, conflict resolution costs are ex-post transaction cost. Similarly communication cost and formation cost are ex-ante transaction cost. Meeting, registration and negotiation (formation) costs, are ex-ante in nature as they arise prior to the formation of an organization

Kumar (2010) Identified the transaction cost involved in watershed management broad classified them into three types of transaction costs namely (i) searching opportunities and information cost, (ii) negotiation and contractual costs and (iii) monitoring and enforcement costs. These costs are decomposed into government and private transaction costs. The government transaction cost includes the costs incurred by the state agencies in planning, implementation and maintenance of watershed development program. The private transaction costs include the costs incurred by the watershed community through time spent in identification of location for different structures, participation in PRA exercises, meetings, monitoring, contribution in terms of cash and kind for implementation of watershed development.

In present study, transaction cost in tank irrigation management involve cost of information and decision making for provision and appropriation of water, contractual cost, and cost incurred for monitoring and enforcement of the collectively taken decision by stakeholders and state administrative agency.

Information and decision making cost includes opportunity cost of time spent in attending meeting, for provision and appropriation water by stakeholders. Contractual cost includes cost of negotiating with administrative agency and cost of complying with rules and regulations of tank management institution. Monitoring and enforcement cost involve cost of accomplishing various monitoring activities, enforcing rules and regulations etc.

Provision includes all activities under taken for bringing adequate water to tank and making it available for use at the outlet. It involves maintenance of supply channel, catchment treatment, removal and prevention of encroachment into tank water spread areas, de-silting, maintenance and repair of the bunds, surplus weir and sluices. Appropriation includes all activities related to sharing of irrigation benefits from the tank such as sluice control, maintenance of water distribution system such as weeding of channel, repair of breach or leak form channel and stabilisation of channel bund and de-silting of channel bed till water reaches the field.

Empirical research

Transaction costs

Gireesh (1996) highlighted the transaction cost in the context of tank rehabilitation, as it is a combination of information, contractual and enforcement cost. Information cost refers to the cost of educating farmers regarding the benefits of tank rehabilitation, the cost of conducting village level meetings and cost of organizing villages to achieve a common goal. The contractual cost refers to the cost of meeting officials at different levels to get the required budget sanctioned, the cost of raising funds from the villages etc. The enforcement cost refers to the cost of frequent efforts in achieving the objectives.

Lokesha *et al*., (2008) noted that transaction cost in watershed development program can be grouped into information cost, contractual cost and enforcement cost. The information cost includes cost on educating regarding the benefits of watershed development programme and cost on conducting village level meetings to convince and motivate the farmers. The contractual cost consisting of cost of bargaining to get the required or sanctioned fund from the sponsoring institutions and cost of raising funds from the beneficiaries as well as establishing local level institutions. The enforcement cost made up of cost of imposing rules and regulations for rational utilization of natural resources.

Sripadmini (2001) highlighted that information and contractual costs are higher in the NGOs implemented watershed while the enforcing costs are higher in GO managed watershed. On per acre basis, transaction costs is higher in NGO managed watershed in comparison with GO managed watershed. Similar scenario was also observed in with transaction cost per beneficiary. Ultimately people’s participation greatly reduced the enforcing cost in the watershed.

The extent of transaction cost involved in watershed development will depend upon the degree of trust that exists between local and macro institutions. The trust is developed within an institutional context by the actions of societal norms, political organizations, regulations, professional standards and networks. The institutions involved in watershed development will not have to invest such a high proportion of their time in seeking information and building rapport with communities. In this regard, non–governmental organizations often have an advantage over government departments where an impasse has been reached with the local people in managing the local resources. The existence of trust amounts to lower the transaction cost and serves as a social lubricant (Turton, *et. al*., 1998).

Adhikari *et al*., (2006) in their study on transaction costs in community-based forestry resource management, found that the average 'poor' household incurred Nepalese rupees (NRS) 1265 as transaction costs annually, while wealthier 'rich' households incurred an average of NRS 2312 per year. Although richer households bear higher proportions of such costs, transaction costs for CF management as a percentage of resource appropriation costs are higher for poorer households (26%) than those of middle-wealth (24%) or rich households (14%) show that transaction costs are a major component of resource management costs and vary according to socio-economic status of resource users and characteristics of the community. They also found that annual transaction cost for the household in community forestry ranges between 9-14% of total cost.

Athula and Kalpa (2007) in his study on community-based aquaculture in Anuradhapura district of Srilanka found that the enforcement and monitoring costs were substantial when compared to that of information and collective decision-making costs.

A study conducted on in Kolaramma tank watershed of the Kolar district (Karnataka) revealed that the transaction cost incurred on the Kolaramma tank watershed, with a geographical area of 6,570 hectares and covering 26 catchments has been found to be Rs 78,89,210. The decomposition of this transaction cost into information, contractual and enforcement costs has revealed that enforcement cost amounted to a vast share of (82.0) per cent, followed by contractual cost (13.6%) and information cost (4.4%) in the total transaction cost (Lokesha, 2008).

Meshack (2006) found that the total annual average transaction costs of forest management are higher for the poorer households than that of rich and middle groups.

However benefits were low for the poorer groups than the middle and rich income groups.

Bhattarai (2010) found that the main element of transaction time is watching, waiting and negotiating which constitutes more than 92 per cent of the total transaction time. That the transaction time is relatively low for FMIS amounting to 5 per cent to that of total time required for the production of crops 4-6 per cent of total labour cost and just one per cent of total production cost. The transaction time is higher for the households cultivating the land at downstream of the canal compared to the households cultivating the land at upstream of the canal. The share of transaction time is relatively low compared to the total human labour required for the production of crops –in an average it is about 4 per cent for upstream and it is about 6 per cent for downstream households. The total value of output per hectare is significantly affected by transaction cost, reliability of the irrigation facility and infrastructure quality.

Kumar (2010) in his study found that the total transaction cost on an average incurred in a watershed with an area of 500 hectares is worked out to around Rs. 5.71 lakhs (USD 12687). The decomposition of transaction cost indicates that the government transaction costs account for 78.9 per cent and private transaction costs account for 21.1 per cent of the total transaction cost involved in watershed management. Being an important transaction cost reducing mechanism, setting up of effective institutional mechanism will help reduce the transaction cost involved in watershed management particularly in the post project period. Roles of different stakeholders like state agencies, local Panchayat and watershed community based organizations are extremely important to implement the negotiation support system and develop multi-stakeholders strategy to reduce transaction costs, especially to ensure sustainability in watershed management.

Tank management performance

Bromley (1992) viewed that institutions created by government or bureaucratic hierarchies for water management in developing countries are not congruent with the rules and customs associated with informal institutional arrangement. This incongruence can induce suboptimal behaviour from irrigators thereby increasing the social cost of managing scares water resources.

Jayaraman (1981) listed certain aspects which are to be considered before facilitating collective action for irrigation management. These include: (a) type of organization to be formed, (b) size of the organization, (c) functions and powers of the organization, (d) leadership, (e) administrative status, (f) motivation of the farmers who are unwilling to join and (g) special consideration with regard to weaker sections of the society.

Wade (1988) based on a study of community-managed irrigation systems in South India found that (a) local context (locally devised access and management rules, ease in enforcement of rules), (b) user groups (small size, past successful experiences, interdependence among group members), (c) resource systems (small size, well defined boundaries) and (d) the relationship between users and resources are important in facilitating successful management of the commons.

Meinzen-Dick *et al*., (2002) in their study on canal irrigation systems in India emphasized that farmers are most likely to participate in irrigation management under the following conditions: (a) inadequate water supply, (b) smaller group size, (c) homogeneity among members, (d) low market penetration in the region, (e) presence of other end-users' organizations and (f) strong leadership.

Sakthivadivel (2004) viewed institutional performance in tank irrigation is measured by the structure and composition of the tank user's group, their decision-making process, effectiveness in augmenting tank storage, rules and tools for operation and maintenance, conflict resolution procedure, the institution's ability to make plans according to water availability so as to provide social safeguards against water scarcity, avenues of resource mobilisation and interventions undertaken for improving the tank performance.

Rao and Rao (2005) studied the efficacy and performance of WUAs using six indicators. The indicators include transparency, conflict resolution, equity, relationship, participation and efficiency. These indicators can be understood as: (a) transparency in relation to records-keeping and WUA functioning, (b) conflict resolution in terms of resolving disputes among WUA members, (c) equity in relation to water distribution across various reaches of the minor canal, (d) relationship between WUA, irrigation department and NGO (DSC) and also amongst farmers within a WUA, (e) participation in respect of members' attendance in various WUA meetings and (f) efficiency in respect of overall operation and maintenance of the transferred irrigation system.

Jayabalan (1982) identified the major constrains in functioning of irrigation associations were inadequate maintenance of technically deficient sluices and surplus weirs of supply channels, seepage losses in delivery system. These adequacies result permanent gap between registered command area and actual irrigated area.

Palanisami (1984) assessed farmers organization have usually organized themselves to allocate water but in many cases the results were inefficient and inequitable.

Palanisami *et al*., (1995) have reported that for better functioning i.e., to operate and maintain, it is needed that the tank institution should have sufficient revenue resources. The extent of revenue mobilisation was found to be strongly connected with the presence of water associations.

According to Palanisami *et al*. (1997), the tanks support not only crop production but also a host of other related activities such as providing water for drinking, washing, bathing (domestic uses), fodder and drinking water for livestock, fish culture, duck rearing, brick making, social forestry and silt collection.

Palanisami and Balasubramanian (1998) found out that there is negative relationship between well density and tank degradation both in the state of Tamil Nadu from cross-section data of 690 sites in Tamil Nadu. If the number of private wells is sufficiently large, not only do the well owners reduce their participation in tank management, but it also promotes the emergence of competitive groundwater markets in tank commands, which further contributes to reduced dependence on tanks for even non-well owners (since they will become water buyers). Therefore, emergence of private wells in large numbers in tank commands contributes for the declining performance of tanks.

Kajisa (2004) found that collective action in tank system is on decline because of exit behaviour by some farmers from collective management of tank ultimately leading to deterioration of tank performance. Farmers who have gained alternative income sources other than tank by farming with private wells and non-agriculture jobs will exit from collective management of tank leading to decline in performance of tank finally imposing negative externality on farmers whose income depend only on tank due to reduction in yield and income as compared with exiting farmers.

Functioning of tank WUAs

Bardhan (2000) examined cooperative actions in canal and tank irrigation management in 48 irrigation communities in Tamil Nadu using cross section data used three proxy variables for successful collective action, namely (a) absence of conflict over water within village during last five years, (b) frequent violation of water allocation rules, and (c) maintenance of distributaries channels.

Karthikeyan (2000) found the presence of Informal Tank Water User Association (ITWUA) in most of tanks (91.25%) followed by presence of formal WUA in 8.75 per cent of tanks. Organisation structure of informal tank water user association operates at two level: one is at top level which is an enforcing authority called 'nattamaikar' (a group of persons, almost representing the entire village) and other is more of menial labour involving hard labour, concerned with organising water distribution and maintenance of works. He found that higher storage capacity of tank, better organisational and financial status of the tank irrigation institutions, higher farmer participation in tank management and lower well density in tank command areas have significant and positive relationship with effectiveness of tank irrigation institutions.

Kajisa (2004) stated that traditionally tank are managed collectively by an informal local water users' organization (WUO), which mobilizes community labour to perform the maintenance and management tasks, which mainly includes de-silting of water storage area, cleaning of supply channel and arranging for water distribution.

Bassi *et al*., (2010) considered six parameters to capture the efficacy and performance of WUAs. These parameters can be understood as: (a) transparency in relation to records-keeping and WUA functioning, (b) conflict resolution in terms of resolving disputes among WUA members, (c) equity in relation to water distribution across various reaches of the minor canal, (d) relationship between WUA, irrigation department and NGO (DSC) and also amongst farmers within a WUA, (e) participation in respect of members' attendance in various WUA meetings and (f) efficiency in respect of overall operation and maintenance of the transferred irrigation system.

CHAPTER III

DESIGN OF THE STUDY

The design of the study is an important component of research. In order to fulfill the objectives of the study, an appropriate methodology for conducting the study is inevitable. In this chapter, the methodology adopted for the present study including the selection of study area, sampling design, the method of data collection and the different tools of analysis are discussed.

3.1 Selection of Study Area

The study was conducted in Kolar district of Karnataka state. The Kolar district was purposively selected as it has high density of tanks. It has a total of 1,738 irrigation tanks, of which 1,578 are managed by the Zilla Panchayat and the rest 140 tanks are managed by the minor irrigation department of the Government of Karnataka (Kolar district at glance, 2009-10). Moreover, presence of unique traditional informal water and land sharing institution in tank irrigation management called the "Damasi" was also reported to be found only in the district (Acharya, 2010; Deccan Hearld, 2005). In addition, formal community based tank management institution could also be found in the district as Kolar district was one among the nine districts where Karnataka Community Based Tank Management Project (KCBTMP) was implemented in the first phase.

Formal community based Tank Management Institution (TMI) represented by tanks which are managed by formal tank user group after withdrawal by KCBTMP and handed over to stakeholders. These tanks are referred as JSYS tanks in present study. JSYS tanks are formal community based TMI's that are registered under Karnataka Societies Registration Act, 1960 or formal tank user group formed as Gram Panchayath sub Committee under section 61.4 of Karnataka Panchayath Raj Act, 1993. Informal community based TMI is represented by Zilla Panchayat tanks, where Damasi system in practice. In Damasi system, the operation of sluice for appropriation activity is left completely to the discretion of command area farmers. Only major repair and rehabilitation works are carried out under supervision of Panchayath Raj Engineering (PRE) department under Ministry of Panchayath Raj of government of Karnataka. Minor irrigation tanks with command area above 40 hectares are managed by minor irrigation department of the state government. In minor irrigation tanks, the opening of sluice requires the permission from the Taluk Irrigation Consultative Committee (TICC). A minor irrigation tank represents formal centralized tank irrigation management institution.

Table 3.1. Taluk wise distribution of tanks in Kolar district

Sl. No.	Taluks	Zillah Panchayath Tanks <40 Ha	Minor Irrigation Tanks 40 to 2000 Ha	Total Number of Tanks
1.	Bangarpet	366	13	379
2.	Kolar	240	44	284
3.	Malur	239	13	252
4.	Mulbagal	494	35	529
5.	Srinivasapura	259	35	294
6.	**District Total**	**1598**	**140**	**1738**

3.2 Sampling work frame

A total of three tanks to represent three different institutional arrangements were selected purposively in Mulbagal taluk of Kolar district as it has more number of tanks. Three tanks each functioning under three different type of institutions *viz.,* (i) Formal community based TMI represented by JSYS tank, (ii) informal community based TMI delineated by Damasi tank and (iii) formal centralized TMI represented by minor irrigation tank. From each selected tank, respondents were selected through stratified random sampling representing head and tail end of the command area. In each tank, a total of 34 samples were selected randomly across head and tail regions. Thus a total of 102 farmers were selected and studied.

In addition, detailed discussions were held with officials of Panchayath Raj Engineering Department (PRE) , Department of minor irrigation (MI), Karnataka Community Based Tank Management project under Ministry of minor irrigation (MoMI), researchers and members of NGO’s involved were interviewed to know about the governance structure, functioning, problems in tank management and presence of various tank management institutions.

3.3 Study period

The primary data were collected from the sample respondents during the month of April to May, 2010 and the data collected in respect to objectives of the study pertain to the agricultural year from 2007-2008 to 2009-10.

Table 3.2. Distribution of Sample Farmers across three tanks

Sl. No	Tank Management Institutions	Tank	No of Respondents
1	Formal community based TMI	JSYS Tank	34
2	Informal community based TMI	Damasi Tank	34
3	Formal centralized TMI	Minor Irrigation Tank	34

3.4 Collection of data

A well-structured interview schedule bearing questions in relation to the specific objectives of the study was prepared for collection of required data at administrative level, tank level and farm level. Data relevant to the existence, functioning and governance structure of different institutional setup were collected from the published sources, in minor irrigation department, Panchayath raj, engineering and District Project Unit- KCBTMP. Tank level and farm level data pertaining to functioning of tank management institution at village level, participation of farmers in tank management institution, socio-economic conditions, cropping pattern, pattern of water use, crop productivity and cost of cultivation were collected by personal interview method. Data collection and PRA in Damasi tank is illustrated in the figure 3.1. and figure 3.2.

3.5 Method of analysis

The data collected were tabulated for subsequent analyses. Keeping in view of the objectives of the study, the following tools of analysis were employed to analyze the data, interpret the results and to come out with inferences for policy options.

3.5.1 Conventional Analysis

Percentage analysis and simple averages were worked out to interpret the data related to general characteristics of sample respondents. They include age, educational level, land holding pattern, benefits obtained by the household from the tank, social status of the sample respondents and participation in tank irrigation management institution.

3.5.2 Performance of tank management institutions

Performance of tank management institutions was measured based on household's participation in collective action and decision making in operation and maintenance tank system, household's perception about performance of tank with reference to equity, water rights, monitoring and enforcing rights and conflict resolution was examined. All parameters were selected based on the design principles illustrated by long-enduring CPR institutions (Ostrom, 1990).

