TRANSACTION COST ECONOMICS OF RICE IRRIGATION SYSTEMS IN TANZANIA: IMPLICATIONS FOR COLLECTIVE ACTION

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A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ECONOMICS OF THE OPEN UNIVERSITY OF TANZANIA

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CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the Open University of Tanzania a thesis entitled: "**Transaction Cost Economics of Rice Irrigation Systems in Tanzania: Implications for Collective Action"** in fulfillment of the requirements for the Degree of Doctor of Philosophy of the Open University of Tanzania.

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Date

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DECLARATION

I, **George Barnabas Sonda**, do hereby declare that this thesis entitled: Transaction cost economics of rice irrigation systems in Tanzania: Implications for collective action” is a result of my own original work and that it has not been presented to any other University for a similar or any other degree award.

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Signature

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Date

DEDICATION

To my mum, Mary Sayilwa (RIP), and to my dearly loved family: Mum you always took pride in my academic success, it is pity that you did not live to see this day; to my family- particularly my dear wife Veronica, and beloved children: Geoffrey Ngello, Laurent Magoti, and little girl Laura Sayilwa- this day is seen because of your perseverance of hard time you faced in my absence but also prayers you made during my studies.

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ABSTRACT

The institution mechanisms for the organisational and coordination aspects in a collective action (CA) on irrigation systems of Tanzania have not been given sufficient attention. Consequently, smallholder rice irrigation systems, which are either traditional improved or modern schemes, perform poorly in operations and maintenance of infrastructures, water management, respect of bylaws and regulations. Contrary to the collective incentives previously studied in managing the irrigation systems, the novelty of this study is the focus of analysis on the transaction costs (TC) of collective action and the factors, which influence the institutional quality based on individual resource user incentives**.** The study combined cross sectional and panel data designs to address the different objectives. Using different econometric analyses techniques (Heckman sample selection, Mixed effect linear model, SFA and 2SLS) in each objective, four major findings emerged: Self-selection effect has greater impact on CA survival; the TC related to contact, and control influence the institutional quality; CA affect the technical efficiency and allocation of factors of production; and farm household objectives was an important incentive for CA coordination. The study concludes that self-selection effect factors are important criteria for CA member recruitment, and that the institutional quality is improved by managing TCs. CA leads into technical inefficiency and over use of factors of production. Farm household objectives influence coordination efficiency. The study recommends consideration of self-selection effect factors, and TCs-contact and control increase, along with TCs attributes asset specificities: site specificity like soil fertility, water, market access, and human capital assets development on technologies application and agri business oriented production for successful CA.

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LIST OF ABBREVIATIONS

2SLS	Two Stage Least Square
AE	Allocative Efficiency
ARI	Agricultural Research Institute
CA	Collective Action
CI	Cropping Intensity
EAAPP	Eastern Africa Agricultural Productivity Program
FSZ	Farming System Zone
GMM	Generalized Method of Moments
IV	Instrumental Variable
Kg	Kilogram
Km	Kilometres
LIML	Limited Information Maximum Likelihood
LN	Natural logarithm
LVB	Lake Victoria Basin
MAFSC	Ministry of Agriculture, Food Security and Cooperatives
MFC	Marginal Factor Cost
MLE	Maximum Likelihood Estimation
MPP	Marginal Physical Product
O &M	Operation & Maintenance
OLS	Ordinary Least Square
SACCOS	Savings and Credit Cooperative Society

SFA	Stochastic Frontier Analysis
SSA	Sub Sahara Africa
TC	Transaction Cost
TCE	Transaction Cost Economics
TE	Technical Efficiency
TZS	Tanzania Shillings (currency)
VMP	Value Marginal Product
WMC	Water Management and Control
WUA	Water Users Association

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Governments in developing countries worldwide have transferred, in a varying degrees, the rights and management responsibilities for natural resources such as forestry, rangelands, protected areas, and water particularly, irrigation systems and water sheds to the communities (Meinzen-Dick, 2004; Araral, 2008; Behera, 2009). This policy shift is a response towards among other factors, greater awareness of the governments in regard to incentive problems amongst these resources management. As such the expectation has been that ‘‘since these resources are usually important to the livelihood of the users themselves, they will in that case manage such resources more efficiently, equitably, and sustainably than government bureaucrats per see’’.

In Tanzania, common property rights in the form of common water right permit that is granted collectively to the groups of water users in a collective action setting has been the policy instrument implemented to ensure management of irrigation systems (NIPO, 2009). The common water rights permit is an institution with clearly defined property rights and legal aspects considered to allow contracts to be enforced for water resource utilization by water users, based on collective management of the group of water users. It requires that water users organize themselves into groups before they are granted the common water right permit to access water. In consequence, organized user-groups in a collective action setting are considered as a strategy that translates into efficient performance of irrigation systems. The irrigation systems are either traditional improved schemes, defined as ones, which were initiated by farmers and later on improved by the government/external agents, or modern schemes that are characterized by high level of mechanization, constructed by external agents (NIPO, 2009; Matekere and Lema, 2012).

Understanding the determinants of performance has been a central concern because most irrigation systems perform poorly contrary to the envisaged expectations, as a result low level of irrigation farming practice is evident (Water sector, 2009; You et al. 2010). This low level of farming practice is characterized by two main features: frequent entry and exit of farmers; and smaller cultivated land area compared with their holdings (Msuya and Isinika, 2011; MAFC, 2011). It has been argued that a number of factors have contributed to the problem, like poor operation and maintenance of infrastructure, poor water management and control, inefficient extension services (NIPO, 2009; SUA, 2010), and farmers' disregard of by-laws (Rajabu and Mahoo, 2008). Practically, these underlying contributing factors are manifestation of a lack of collective action amongst farmers. Theories of common natural resources management suggest that "failure to abide by mutual obligations is a deterrent to collective action efforts'' (Wade, 1987; Ostrom, 2002, 2010).

Collective action (CA) has been defined in several ways, but the definition common to all authors is "the tendency for a group of people with shared interest to act together in pursuit of those interests'' (Oliver, 2004; Araral, 2008; Becker, 2012). The concept of CA is closely linked to property rights, implying the presence of an "authority that undertakes a particular action to enforce in a specific domain, e.g. the right of access, withdrawal, management, exclusion and alienation''. In other words, it is a function of legal rules, organisational form, enforcement, norm and behaviour.

In this regards, the benefits and process of CA institution management entail some costs arising from the transaction or actions undertaken between individuals involved. According to Commons, (1934) cited in Groenewegen et al. (2010) transaction comprises a legal transfer of ownership, which, include exchange of rights and duties – it correlates law, economics and ethics. As such, CA involves varying degrees of transaction costs (TCs) in order for the farmer organisations to function and realize benefits from efficient coordination of resource utilization (Marshall, 2013).

The coordination of economic activities creates costs due to imperfection and uncertainty in the economic system. According to Groenewegen et al. (2010), TCs have been grouped into three categories of costs (i) contact costs, which are related to search and information cost aspects. For example, one may incur expenses like phone expenses or travel costs in the process of striking deals, (ii) contract costs, which comprise of negotiation issues and concluding contracts such as service costs of an agent, and (iii) control cost, which entails monitoring and enforcement costs to ensure compliances of the agreements among parties.

At the same time, TCs can take several forms, and normally vary from system to system. For example, in the irrigation systems, farmers can mobilize labour and or money for operation and maintenance of irrigation infrastructures, agree on the mechanisms of water allocation, distribution of benefits, control and enforcement of rules and regulations set there in, as well as make use of the farmer group(s) as a capital or social network to mobilize and contact various support services like research, extension, marketing arrangements and credit services among others to enhance their irrigation resource utilization for their livelihood improvement. Clearly, all these functions are integral part of the CA organisational and coordination aspects, which are the transaction costs elements that can vary in the magnitude depending on the mode of governance, leadership, and how members value the collective action institution (Williamson, 2007; Groenewegen et al, 2010). Therefore, understanding better the working of CA is important to make irrigation systems, farmer organisations and cooperation, and agri- business chains management and policies in Tanzania more effective.

Little or none is debated in the literature on the actual working of CA and its mechanism of organizational efficiency in the irrigation systems. Several authors, Agrawal, (2000), Meinzen-Dick, (2000), and Ostrom, (2002,2010), have identified factors such as group size, physical characteristics of the common resource, and characteristics of resource users in influencing collective action successfulness in the commons. Others, Komakech et al. (2012) studied how local institutions emerge to facilitate CA in a small water catchment area in Tanzania; they argued that a combination of inequalities and interdependence of resource users explain sustained CA. Altogether, these studies provided insights on factors, which facilitate CA, but they did not explicitly tell how such factors affect the CA.

For example, how member farmers self-select into groups or farming types, and where do these difference come from (Lanteri, 2008), how TCs and physical variations due to uncertainty of the resource use or inequalities and interdependence of members and resource users preferences affect CA organisational coordination efficiency, strategic management on the institutional quality, and how TCs embedded in CA affect technical efficiency and production factors allocation in the irrigation systems performance.

The aim of this study was to fill such gaps by analyzing in detail the transaction costs of collective action and the factors behind the institutional quality influence on the rice irrigation systems performance in the Lake Victoria basin of Tanzania. In particular, evaluate the attitudinal behaviour among farmers and the nature of CA survival: self selection effects, commitments there in and transaction costs involved and institution quality status, building on the work of Komakech et al. (2012), and the various studies e.g. Wade, (1987), Ostrom, (2002, 2010), Araral, (2012) and Lanteri (2008).

Criteria generated from household decisions are important indicators (factors) for performance evaluations. Indicators that farmers themselves have consensus are easy to monitor and evaluate, this will help the irrigation schemes performance and policies in Tanzania to be more effective.

1.2 Problem Statement

Despite endowment for water resources and government policy efforts directed towards investment on irrigation development (Walter, 2008; MAFSC, 2013), smallholder irrigation schemes still perform poorly in Tanzania. In fact, the poor performance is observed in low level of irrigation practices (You et al. 2010). Yet, most of the interventions have been from top down mainly focusing on development of infrastructure rather than on the participants and extension services. Though, common property rights granted collectively to the groups of water resource users in a collective action setting has been the policy instrument implemented to accommodate participants to ensure efficient performance of irrigation schemes management (NIPO, 2009), hitherto, low level of irrigation farming practices is evident (Water sector, 2009; You et al. 2010). The area under irrigation has remained low about 6.3% of the total high to medium irrigation potential of 29.4 million hectares, and the households that use irrigation are less than 5% (NAPO, 2013), while farmers' participation in irrigation development plans on a public- private partnership basis as key actors has also been absent (Meinzen-Dick, 2015).

As a consequence, the irrigation systems' inefficient outcomes pointed out such as frequent entry and exit due to deficient in management that keeps available water from reaching entire participants' land area in the scheme (Svendsen et al. 2008), and smaller cultivated land areas compared with their holdings in various irrigation schemes, characterise the poor performance (NIPO, 2009; SUA, 2010; Msuya and Isinika, 2011; MAFC, 2011).

A number of factors have been identified out to contribute to the problem of inefficient outcomes outlined above. They include factors like poor operation and maintenance (O&M) of irrigation infrastructure, poor water management and control (WMC) (NIPO, 2009; SUA, 2010, Evans et al. 2012), and farmers' disregard of by-laws, aggravated by inefficient extension advisory services (Rajabu and Mahoo, 2008). Practically, these underlying contributing factors, especially poor O&M, poor WMC, and farmers' disregard of by-laws are attributed to a lack of collective action (CA) amongst farmers.

Collective action is an instrument that is expected to ensure irrigation system-a common pool resource functional (Ostrom, 2010). Nevertheless, the successfulness is associated with the reduction or proper alignment of transaction costs or barriers and constraints embedded in it. Several authors, Agrawal, (2000), Meinze-Dick, (2000), and Ostrom, (2000, 2010), have identified factors such as group size, physical characteristics of the common resource, and characteristics of resource users as influencing collective action successfulness. Other scholars have argued both theoretically and empirically that the openness and stability of the community is a crucial determinant of community resource management, because the higher the rate of migration, mobility, and market integration, the lower the likelihood of voluntary cooperation, or organisation (Ostrom, 2002). These studies are useful in explaining collective action conditions for successfulness, but did not explicitly tell the extent of their effects, and ignored transaction costs, which are important characteristics of the collective action. Transaction costs are the costs of contact, contract and control arising due to environmental uncertainty and human behaviour uncertainty such as risks for the contractual party's opportunistic behaviour, misappropriation of rents from transaction specific investment (Groenewegen et al 2010). This thesis focused on the transaction costs in the context of individual resource users' incentives to understand better how CA works, and how such insights can assist in aligning incentives in farmer organisation and cooperations.

1.3 Justification of the Study

Understanding better the mechanisms and organizational dynamics for the working of CA is important to make irrigation systems performance and related policies in

Tanzania more effective. Particularly, scholars have explained CA differences on natural resources management across the world by groups or sociability identification, environmental (ecology) and technology congruency, and economic factors on their own right (Wade, 1987; Ostrom, 2002). While in Sub Saharan Africa (SSA), existing studies on CA have focused on the implications of local institutions involving water, forestry and grazing land (Cleaver, 2001; Quinn et al. 2007; Deneke et al. 2011; German et al. 2012).

In Tanzania, few studies on CA e.g. Komakech et al. (2012) have been conducted - involving farmers from one village using case study that employed qualitative approach to assess how local institutions emerge to facilitate CA in a small water catchment area. They argued that a combination of inequalities and interdependence of resource users explain sustained CA. The reviewed studies are very useful in providing insights on how local institutions work.