Respondents were required to rate their participation in collective action and decision making in operation and maintenance tank system and perception about performance of tank with reference to equity, water rights, monitoring and enforcing rights and conflict resolution on a modified Likert's scale. In the adopted format, responses were taken on a three-point rating scale for all sub components of collective action, decision making and equity and in two and three point rating for sub components of water rights, monitoring and enforcement and conflict resolution. (Karthikeyan *et al.,* 2010 and Bassi *et al.*, 2010).

3.5.2.1 Operational definition of parameters selected for study

Collective action – it is operationalized as "all actions such as contribution in the form of physical labour, monetary contribution and self commitment to tank management institutions complied by members of tank user group for provision and appropriation of water for irrigation collectively either by working altogether in group or organised work in rotation or independently." (Sakurai, 2002)

Decision making – It refers to the extent of freedom enjoyed by the members of the tank user group to participate in decision making process with respect to water allocation, tank operation and maintenance, fund mobilisation and related activities either directly or indirectly through representative. (Bassi *et al.,* 2010)

Equity – Refers to the situation wherein everyone has an equal chance of getting tank water for irrigation with the same frequency and proportion as facilitated through the tank institution (Trawick *et al.,* 2006).

Water Rights – Defined as the degree to which the individual members of the tank user group's right to access and withdraw water from tank for irrigation use is clearly defined and unauthorised use of water is prohibited and rules for allocation is transparent and known to all. (Ostrum, 1990; Trawick *et al.,* 2006)

Monitoring and enforcing – Refers to the presence or absence of monitors and enforcing agents such neergantis (water man), responsible for monitoring and enforcement of the decisions taken by the water users group and the extent to which they are functioning and are accountable to tank users (Ostrum, 1990).

Conflict resolution – It refers to the pattern of resolving the conflicts that arise among the members of the tank users and/or conflicts between members and other stakeholders related to tank irrigation management (Bassi *et al.,* 2010; Rao and Rao, 2005)

3.5.2.2 Measurement of parameters

Collective action- Respondent's participation in tank management activities such as provision, appropriation, participation in meeting, monitoring (monitoring of function of institution and check violators), commitment to institutions was rated on a three point scale and these scores were used to compute the collective action.

Decision making- Respondent's involvement in decision making regarding tank management activities such as fund mobilisation, tank operation and maintenance, water allocation was rated on a three point scale and these scores were used to compute the decision making.

Equity – Each respondent was asked about number of irrigation and quantum of water per irrigation as compared to other farmers and their responses was captured on three point scale and these scores were used to compute scores.

Water Rights –This was analyzed under two components. One was the respondent's knowledge about water rights and rules of the institutions and abiding to the rules responses was rated on two points scale. Later the effectiveness of the institution in checking on unauthorized usage of tank water was rated on three point scale.

Monitoring and enforcing – Each respondent was asked to rate the effectiveness of functioning of Neerganti (water man) with respect to water management, monitoring of command to protect form water theft and stray cattle damage on three point rating scale and accountability of 'Neerganti' (water man) for deviation in appropriation of the responses were captured on two point scale.

Conflict resolution – The conflicts under each tank were discussed with the respondents and the effectiveness of the tank management institution in resolving these conflicts were captured on three point scale based on the responses of the respondents.

3.5.2.3 Institutional Performance

The scores rated by respondents for each sub component of the parameters was summed and normalised so that score of each component lie between 0 and 1. Simple average of all normalised scores of collective action and decision making was used to construct household's participation and for household's perception about performance of tank in each tank (Bassi *et al.*, 2010).

3.5.2.4 Computation of Normalized Scores

The methodology used in UNDP's Human Development Index (HDI) (UNDP, 2006) was followed to normalize scores for each parameter so that score of each component lie between 0 and 1. Before doing this, it is important to identify the functional relationship between the parameters and institutional performance and identify suitable formula for normalisation. Two types of functional relationship are possible: if performance increases with increase in the value of the parameters following formula is used is used for normalisation of value of parameters.

$$x_{ij} = \frac{X_{ij} - \min_i\{X_{ij}\}}{\max_i\{X_{ij}\} - \min_i\{X_{ij}\}}$$

If performance increases with decrease in the value of the parameters following formula is used for normalisation of parameters.

$$y_{ij} = \frac{\max_i\{X_{ij}\} - X_{ij}}{\max_i\{X_{ij}\} - \min_i\{X_{ij}\}}$$

In present study institutional performance increases with increase in value of parameters normalisation is done using is done using formula

$$x_{ij} = \frac{X_{ij} - \min_i\{X_{ij}\}}{\max_i\{X_{ij}\} - \min_i\{X_{ij}\}}$$

Where,

i = Number of parameters selected in for evaluation of institutional performance

j = (1 ……. n) in the number of individuals

x_{ij} = Sum of score rated for i^{th} component by j^{th} individual

3.5.2.5 Computation of Household participation index (HPI)

Household participation index (HPI) was constructed by taking simple average of normalized scores of collective action and decision making parameters using following formula

$$\mathrm{HPI} = \frac{\sum X_{ij}}{k}$$

Where

HPI –Household Participation Index at household level.

$\sum x_{ij}$ - Normalised score for each parameter under study

k - Total number of parameters selected for computation of participation index

i - Number of parameters selected in the study for the computation of participation index

j - Number of individuals (1 to n) in this study: j = (1 to 102)

3.5.2.6 Household perception index about tank performance

Household perception about tank performance was computed in terms of equity, water rights, monitoring and enforcing and conflict resolution. This was done by taking simple average of normalized scores of for each parameter.

$$\mathrm{HPIP} = \frac{\sum X_{ij}}{m}$$

Where,

HPIP –Household perception Index.

$\sum x_{ij}$ - Normalised score for each parameter under study

m - Total number of parameters selected for computation of perception Index

i - Number of parameters selected in the study for the computation of performance index

j - Number of individuals (1 to n) in this study: j = (1 to 102)

3.5.3 Transaction Cost measurement and analysis

Transaction cost in tank irrigation management is broadly classified into three types namely (i) cost of information and decision making, (ii) contractual and negotiation cost and (iii) monitoring and enforcement cost. Transaction costs incurred in tank irrigation management is incurred through cash paid, value of kind given and cost of time spent. For the purpose of the study, the transaction costs in tank management were quantified at two different levels *viz.*, tank level and household level. The components of transaction costs at different levels are presented in Table.3.3.

Transaction cost involved in tank irrigation management was estimated at tank level and household level under three different institutions: Minor Irrigation tank managed JSYS tank and Damasi system of tank.

Transaction cost involved in tank irrigation management can be given as follows:

$$\mathrm{TC} = \mathrm{IC} + \mathrm{CC} + \mathrm{MEC}$$

Where,

TC – Transaction Cost

IC – Information and decision making cost

CC – Contractual and negotiation cost

MEC – Monitoring and enforcement cost

Table 3.3 Transactions in tank irrigation management

Level	Types	Particulars
Tank Level	Information and decision making cost	Cost of organising and conducting tank level meetings by water users association (WUA)
	Contractual and negotiation cost	Cost to obtain external assistance for improvement of tank including rent seeking, lobbying
		Opportunity cost of time spent in negotiating with administrating agency for release of water
		Cost of renewal, registration and filing of income and expenditure account
	Monitoring and enforcing cost	Opportunity cost of time spent for monitoring tank improvement activity by water users association (WUA)
House Hold Level	Information and decision making cost	Cost of collection of information i.e. messages(Phone, messenger, commuting)
		Opportunity cost of time spent in attending meetings, costs incurred towards SMS messages, phone charges etc (Appropriation, Dispute resolution)
	Contractual and negotiation cost	Cost incurred towards Water tax
	Monitoring and enforcing cost	Neerganti wages or wages for watch man

3.5.3.1 Analysis of Variance (ANOVA) model

Analysis of Variance (ANOVA) models are used to assess the statistical significance of the relationship between a quantitative regress and qualitative or dummy regressors. They are often used to compare the differences in the mean values of two or more groups or categories, and therefore more general than the ‘t’ test which can be used to compare the means of two groups or categories only. For the present study, ANOVA model was employed to assess the statistical significance of difference between the mean transaction cost.

Analysis of Variance (ANOVA) model was fitted using two dummy variables D_1 for Damasi tank management institution, D_2 for minor irrigation tank management institution and the values of JSYS tank management institution as a reference variable.

Specified Analysis of Variance (ANOVA) model for the analysis:

$$Y_{ij} = \beta_0 + \beta_{1i} D_{1i} + \beta_{2i} D_{2i} + u_i$$

Where,

Y_{ij} = Transaction cost per hectare of j^{th} household in i^{th} tank.

D_{1i} = Damasi tank dummy (1 if household is from Damasi tank, 0, otherwise)

D_{2i} = Minor Irrigation tank dummy (1 if household is from MI tank; 0, otherwise)

3.5.3.2 Functional analysis

A multiple regression analysis was employed to examine the factors which affect the transaction cost and impact of transaction cost on the incentive structure to suggest policy measures to improve tank management.

Determinants of transaction cost.

Transaction cost was hypothesized to be determined by age of the head of the household, education level of the head of the household, functionaries of the respondents, owning of wells, farm size in hectares, membership in number of organisation and type of tank management institution.

Empirical Model Specification

$$TC = a_0 + a_1 AGE + a_2\ EDU + a_3\ DSVLF + a_4\ MO + a_5\ DOWL + a_6\ FSIZE + a_7\ DM + a_8\ DMI + u$$

Where:

TC : Transaction cost incurred by the household (Rs/year/ per household)

AGE : Age of the head of the household in years

EDU : Educational level of the head of the households in years

DSVLF : Household level functionary (1 if the respondent is a supervisory level functionary; 0, otherwise)

MO : Membership in organisation number of organization

DOWL : Well ownership (1 if household owns well; 0, otherwise)

FSIZE : Farm size in hectares

DM : Damasi tank (1 if respondent is from Damasi tank, 0, otherwise)

DMI : Minor Irrigation tank (1 if respondent is from Minor Irrigation tank; 0, otherwise)

u : Error term

Table 3.4 Expected Signs of the Determinants of transaction cost.

Sl. No.	Name of Variables	Explanation of Variable	Expected Sign	Reasons
1	AGE	Age of the household head in years	+ve	Age is a human capital indicator that is important in facilitating negotiations, bargaining and resolving conflicts in tank irrigation management process. Thus, one may expect that the age may influence positively the transaction cost incurred by the household (Mburu *et al.*, 2003)
2	EDU	Educational level of the head of the households in years	(+) / (-)	Education level is a human capital indicator that is important in facilitating negotiations, bargaining and resolving conflicts in tank irrigation management process. Hence, we can expect a positive sign (Mburu *et al.*, 2003). Education may also offer exit options that are likely to reduce participation resulting in negative impact on transaction cost (Lise, 2000)
3	DSVLF	Household level functionary (1 if the respondent is a supervisory level functionary;0, otherwise)	+ve	Supervisory level assumes the responsibilities of tank management (Asian Development Bank, 2006; Karthikeyan, 2000). So, one can expect DSVLF to have a positive influence on transaction cost

4	MO	Membership in organisation in number	+ve	Membership in organisation is a social capital indicator and establishes the respondent's willingness to actively participate in tank management activities and has a positive influence on transaction cost (Mburu, 2003).
5	DOWL	Well ownership (1 if household owns well; 0, otherwise)	-ve	Well is an alternative source of irrigation which reduces dependency on tank water for irrigation and hence reduces participation in tank irrigation management (Balasubramaniam, 1998; Palanisami, 1986).
6	FSIZE	Farm size in hectares	+ve	Wealthy households may supplement collective resources with their own and can be influential in the community and can motivate members to work together (Mburu *et al.*, 2003)
7	DM	Damasi tank (1 if respondent is from Damasi tank, 0, otherwise)	-ve	Damasi is an informal institution of cooperation of tank irrigation management with traditionally well defined and complied social norm for water sharing and hence transaction cost will be less.
8	DMI	Minor Irrigation tank (1 if respondent is from Minor Irrigation tank; 0, otherwise)	+ve	Minor irrigation tank is centralised tank irrigation management which required paying of water tax. Being a larger tank system it is quite likely that cooperation is difficult and hence transaction cost will be higher (Karnataka Irrigation Act 1965; Kumar, 2011)

3.6 Garrett's scoring technique

In order to know major problems faced in tank irrigation management office bearers from minor irrigation department, Panchayath raj engineering and JSYS project implementing agency and researchers who have worked in tank management projects were interviewed and asked to rank about the various problems in tank irrigation management. Garret ranking technique was employed to rank the problems.

Garrett (1965) suggested a scoring technique procedure for converting the ranks into scores when the number of items ranked from respondent to respondent. To rank the constraints faced in the functioning of tank and tank irrigation, Garrett's ranking technique was used. The ranks assigned by the respondents were converted into percent position by using the formula

$$\text{Percentage Position} = \frac{100(R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} = Rank given for i^{th} factor by j^{th} individual

N_j = Number of factors ranked by j^{th} individual

By referring to Garrett's table, the percentage positions estimate was converted into scores and then for each factor the scores of various respondents were added and mean value was arrived at. These means were arranged in descending order. The problem having the highest mean value was considered to be the most important and was given the highest rank and vice versa.

Figure 3.1. Data Collection by personal interview method in April – May 2011.

1. Honnasettihalli Doddakere Tank:- JSYS TANK

2. Mellarikere Tank:- Damasi Tank

3. Rajendrahalli Doddakere:- Tank Minor Irrigation

Figure 3.2. PRA conducted at mellari tank with damasi system of tank irrigation management.

1. PRA and Group discussion at Mellari tank with Damasi system of Tank irrigation mangement.

2. Map of Mellarikere Tank with Damasi system of Tank Irrigation Mangement.

CHAPTER IV

DESCRIPTION OF THE STUDY AREA

An understanding of the agro-climatic and socio-economic conditions of the study area would serve as a backdrop for drawing meaningful inferences from the results of the study. This chapter provides an overview of some of the general features of the study area namely geographic location, demography, climate, rainfall, irrigation, land use pattern, cropping pattern, financial, institutional and infrastructure facilities.

4.1. The District

Kolar is a district in Karnataka state of India. The town of Kolar is the district headquarters. Kolar district is located in the southern region of the State and is the eastern-most district of the Karnataka State. The district is bounded by the Bengaloru Rural district in the west Chikballapur district in the north, Chittoor District of Andhra Pradesh in the east and on the south by Krishnagiri and Vellore district of Tamil Nadu. On 10 September 2007, Kolar district was bifurcated to form the new district of Chikballapur. The average altitude of the district is 820.33 meters above Mean sea level. Kolar district is known for the production milk, mangos, silk and tomatoes.

4.2. Location and Physiography

Kolar District lies between 77° 21' to 78° 35' east longitude and 20° 46' to 130° 58' north latitude, extending over an area of 8,225 km². The district, at its greatest length, reaches about 135 km from north to south with almost the same distance from east to west. It occupies the table land of Mysore, bordering the Eastern Ghats. The general plateau surface is interrupted by a number of hills and peaks of varying heights, particularly in the north. The principal chain of mountains is the Nandidurga range which runs north from Nandi towards Penukonda and Dharmavaram of Andhra Pradesh. The elevation of the district ranges between 732 m Mean Average Sea Level (MASL) at Bangarpet to 901.9 m MASL in Malur. The rivers of the district are small and seasonal. Palar, Uttara Pinakini and Dakshina Pinakini are the important rivers which originate in the elevated regions in the district.

Table. 4.1 Location and Physiography of Kolar District

Taluk	Latitude	Longititude	Mean Average Sea level (MASL) (m)
Bangarpet	12.59	78.1	732
Kolar	12.08	78.08	844.3
Malur	12.59	77.56	901.9
Mulbagal	13.1	75.3	840.33
Srinivasapura	13.2	78.13	805

Source: Kolar District at glance 2009-10, Published by Office of the District Statistical Officer, Kolar.

4.3. Demographic features

The total population of the district is 13.87 lakhs (as per 2010 census) with population density of 348 persons/sq. km. The rural population constitute 7.01 lakhs and urban population constitutes 6.85 lakhs .The schedule caste population constitute 6.6 lakhs and the scheduled tribal population constitute 2.05 lakhs. The sex ratio in the district is 972 females for every 1000 males. Kolar District consists of five taluks, namely Kolar, Bangarpet, Malur, Mulbagal, and Srinivaspur. Total Population is highest in Bangarpet taluk and lowest in Srinivaspur taluk.

Table. 4.2 Taluk wise breakdown of rural and urban population of Kolar District (2001)

Taluk	Total population	Rural	Percentage to total taluk	Urban	Percentage to taluk
Bangarpet	421437	225650	53.54	195787	46.46
Kolar	342593	228686	66.75	113907	33.25
Malur	207009	179194	86.56	27815	13.44
Mulbagal	231302	187269	80.96	44033	19.04
Srinivasapura	184721	161762	87.57	22959	12.43
Total	1387062	701677	50.59	685385	49.41

Source: Kolar District at glance 2009-10, Published by Office of the District Statistical Officer, Kolar.

4.4. Climate and Rain fall

Kolar district lies under eastern dry agro-climatic zone of Karnataka. It experiences a semi-arid climate, characterized by typical monsoon, tropical weather with hot summer and mild winters. Total normal rainfall of the district is 742 mm which is lower than that of state average of 1139 mm. The south-west monsoon contributes around 55 per cent of the annual rainfall. The other monsoon (NE) yields around 30 per cent. The balance of 15 per cent results from the pre-monsoon. September and October are the wettest months with over 100 mm monthly rainfall. The post- monsoon season often gets ample rains due to passing depressions.