However, most of previous work and case studies reviewed do not explicitly tell the relations between transaction costs of collective action and institutional quality in regard to household decision and irrigation performance. In particular, several authors studying CA have assumed zero transaction costs and exogenous variables, which is not realistic. They have also ignored some relevant non tangible values like social networks and helpfulness, and unobserved differences resulting from preferences among households such as livelihood strategies/adjustments like choice of farming systems, abilities and attitudes, inputs used, as well as engagement in off farm (or entrepreneurship) activities. These aspects can condition farmers' decisions to foster or deter CA successfulness (Dercon et al. 2012; Araral, 2012). Thus, this study used an innovative approach that integrates classical and institution economic theories, and employ mixed econometric analytical approaches, accounting for transaction costs, institutions, and endogeinety problems to establish cause and effect relations. This approach allows understanding better the irrigation systems performance. The outcome of such insights can help researchers, development practitioners and policy makers in reaching consensus on performance evaluation indicators/criteria measurement in the Tanzanian irrigation systems performance.

1.4 Objectives of the Study

1.4.1 Main Objective

The general objective of this study is to improve on understand the transaction costs of collective action and the factors behind the institutional quality influence on the rice irrigation systems performance in the Lake Victoria basin of Tanzania.

1.4.2 Specific Objectives

(i) To determine how self-selection effects and transaction costs, affect farmers' participation in irrigation agro ecosystem in the study area.

(ii) To identify factors influencing institutional quality in the groups of irrigation resource users.

(iii) To assess the effect of CA transaction costs embeddedness for shared irrigation resources utilization on farmers' allocation of factors of production.

(iv) To determine how farm household varying objectives affect the extent of entrepreneurship of a household in enhancing CA coordination in irrigation system.

1.5 Hypotheses

The study aim was to test the following four null hypotheses, which are derived from the literature, and are postulated to explain the efficiency working of CA in irrigation systems.

(i) Self-selection factors and transaction costs do not affect participation of farmers in irrigation ecosystem.

(ii) Transaction costs, market factors and rainfall characteristics do not influence institutional quality in irrigation group members.

(iii) Collective action does not affect farmers' technical efficiency and allocation of production factors in the irrigation scheme.

(iv) Household own individual investment decision in irrigation farming does not depend on enterprising orientation farming objectives.

1.6 Significance of the Study

This study is important and relevant to various stakeholders who are interested in economic development and growth, and those feel bad with the business as usual with regard to the waste of public funding investment in irrigation sub sector. It is important also in ensuring the value of money invested by inclusion of smallholder farmers' participation in the mainstream economy on the resources utilization and management in general.

At macro level policy formulation, the study is important to understand the challenges facing the irrigation development in the country and Sub-Sahara Africa (SSA) at large. For academia to understand and further follow up the debate on collective action functioning- framed along transaction cost and social capital theories combined with other complementary analytical approaches applied in classical economic theories. While for planners and other development practitioners it is important to understand and prioritize important critical success factors in the process to support the agricultural transformation effort envisioned, particularly understand and have consensus on irrigation systems performance evaluation indicators/criteria to be used in the provision of common pool resources.

Of paramount importance, the study is directly useful at micro level, where smallholder farmers will profit most because the study aims at understanding decisions for households' farm plan to enhance their livelihood improvement. The study will also contribute to the understanding of agricultural cooperatives and value chains coordination and management challenges. This will support sustainability of interventions by enhancing fully inclusion of different category of beneficiaries along the entire agri-chains

1.7 Scope and Limitation of the Study

The study covered only selected irrigation schemes in the Lake Zone water basin, hence observations of only one Zonal water basin management may not be sufficient to draw conclusive recommendations on irrigation systems performance in Tanzania. In addition, available information for institutional analysis is generally not directly measurable, hence a researcher was forced to construct (transform) own sets of data, and rely on proxies, which are sometimes only indirectly linked to the phenomenon under study.

1.8 Organisation of the Thesis

The study consists of five chapters, which are organised to address the specific objectives outlined in section 1.3.2. Chapter one introduces the study and provides background information, problem statement, justification of the study, objectives, hypotheses, and outlines significance, scope and limitations of the study. Chapter two presents literature review, which is organised into conceptual definitions, theoretical, empirical, and policy related literature review.

Chapter three describes the methodology, and research design used in this study. It also explains data types, collection methods and the econometric analytical techniques used to analyse the data for each objective: Heckman sample selection two step is used to address objective one; Mixed effect model (fixed and random effect) was employed to address panel data set based on linear regression for objective two; standard stochastic frontier analysis was used to analyse technical efficiency and allocative efficiency to answer objective three; while instrumental variable strategy based on two stage least square (2SLS) addresses objective four.

Chapter four presents results and discussions of each specific objective and test of the hypotheses formulated. The chapter is made up of sub sections, which addresses results to answer the objectives and hypotheses tests. It starts by describing the characteristics of households, irrigators groups and irrigation systems characteristics in the study area, followed by presentation of analysis results. The results are presented into four topics based on each objective as follow:

First, the impact of self-selection effects on collective action is determined, and the sources of self-selection described to answer specific objective one. The hypothesis that Self-selection factors and transaction costs do not affect participation of farmers in irrigation agro-ecosystem was rejected.

Second, objective two results are presented under the sub section "factors influencing institution quality of CA in the irrigation systems". Institutional variables- contract, contact and control in their proxies are analysed. The hypothesis that transaction costs as governance mechanisms, market factors and rainfall characteristics do not influence institutional quality in irrigation groups was rejected.

Third, objective three consists of three aspects: technical efficiency, output elasticity and allocative efficiency issues. The production frontier, output elasticity and technical efficiency are estimated using Maximum Likelihood Estimation method to answer the question of technical efficiency and output elasticity issues. Allocative efficiency data were analysed using OLS estimation method. Together, results are described in sub sections namely, empirical model estimates for the stochastic production frontier analyses, which present productivity parameters: technical efficiency, output elasticities and determinants of technical efficiency (technical inefficiency effects). In addition, allocative efficiency to answer the question part of input factors allocation in the irrigation system is presented in this section to address same objective three. The hypothesis that collective action does not affect farmers' technical efficiency and allocation of production factors in the irrigation scheme was rejected.

Objective four is described under the sub section "the link between farm household objectives and enterprising tendency: implications on collective action coordination".

The hypothesis that household own individual investment decision in irrigation farming does not depend on enterprising orientation farming objectives was rejected. Chapter five presents conclusion and recommendations both for policy and further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Definitions

2.1.1 Collective Action

Different authors have provided a variety of definitions of collective action; which have encompassed a broad spectrum of aspects related to social, political, and economic group organisations context. According to Olson, (1965, 1971) collective action is defined as the action taken by the group of individuals through organisation in order to keep up the interest of their members. Gillnson, (2004) defines collective action as the group of people with common purpose formed to benefit for the cooperation on the common good. Similarly, for Holzinger, (2003), collective action refers to the joint actions of a number of individuals, which aim to achieve and distribute some gains through coordination and cooperation.

However, despite of different perspectives regarding collective action explanation, the definition common to all is “the tendency for a group of people through organisation of shared interest to act together in pursuit of those interests’’. This thesis adapts the definition by Olson (1971), and Holzinger (2003), which both encompass distribution of gains and coordination aspects among members in the process of pursuit of their concerns.

It is theoretically, and empirically accepted that individuals will join the group for collective action if the private benefits exceed the cost of cooperation (Olsen, 1965), and that individual not only considers private material benefits, but also non tangible benefits offered by the collective action (Oliver, 2004). This thesis is based on this conceptual understanding to assess the transaction costs of collective action and institution quality in addressing the issues in the irrigation systems performance in Tanzania, particularly in the Lake Victoria basin.

2.1.2 Transaction Cost

The provision of collective action coordination and benefits in an economic system or social group interactions do not come freely, because of several kinds of imperfections and uncertainty among participants of the transaction. The imperfection and uncertainty originate from human rational interaction behaviour, which involve strategic decision making and maximization of pay off due to self-interest behaviour. Consequently, they affect the outcome of strategic interactions (Binmore, 2007; Osborne, 2009).

In order to undertake the transaction properly amongst participants in the collective action, a cost must be incurred to find out the opportunities and about the risks and uncertainties involved. Such expenses/costs, which can be in the form of monetary (materials) or non-monetary costs like time, information cost, for running economic activities are called transaction costs (Tadelis and Williamson, 2010).

According to Groenewegen et al. (2010) transaction cost refers to all costs, which have to be incurred when preparing, concluding and enforcing market, managerial and political transactions. Coase (1937) defines transaction cost as that cost necessary to coordinate production processes, and that the magnitude of transaction cost depends on individual entrepreneur. Coase (ibid) assumes that the entrepreneur can circumvent the uncertainties using price mechanism. Williamson (1979) transaction cost refers to the cost arising due to misaligned incentives, especially attributable to risks for the contractual party's opportunistic behaviour, misappropriation of rents from transaction specific investment. Hence, the transaction cost arises due to critical dimensions of transaction costs characteristics: asset specific, uncertainty, and frequency. Dahlman, (1979) categorises the transaction costs into three scenarios (i) search and information cost (ii) bargaining and decision costs, and (iii) policing and enforcement costs, and that all these costs represent resource loss due to lack of information.

Together, all these definitions are related and they represent unavoidable costs in any deal striking. Thus, the definitions by Williamson (1979) and Dahlman (1979) are adapted in this thesis because these definitions   represent the focus of this study. i.e. economic organisation by aligning transaction costs that cannot be traded in the market. In irrigation system, transaction costs could be defined as the costs of acquiring and handling the information about the mobilization of voluntary cooperation on irrigation infrastructure O&M as well as cost of ensuring water allocation and distribution (coordination/contact), water management and control, costs to ensure contributions of relevant costs and contracts compliances on the resource utilization (contract), and enforcement costs of contracts for resource users' characteristics and reputation (respect of laws and regulations) on interactions (control/monitoring), and so on. TCs in this thesis are measured based on monetary costs, and end point (proxy) implementation outcome such as e.g. contact is measured in number of frequency of contact, contract is measured in terms of compliance rate, and control is measured in terms of penalties implemented as enforcement mechanisms for working of the rules (institutions).

2.1.3 Institutions and Institutional Quality

The study of transaction cost is the core of institutions, and is important in studying coordination and organisational aspects. In English, the word institution has several meanings depending on the context. It includes, an established organisation; the building in which an organisation is hosted; and a custom, practice or rule (Groenewegen et al. 2010). In this thesis the connotation related to custom, practice or rule is referred as implied in the common property rights, in order to understand how collective action works in the irrigation systems. Other authors (Hodgson, 2006 have defined institutions as the systems established and prevalent social rules that structure social interactions. North, (1990) defines institutions as the humanly devised constraints that shape interactions, and in consequence they shape incentives for human exchange, whether political, social or economic. Institution constraints include both what individuals are prohibited from doing, and sometimes under what conditions are allowed to undertake certain activities. Institutions can be formal such as the rules, which human being devise and informal such as convention and codes of human behaviour. On the other hand, DFID, (2010) have defined institutions as formal and informal rules of the game that shape, but do not determine human behaviour in economic, political or social life. The DFID argument is that institutions are shaped, implemented and undermined or reformed by individuals and organisations; hence the outcome depends on how institutions interact with individuals and organisations.

At the same time, institution quality must possess strong characteristics that enforce property rights and bound by rule of law among other perceived incentives in order for the institution to work (DFID, 2010). Groenewegen et al. (2010) point out two aspects of institution quality attributes: (i) sufficient percentage share of individuals must comply with the institutions, and (ii) there must be credible (enforceable) sanctions to prevent the rest of individuals to act against the norm.

This thesis builds on Groenewegen et al (2010) institutional quality attributes definition, and adapts by merging concepts and insights of institution definitions described above. As a consequence, the institution quality is thus defined as a state of efficient contract enforcement, respect of property rights and by laws, and investors (irrigators) rights protection (Levchenko, 2006). Overall, amalgamation of the concepts of collective action, transaction costs, and institution quality described above allow understanding better the irrigation systems performance and collective action problem in particular.

2.1.4 Irrigation System Performance

According to Groenewegen et al. (2010) irrigation systems are categorized as common property resources because they are characterized by non-exclusiveness in that everybody has access to the resource, but have become rival because of scarcity, so if not well managed the performance is doomed. Common property resources need to have defined property status to prevent conflict and depletion thereby enhancing resource utilization and economic performance. Irrigation systems represent the entity of a common property regime, where there is a well-defined group whose membership is restricted, there is an asset to be managed, usually the physical state of the resource/irrigation system, there is an annual stream of benefits through the use of irrigation water- which constitutes a valuable agricultural input, and there is a collective management for necessary maintenance of the system and process like O&M of infrastructures, water allocation, distribution and control to ensure efficient performance of the system that generate benefits intended to the users (Meinzen- Dick, 2004; Araral, 2008).

Thus, the performance of irrigation system as a production unit is usually indicated or explained in terms of productivity and efficiency measurement. Fried et al. (2008) define productivity as the ratio of outputs of the production process to its inputs, while efficiency refers to the comparison between observed outputs and optimal outputs, and observed inputs and optimal inputs. These two concepts (productivity and efficiency) are usually used interchangeably in an overlapping way to explain performance, though they are slightly distinct. Productivity is a residual due to variations either across producing units or through time. The residual can be attributed to differences in production technologies, scale of operation, operating efficiency, or environment in which production occurs. Efficiency is a residual too, but it also requires the existence of a benchmark or comparison to the best practice.