Based on past 10 year rainfall data, it could be observed that the mean annual rainfall is 834.83 mm, highest rain fall was received in 2005 with 87.97 per cent above normal and lowest rain fall was recorded in 2002 with 22.7 per cent below normal (Table.4.3). Rainfall was above normal in six years and below normal in four years with standard deviation of 227.06 mm and coefficient of variation of 27.19 per cent. Temperature ranges between 10°C and 40° C, normally April and May are hottest months with temperatures as high as 40° C. The temperature is generally low during December with 10°C.

Table. 4.3 Annual Rainfall of Kolar District (2000-2010)

Year	Rain Fall		
	Normal (mm)	Actual (mm)	Deviation (mm)
2001	724	1,002.40	38.45
2002	724	562.8	-22.27
2003	724	602.8	-16.74
2004	724	906.7	25.23
2005	724	1360.9	87.97
2006	724	666.2	-7.98
2007	724	782.4	8.07
2008	724	896.4	23.81
2009	724	646.8	-10.66
2010	724	920.9	27.20
Mean	724	834.83	15.31

Source: Kolar District at glance 2009-10, Published by Office of the District Statistical Officer, Kolar.

4.5. Soil

The soils of Kolar district occur on different land forms such as hills, ridges, pediments, plains and valleys. The predominant types of soils are red loamy soil, red sandy soil and lateritic soil.

4.6. Land Use Pattern

The land use pattern of the district is presented in Table 4.4. The total geographical area of the district is 3,74,966 hectares. Of which, 1,72,861 hectares (46.10 per cent) is the net sown area and 1,79,355 hectares (47.83 per cent) is the gross sown area. Land not available for cultivation 95,167 hectares (25.38 per cent), fallow lands account for 54,114 hectares (14.43 per cent) while the other cultivated land was spread in an area of 52825 hectares (14.09 per cent).

Table.4.4 Land Utilization Pattern of Kolar (2007-2008)

Particulars		Area (Ha)	Percentage to Total
Total Geographical Area		374966	100.00%
Land not available for cultivation	Forest	20620	5.50%
	Non Agricultural	45677	12.18%
	Barren	28870	7.70%
	Total	95167	25.38%
Other Cultivated Land	Cultivable Waste	6397	1.71%
	Permanent Pasture	39418	10.51%
	Trees and Grows	7009	1.87%
	Total	52825	14.09%
Fallow Land	Current	41301	11.01%
	Others	12813	3.42%
	Total	54114	14.43%
Area Sown	Net	172861	46.10%
	More than Once	6494	1.73%
	Total	179355	47.83%

Source: Kolar District at glance 2009-10, Published by Office of the District Statistical Officer, Kolar.

4.7. Agriculture

4.7.1. Cropping Pattern of Kolar District

The cropping pattern of Kolar district is presented in Table.4.5. Kolar district has a gross cropped area of 1,79,355 hectares. Food grain productions constitute 44.58 per cent of the total cropped area. Total Cereals and minor millets account for 37.57 per cent and pulses account 7.01 per cent to the total gross cropped area. It is seen that Kolar is major horticultural district as fruits and vegetables occupy 20.13 per cent and 8.76 per cent of the gross cropped area respectively. Pulses and oilseeds also contribute prominently to the cropping pattern by contributing 7.01 per cent and 6.25 per cent respectively. Sugarcane is also cultivated in an area of 352 hectares in the district.

Table.4.5 Cropping pattern followed during 2007-08

Particulars		**Area (Ha)**	**Percentage to Total**
Cereals	Paddy	5560	3.10%
	Ragi	60690	33.84%
	Jowar	0	0.00%
	Bajra	39	0.02%
	Maize	1041	0.58%
	Wheat	0	0.00%
Other Cereals & Minor Millets		53	0.03%
Total Cereals and Minor Millets		67383	37.57%
Pulses	Gram	0	0.00%
	Tur	3195	1.78%
	Other Pulses	9373	5.23%
	Total Pulses	12568	7.01%
Total Food Grains		79951	44.58%
Oilseed	Groundnut	10871	6.06%
	Sunflower	117	0.07%
	Others	219	0.12%
	Total Oilseeds	11207	6.25%
Total Fruits		36098	20.13%
Total Vegetables		15706	8.76%
Sugarcane		352	0.20%
Other Non-Food Crops	Tobacco	0	0.00%
	Cotton	0	0.00%
	Others	0	0.00%
	Total	0	0.00%
Total Crops		179355	100.00%

Source: Kolar District at glance 2009-10, Published by Office of the District Statistical Officer, Kolar.

4.7.2. Tank Infrastructure

Kolar district has 1,736 tanks with cultivable command area of 38,433 hectares. Zilla panchayath tanks account for 92.05 per cent of total number of tanks, having potential to irrigate 26,976 hectares. Minor irrigation tank contribute for remaining 7.95 per cent of tank with 138 tanks having potential to irrigate 11,475 hectares which is 29.81 per cent of total cultivable command area under tanks. Mulbagal has highest number of tanks (30.47 per cent) followed by Bangarpet (21.83 per cent), Srinivaspur (16.94 per cent), Kolar (16.36 per cent) and Malur (14.40 per cent). Cultivable command area under tank was highest in Mulbagal (31.78 per cent), followed by Kolar (18.53 per cent), Malur (17.40 per cent), Srinivaspur (16.89 per cent) and Bangarpet (15.40 percent)

Table.4.6 Details of number of tanks and cultivable command area

Taluk	Number of tank			Cultivable command area in ha		
	Zilla panchayat	Minor irrigation	Total	Zilla panchayat	Minor irrigation	Total
Kolar	240 (13.82)	44 (2.53)	284 (16.36)	3190 (8.3)	3933 (10.23)	7123 (18.53)
Malur	239 (13.77)	11 (.63)	250 (14.40)	6075 (15.81)	611 (1.59)	6686 (17.40)
Bangarpet	366 (21.08)	13 (0.75)	379 (21.83)	4376 (11.39)	1543 (4.01)	5919 (15.40)
Mulbagal	494 (28.46)	35 (2.02)	529 (30.47)	9727 (25.31)	2487 (6.47)	12214 (31.78)
Srinivasapura	259 (14.92)	35 (2.02)	294 (16.94)	3608 (9.39)	2882 (7,5)	6490 (16.89)
Total	1598 (92.05)	138 (7.95)	1736 (100.00)	26976 (70.19)	11457 (29.81)	38433 (100.00)

NOTE- (Figures in the parenthesis indicate percentage to total)

Source – Panchayath Raj Engineering department Kolar and Minor Irrigation Department Kolar

4.8. Demography of tank villages

The Rajendrahalli village, where Minor Irrigation tank is located, has the highest population of about 948 whereas the farm household is less of about 62.5 per cent when compared to other two tanks. The Mellari village, where Damasi tank is located has the second highest population of about 417 and highest farm household of about 94.67

percent. The Honshetalli, where the JSYS tank is located has the population of 219 and farm household of 81.82 percent.

Table. 4.7 Demography of tank villages

Particulars	JSYS Tank	Damasi Tank	Minor Irrigation Tank
Population	219	417	948
Households	66 (100.00)	75 (100.00)	200 (100.00)
Farm households	54 (81.82)	71 (94.67)	125 (62.5)
Land less household	12 (18.18)	4 (5.33)	75 (37.5)

NOTE- (Figures in the parenthesis indicate percentage to total number of Household)

Source – Gram Panchayath office.

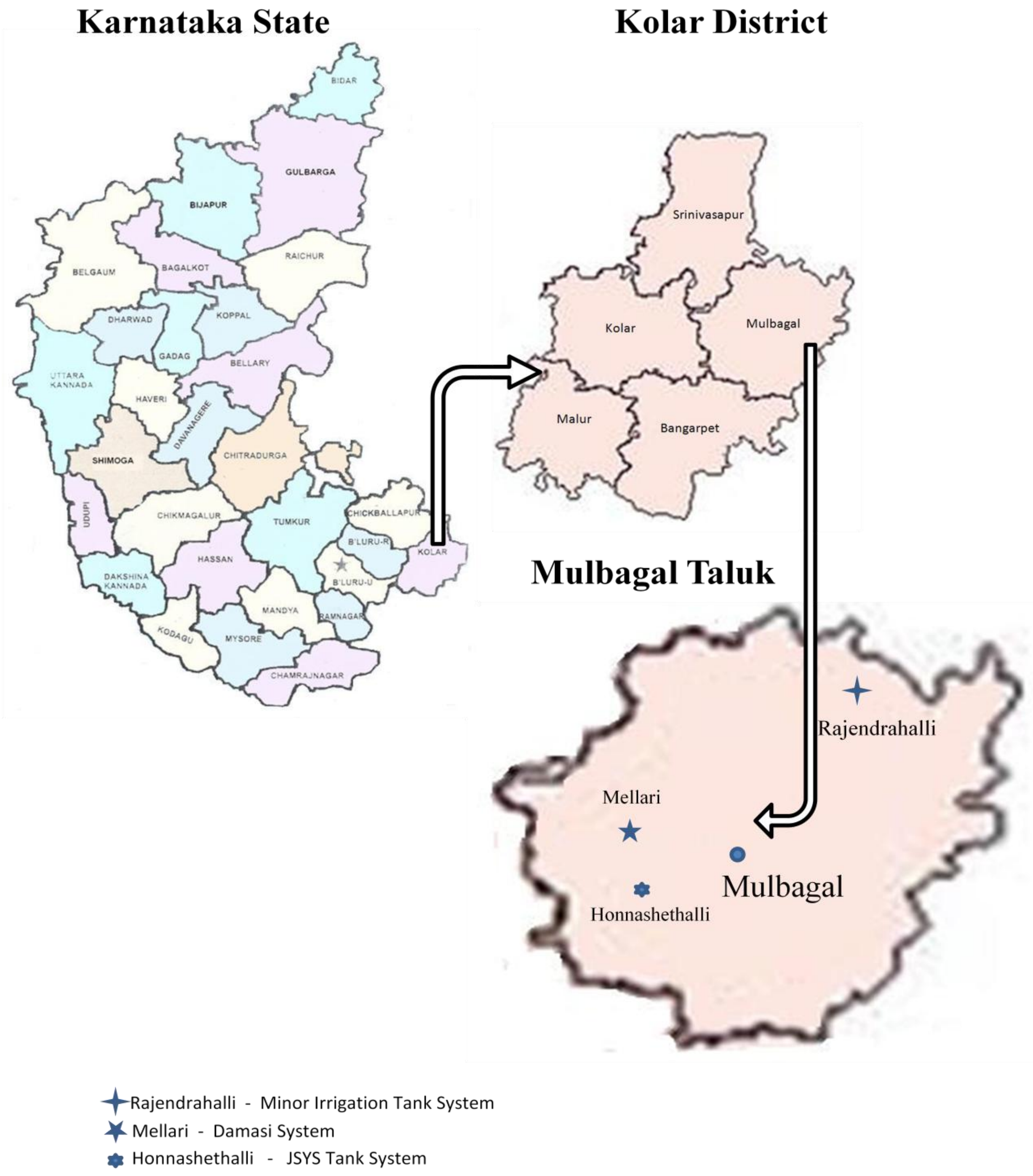
4.9. Geographical location of tank under different institutional management

The three tanks selected in study are located in the Mulabagulu Taluk of Kolar district. The Doddakere Tank which is a JSYS TMI, is located in Avani Hobli, the Mellarikere Tank which is Damasi TMI is located in Dugsandra Hobli and the Rajendrahalli Doddakere Tank which comes under Minor Irrigation TMI is located in Nangli Hobli. All three tanks were constructed about 100 years back in Palar river basin. The Doddakere Tank and the Mellarikere Tank are in Ramasagara series and Rajendrahalli Doddakere Tank is in Nagali series of Palar river basin.

Table.4.8 Geographical location of tank under different institutional management

Sl. No.	Particulars	JSYS TMI	Damasi TMI	Minor Irrigation
1	Tank Name	Doddakere Tank	Mellarikere Tank	Rajendrahalli Doddakere Tank
2	Tank management Institution	Formal Community based	Informal Community based	Public sector minor irrigation
3	Governance structure	Tank Users Group	Zillah Panchayath	Minor Irrigation
4	Village	Honnasettihalli	Mellari	Rajendra Halli
5	District	Kolar	Kolar	Kolar
6	Taluk	Mulbagal	Mulbagal	Mulbagal
7	Hobli	Avani	Dugsandra	Nanagli
8	Panchayath	Devarayasamudra	Hanumanhalli	Rajendra Halli
9	Year of construction	About 100 years back	About 100 years back	About 100 years back
10	River Basin	Palar	Palar	Palar
11	Series	Ramasagara series	Ramasagara series	Nanagli

Fig 4.1 Map showing the study



CHAPTER V

RESULTS AND DISCUSSION

The overall objective of the study is to analyse the functioning, performance of tank management institutions and quantify the transaction cost involved in tank irrigation management under various institutional arrangements. The data collected were subjected to economic and statistical analysis to address the objectives of the study. The results are presented and discussed in this chapter under the following headings:

8.1 General characteristics of tank and sample respondents
8.2 Functioning of tank management institutions in different governance structure
8.3 Characteristics of existing governance structure involved in irrigation tank management
8.4 Institutional performance
8.5 Economic analysis of Transaction Cost in tank irrigation management
8.6 Factors affecting transaction cost
8.7 Problems in tank irrigation management

5.1 General characteristics of tank and sample respondents

The general particulars of the sample respondents such as age, education and land holding pattern which have a bearing on the farmer's participation in tank management institutions are discussed in this section.

5.1.1 General profile of selected tank villages

The general profiles of selected tank villages are presented in Table 5.1. The Rajendrahalli village, where Minor Irrigation tank is located, has the highest population of 948 with 200 households. Farm household constituted 62.5 per cent of the total households and was less when compared to other two tanks. The Mellari village where Damasi tank is located has the second highest population of about 417 with 75 households and has the highest proportion of farm household at 94.67 percent. The Honshetalli village, where the JSYS tank is located has the population of 219 with 66 households and farm household constituted 81.82 percent of the total households.

Table 5.1 General profile of selected tank villages

Particulars	JSYS Tank	Damasi Tank	Minor Irrigation Tank
Population	219	417	948
Households	66 (100.00)	75 (100.00)	200 (100.00)
Farm households	54 (81.82)	71 (94.67)	125 (62.5)
Land less household	12 (18.18)	4 (5.33)	75 (37.5)

NOTE- (Figures in the parenthesis indicate percentage to total number of Household)

5.1.2 General characteristics of tank

General characteristics of tanks are present in table 5.2. Two Zilla Panchayat and one minor irrigation tanks were selected for the study. The minor irrigation tank with command area of 40.5 hectares is the largest while Damasi tank has a command area of 23.2 hectares and JSYS tank has a command area of 18.09 hectares. The water spread is 41.29 hectares in minot irrigation tank, 31.15 hectares in Damasi tank and 13 hectares in JSYS tank. The catchment area of Damasi tank was highest with 2120 hectares followed by Minor Irrigation tank with 634 hectares and JSYS tank with 300 hectares. In the span of past five years from 2006-07 to 2010-11, the JSYS tank and Damasi tank have been filled and discharged in all the years whereas the Minor Irrigation tank has been filled and discharged only thrice.

Table 5.2. General characteristics of tank

Physical Features	TANK		
	JSYS	Damasi	Minor Irrigation
Present Command Area (ha)	18.09	23.2	40.5
Live Tank Capacity (mcm)	0.11	0.54	0.71
Water Spread (ha)	13	31.15	41.29
Catchment Area (ha)	300	2120	634

a. Independent Catchment Area ha) b. Intercepted Catchment Area (ha)	200 100	558 1562	391 243
Physical Performance (No of times tank filled in last five years)	5	5	3

Source – Panchayath Raj Engineering department Kolar and Minor Irrigation Department Kolar.

5.1.3 Age of the Respondents

The age of farmers is one of the important factors which could influence various decisions taken by tank system institutions related to water management and water conservation. Age reflects the experience of the head in farming and participation in other socio-economic, socio-cultural activities and tank management activities. The details on age of the head are presented in Table 5.3. The age group analysis revealed that the age of the head of the household in majority of the cases lie in the range of 45 to 60 years (45.10%) followed by the age group 30 to 45 years (29.41%), above 60 years (23.53%) and below 30 (1.96%) across all Tank.