For example, in the efficiency measurement, optimum is defined in terms of production possibilities, or in terms of behavioural goal of the producer. In these events, efficiency in the former is technical, and in the later, efficiency is measured by comparing observed and optimum costs, revenue, profit (allocative), or whatever goal the producer is assumed to pursue. Thus, efficiency and productivity are success indicators, which are performance metrics, by which producers or producing units are evaluated (Kumbhakar, and Lovel, 2000; Fried et al. 2008).

2.2 Theoretical Literature Review

Worldwide, natural resources management, particularly common natural resources (common pool resources) like irrigation systems management is studied based on collective action theory (Olson, 1965). The collective action (CA) consists institution design with principles, which are thought to motivate the successful resource management. Some of these CA institution design principles consist of a list of attributes such as social identity and resource importance for users, availability and predictable condition for the resources e.g. irrigation system sustainable and functional predictable physical state, congruence between the rules linking social structure, ecology and technology, collective decision making, (Ostrom (2002, 2010). These institutional designs are useful in explaining factors, which may influence collective action, but have overlooked the important characteristics underlying the interactions, and how actor can efficiently coordinate their undertaking (transaction) without friction. It is acknowledged that collective action theory seeks to understand how individuals in groups cooperate to undertake their common concern, given that they are self-interested and the conditions under which the interaction takes place is full of uncertainty (Olson, 1965; 1971). In order to transact safely, individual actors have to incur costs to find out where opportunities occur and about the possible risks and uncertainty; such these expenses are transaction costs (Groenewegen et al. 2010). These aspects have not been explicitly addressed in the theory of collective action.

Other theories related to common natural resources management stress on the importance of property rights in overcoming collective action problem (Wade, 1987). The argument is that individuals treat more carefully when they own the resource, because the returns generated by the possession of the resource accrue to them and not to others. This notion of property rights is important in rights appropriation (assigning property rights) to legitimize members on resource utilization there by excluding non-members, but not sufficient condition to overcome the problem of collective action, because an individual using the resource might not necessarily be the owner due to the right of disposal, the owner can legally transfer temporarily part of his/her bundle of property rights control to someone else. For example, renting out or in the land within the irrigation command area; hence this may result into inefficiency in contributions commitment because may not necessarily continue the activity in the subsequent period. In this regard, the theory of property rights has ignored the individual incentives, and other important drivers in the collective action coordination such as issues of self-selection effects, perceptions and non-tangible aspects, because group benefits are inherently shared based on lumped collective incentives in the common property rights (Oliver, 2004).

However, Baland and Platteau (1996) put forward additional elements in the theory of property rights as facilitating factors to enhance overcome the collective action problem in the common. The additional elements are external forces such as aid, enforcement of rules, and leadership with broad experience. Similarly, the study, did not explore the extent of their effects on collective action and individuals' preferences/choice.

Game theory is another paradigm, which has extensively been used to study the problems of collective action in the common pool resources management. The theory emphasizes on strategic interaction by observation of individuals' behaviour, taking into account the decisions that others might make (Jehly and Reny, 2011). A large variety of theoretical studies in the collective action problem in the common has been modelled as strategic form game (prisoner's dilemma).

In this respect, the argument is to overcome the prisoner's dilemma, where the individual's choice in aggregate, lead to the outcome that is not preferred by others (Binmore, 2007). This theory is particularly important in examining free riders' problems where players (individuals) only care what they end up with. Game theory is indeed good at observing individuals' behaviour, but has shortfall in its construction- (assuming rational behaviour), because it does not tell what motivates individuals to behave how they are behaving. Yet, making moral judgements –either for or against is essential in overcoming collective action problem.

On the other hand, the neo-classical economics theories tend to focus resource management around market mechanism (Kreps, 1990). That the price responds to factor scarcity resulting into factor substitutions, and ultimately resource management efficiency is achieved because scarcity will lead to higher price; hence stimulate investment and adjust to reach equilibrium. These assertions are rights, but cannot solve the problem of the common, especially on issues related to equity allocation (pro poor inclusion), because individuals interest is profit maximization rather than efficiency (Varian, 1987; Kreps, 1990). The theory implies that the market mechanism requires setting price based on supply and demand in line with current resource utilization to achieve equilibrium. But, this is not the case because prices may be static or dynamic due demand conditions. For example, some resource users may require more resource than others, and willing to pay more due to self-interest and heterogeneity in objectives and abilities.

As such, excluded individuals may devise mechanisms like opportunism or free riding on resource utilization, and so inefficiency outcome remain unsolved. Therefore, this classical theory assumes zero transaction cost and that the perfect market exist that transmit sufficient information to the economic activities, yet, perfect market does not exist, particularly in developing countries like Tanzania, and that transaction costs are the costs of using the market mechanism as defined by Coase, (1937).

At the same time, game theorists have also criticized the neoclassical paradigm in solving the problem of private provision of public/common goods in a collective action setting. They argued that neoclassical economic theories have limitations on the aspect of type of behaviour analysis, because they assume no syndicates and coalition are formed in the interactions, no cheating or lying is done, no threats or conflicts are made (Binmore, 2007; Jehle and Reny, 2011).

Others theories have looked up collective action successfulness on the ground of private incentives in terms of materials or monetary benefits after harvest (Ostrom, 2000); and sociological context based on motivating group action (Oliver, 2004; Diener and Seligman, 2004; Kassie et al. 2012). They asserted that materials in forma of tangible values such as payments, incentive for participation, or coercion for not participation; and non-tangible values such as benefits or costs of participation arising from relationship with other people, networks, respect/honour, or feeling good in doing things together are likely to overcome the collective action problem.

Together, the reviewed theoretical foundations have in common concentrated on creating collective incentives through institution design and sustainability of the resource- based on different approaches, but mostly comprised of price mechanism and game theoretic perspective. This is useful as a starting point of this research. Further the theories helped identification of other pitfall aspects, which have not previously been addressed in detail such as individual decisions (preferences and choice), and institution and organisational aspects in a combined way with regard to collective action successfulness.

Thus this thesis extends beyond institution design to institutions impact by analysing in details the organisational and institutional embeddedness aspects of a CA in the context of individual incentives-framed in amalgamation form of wider theoretical variables framework. The amalgamated theories, which combine social capital paradigm, transaction costs economics, and transformation cost based on neoclassical economics paradigms, help to understand better how collective action problem can be solved. None of the previous theories succinctly reviewed have incorporated a mixture of theoretical perspective- a novelty in studying collective action problem in this thesis. This is particularly important because collective action problem involve many and diversity of variables (Agrawal, 2001), complex human interactions (Ostrom, 2010) and competing theories as described above. Therefore, focusing on a single theory does not improve efficiency gain in this context.