Table. 5.3. Age of the Respondents

(Number of respondents)

Age (years)	Tanks			All tanks
	JSYS	Damasi	Minor irrigation	
Below 30	0 (0)	1 (2.94)	1 (2.94)	2 (1.96)
30 to 45	13 (38.24)	9 (26.47)	8 (23.53)	30 (29.41)
45 to60	14 (41.18)	15 (44.12)	17 (50.00)	46 (45.10)
Above 60	7 (20.59)	9 (26.47)	8 (23.53)	24 (23.53)
All	34 (100.00)	34 (100.00)	34 (100.00)	102 (100.00)

(Figures in the parenthesis indicate percentage to total)

In JSYS tank, age group of head of households ranging between 45 to 60 years is highest with 41.18 per cent, followed by the age group 30 to 45 years with 38.24 per cent and above 60 years 20.59 per cent. In Damasi tank, the head of the households with age group of 45 to 60 years is highest with 44.12 per cent followed by age group 30 to 45 years and above 60 years constitute 26.47 per cent each and 2.94 per cent are of below 30 years age group. In Minor irrigation tank, the percentage of head of households with age group of 45 to 60 years is highest with 50.00 per cent followed by age group 30 to 45 years, above 60 years with 23.53 per cent and age group below 30 years 2.94 per cent. Members in the age group of below 30 years are least likely to head the family and take decisions related to tank management.

5.1.4 Educational Level

Educational level is a human capital indicator that can be expected to play a major role in facilitating negotiations, bargaining and resolving conflicts in tank irrigation management. The details regarding educational level of the sample respondents across different tank management systems are presented in Table 5.4. Among total sample respondents, majority of the sample respondents are illiterates (54.90%) followed by primary school level of education (16.67 %), high school level of education (13.73%), middle school level of education (11.76 %) and only 2.94 per cent of the head of the households completed college level across all tank systems. The analysis revealed that the highest percentage of illiteracy is found in the JSYS system of tank management with 67.65 per cent whereas least illiterates are found in minor irrigation tank about 41.18 per cent. The Damasi system of tank management has the highest percentage of individuals who have completed high school level education with 23.53 per cent. Minor irrigation tank had the highest number of respondents who had completed primary school education (23.53%) and Middle school education (20.59%). There was equal number of respondents across all the tank types who have completed college level of educational (2.94%).

Table. 5.4. Education Level of the Respondents

(Number of respondent)

Level of education	Tanks			All Tanks
	JSYS	Damasi	Minor Irrigation	
Illiterate	23 (67.65)	19 (55.88)	14 (41.18)	56 (54.9)
Primary school	5 (14.71)	4 (11.76)	8 (23.53)	17 (16.67)

Middle school	3 (8.82)	2 (5.88)	7 (20.59)	12 (11.76)
High school	2 (5.88)	8 (23.53)	4 (11.76)	14 (13.73)
College and above	1 (2.94)	1 (2.94)	1 (2.94)	3 (2.94)
Total	34 (100)	34 (100)	34 (100)	102 (100)

(Figures in the parenthesis indicate percentage to total)

5.1.5 Tank management institution functionaries

Tank management institution functionaries across different tank management institutions are presented in Table 5.5. From the analysis it is observed that among all sample respondents, supervisory functionaries constitute 24.51 per cent and others constituting 75.49 per cent of the respondents across all tanks. Supervisory level functionaries consist of all the members of governing body. In JSYS tanks, supervisory level functionaries, which is a formal governing body comprised of about 29.41 per cent while others comprised of 70.59 per cent. In Damasi tank, supervisory functionary formed 20.59 per cent and others formed 79.41 per cent. Similarly in minor irrigation tank, supervisory functionary comprises about 23.53 per cent and others comprises about 76.47 per cent.

Table. 5.5 Stratification Level of the Respondents

(Number of respondents)

Functionary	**Tanks**			
	JSYS	**Damasi**	**Minor irrigation**	**All Tanks**
Supervisory Functionaries	10 (29.41)	7 (20.59)	8 (23.53)	25 (24.51)
Others	24 (70.59)	27 (79.41)	26 (76.47)	77 (75.49)
OVERALL	**34 (100)**	**34 (100)**	**34 (100)**	**102 (100)**

(Figures in the parenthesis indicate percentage to total)

5.1.6 Social status of the sample respondents

Social status of sample respondents is one of the important factors that influence the role and function played by the sample respondents in tank system. In the present study, the classification is done based on the representation and influence of a respondent on the supervisory level. The caste of any respondent who has highest representation in the governing body or the supervisory level is considered dominant caste and the rest are considered as non-dominant caste. Social status of the sample respondents across different tank management systems are presented in Table 5.6. In all three types of tank management, dominant caste constituted 58.82 per cent while non-dominant caste constituted for 41.18 per cent.

From the analysis it is observed that dominant caste is highest in Damasi tank with 76.47per cent, followed by minor irrigation tank with 55.88 per cent and JSYS tank with 44.12 per cent. Also Damasi tank has homogenous pattern of caste distribution when compared to other two tanks. This may promote collective action in tank irrigation management as social homogeneity represented by caste is expected to positively influence participation in collective action. Moreover, collective action is strongly shaped by structures of power and authority and their cultural construction rather than calculated pay-offs (or tradition). This is not to suggest that resource use is other than rational, but that what constitutes a 'resource' is cultural specific. Tank systems also involve symbolic resources. They are public institutions (like temples) which articulate social relations, status and prestige.

Table. 5.6 Social status based on caste

(Number of respondents)

Social Status	Tanks			All Tanks
	JSYS	**Damasi**	**Minor irrigation**	
Dominant Caste	**15** (44.12)	**26** (76.47)	**19** (55.88)	**60** (58.82)
Non-Dominant Caste	19 (55.88)	8 (23.53)	15 (44.12)	42 (41.18)
Total	34 (100)	34 (100)	34 (100)	102 (100)

(Figures in the parenthesis indicate percentage to total)

5.1.7 Land Holding Pattern of the Respondents.

Land holding patterns of sample respondents can be expected to influence farmers' participation in tank management. The details of the land holding pattern are furnished in Table 5.7. Among total sample respondents, the per cent of the small farmers is highest with 36.27 per cent and that of large farmers is less with 14.71 per cent. Marginal farmers constituted 27.45 per cent while medium farmers constituted 21.57 per cent of the total sample.

The analysis revealed that the highest per cent (41.18%) of marginal farmers are present in the JSYS system of tank management and the lowest per cent (17.65 %) of marginal farmers are present in minor irrigation tank management. The per cent of small farmers is highest in minor irrigation and Damasi (41.18%) followed by JSYS system (26.47%) of tank. The medium farmers formed the highest per cent in JSYS and minor irrigation tank (26.47%) and lowest in Damasi (11.76%). It is observed that in JSYS and minor irrigation tanks the percentage of large farmers is lowest with 5.88 per cent and 14.71 per cent respectively.

Table. 5.7 Land holding pattern among sample respondents

(n=Number of respondents)

Farm Holding	**Tanks**			**All Tanks**
	JSYS	**Damasi**	**Minor Irrigation**	
Marginal (<1Ha)	14 (41.18)	8 (23.53)	6 (17.65)	28 (27.45)
Small (1 to 2 ha)	9 (26.47)	14 (41.18)	14 (41.18)	37 (36.27)
Medium (2 to 4 ha)	9 (26.47)	4 (11.76)	9 (26.47)	22 (21.57)
Large (>4 ha)	2 (5.88)	8 (23.53)	5 (14.71)	15 (14.71)
All	**34** (100)	**34** (100)	**34** (100)	**102** (100)

(Figures in the parenthesis indicate percentage to total)

5.1.8 Non-irrigational benefits obtained by the household from tanks

Apart from irrigation, there are the other benefits reported to have availed by stakeholders from tanks. The details of the non-irrigational benefits obtained by the household from tanks are furnished in Table 5.8. The analysis revealed that among non-irrigational benefits obtained from tank, domestic purpose and livestock related activities referring to grazing and cleaning of livestock and fodder harvesting hold a significant proportion. Fishery is auctioned out by the institution and revenue realized is used for common purpose in the village like celebrating festivals etc. Tank silt is used for agricultural land and sand is used for domestic constructions. Only in JSYS tank, the trees in the common land around the tanks are used as source of green leaf manure for paddy crop. Tanks support not only crop production but also a host of other related activities such as providing water for drinking, washing, bathing (domestic uses), fodder and drinking water for livestock, fish culture, duck rearing, brick making, social forestry and silt collection. Major benefits of tank including irrigation are illustrated in the figure 5.1.

Fig. 5.1. Major Benefits of Tank

1. Irrigation

2. Washing

3. Domestic Purpose

4. Fodder

5. Grazing on foreshore

6. Cleaning of LiveStock


7. Fisheries


8. Tank silt and Sand


9. Silviculture on foreshore

Table. 5.8 Non-irrigational benefits obtained by the household from tank

(Number of respondents)

Benefits other than Irrigation	Tanks			All Tanks
	JSYS	Damasi	Minor Irrigation	
Domestic purpose (Washing, drinking etc)	22 (64.71)	14 (41.18)	15 (44.12)	51 (50)
Grazing	20 (58.82)	22 (64.71)	15 (44.12)	57 (55.88)
Cleaning of livestock	14 (41.18)	14 (41.18)	20 (58.82)	48 (47.06)
Fodder Harvesting	15 (44.12)	30 (88.24)	20 (58.82)	65 (63.73)
Tank silt	14 (41.18)	17 (50)	6 (17.65)	37 (36.27)
Sand	12 (35.29)	8 (23.53)	8 (23.53)	28 (27.45)
Green leaf manure	22 (62.86)	0 (0)	0 (0)	22 (20.95)
Fisheries*	34 (100.00)	34 (100.00)	34 (100.00)	102 (100.00)

(Figures in the parenthesis indicate percentage to total number of house-holds)

*Fisheries is a common property resource and revenue obtained is used for common purpose

5.1.9 Livestock particulars

The details of the livestock holdings are furnished in the Table 5.9. Among the total sample respondents, about 87.25 per cent possess livestock. About41.18 per cent of the sample respondents own hybrid cows followed by bullocks accounting for 40.2 per cent and sheep accounting 37.25 per cent. Goat forms the lower per cent of livestock holding with just 6.86 per cent.

In minor irrigation tank, the percentage of household possessing livestock is highest with 94.12 per cent. The average livestock per household is highest in Damasi tank with 18 livestock per household. The JSYS has highest percentage of respondents holding bullock pair (44.12%) followed by sheep (38.24%) and hybrid cow (32.35%). Damasi has highest percentage of respondents possessing sheep (55.88%) followed by hybrid cow (50%) and bullock pair (47.06%). Minor Irrigation tank area has highest percentage of respondents possessing hybrid cow (41.18%) and buffalo (41.18%) followed bullock pair (29.41%). It is evident that milch animals form major among all livestock holding supporting the fact that Kolar is also known as 'Land of Milk'.

Table. 5.9 Livestock holdings of the Respondents

(Number of respondents)

Live Stock Holdings	Tanks						Tanks	
	JSYS		Damasi		Minor Irrigation			
	No. of house-holds	Average No. of Live Stock	No. of house -holds	Average No. of Live Stock	No. of house-holds	Average No. of Live Stock	No. of households	Average No. of Live Stock
No livestock	8 (23.53)	0	3 (8.82)	0	2 (5.88)	0	13 (12.75)	0
Country Cow	10 (29.41)	3	11 (32.35)	3	9 (26.47)	2	30 (29.41)	3
Hybrid Cow	11 (32.35)	2	17 (50.00)	1	14 (41.18)	2	42 (41.18)	2
Buffalo	5 (14.71)	1	9 (26.47)	3	14 (41.18)	2	28 (27.45)	2
Bullock Pair	15 (44.12)	1	16 (47.06)	1	10 (29.41)	1	41 (40.2)	1
Sheep	13 (38.24)	22	19 (55.88)	24	6 (17.65)	21	38 (37.25)	23
Goat	3 (8.82)	3	3 (8.82)	2	1 (2.94)	2	7 (6.86)	2
Total Livestock	26 (76.47)	14	31 (91.18)	18	32 (94.12)	7	89 (87.25)	13

(Figures in the parenthesis indicate percentage of households possess the live stock to total number of households)

5.2 Functioning of tank irrigation institutions

5.2.1 Functioning and organization structure of JSYS (formal community based) tank management institution

Jala Samvardhane Yojana Sangha (JSYS) tank is a registered society established by Government of Karnataka to facilitate the project implementation and post-project management of the tank system. It functions at tank level to manage tank and water.

JSYS tank management society has a governing body and general body. Governing body includes President, Secretary, Treasurer and Executive members. At least 50 per cent of the members of the governing body should be women and minimum of 18 per cent should be from SC/ST. Term of this governing body is 2 years. Upon the end of the term, the governing body is selected through unanimous selection or formal elections. Governing body actively involved in promoting community participation for tank management. It works towards promoting conservation and proper usage of natural resources and infrastructural facilities of tank. Governing body is involved in constant monitoring of tank infrastructure and tank management activities.

General body consists of all farmers of the command area. All members collectively attend the meetings held and take up the responsibility of incorporating the decisions made in the meeting. The tank also organizes annual canal cleaning where, all the farmers dedicate voluntary labor for the task. Neerganti is responsible for irrigating the field. The Neerganti attends the meetings of both the governing body and general body. All farmers in the command area pay the neerganti in kind. Usually this responsibility is passed over hierarchically for persons belonging to the same family. They rotate their turns of service.

Functions of JSYS:

1. To hold meetings and take decisions regarding tank system management such as catchment area, tank bund and tank area, command area and agricultural activities such as cropping patterns, sowing date and water appropriation
2. To select governing body
3. To renew the registration of the society
4. To maintain financial accounts and auditing

5. To mobilize funds for tank improvement
6. To mobilize resources including human resources
7. To conserve water and tank infrastructure canal cleaning, removal of silt, repair of bunds, sluice etc and
8. To raise additional revenue through activities such as fishery and trees in common land around the tank.

5.2.2 Damasi (informal) tank management institution functioning and organization structure

Damasi system is a traditional system of tank irrigation management. This system consists of supervisory level and the subordinate level. Supervisory level is usually the rank of village heads which is engaged in more of decision making as an enforcing authority at tank level. Supervisory level also takes up the responsibility of mobilizing the funds from external agency for tank maintenance. Subordinate functionary is directly involved in menial labor such as assembling the farmers, announcing the decisions of the supervisory level, appropriation of water for irrigation as facilitated by the supervisory level etc. The tank management also organizes annual canal cleaning where all the farmers dedicate voluntary labor for the task.

The uniqueness of this system is highlighted in the context of scanty rainfall. In the years of less rainfall, if the water falls short of the requirement for the entire command, the supervisory level with the consent of the farmers of the tank command decide on enforcing a proportionate restriction on land area to be cultivated. Apart from the above, another interesting observation is the rotation of command area for cultivation of rabi crop. The command is divided into two to four parts depending on land and water proportions. The supervisory level hold meetings before each rabi crop involving all farmers and decide the part of the command to be used for cultivating the crop. The next part of the command is allowed to cultivate in the subsequent years and thereby completing a cycle. This ensures optimum use of the water availability. However, during the karif crop, entire command is used for cultivation.

Functions of WUA:

1. To hold meetings and take decisions regarding tank system management such as catchment area, tank bund and tank area, command area and agricultural activities such as cropping patterns, sowing date and water appropriation
2. To rationing of land and water in times of drought
3. To select water man neerganti
4. To mobilize resources including human resources
5. To conserve water and tank infrastructure canal cleaning, removal of silt, repair of bunds, sluice etc and
6. To raise additional revenue through activities such as fishery and trees in common land around the tank.

5.2.3 Minor Irrigation (Formal centralized) tank management institution functioning and organization structure

Minor Irrigation tank is managed by Minor Irrigation (MI) department, Government of Karnataka. This comprises of tanks which have command area more than 40 hectares and less than 2000 hectares. In minor irrigation tanks farmers manage and monitor the water distribution by appointing the Neerganti (Water Man) at tank level with permission from Taluk Irrigation Consultative Committee (TICC) for irrigation. Major tank management and maintenance activities are being taken up by the Minor Irrigation department. Taluk Irrigation Consultative Committee (TICC) is the consulting committee which monitors and facilitates the irrigation in minor irrigation tank at taluk level. This body comprises of officials and some progressive farmers. The officials include a President – played by Assistant Commissioner, a Secretary – played by Executive Engineer and members involving Assistant Executive Engineer, Assistant Director of Agriculture, Assistant Director of Horticulture, PLDB secretary, Tashildar, Executive Officer from Taluk Panchayath.

Unlike other two tank management systems, this is more centralized. The opening of sluice requires having the permission from the Taluk Irrigation Consultative Committee (TICC). The revenue inspector of village panchayat collects the water tax based on the direction given by the minor irrigation department. Meetings are held once or twice in a year for each taluk. Assistant Commissioner presides the meeting. Minor irrigation department will be represented by Executive Engineer and Assistant Executive Engineer. Assistant

Engineer (AE) or Junior Engineer (JE) of particular taluk will be present at the meeting. Primary Land Development Bank (PLDB) secretary will be present to address financial concerns. The Assistant Director of Agriculture (ADA) and Assistant Director of Horticulture (ADH) will also be present from agriculture and horticulture department. This meeting inspects the water availability in the tank and requirement for the command. The permission to open the sluice is granted only if the water in the tank is sufficient for the entire command for the crop. Based on this information, the ADA and ADH recommend the suitable crop, sowing date, crop variety and other related information.

After the taluk irrigation committee meeting, the farmers from respective village will meet up and decide on the sowing dates. During the cropping period, two visual inspections of the command is carried out by revenue inspector of village Panchayat or his representative along with AE or JE from minor irrigation department. The first inspection happened just after planting and the second inspection just before harvesting.

5.2.4 Functioning of Tank Management Institutions

In all the three tanks, the presence of recognized local institution operating at tank level could be observed. These institutions are present mainly for water distribution, celebrating tank festivals (deepothsava), rationing of water at times of shortage and mechanisms for agreeing distribution and conflict resolution. Supervisory level functionary is involved in decision making whereas the subordinate level functionary is involved in enforcing decision of supervisory level. Subordinate level functionary consisted of Neerganti, tothi (Sweeper), talari (messenger) etc. Gantt chart of activities under different tanks is illustrated in figure 5.2.

In all the tank management systems there exist a defined rights and traditional cooperative norms regarding celebrating tank festival, appropriation of water, monitoring and enforcement. Cases of violations are usually dealt with flexible and social sanctions like losing reputation. Norms impose uniformity of behavior within a given social group but often vary substantially between the groups. Likewise in present study, norms of rationing of water at times of shortage were different in Damasi tank when compared to that of other two systems. Bardhan (1993) emphasized that “In a world where we often cannot predict each other’s reactions, norms provide much needed rules of thumb and focal points and lend a degree of inflexibility and commitment which forms the basis of our binding agreements”.

These norms in turn reflect on the transaction cost incurred by different functionaries in tank management. They establish an organizational and functional pattern and define the roles of each of the individual thereby enabling a similar pattern in transaction cost with respect to tank management. This helps in effective reduction in transaction cost incurred by the individual. Norms coordinate expectations and thereby reduce transaction costs in interactions that possess multiple equilibria (Warneryd, 1994).

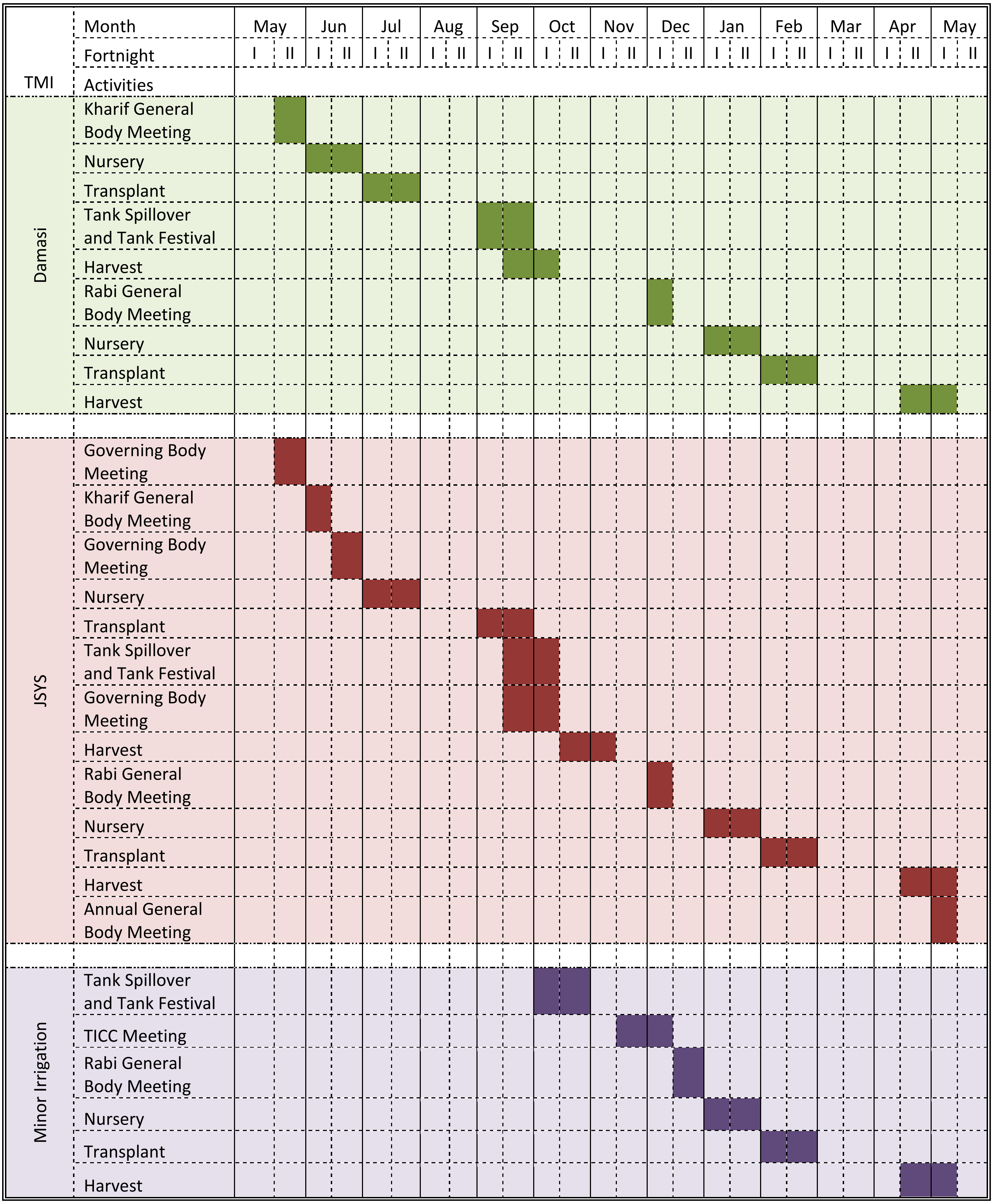
5.2.5 Tank Management activity taken up in different tanks

From the table 5.10 it could be observed that tank management activities like annual canal cleaning and meeting for appropriation of water are common in all types of tanks. Fisheries are auctioned once in every two years in all tanks.In JSYS tank, more revenue generation activities like auctioning of fodder and trees are being done. Tank improvement activities like canal repair, regulator repair and cleaning of bunds are done in JSYS tanks. In Damasi tank, the improvement activities such as feeder channel cleaning and waste weir stabilization are carried out. However, in minor irrigation tank, no tank improvement activity was done in reference period of study.

Table. 5.10 Management activities taken up in different tanks during 2007-09 to year 2010-11

Year	Tanks		
	JSYS	**Damasi**	**Minor irrigation**
2008-09	Annual canal cleaning Fodder auction Fisheries Auction	Annual Canal cleaning Fisheries Auction Feeder channel cleaning Fodder Auction	Fisheries Auction
2009-10	Canal repair and Cleaning Waste weir repair Fodder auction Mesh Placement at waste weir Fisheries Auction	Annual Canal cleaning Fisheries Auction Waste weir stabilization	Annual Canal Cleaning Fisheries Auction
2010-11	Annual canal cleaning Bund repair Fodder auction Regulator repair Cleaning of Bund and Tree auction	Annual Canal Cleaning Fisheries Auction	Annual canal cleaning

Figure 5.2 Gantt chart of activities under different tanks



5.3 Characteristics of existing governance structure involved in irrigation tank management

Figure. 5.3 Flow chart of organization structure and functioning of Minor Irrigation Department

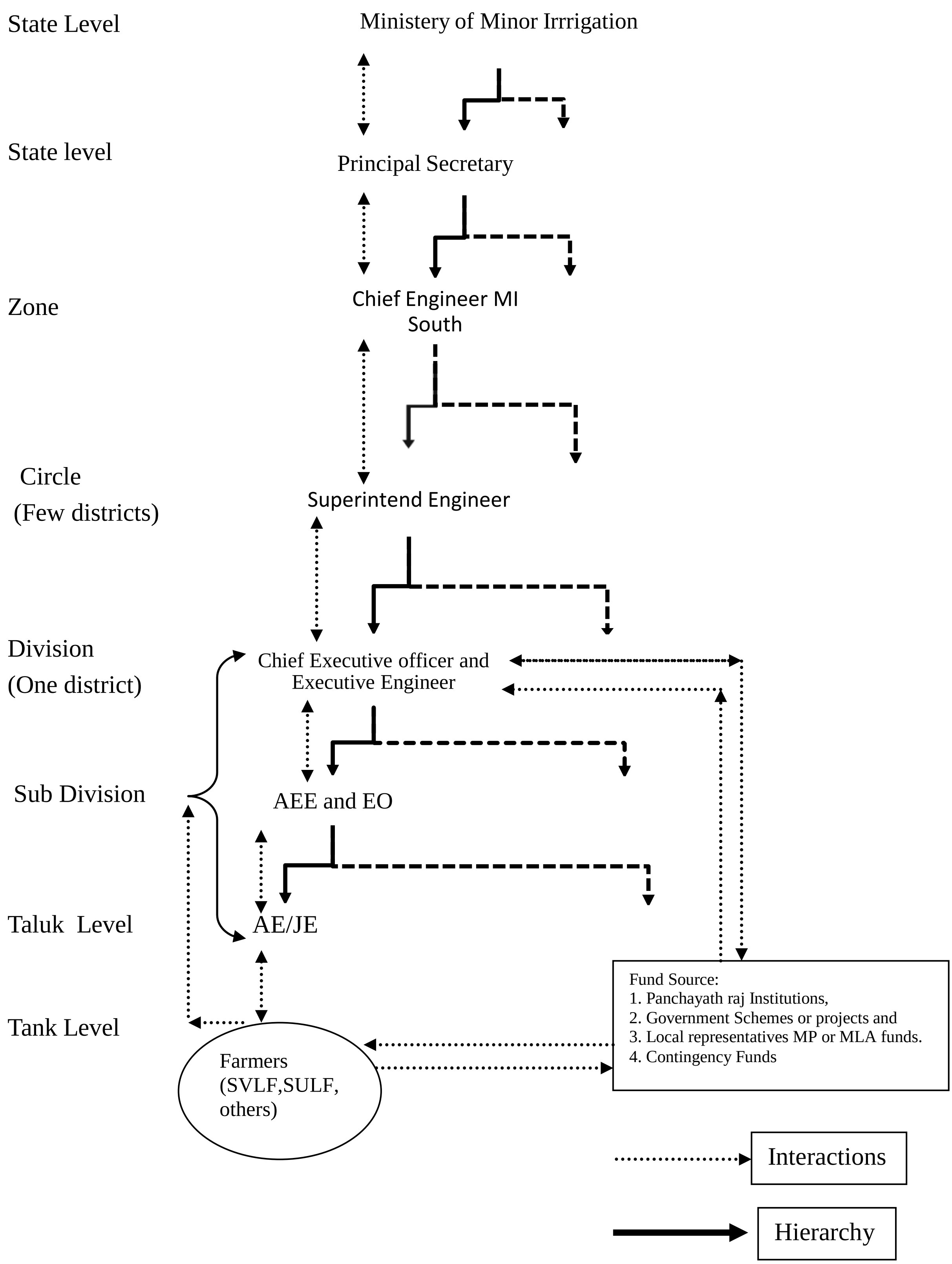
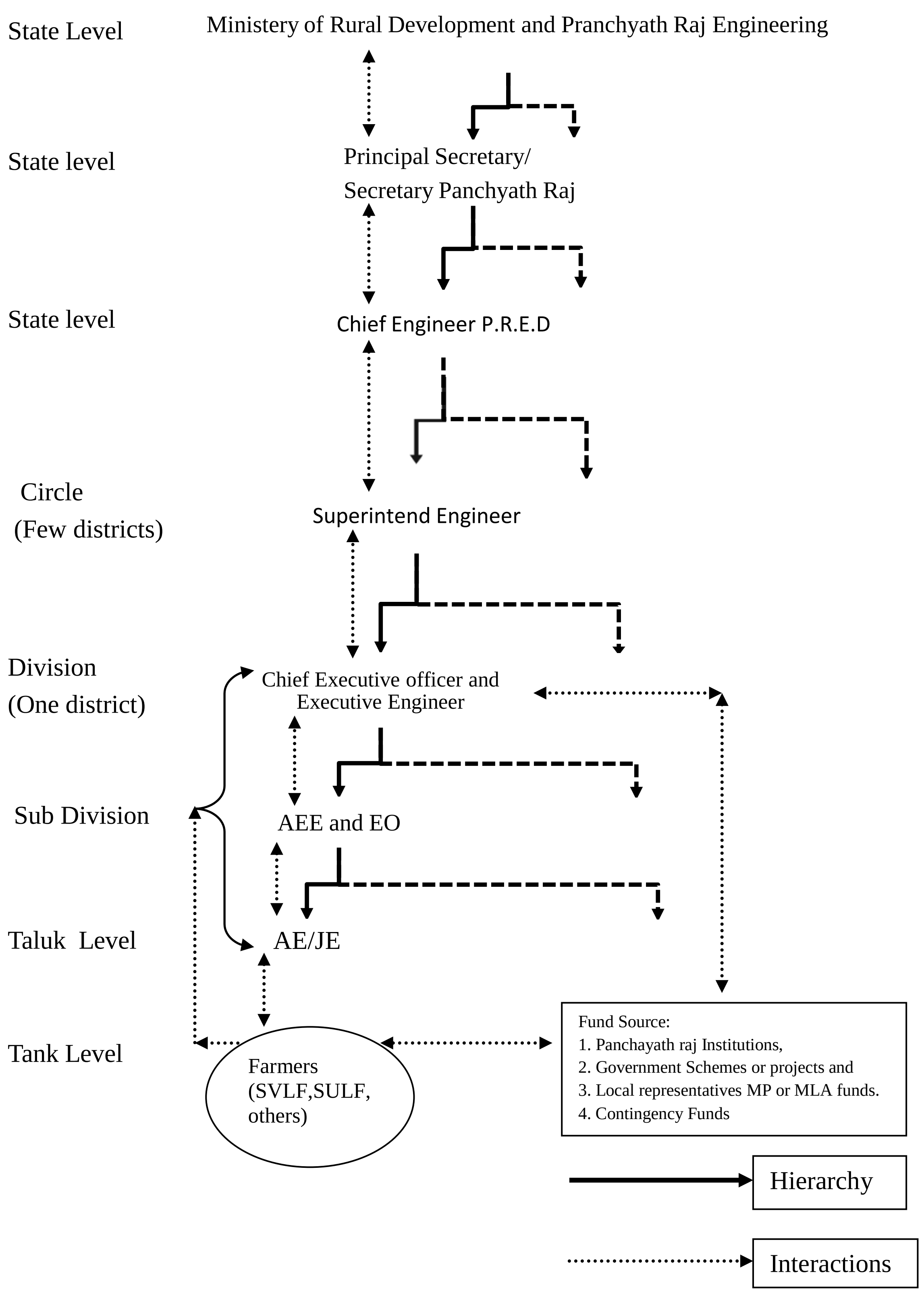


Figure 5.4 Flow chart of organization structure and functioning of Panchayath raj Engineering Department



5.3.1 Institutional Performance

5.3.1.1 Collective action and participation in tank management activities in selected tanks

It could be observed from the Table.5.11 that proportion of members in executive committee is highest in JSYS tank with (20.37 %) followed by Damasi tank with (9.86 %) and minor irrigation tank with (6.40%). Annually six meetings are held in JSYS tank which includes three governing body meeting, two seasonal meeting one each in Kharif and Rabi season for appropriation of water and one general body meeting. In Damasi tank, only two seasonal meetings are held in Kharif and Rabi season for appropriation. In Minor irrigation tank, one meeting is held before appropriation of water in Rabi season.

JSYS tank is a formal tank management institution registered under Karnataka Societies Registration Act, 1960 through KCBTMP (Karnataka Community Based Tank management project). It has governing body at tank level and is involved in constant monitoring of tank infrastructure and tank management activities. Participation rate in governing body meeting is (38.24 per cent) and governing body meetings are held to generate revenue from non irrigational benefit of tank, maintain accounts, minutes report, auditing, filing of income expenditure statement at district registrar office, and to mobilize people for tank management activities like annual canal cleaning.

Participation rate in seasonal meeting is varied from 58.82 per cent in minor irrigation tank to 79.41 per cent in Damasi tank. However participation in canal cleaning activity is 88.24 per cent in Damasi tank, 85.29 per cent in JSYS tank and that of minor irrigation tank it is 82.35 per cent. Farmers give more importance to canal cleaning activities which ensure efficient flow of irrigation water to field all tanks. Participation rate in meeting is lowest in minor irrigation tank when compared to that of other community based tank management institutions. The average time spent in attending meetings is around two hours per time and it is common to all the three types of tanks.

Fund mobilization for maintenance activities in in JSYS tan is worked out to Rs1474/- per ha and Rs. 1238/ha in Damasi tank. Some of the maintenance activities like feeder channel cleaning, bund stabilization and canal repairing are being done as part of National Rural Employment Guarantee Scheme (NREGS). Revenue is mobilized from different sources such as fisheries, auctioning of fodder, trees etc. It is evident that the revenue mobilized is varied from Rs.524/ha in Damasi tank to Rs. 1305/ha in JSYS tank.

Table. 5.11. Collective action and participation in tank management activities in selected tanks.