Transaction cost economics, and social capital- “fundamental to the collective action theory” provide the overall theoretical framework to guide the understanding issues of organisations and cooperation in this research. North, (1990) theory is constructed on the basis of human behaviour, combined with transaction costs. The TCE is an ex-post governance construction, with emphasis on transactions for which continuity or breakdown of the exchange relations is concerned, (Williamson, 2010). Governance is viewed as a means by which to infuse order there by mitigates conflict and realizes mutual gains. The TCE theoretical component is thus considered in understanding the economic organisation and institutional aspects related to human behaviour and identify factors, which predict successfulness in the CA to enhance irrigation systems performance. The social capital theory central premise is concerned with sociability relations, trust, networking, membership choices, and understanding, which facilitate cooperation (Narayan and Pritchett, 1999; Woolcock and Narayan, 2000; Fafchamps, 2002). Social capital has an important influence on the performance of societies at the economic, social, and political level organisations (Coffe and Geys, 2005).

Theories of institutional economics analyse the organisation and institutions in different perspectives, which sometimes treat organisation as a sub group of institutions, or that organisation and institutions are two aspects (Chavance, 2011). North, (1990) put forward that organization and institutions are different aspects but interactive, while Common, (1934) asserts that organization and institutions represent two facets of one and the same phenomenon. Other scholars view organization as a coordinative entity of various interactions, and as an enriching language of coordination (VAASA, 2012). This thesis adapts the definition by North, (1990) and VAASA, (2012) to analyze the transaction costs and institutions in collective action.

In consequence, transaction cost economics is a core on institutions with established mechanisms to circumvent and constrain human behavior that generate transaction costs in the process of transaction. North, (1990) specifies institutions into formal rules and informal conventions or behavioral norms, plus the enforcement characteristics of both. The formal rules usually exist in three levels (i) Fundamental rules derived from the basic human rights, (ii) legal system, which contains property rights and contract laws as well as the rules about the structure of the state and political decision making process, and (iii) the fundamental rules- that are both formal and informal, and the legal system, which together form the "institutional environment". Within the institutional environment, individuals, and organizations (e.g. economic organizations like farmer organizations, firms or markets) enter into contracts (institutional arrangement) to coordinate their transactions, which eventually determine economic performance.

On the other hand, informal rules or institutions can be defined as private rules of behavior that have been developed gradually and spontaneously and do not need any legal enforcement because the rules are sanctioned by the private parties themselves or because it is in the self-interest of the actors to follow the rules of their own agreement (Groenewegen et al. 2010).

This study builds on North (1990) and Williamson (1975, 2010), and Olson, (1965), Narayan and Prittchet, (1999) as well as the other studies by Wade, (1987), Baland and Platteau, (1996) and Ostrom (2000) and Agrawal, (2001), to construct variables relationship as explained in the subsequent conceptual framework section 2.4.

2.3 Empirical Literature Review

2.3.1 Transaction Cost Economics and Collective Action

According to Williamson, (2005) transaction cost economics theory concentrates on the relative efficiency of different exchange processes. While, North, (1990) categorized the total costs of production into transformation costs- the cost of inputs involved in the transformation of physical resource into goods and services, and transaction costs- the cost of defining, protection and enforcement costs. North (ibid) then argued that a successful collective action has to be governed by a third part based on the institutions. Thus understanding the organization (coordination) and institutional performance require a thorough analysis of the transaction costs involved in the collective action as a tool for smallholder irrigation systems management.

A body of literature on transaction cost economics (TCE) exists, and it is generally recognized that TCs are very important in determining the decision about economic organization and strategic management aspects (Kim and Mahoney, 2005). Transaction cost analysis can be applied to issues of irrigation systems management, because in many common resources, efficient management of common property rights that is granted collectively is often challenged by various sources of uncertainty that result in high transactions costs in the management (Bhattarai, 2011). Resource users usually enter into various kinds of explicit and implicit agreements in order to initiate collective action and agree to exchange or transfer goods or services, which involve costs or contributions. These contributions are normally incurred in the form of negotiation, monitoring and enforcement costs, as part of resource utilization. For example, the transaction costs for individual resource users, include the costs related to participation, opportunity cost of time involved in meetings, time required to acquire information and communication, direct monetary expenses e.g. costs for travel, communication like phones costs and information or knowledge search and acquisition-based on training such as costs involved in attending trainings, seminars, and so on through extension advisory services or other kind of capacity building offering body. At managerial level, the costs can be related to contact and contractual enforcement. These costs are directly related to management of a collection action, and may foster or deter its successfulness and so do irrigation systems performance doomed.

Empirical evidence on transaction cost analysis has generated different results, which are sometimes contradictory. For example, scholars (Adhikari, 2001) studying transaction costs in collective action argue that CA benefits may be exceeded by transaction costs but are not explicitly felt in a situation where resource users see resource management as a way of their life rather than enterprise activities. While, Bhattarai, (2011), Jansen et al. (2014) agree that transaction costs such as information and communication matter in influencing the level of cooperation. The contradictory arguments arise due to the fact that resource users attach/value differently the importance of the resources for their livelihood (Ostrom, 2010). It is also a result of heterogeneity in objectives and that collective action members are never having common interests that motivate them cooperate (Oliver, 2004).

The focus of this thesis is to incorporate the transaction costs in understanding the collective action problem, which most of empirical research on economic analysis of the common have scarcely incorporated transaction costs. Most previous studies have generally focused on the external factors (characteristics) affecting collective action, and evaluation of institution design principles effectiveness.

They argue that characteristics of the resource like physical state conditions-abundance or scarcity, the characteristics of resource users such as social identity (ethnicity, gender, and location), group size, and the institutional arrangement (governance) context like leadership and community or government control affect the likelihood of successful collective action (Ostrom, 2010, Araral, 2008: Mosha et al. 2014). Studies that examined transaction costs are scanty (Meinzen Dick et al. (2000), and have put forward that group size as factor in influencing joint collective action represent a trade- off between potential economies of scale and increase in transaction costs.

Although such studies identified important aspects in predicting factors influencing CA, they have limitation in that they did not adequately address in a linked way the transformation costs- the physical cost- benefit position of enterprises (Ostrom, 2010), and transaction costs imposed (contract, contact, and control) in regard to resource use. They have also not explicitly presented the extent and type of transaction costs related to group size.

On the other hand, Bhattarai, (2010) identified the type of transaction costs in farmer managed irrigation in Nepal on the basis of transactions undertaken by farmers, which included time of meeting in the formation of organization, and travel costs and statute preparation costs. However, the study did not provide the extent of their effects on the irrigation performance.

Human and resource use interactions and sociability aspects have extrinsic or intrinsic motivation for the household decision. According to social psychologists perspective ‘‘extrinsic motivation behavior is understood in terms of external forces such as monetary expectance, while, intrinsically motivated is otherwise because individuals wish to undertake a task for its own sake’’-This is likely a result of unobserved characteristics, which can be expressed in differences among households such as choice of the type of farming agro ecosystems, crops grown, inputs used and, and off farm engagement as a proxy indicator of entrepreneurial characteristics. These aspects are important in understanding the problems in CA and its organizational mechanisms, which are the subjects of this very study.

Scholars, e.g. Kim and Mahoney, (2005) have emphasized that there exist different ways to manage the transaction costs based on the nature and characteristics of transaction, which influence the transaction costs in the economic organization and strategic management where inefficient economic outcome occur. The transaction characteristics, which influence the transaction costs, have been classified into frequency relation, uncertainty in relation and Asset specificity (Willianmson, 2005; Groenewegen, 2010). These characteristics are presented in details in the subsequent section as described by Williamson (ibid).

2.3.1.1 Frequent Relationships

The exchange relationship may be one-time, occasional or recurrent; a frequent transaction (especially in the presence of asset specificity) is more likely to be internalised since expected damages from opportunistic behaviour are higher. Opportunism is self-interest with guile. The irrigation systems management require frequent transactions to reduce opportunistic behaviour for sustainable resource utilization. It is particularly important because if the interaction is repeatedly, then a "tit –for tat" reward and punishment can be achieved to enhance stable cooperation (Binmore, 2007).

2.3.1.2 Uncertainty of Relationships

As far as there is uncertainty, complete contracts cannot be foreseen and the firm making the specific investment is disadvantaged when future contingencies impose to re-negotiate the contract terms. Transaction cost theory individualises two kinds of uncertainty: *environmental uncertainty* that is unpredictability of future contingencies, and *behavioural uncertainty*, that is the possibility of monitoring the behaviour of the contracting party.

In irrigation systems particularly, for the Tanzanian setting both uncertainties hold. The former involves unreliability and unpredictability of the resource physical state, which in turn creates uncertainty to resource users because irrigation systems hydrological functions depend on rainfall- which is erratic, and due to climate change results into variability, and the later is related to behavioural preferences of resource user members who have opportunistic characteristics syndicates, cheating, lying, and so on because of self-interest, but also bounded rationality-lack of information with regard to the irrigation resource use and the management in general.

2.3.1.3 Asset Specificity

Transaction cost is also important if different types of asset specificity have been detected such as *physical capital specificity* (when some particular machinery or assets like land-which have sunk cost if not used in irrigation system or if cannot be converted for alternative use), *human capital specificity* (when some members obtain specific knowledge of the technology and of the productive process and other members depend on them (interdependence), *site specificity* (when downstream farmers have unequal opportunities as upstream farmers such as distance or proximity to the water distribution or soil fertility status for improving productivity or technical efficiency)- this may add or reduce transaction costs, *dedicated assets* (when some non-specific investments, made in view of the relationship, lead to excess capacity after the relationships has been broken), *design specificity* (when inputs are specifically designed for the particular resource use), and *temporal specificity* (when timely performance is critical, and the failure to supply a particular input on schedule can cause interruptions of the production process (ibid). Consequently, efficient, adequate and timely water distribution is essential to cause high or low transaction costs which are necessary factors to influence decisions to promote or deter collective action efforts as argued.

In general, CA is considered a tool that translates into efficient performance of irrigation systems. Yet, most studies have ignored transaction cost analysis, which are important elements in the CA successfulness (Araral, 2012; Bhattarai, 2012;

Marshall, 2013), and it also embodies non-tangible values (Oliver, 2004; Dercon et al. 2012). The transaction costs emerge as a linkage within the institutions and others between social, economic, and environmental/ecological interactions with resource users. Thus, it is important to understand the transaction cost economics in order to derive institutional analysis for the collective action. It is therefore against these theoretical and empirical contexts that set the scene and provide motivation for this research.

2.3.2 Groups, Preference, and Ecological Uncertainty Context in CA

In irrigation systems, an organized user group in a collective action (CA) reflects efficient irrigation performance because all members have exclusive rights to make use of the irrigation facilities and services in such a way that renders maximum utility. Based on conceptual definitions of collective action above, authors have defined CA in several ways, but the definition common to all is "the tendency for a group of people with shared interest to act together in pursuit of those interests'' (Oliver, 2004; Araral, 2008; Becker, 2012). Consistent with this literature, CA is all about groups, membership and institutions.

Therefore, group's characteristics are important in defining membership attachment/affiliation and the way individual resource users integrate and behave in a CA under certain institutional arrangement (North, 1990; Sokile et al. 2005; Leucoutere, 2010). Memberships to group in irrigation systems may help farmers easily interact themselves, mobilize collective labour and management, and associate with other external development agents like extension services and other relevant supports such as technologies accessibility to enhance economic activities outcome.

Scholars have stressed the importance of groups as a capital that can positively or negatively influences the outcome of economic activities through a link of aspects which constitute prediction factors of CA such as collective identity, social structure characteristics like group stability, and trustworthy, among others (Narayan and Pritchett, 1999; Becker, 2012). These previous studies, however, did not examine in detail the pattern of management and the embeddedness aspects as a result of interactions such as transaction costs and non-tangible benefits like information sharing, helpfulness, and other perceived beliefs related to social structure, e.g. respect of regulations and law. These factors might influence collective action successfulness for group functioning, and farmers' self-selection into different farming types, such as irrigation or rain-fed agriculture.

Similarly, on one hand, ecological (environmental) uncertainty resulting from climate variability that is reflected on rainfall amounts and seasonal timing variations has an implication on resource economic conditions, which in turn influences farmers' coping strategy to sustain their livelihood in different geographical locations (Mary and Majule, 2009). Accordingly, geographical location has an important influence on the characteristics of farming systems like ecology, hydrology, technology adoption, and livelihood opportunities, which directly affect farm household income, and indirectly through its impact on market integration or institutional quality (Rodrik et al. 2002) such that farmers can make use in their decisions to promote or deter CA working.

Household preferences usually determine the differences in livelihood strategies/plans undertaken among resource users (Berkhout, 2009). These differences in livelihood strategies are likely to be a result of largely unobserved differences in household objectives, expressed in terms of types of crops grown, inputs used/ entrepreneurial skills, off farm activities engagement, and investment choices/decisions. The relative preferences of livelihood strategies and plan may vary among household's objectives and relate to differences in efforts/motivation towards CA. In economic organization theory, motivation is multi-dimensional (Grandori, 2013) therefore systematic preferences based on standard utility maximization approach may not necessarily represent rationality in preference. These issues/factors have received less scrutiny in the previous collective action studies in the irrigation systems research.

Largely, group characteristics, household preferences and the ecological uncertainty play important role in collective action problem analysis. Agrawal, (2001) summarized the characteristics from the work of Ostrom (2000), Baland and Platteau, 1996) and Wade, (1987) which influence collective action. Some of the characteristics include resource users' characteristics, characteristics of the resource, resource importance to users and clearly defined property rights, collective decisions, higher level authority recognize the right of appropriator to self-governing, which most previous studies have been focused towards institution design.