Sl. No.	Particulars	Tank		
		JSYS	Damasi	Minor Irrigation
A.	**Organisation**			
	Total Number of sample households	34	34	34
	Proportion member in executive committee (Supervisory Level Functionary)	11 (20.37)	7 (9.86)	8 (6.40)
B.	**Meetings at tank level**			
1.	Total number of meetings held (No./year)	6	2	1
2.	Governing body meetings held (No./Year)	3	0	0
3.	Participation rate in governing body meeting (%)	38.24	-	-
4.	General body meeting held (No./Year)	1	-	-
5.	Participation rate in general body meeting (%)	64.81	-	-
6.	Seasonal meetings (No./year)	2	2	1
7.	Participation rate in seasonal meeting body meeting (%)	78.70	79.41	58.82
8.	Average time spent for meeting per year	2.19	2.04	2.31
B.	**Voluntary Labour Contribution**			
1.	Participation rate in annual canal cleaning activity (%)	85.29	88.24	82.35
C.	**Revenue realized and fund mobilized**			
1.	Revenue realized from various sources in Rs per ha	1305	524	571
2.	Fund mobilized for maintains of tank infrastructure form developmental department Rs per ha	1474	1238	-

Fig 5.5 Household Participation Index

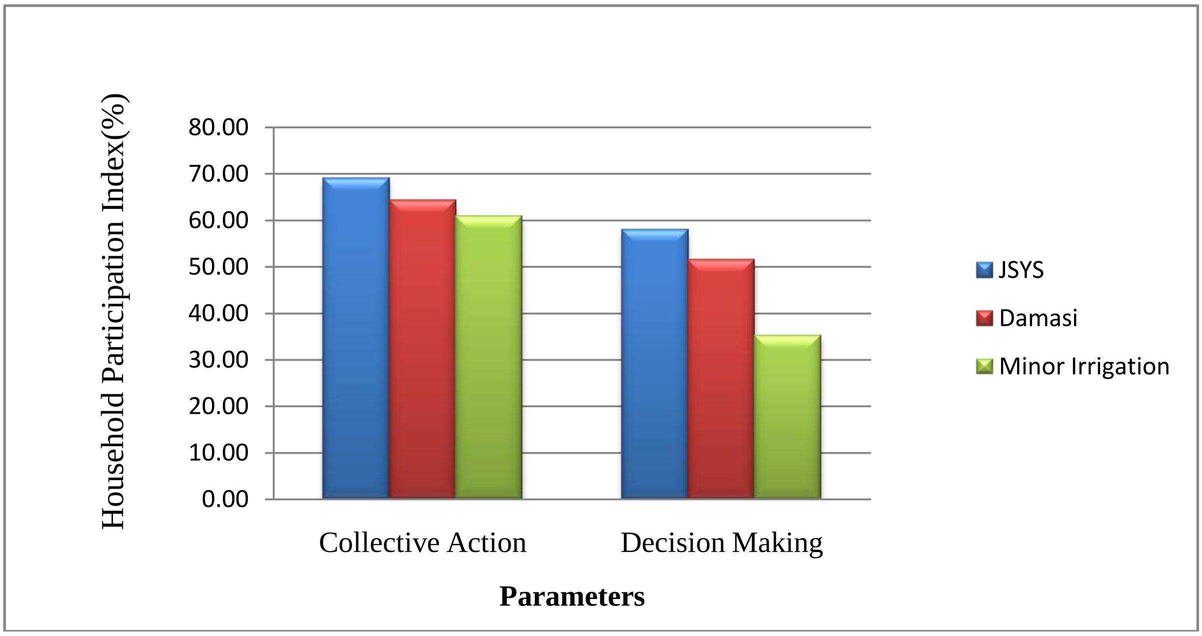
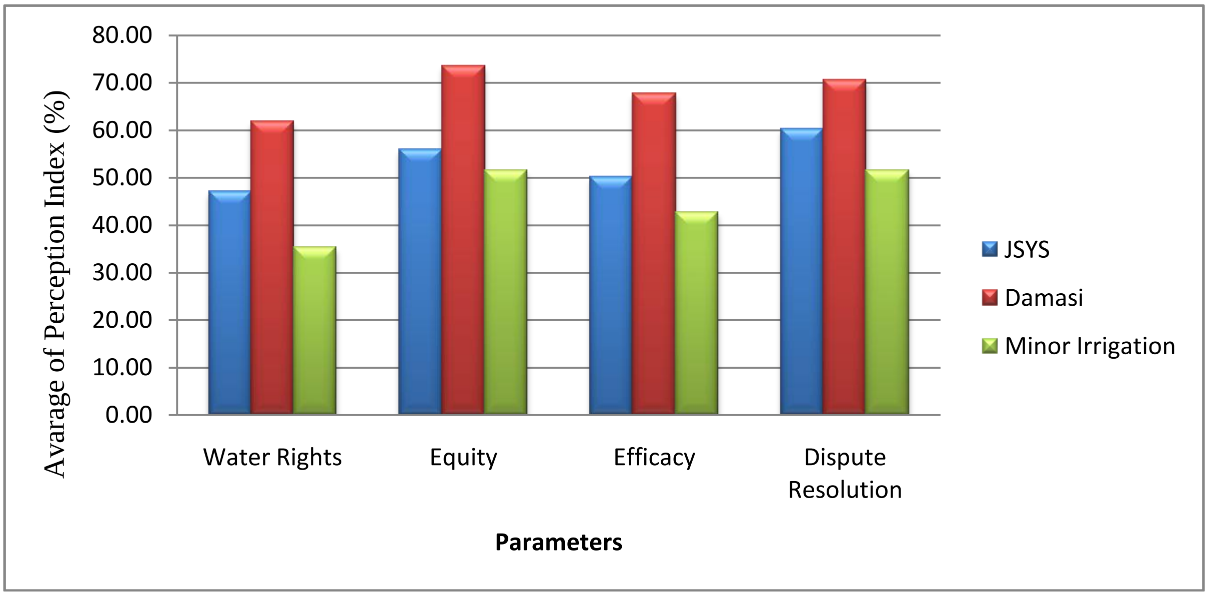


Fig 5.6 Households Perception about performance of tank



5.3.1.2 Performance based on household Participation in tank management

The performance of each tank is evaluated based on household's participation in collective action and decision making in tank management activities is illustrated in figure 5.5. JSYS tank recorded highest household participation (63.48%) followed by Damasi (57.92%) and Minor Irrigation tank (48.09). It could be seen from Table.5.12 the average of household participation index is highest in JSYS for both collective action (69.12%) and decision making (51.47%). JSYS tank is under formal tank management institution, it has defined bylaw for functioning of the institution at tank level,   management responsibility has been entrusted to governing body which conducts frequent meetings and monitors tank management activities. There is more participation of farmers in collective action and decision making in JSYS system of tank management.

Table. 5.12 Household Participation Index

SL. No	Particulars	Tanks		
		JSYS	Damasi	Minor Irrigation
1	Collective Action	69.12	64.38	60.88
2	Decision Making	57.84	51.47	35.29
	Household Participation Index	63.48	57.92	48.09

(Household participation Index)

5.3.1.3 Household Perception about Performance of Tank

The household perception index about performance of tank is presented in Table 5.1.3 and figure 5.6. Considering all the four parameters studied, the household perception index was found to be highest in Damasi (68.38%) followed by JSYS (53.31%) and Minor Irrigation (45.22%). Household perception about functioning of tank is highest in Damasi tank for all components viz., water rights (61.76 %), equity (73.53%), efficacy of functionaries (67.65 %) and conflict resolution (70.59%). It is observed that minor irrigation is lowest in all the components. This implies that according to farm household perception, the Damasi tank is performing well in terms of defining water rights, ensuring equity, efficiency of functionaries and resolving conflicts in tank irrigation management.

Table. 5.13 Household Perception Index

SL. No	Particulars	Tanks		
		JSYS	Damasi	Minor Irrigation
1	Water Rights	47.06	61.76	35.29
2	Equity	55.88	73.53	51.47
3	Efficacy of Functionaries	50.00	67.65	42.65
4	Conflict Resolution	60.29	70.59	51.47
	House hold Perception Index	53.31	68.38	45.22

(Household perception Index)

5.4 Economic analysis of Transaction Cost in tank irrigation management

5.4.1 Transaction cost per ha between the institutions

Transaction cost in tank irrigation management by households includes cost incurred at tank level and house hold level and is broadly classified into three types namely (i) cost of information and decision making, (ii) contractual cost and (iii) monitoring and enforcement cost. Information and decision making cost includes cost on organising and conducting tank level meetings by WUA, Cost for collection of information i.e. messages(Phone, messenger, commuting) and Opportunity cost of time spent in attending meetings, costs incurred towards SMS messages, phone charges etc (Appropriation, Dispute resolution) . Contractual cost includes Cost to obtain external assistance for improvement of tank including rent seeking, lobbying, Opportunity cost of time spent in negotiating with administrating agency for release of water, Cost for renewal, registration and filing of income and expenditure account and Cost incurred towards Water tax. Monitoring and enforcement cost comprises of Opportunity cost of time spent for monitoring tank improvement activity by WUA and Neerganti wages or wages for watch man.

The ANOVA model is employed to compare the transaction cost per hectare of tank irrigated area among the three different institutions under study. The regression results are presented in Table 5.14 revealed that estimated ANOVA model is valid for interpretation as the ‘F statistics’ is significant at one per cent level.The dependant variable considered here is transaction cost per hectare and two dummy variables dummy for Damasi (=1 if Damasi, 0 = otherwise), dummy for Minor Irrigation (=1 if Minor Irrigation, 0 = otherwise) and as independent variables and JSYS has been taken as reference dummy.

Table. 5.14 Regression results of ANOVA model

Tanks	Co-efficient	't' Statistics
Intercept	1162***	29.73
DM	-89	-1.60
MI Tank	129***	2.50
R squared	0.13	
F	8.5467	
N	102	

It is observed that intercept (JSYS) and slope coefficient of minor irrigation tank is statistically significant at 1 per cent. Therefore, the overall observation is that statistically the mean transaction cost per hectare in the JSYS and the Damasi both of which are community based tank management institutions are about the same but the mean transaction cost of minor irrigation which is centralized based tank management institution is significantly higher by about Rs.129/- only.

5.4.2 Transaction cost at Tank Level

Transaction cost at tank level includes cost incurred by the tank Water Users' Association and formal and informal office bearers such as Supervisory Level Functionary. It is classified in Information and decision making cost, contractual cost and monitoring and enforcement cost. Information and decision making cost includes time Cost on organising and conducting tank level meetings by WUA. The contractual cost includes Cost to obtain external assistance for improvement of tank including rent seeking, lobbying, Opportunity cost of time spent in negotiating with administrating agency for release of water and Cost for renewal, registration and filing of income and expenditure account. The monitoring and enforcement cost includes Opportunity cost of time spent for monitoring tank improvement activity by WUA.

From the table 5.15 it can be observed that average tank level transaction cost all the three tanks unveil that contractual cost is highest at 41.16 per cent followed by monitoring and enforcement cost with 32.77 per cent and information and decision making with about 26.07 per cent.

Transaction cost at tank level is highest in JSYS tank followed by Damasi and minor irrigation tank. In JSYS system of tank, transaction cost at tank level unveil that contractual cost forms the major part with 58.87 per cent followed by monitoring and enforcement cost with 24.66 per cent and information cost which accounts for 16.46 per cent. Nevertheless, in Damasi system of tank management, information and decision making costs account for 44.96 per cent followed by Contractual cost with 26.46 per cent and monitoring and enforcement cost with 28.58 per cent and. In Minor irrigation tank, transaction cost at tank level consists of contractual cost with 58.33 per cent and information and decision making cost with 41.67 per cent. There was no monitoring and enforcement cost as there was no tank improvement activities have been carried out in the reference period of study.

Table. 5.15 Transaction cost at Tank Level

(Rs per ha of gross irrigated area)

Particulars	Tanks			All tanks
	JSYS	Damasi	Minor Irrigation	
Information and decision making cost	14 (16.46)	23 (44.96)	6 (41.67)	12 (26.07)
Contractual and negotiating cost	49 (58.87)	14 (26.46)	9 (58.33)	18 (41.16)
Monitoring and enforcement cost	21 (24.66)	15 (28.58)	0 (0)	15 (32.77)
Transaction Cost	84 (100.0)	52 (100)	15 (100)	45 (100)

(Figures in the parenthesis indicate percentage to total)

5.4.3 Different components of Transaction cost at household level

Information and decision making cost involve cost of conducting and attending meeting at village level to take up tank management activity and furthermore in case of JSYS tank it also includes opportunity cost of time spent in annual general body meeting and governing body meetings. Monitoring and enforcement cost in all three tanks management institutions comprises of cash and value of kind in stakes of yield paid to the neerganti for irrigating the fields as facilitated by the tank management institution at village level meeting. In addition, JSYS and Damasi system of tank it also includes opportunity cost of time spent on monitoring the implementation of developmental activities. Different components of Transaction cost incurred at household level is illustrated in the figure 5.7.

In JSYS tank, the contractual cost includes cost for fund mobilisation from developmental departments and cost of maintaining legal status of society. The cost for fund mobilisation includes cost of negotiating, waiting, commuting and cost of maintaining legal status of society includes auditing and filing of the list, balance sheet, income and expenditure account as imposed under section 13 of Karnataka Societies Registration Act, 1960. In Damasi tank, the contractual cost encompasses the cost of negotiating, waiting, commuting for fund mobilisation from developmental departments. Contractual cost in minor irrigation tank comprises of water tax levied by minor irrigation department for water made available for irrigation as stated under section 10 of the Karnataka Irrigation (levy of betterment contribution and water rate) Act, 1957 and cost of commuting and attending TICC meet to avail permission to use water for irrigation.

It could be seen from the table 5.16 that in JSYS tank monitoring and enforcement cost is highest with 74.18 per cent followed by information and decision making cost with 22.46 per cent and contractual cost with 3.27 per cent. Similarly in Damasi tank percentage of monitoring and enforcement cost is highest with 81.92 per cent followed by information and decision making cost with 17.8per cent and contractual cost with 0.37 per cent

Table. 5.16 Different components of Transaction cost at household level

(Rs per ha of irrigated area)

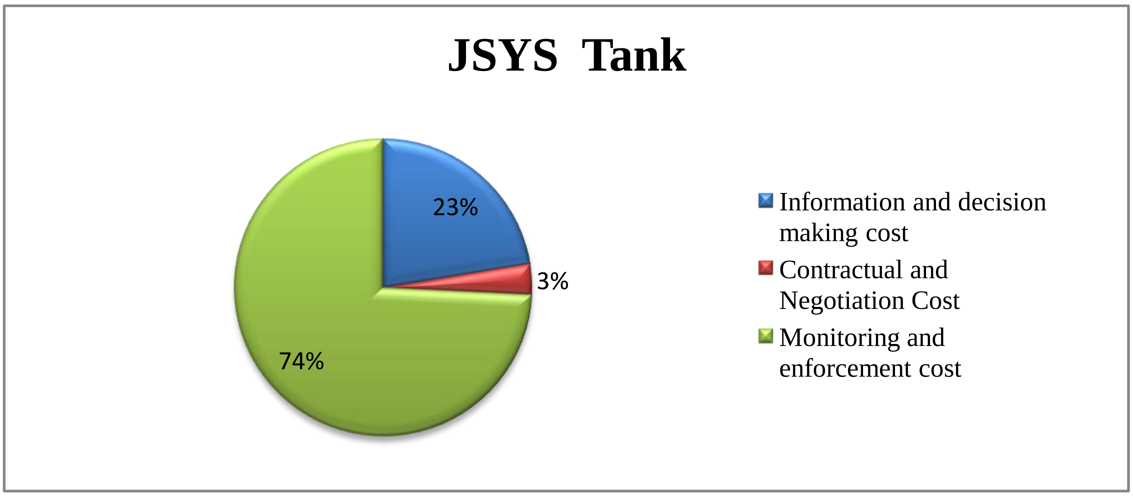
Particulars	Tanks			All Tanks
	JSYS	Damasi	Minor irrigation	
Information and decision making cost	261 (22.46)	191 (17.8)	105 (8.13)	186 (15.83)
Contractual and negotiating Cost	38 (3.27)	4 (0.37)	252 (19.52)	98 (8.34)
Monitoring and enforcement cost	862 (74.18)	879 (81.92)	933 (72.27)	891 (75.83)
Total	1162 (100)	1073 (100)	1291 (100)	1175 (100)

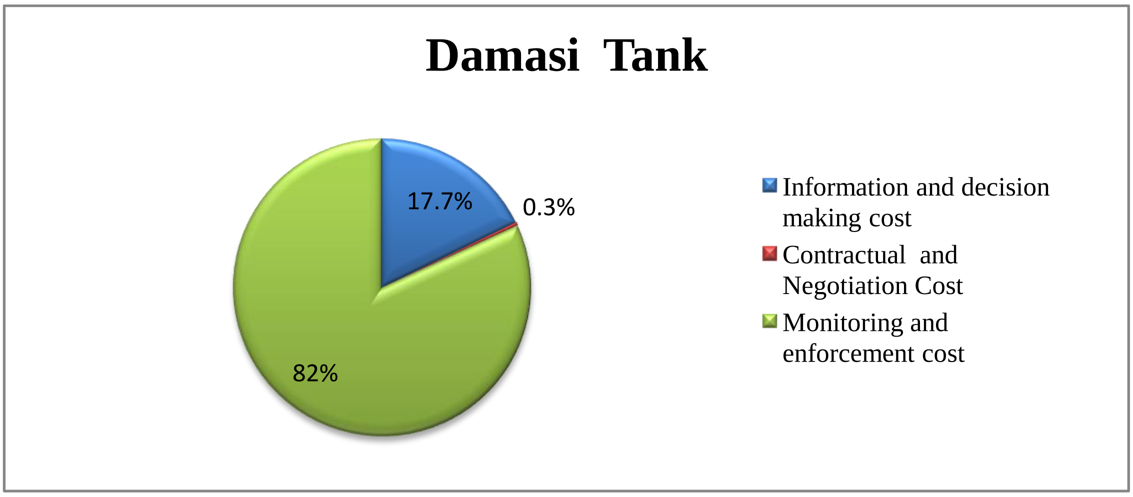
(Figures in the parenthesis indicate percentage to total)

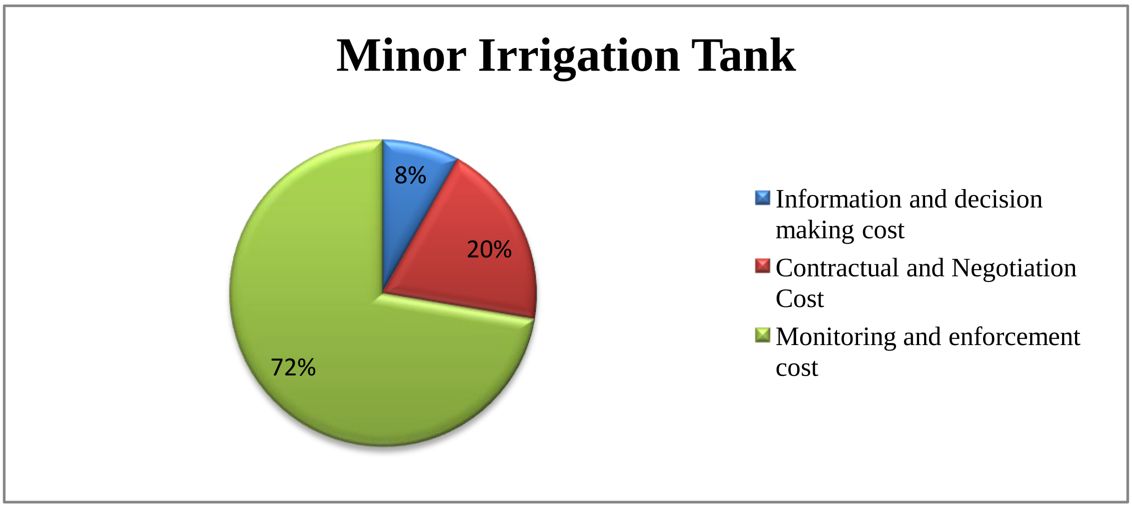
5.4.4 Different mode of transaction cost

Transaction costs incurred in tank irrigation management include cash paid, value of kind given and cost of time spent by the household level in relation to tank management activities and is presented in the table 5.17. The chief mode of transaction cost is in kind which constitute 73.36 per cent of transaction cost, followed by opportunity cost of the time spent about 15.91 per cent and rest is in cash which is around 10.72 per cent of total

Fig. 5.7 Share of different components of transaction cost at household level







transaction cost. It is observed that the transaction costs incurred through payment of kind varied from Rs.830/ha in JSYS tank to Rs.905/ha in minor irrigation tank. Transaction cost is paid in kind to waterman for irrigating field, protecting crop from stray cattle and prevention of water theft from canal and field.

Transaction cost in cash is highest in minor irrigation tank management institution which accounts for about 21.84 per cent followed by JSYS with 5.51 per cent and Damasi tank with 2.89 per cent of total transaction cost. The cost paid in terms of cash is relatively high in minor irrigation tanks. This is mainly because the farm household in minor irrigation tanks have to pay Rs. 100 per acre with service charge Rs 4 to the revenue department towards water tax.

Table. 5.17 Different modes of Transaction cost

(Rs per ha of gross irrigated area)

Particulars	Tanks			All tanks
	JSYS	Damasi	Minor irrigation	
Time	268 (23.06)	191 (17.8)	104 (8.06)	187 (15.91)
Cash	64 (5.51)	31 (2.89)	282 (21.84)	126 (10.72)
Kind	830 (71.43)	851 (79.31)	905 (70.1)	862 (73.36)
Total	1162 (100)	1073 (100)	1291 (100)	1175 (100)

(Figures in the parenthesis indicate percentage to total)

5.4.5 Transaction cost incurred by sample respondents across the land holding

The analysis of transaction cost per hectare of irrigated area across the farm size category in table 5.18 revealed that transaction cost per hectare of GIA is highest for marginal farmers (Rs.1270/-per ha) followed by small farmers (Rs. 1146/-per ha), medium (Rs. 1142/-per ha) and large farmers (Rs. 1118/-per ha). It is evident that there is an inverse relationship between the farm size and transaction costs incurred per hectare.

In JSYS tank, the transaction cost incurred by marginal farmers (Rs.1321/-per ha) is highest followed by small farmers (Rs.1071/-per ha), medium farmers (Rs. 1067/-per ha) and large farmers (Rs.877/-per ha). In Damasi tank, marginal farmers (Rs.1148/-per ha) incurred highest transaction cost followed by small (Rs.1098/-per ha) and large farmers (Rs.1028/-per ha). The medium farmers incurred lowest transaction cost. In minor irrigation tank, transaction cost per hectare of GIA is highest for large farmers (Rs.1358/-per ha) and lowest is by small farmers (Rs.1242/-per ha).

Table. 5.18 Transaction cost by farm size category

(Rs per ha of Gross Irrigation)

Land Holdings Pattern	Tanks			All tanks
	JSYS	Damasi	Minor irrigation	
Marginal	1321	1148	1314	1270
Small	1071	1098	1242	1146
Medium	1067	926	1314	1142
Large	877	1028	1358	1118
OVERALL	1162	1073	1291	1175

5.4.6 Transaction cost per ha per irrigation incurred by sample respondents across the social status

The caste plays a major role in functioning of organisations at village level. Traditional systems are characterised by caste-based organizational structure. Community participation in tank irrigation management is strongly shaped by structures of power and authority and their cultural construction of the community (Mosse, 1998). So, one can expect that the social status of the households had a considerable influence on the transaction cost they incur.

Transaction cost incurred by the respondents across their social status in institution is presented in the Table 5.19. It could be observed that the average transaction cost per hectare household in all tanks for non-dominant caste is worked out to Rs.1191/- per ha and for the dominant caste is worked out to Rs.1164/- per ha.

In JSYS tank, average transaction cost per hectare for non- dominant caste (Rs. 1179 per ha) is higher than that of dominant caste (Rs.1140 per ha). Average of information and decision making cost of households from non-dominant caste (Rs.317 per ha) is higher than that of dominant cost (Rs.191 per ha). Contractual cost is again highest for dominant caste

Table. 5.19 Transaction cost per ha per irrigation incurred by sample respondents across the social status

(Rs per ha gross Irrigated area)

Particulars	Tanks									All tanks		
	JSYS			Damasi			Minor irrigation					
Social Status	**DC**	**NDC**	**OV**	**DC**	**NDC**	**OV**	**DC**	**NDC**	**OV**	**DC**	**NDC**	**OV**
Information and Decision Making Cost	191 (16.75)	317 (26.89)	261 (22.46)	192 (17.81)	187 (17.69)	191 (17.8)	61 (4.69)	161 (12.61)	105 (8.13)	150 (12.89)	236 (19.82)	186 (15.83)
Contractual and negotiating cost	50 (4.39)	29 (2.46)	38 (3.27)	5 (0.46)	0 (0)	4 (0.37)	266 (20.43)	233 (18.25)	252 (19.52)	99 (8.51)	96 (8.06)	98 (8.34)
Monitoring & Enforcement Cost	899 (78.86)	833 (70.65)	862 (74.18)	881 (81.73)	870 (82.31)	879 (81.92)	974 (74.81)	882 (69.07)	933 (72.27)	915 (78.61)	858 (72.04)	891 (75.83)
Total	1140 (100)	1179 (100)	1162 (100)	1078 (100)	1057 (100)	1073 (100)	1302 (100)	1277 (100)	1291 (100)	1164 (100)	1191 (100)	1175 (100)

(Figure in parenthesis is percentage to the total) Note: DC-Dominant Cast, NDC-Non dominant caste and OV-Overall households (Rs.50 per ha) than non-dominant caste households (Rs.29 per ha). The scenario is slightly different in Damasi and minor irrigation tanks where the total transaction cost incurred by the household is little higher for dominant caste when compared to non-dominant caste households.

5.4.7 Transaction cost incurred by type of functionaries

Transaction cost incurred by the respondents by type of functionaries in institution is presented in the Table 5.20. It could be observed from table that Supervisory level functionary (SLVF) incurred highest average transaction cost per hectare which is work out to be Rs.1291/- per hectare. The average transaction cost per hectare is lowest for other farmers Rs.1112/- per hectare. Average transaction cost per hectare is highest for SVLF in minor irrigation tank with Rs.1375/- per hectare and lowest for SVLF in Damasi tank with Rs.1081/- per hectare. Transaction cost per hectare of SVLF in JSYS tank is Rs.1369/- per hectare

In JSYS tank, the average transaction cost per hectare is higher for SLVF (Rs.1369/- per ha) and that of other farmers is (Rs.1016/-per ha). Information and decision making cost is higher for the SVLF (Rs.380/-per ha) whereas for other farmers it's (Rs.178/-per ha). SVLF of JSYS along with the annual general body meet and two seasonal meets which is attended by all the farmers, the supervisory level also conduct and attend three governing body meets annually to maintain accounts, minutes reports, audit reports and organized tank festivals which accounts for the high cost information and decision making cost for SVLF of JSYS tank. Contractual cost of SVLF (Rs.51/-per ha) in JSYS tank is greater than that of other farmers (Rs.29/-per ha). This is accounted by the commuting expenses and opportunity cost of time for commuting and negotiating for auditing, maintaining account, filing of income and expenditure statement and fund mobilization from developmental departments for tank infrastructure improvement activity by SVLF. Higher monitoring and enforcement cost for SVLF (Rs.937/- per ha) is accounted by contribution in term of time for implementation of tank improvement works in addition to value of kind and cash paid to neerganti.

Table. 5.20 Transaction cost per ha per irrigation incurred by sample respondents by type of functionaries

(Rs per ha of Gross Irrigated area)

Particulars	Tanks									All tanks		
	JSYS			Damasi			Minor irrigation					
Functionaries	SVLF	OTH	OV	SVLF	OTH	OV	SVLF	OTH	OV	SVLF	OTH	OV
Information and Decision Making Cost	380 (27.76)	178 (17.52)	261 (22.46)	143 (13.23)	211 (19.72)	191 (17.8)	111 (8.07)	103 (8.27)	105 (8.13)	225 (17.43)	165 (14.84)	186 (15.83)
Contractual and negotiating cost	51 (3.73)	29 (2.85)	38 (3.27)	12 (1.11)	0 (0)	4 (0.37)	264 (19.2)	245 (19.68)	252 (19.52)	111 (8.6)	91 (8.18)	98 (8.34)
Monitoring & Enforcement Cost	937 (68.44)	810 (79.72)	862 (74.18)	925 (85.57)	859 (80.28)	879 (81.92)	1001 (72.8)	897 (72.05)	933 (72.27)	955 (73.97)	857 (77.07)	891 (75.83)
Total	1369 (100)	1016 (100)	1162 (100)	1081 (100)	1070 (100)	1073 (100)	1375 (100)	1245 (100)	1291 (100)	1291 (100)	1112 (100)	1175 (100)

(Figure in parenthesis is percentage to the total)

Note: SVLF-Supervisory Level Functionary, TE- Subordinate Level Functionary and OTH- Other Farmers

In Damasi tank, there was only a narrow difference between average transaction cost per hectare of SVLF (Rs. 1081/- per ha) and that of other farmers (Rs.1070/- per ha). In contrary to JSYS tank Information and decision making cost is lower for the SVLF (Rs.380/- per ha) whereas, for other farmers it's (Rs.178/-per ha). In Damasi only two seasonal meetings are held for appropriation of water and organize tank festivals (deepothosava) in which all farmers participate.

It can be observed that contractual cost is incurred only by supervisory level (Rs.12/- per ha) for fund mobilization from developmental department for tank improvement work. Similar to JSYS tank, Monitoring and enforcement cost is highest in the SVLF (Rs. 925/- per ha) which is again accounted by opportunity cost time for implementation of tank improvement works in addition to value of kind and cash paid to neerganti.

In Minor irrigation tank, the average transaction cost per hectare is for SLVF (Rs.1369/- per ha) is greater than that of other farmers (Rs.1016/-per ha). Information and decision making of SVLF (Rs.111/-per ha) and for other farmers it's (Rs.103/-per ha). Since the minor irrigation tank provides water for one irrigation in rabi season only a single meeting is held at village level for appropriation of water and organize tank festivals (deepothosava). Contractual cost for SVLF (Rs.264/-per ha) is greater than that for other farmers (Rs.245/-per ha), SVLF along with paying water tax, also attended taluk irrigation consultative committee meet to avail permission to use water for irrigation. Similar to other two tanks, supervisory level incurred highest monitoring and enforcement cost (Rs.1001/- per ha), it may be due to higher payment of cash and kind to Neerganti for enforcing decision of supervisory level.

5.4.8 Transaction cost per ha per irrigation incurred by sample respondents across the proximity of holding to the resource

The details of the transaction cost incurred by sample respondents across the region are presented in the Table 5.21. It could be seen that though there are no much variation in transaction cost incurred by households across regions the transaction cost is little higher in tail end region than in head end region. It is mainly because the farmers whose holdings located in the tail end region have to spend little more time in search of information, payment to neerganties and negotiation.

Table. 5.21 Transaction cost per ha per irrigation incurred by sample respondents across the proximity of holding to the resource

(Rs per ha per Irrigation)

Particulars	All Tanks											
	JSYS			Damasi			Minor irrigation			All tanks		
Location	**HE**	**TE**	**OV**	**HE**	**TE**	**OV**	**HE**	**TE**	**OV**	**HE**	**TE**	**OV**
Information and decision Making Cost	282 (24.23)	240 (20.71)	261 (22.46)	153 (14.43)	224 (20.66)	191 (17.8)	101 (8.08)	110 (8.26)	105 (8.13)	179 (15.43)	192 (16.15)	186 (15.83)
Contractual and negotiating cost	29 (2.49)	47 (4.06)	38 (3.27)	8 (0.75)	0 (0)	4 (0.37)	236 (18.88)	268 (20.14)	252 (19.52)	93 (8.02)	103 (8.66)	98 (8.34)
Monitoring and Enforcement Cost	853 (73.28)	871 (75.15)	862 (74.18)	899 (84.81)	860 (79.34)	879 (81.92)	913 (73.04)	954 (71.68)	933 (72.27)	888 (76.55)	894 (75.19)	891 (75.83)
Total	1164 (100)	1159 (100)	1162 (100)	1060 (100)	1084 (100)	1073 (100)	1250 (100)	1331 (100)	1291 (100)	1160 (100)	1189 (100)	1175 (100)

(Figure in parenthesis is percentage to the total)

Note: HE-Head End, TE-Tail End, and OV-Overall

5.4.9 Transaction cost net returns and cost of cultivation

Paddy is the major crop cultivated in tank command area of all three tanks. It could be observed from the table 5.22 that average cost of cultivation per hectare of paddy is worked out to Rs. 48,387/- across all three tanks. Average cost of cultivation per hectare is found to be highest in minor irrigation tank management institution with Rs. 50,170/- per ha followed Damasi tank with Rs. 48,124/- and JSYS tank with Rs. 46,865/-.

The percentage of average transaction cost per hectare is 2.43 per cent to average cost of cultivation. The average percentage of transaction cost per ha to total cost of cultivation is highest in minor irrigation tank with 2.57 per cent and lowest in Damasi tank with 2.23 per cent and that of JSYS tank is 2.48 per cent. The findings of the present study are consistent with those of Bhattarai (2010) who shows that the transaction time is relatively low for FMIS amounting to 5 per cent to that of total time required for the production of crops.

An average net return of paddy per hectare in all three institutions is found out to be around Rs. 19,629/- per hectare ranging between Rs. 10,378/- in Damasi tank to Rs. 28,830/- in JSYS tank. Average net returns per hectare is found to be highest in minor irrigation tank management institution with Rs. 20,737/- per ha followed by JSYS tank with Rs. 19,334/-and Damasi tank with Rs. 18,815/-.

Average transaction cost per hectare is 5.99 per cent of average net returns per hectare. The average percentage of transaction cost per ha to net returns per ha is highest in minor irrigation tank with 6.23 per cent and lowest in Damasi tank with 5.70 per cent and that of JSYS tank is in-between with 6.01 per cent.

Table. 5.22 Transaction cost per ha, net returns and cost of cultivation.

Particulars	Tanks			All Tanks
	JSYS	Damasi	Minor irrigation	
Cost of cultivation in Rs Per ha	46865	48124	50170	48387
Net Returns in Rs Per ha	19334	18815	20737	19629

Transaction cost per ha	1162	1073	1291	1175
Transaction cost as percentage cost of cultivation	2.48	2.23	2.57	2.43
Transaction cost as percentage of Net returns	6.01	5.70	6.23	5.99

5.4.10 Factors influencing transaction cost incurred by farm households

The magnitude of influence of various factors on transaction cost was analyzed with the help of multiple linear regression model, in which the transaction cost per household in rupees (TC) is the dependent variable while the independent variables are the age in years (AGE) and educational level of respondents in years (EDU), membership in number of organisation (MO), Supervisory level functionary (SVLF), owning of well in command (DOWL), FSIZE size of the land holding, Dummy variable for Damasi (DM) and Minor Irrigation (MI). The descriptive statistics of all the variables used in econometric model are presented in the table 5.23

Table. 5.23 Descriptive statistics of the Variables included in the econometric model

Variables	Descriptive Statistics				
	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
TOT_TC (Rs per house hold)	102	514.75	576.46	37.25	2591.75
AGE (Years)	102	53.92	11.74	30.00	86.00
EDN (Years)	102	3.21	4.06	0.00	15.00
SVLF (Dummy)	102	0.25	0.43	0	1.0
MO (Number)	102	1.49	1.11	0	4.0
DOWL (Dummy)	102	0.23	0.42	0	1.0
FSIZE (In ha)	102	2.40	2.79	0.10	19.4
DM (Dummy)	102	0.33	0.47	0	1.0
MI (Dummy)	102	0.33	0.47	0	1.0

It could be observed from table 5.24 that the estimated function is valid for interpretation as shown by F statistics which is significant at one per cent level. Further, the function had coefficient of multiple determination (R^2) value 0.72 which would indicate that 72 per cent of the total variations in transaction cost are explained by the explanatory variables included in the model.

Table. 5.24. Regression results of factors influencing the transaction cost.

Variables	Coefficients	t Stat
CONSTANT	-216.49	-1.1849
AGE	2.28	0.8388
EDU	18.15	2.1125**
DSVLF	233.81	3.0573***
MO	78.27	1.9157*
DOWL	108.20	1.3461
FSIZE	124.66	8.7274***
DM	-190.51	-2.3245**
DMI	346.25	3.1857***
Adjusted R Square	0.71	
F	31.8926	
N	102	

NOTE: *** significance at 1 % level; ** significance at 5 % level; * significance at 10 % level

It could be seen that variables educational level of head of household (EDN), Supervisory level functionary (SVLF), membership in number of organisation (MO), farm size (FSIZE), Damasi (DM) and Minor Irrigation (MI) significantly influence the transaction cost per hectare in tank irrigation management.

The education level of the respondents has a significant positive influence on the transaction cost of house hold. Education is one of the human capital indicators important in facilitating negotiations, bargaining and resolving conflicts in the tank management process. Respondents with a higher level of education incur higher costs as they participate actively in tank management activities so as to influence in the community and can motivate members to work together.

The dummy variable for the type of functionary has a significant positive influence on transaction cost incurred by household. The SVLF has significant positive influence on transaction cost. The supervisory level functionary plays an active role in initiating collective action, willing to invest more time and resource in tank management activity and hence incur higher transaction cost.

The member in number of organizations has significant positive influence on transaction cost incurred by household. Membership in number of organisation of household is a social capital indicator and establishes the respondent's willingness to actively participate in tank management activities and thus a positive influence on transaction cost.

Size of land holding a proxy for wealth of the household has a significant positive influence on transaction cost. Transaction cost per household increases with increase land holding as household. Generally large farmers required paying more in form of kind to neerganti for irrigating and protecting field from stray cattle sometimes wealthy households supplement collective resources with their own.

The type of tanks has significant bearing on the transaction costs incurred by households. This is evident from the type variables viz., DM and MI found to significantly influence the transaction incurred by the household.

Thus it could be concluded that transaction cost incurred by farmers in tank irrigation management is positively influenced by education, membership in different organization and role played by house hold in tank management and type of institutional arrangement..

5.5. Problems in tank irrigation management

In order to know the major problems faced in tank irrigation management as perceived by officials of minor irrigation department, Panchayath raj engineering department and JSYS project implementing agency. It could be observed from the table 5.25 problem such as silting of tanks, no proper cropping plan, inadequate finance are major problems in tank irrigation management. The problems like poor distribution, encroachment of feeder channel, tank bed, lack of farmer's participation in tank management also assume importance.

Table. 5.25. Problems in tank irrigation management

Sl. No.	Particulars	Score	Rank
1	Silting of tank	57.55	I
2	No cropping plan based on water availability.	47.73	II
3	Inadequate financial strength for functioning of tank management institutions.	47.45	III
4	Poor Water Distribution	46.36	IV
5	encroachment of feeder channel	45.18	V
6	Encroachment of tank bed	42.45	VI
7	Lack of Farmer Participation	36.82	VII
8	Involvement of multiple agencies and lack of coordination	30.73	VIII
9	No information about Quantum of Water	25.45	IX
10	Lack of knowledge about value of water	25.45	X
11	Political Intervention for function of tank	16.55	XI
12	Sand Mining in Streams	7.09	XII
13	Scattered Rainfall and Scanty Rainfall	7.00	XIII
14	Unplanned Utilization at Head end	6.64	XIV

CHAPTER VI

SUMMARY AND CONCLUSION

A brief summary of the research results along with the salient findings is presented in this chapter. Based on the conclusions drawn from this study, policy options are suggested for planners and administrators connected development tank irrigation.

Tanks are one of the most important common property resources in rural India benefiting the livelihood security of people. Tanks cater to the water requirement of village communities for irrigation, washing and feeding of livestock, fishing and other domestic needs of the household like drinking, bathing, washing etc. Some of the intangible benefits of tanks are insulation from floods and drought and vagaries of monsoon, groundwater recharge and improvement of micro climate around tank ecosystem, much of all offer livelihood security to people living in rural areas.

Irrigation is one of the important functions and utility of the multipurpose water harvesting tanks. It is not only prospective but also necessary to sustainably mange tank resources. Several studies had emphasized that people's participation in irrigation management programs is essential for its success. This has triggered the devolving of management responsibility of irrigation from the state to users by creating institutions involving farmers in the management. Transaction costs are unavoidable in functioning of any economic system. Accounting the transaction cost is necessary when evaluating the potential of new institutions as alternatives to existing institutions. With the increase of users participation, the transaction cost which was sidelined all through the years has gained importance.

Realizing the significance of transaction cost in tank irrigation management, the present study makes an attempt to assess the transaction cost in tank irrigation management and the factors influencing the transaction cost under different tank management institutional arrangements in Kolar district of Karnataka state. The overall objective of the study is to assess the functioning, performance of irrigation tanks and transaction cost involved in tank irrigation management under different institutional structures and organisational set up. The specific objectives include: (1)

to study the functioning and performance of tank irrigation institutions under different institutional arrangements (2) to identify and quantify the transaction costs involved in tank irrigation management under different institutional arrangements (3) to examine factors which affect transaction cost in tank irrigation management and (4) to suggest policy measures to improve tank management and achieve sustainability in functioning of institutions.

The Kolar district was selected as it had highest density of tanks besides the presence of different types of institutional arrangements in tank management. Accordingly three tanks each representing the type of institutions namely, (i) Formal community based TMI represented by JSYS tank, (ii) informal community based TMI delineated by Damasi tank and (iii) formal centralized TMI represented by minor irrigation tank were selected purposively from Kolar district as case for the study. Total sample comprising of 102 farmers representing 34 from each tank were drawn randomly from the three selected tanks.

6. Salient findings

6.1. General characteristics of tank and sample respondents

The age of the head of the house hold ranged between 45 to 60 years. Members in the age group below 30 years were least likely to head the family, take decisions and participate in tank management. Literacy level of the sample respondents indicated that illiterates were highest in JSYS TMI (67.65 %). The stratification of sample respondents based on role they played in tank management activities reveal that 24.51per cent were supervisory functionaries. Social status of the sample respondents showed that 58.82 per cent belonged to the dominant caste. Dominant caste is highest in Damasi tank (76.47%), followed by minor irrigation tank (55.88 %) and JSYS tank (44.12 %). This also indicates the existence of social homogeneity in Damasi tank. Small farmers were highest across all three tanks followed by marginal farmers (27.45%). Tank supported people’s livelihood through irrigation and non irrigational benefits. The chief non irrigational benefits obtained from tank constituted livestock related activities like fodder harvesting, grazing and cleaning of livestock in addition to use of tank water for domestic purposes. All the three study tanks had revenue generated out of fisheries which was utilized for common purposes. About 87.25 per cent of sample respondents possessed livestock across all three tanks.

Fodder availability in tank ecosystem supported higher hybrid cow and bullock pair holdings.

6.2. Functioning of Tank Management Institutions

6.2.1. Organization structure

JSYS tank management has a governing body and general body. Governing body included President, Secretary, Treasurer and Executive members selected from among farmers. General body consists of all farmers of the command area.

Damasi system is a traditional system of tank irrigation management. This system consists of supervisory level and the subordinate level. Supervisory level is usually at the rank of village heads who were engaged in more of decision making as an enforcing authority at tank level. Subordinate functionary is directly involved in menial labor such as assembling the farmers, announcing the decisions of the supervisory level, appropriation of water for irrigation as facilitated by the supervisory level.

Minor Irrigation tank is managed by Minor Irrigation (MI) department, Government of Karnataka. In minor irrigation tanks, farmers managed and monitored the water distribution by appointing the Neerganti (Water man) at tank level with permission from Taluk Irrigation Consultative Committee (TICC) for irrigation. Major tank management and maintenance activities are being taken up by the Minor Irrigation department.

6.2.2. Tank Management activity taken up in different tanks

In JSYS tank annually six meetings were held which included three governing body meetings, two seasonal meetings one each in Kharif and Rabi season for appropriation of water and one general body meet. In Damasi tank, only two seasonal meetings are held in Kharif and Rabi season for appropriation. In Minor irrigation tank two meetings, one at taluk level and one more meeting at tank level is held before appropriation of water in Rabi season.

Household's from Damasi tank with well defined and accepted norm for water sharing had the lowest average time spent in meeting for appropriation (2.04 hr per meeting), followed by JSYS tank (2.19 hr per meeting) and minor irrigation tank (2.31 hr per meeting).

JSYS tank being a formal community based TMI undertook more revenue generating activities viz., auctioning of trees in foreshore, fish auction, sharing of green leaf manure from commons and regular auction of fodder on bund. Damasi TMI being an informal community based tank management institution had generated revenue through auctioning of fish and fodder. In minor irrigation tank only fish was auctioned to get revenue.

6.3. Institutional Performance

6.3.1. Collective action and participation

Farmers gave more importance to canal cleaning activity than meetings which ensured efficient flow of irrigation water to command area. Participation in canal cleaning activity was highest in Damasi tank (88.24 %) followed by JSYS tank (85.29 %) and minor irrigation tank (82.35 %).

Participation rate in seasonal meeting was highest in Damasi tank (79.41%) followed by JSYS tank (78.70%) and Minor Irrigation tank (58.82%). One can conclude that participation rate in meetings and decision making is lowest in minor irrigation tank as compared to that of other community based tank management institutions.

Fund mobilization for maintenance and improvement of tank infrastructure in JSYS tank was Rs1474/- per ha, followed by Damasi tank (Rs1238/- per ha) and there was no tank improvement and fund mobilisation activity in minor irrigation department during the reference period. Revenue generation was highest in JSYS tank (Rs.1305/-per ha) followed by Damasi tank (Rs. 524/- per ha) and Minor irrigation tank (Rs. 571/- per ha).

6.3.2. Household Participation Index

The performance of each tank is evaluated based on household’s participation in collective action and decision making in tank management activities. JSYS tank recorded highest household participation (63.48%) followed by Damasi (57.92%) and

Minor Irrigation tank (48.09). The average of household participation index is highest in JSYS for both collective action (69.12%) and decision making (51.47%).

6.3.3. Household Perception Index

Considering all the four parameters studied, the household perception index was found to be highest in Damasi (68.38%) followed by JSYS (53.31%) and Minor Irrigation (45.22%). Household perception about functioning of tank was highest in Damasi tank for all components viz., water right (61.76 %), equity (73.53%), efficacy of functionaries (67.65 %) and conflict resolution (70.59%). It is observed that minor irrigation is lowest in all the components.

JSYS tank recorded high degree of collective action and decision making which was attributed to it's formal nature of institutional arrangement which facilitated the occurance of more number of meetings. Damasi functioned with well defined norms was able to express higher degree of water right, equity, efficacy and conflict resolution.

6.4. Transaction Cost

6.4.1. Transaction cost per ha between the institutions

The mean of households transaction cost per hectare was lowest for Damasi tank (Rs.1073/-), followed by JSYS tank (Rs. 1162/-) and minor irrigation tank (Rs.1291/-). ANOVA reveals that statistically the mean transaction cost per hectare in the JSYS and the Damasi both of which are community based tank management institutions are about the same but the mean transaction cost of minor irrigation which is centralized based tank management institution is significantly higher than its counter parts.

6.4.2. Transaction cost at Tank Level

At tank level, transaction cost per hectare of gross cropped area is highest for JSYS tank (Rs.97/-) followed by Damasi tank (Rs.45/-) and Minor irrigation tank (Rs.15/-). At tank level contractual cost is major component in JSYS and Minor Irrigation tank. Information and decision making cost in JSYS tank and Contractual cost in Damasi tank tank form minor component of transaction cost. There is no Monitoring and Enforcement cost in Minor Irrigation tank.

6.4.3. Transaction cost at household level

Information and decision making cost is highest in JSYS tank with Rs. 261/- per ha GIA, lowest in minor irrigation tank Rs. 105/- per ha GIA and that of Damasi tank is in between with about Rs. 191/-per ha GIA using tank water. Contractual cost is highest in minor irrigation tank with Rs. 252/- per ha GIA followed by JSYS tank with Rs. 38/- per ha GIA and Damasi tank with Rs. 4/ per ha GIA. Monitoring and Enforcement cost is highest in minor irrigation tank with Rs. 933/- followed by Damasi tank with Rs. 879/- per ha GIA and JSYS tank with Rs. 862/- per ha GIA. Monitoring and enforcement cost forms the major component of transaction cost in all tanks and contractual cost the forms minor component in case of JSYS and Damasi tank. However, information and decision making cost forms minor component in minor irrigation tank.

6.4.4. Transaction cost across the land holding, Functionary, Social Status

The analysis of transaction cost per hectare of irrigated area across the farm size category revealed that transaction cost per hectare of GIA is highest for marginal farmers.

The aggregate average transaction cost per hectare of was highest for supervisory functionary for all components of transaction cost than other farmers. Supervisory level functionary actively involved and was willing to invest more time and resource in tank management activity.

The aggregate average transaction cost per hectare GIA of respondents from dominant caste was greater than that of respondents from non-dominant caste in all the Damasi and minor irrigation tank. Whereas transaction cost per hectare of GIA for households from non dominant caste was high in JSYS tank.

There were no much variation in transaction cost incurred by households across regions. The transaction cost was little higher in tail end region than in head end region. It is mainly because the farmers whose holdings located in the tail end region spent little more time in meeting for negotiation and conflict resolution and payment to neerganties.

Aggregate average transaction cost per hectare was 5.99 per cent of average net returns per hectare. The average percentage of transaction cost per ha to net returns per ha was highest in minor irrigation tank (6.23%) followed by JSYS tank (6.01%) and Damasi tank (5.70%).

The percentage of average transaction cost per hectare was 2.43 per cent to average cost of cultivation. The average percentage of transaction cost per ha to total cost of cultivation is highest in minor irrigation tank (2.57%), followed by JSYS tank (2.48%) and Damasi tank (2.23%).

6.4.5. Factors influencing Transaction cost

The education level of the respondents has a significant positive influence on the transaction cost of house hold. Respondents with a higher level of education incur higher costs as they participated actively in tank management activities so as to influence the community and can motivate members to work together.

The dummy variable for the type of functionary had a significant positive influence on transaction cost incurred by household. The SVLF has significant positive influence on transaction cost. The supervisory level functionary plays an active role in initiating collective action, willing to invest more time and resource in tank management activity and hence incur higher transaction cost.

The member in number of organizations has significant positive influence on transaction cost incurred by household. Membership in number of organisation of household is a social capital indicator and establishes the respondent's willingness to actively participate in tank management activities and thus had positive influence on transaction cost.

Size of land holding a proxy for wealth of the household had a significant positive influence on transaction cost. Transaction cost per household increases with increase land holding as household. Generally large farmers required paying more in form of kind to neerganti for irrigating and protecting field from stray cattle sometimes wealthy households supplement collective resources with their own.

The type of tanks had significant bearing on the transaction costs incurred by households. This is evident from the type of variables viz., DM and MI found to significantly influence the transaction incurred by the household.

Thus it could be concluded that transaction cost incurred by farmers in tank irrigation management is positively influenced by education, membership in different organization and role played by house hold in tank management and type of institutional arrangement.

7. **Policy implication**

1. Transaction cost in tank irrigation management is unavoidable. Hence WUA may be encouraged to mobilize funds to meet out the transaction cost.

2. Funds allocated by development departments towards tank maintenance may apportion considerable amount towards meeting out transaction cost by WUA.

3. Experience indicated that presence of formal body enabled the WUA to mobilize funds from various developmental departments towards maintenance of tank. Hence awareness may be created to form registered WUA giving due importance to existing institutional practices such as collective action, local norms for sharing of water and celebration of tank festivals which play a pivotal role in sustaining collective action.

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