Globally, theoretical and empirical evidence related to CA on natural resources management has generated different results, some are contradictory arguments. For example, Naidu (2005), on his study of forestry resources management in India, indicated that CA under heterogeneity in social identity of the group would be unlikely. Yet, in Ethiopia, heterogeneity in social identity was not an important factor (Tesfaye et al. 2012). For resource importance for users' livelihood, Wade (1988) for example, disagrees with Ostrom, (2000) and other scholars that a given natural resource is not necessarily important to users' livelihood, because the resource may not be required by users themselves because of preference or accessibility.

Other scholars studied livelihood diversity have also noted that "most households in developing countries rely on diversified income sources as a way of avoiding risks'' (Ellis, 1999; Berdegue and Escobar, 2002), and there is consensus that diversification improves income and contributes significantly to poverty reduction in rural areas (Dethier, and Effenberger, 2012). Based on institutional design, scholars have argued that due to environmental uncertainty, management institutions for CA in forestry, water and grazing land were weak or absent in Tanzania (Quinn et al. 2007). But, in Trinidad and Tobago, CA in fisheries, watersheds and zone management were strong in order to mediate environmental uncertainty problems (Tompkins and Adger, 2004). Altogether, these studies did not examine in detail other factors embedded in the collective action successfulness such as preferences and transaction costs.

Consistent with this literature, CA like any other economic venture involves individual farmer preferences and valuations of several factors such as benefits and overview of barriers like transaction costs and riskiness in a way of entrepreneurship orientation. At the same time other neoclassical economics scholars have also justified successfulness of economic undertaking on the basis of entrepreneurship behavior. That personality or individual farmer cognitive characteristics and economic factors like transformation and transaction costs explain why some exploit opportunities and others do not (Markman and Baron, 2003; Carolis and Saparito, 2006; Groenewegen et al.2010).

Generally, most of these different views among scholars are complementary, and provide evidence that CA theories might be location specific, and embodies entrepreneurship decisions, among other factors described above.

2.4 Irrigation Systems Policy Context

Common property rights granted to water resource users groups in the irrigation systems management has been the policy instrument implemented to ensure efficient resource management in most developing countries where common resources management has been decentralized to the community. The National water sector policy (NAWAPO, 2009) and the water resources management Act No 11 of 2009 provide for the water use rules and water users association formation guidelines. For example, membership is only to a person who lives in the village or water body system, and own plot within the irrigation scheme. This, policy guides the selection of members' recruitment for the CA automatically, provided a person owns plot(s) and lives in the village. This policy guide apparently prevents other members from irrigation farming participation because of poor mode of membership selection.

In consequence, the policy deters CA successfulness because it does not clearly indicate whether users have to be affiliated into membership based on willingness to participate in the irrigation farming, neither does not tell under what personal attributes or attitudes-which are usually unobserved should be taken into account. Yet, it emphasizes that groups- in a collective action setting are expected to translate into efficient performance of irrigation resource management, which is not realistic because of heterogeneity in objectives and attitudes (Berkhout, 2009). In general, this policy has failed to generate efficiency in irrigation systems performance in Tanzania.

Worldwide at micro level; community managed irrigation systems performance measurements have covered various indicators depending on the extent at which the irrigation stakeholders (farmers or agencies) achieve their objectives. The commonly considered valuable indicators which are thought to cover all stakeholders objectives have centred on several factors/indicators: the extent of farmers participation, nature and mode of water distribution, maintenance of the system, water use efficiency, profitability of the system (benefit- cost ratio, internal rate of return), sustainability of the system and technology cost in relation to increased benefits and productivity (Kadigi et al. 2004), conflict management, and organisational dynamics and institutional strength (Manor and Chambouleyron, 1991).

Other scholars, like Gorantiwar, and Smout (2005) have also suggested four indicators: economic- which is in terms of productivity as influenced by water resource use; social in terms of equity in resource allocation; environmental as related to sustainability which is reflected on upgrading, maintaining and degradation of the environment; management in terms of reliability, adequacy, efficiency and flexibility in water distribution.

Largely, in SSA the performance indicators assessed at micro level for smallholder farmers' irrigation systems have generally covered irrigated agricultural output, water supply and financial returns (You et al, 2010). On the hand, assessment indicators at macro level have covered presence or absence of institutional features like, existence of specialized agency for basin level management, separate infrastructure development from agricultural management, water user association power/authority, existence of irrigation country strategy and action plan (Svendsen et al. 2008).

In Tanzania, micro level smallholder irrigation systems performance indicators have mainly focused on irrigation systems hardware, which include engineering and infrastructures design regarding water flow, and agronomic conditions based on crop suitability and yield outputs, cultivated land size under irrigation, and participation of farmers (NIPO, 2009; Msuya and Isinika, 2011, NAPO, 2013). Clearly, all together, these indicators are important in explaining performance of the irrigation systems, but measures based on CA organisational mechanisms and institution quality, as a software in irrigation systems are useful, which is the subject of this research.

To a large extent, CA studies on performance of irrigation systems have been done in Latin America and Asia. Most studies have focused on equitable allocation and sustainable use of water resources. They used designs, like case study and game theoretic approaches (Ostrom, 2002, 2010; Janssen et al., (2012). Other studies have used econometrics to identify factors that explain joint actions (Meinzen-Dick, 2000; Araral, 2008). These studies provide useful insights on features like strategic interdependence, heterogeneity in wealth, group size, and social identity as building blocks on cooperation among farmers. But these studies have the shortcoming in that they did not adequately capture some of subjective factors such as perceived risks and non-tangible benefits, because the capture of information is normally structured based on rationality of farmers' decisions, rather than what actually farmers decide to do, or what they want (Binmore, 2007). They have not also captured issues like continuity or breakdown of the exchange relations that account for transaction costs, unobserved differences/ heterogeneity in household objectives, and the governance aspects. Furthermore, case study designs employing qualitative approach have the limitation that external validity is low because they do not permit test of the hypothesized factors (Meinzen-Dick, 2004).

In Sub Saharan Africa, existing studies on CA examine the implications or robustness of local institutions involving water, forestry and grazing land (e.g. Cleaver, 2001; Quinn et al. 2007; Deneke et al. 2011; German et al, 2012). They indicated limitations of local institutions to cope with priority changes such as conflict resolution, and equitable CA. Recently, Komakech et al. (2012) provide insights on how local institutions emerge to facilitate CA in one of a small water catchment area in Tanzania, involving farmers from one village. They argued that a combination of inequality and interdependence of resource users explain sustained CA. Altogether, these case studies are useful as a starting point and building block of this research, though they do not explicitly tell the relations between transaction costs (management), environmental/ecological uncertainty, and local institution functioning in regard to household preferences and decisions as argued.

2.5 Conceptual Framework and Research Gap

This study considers collective action as a complex economic entity that comprises actors with different interests but organised to have common concern in order to pursue their diverse interests under external and internal forces. As the main interest in this study is transaction costs (institutions) and organisation aspects of the CA, the remainder of this section conceptualizes the variables focusing on actors (household) decisions process in the interaction. Figure 2.1 gives a schematic representation of the process.

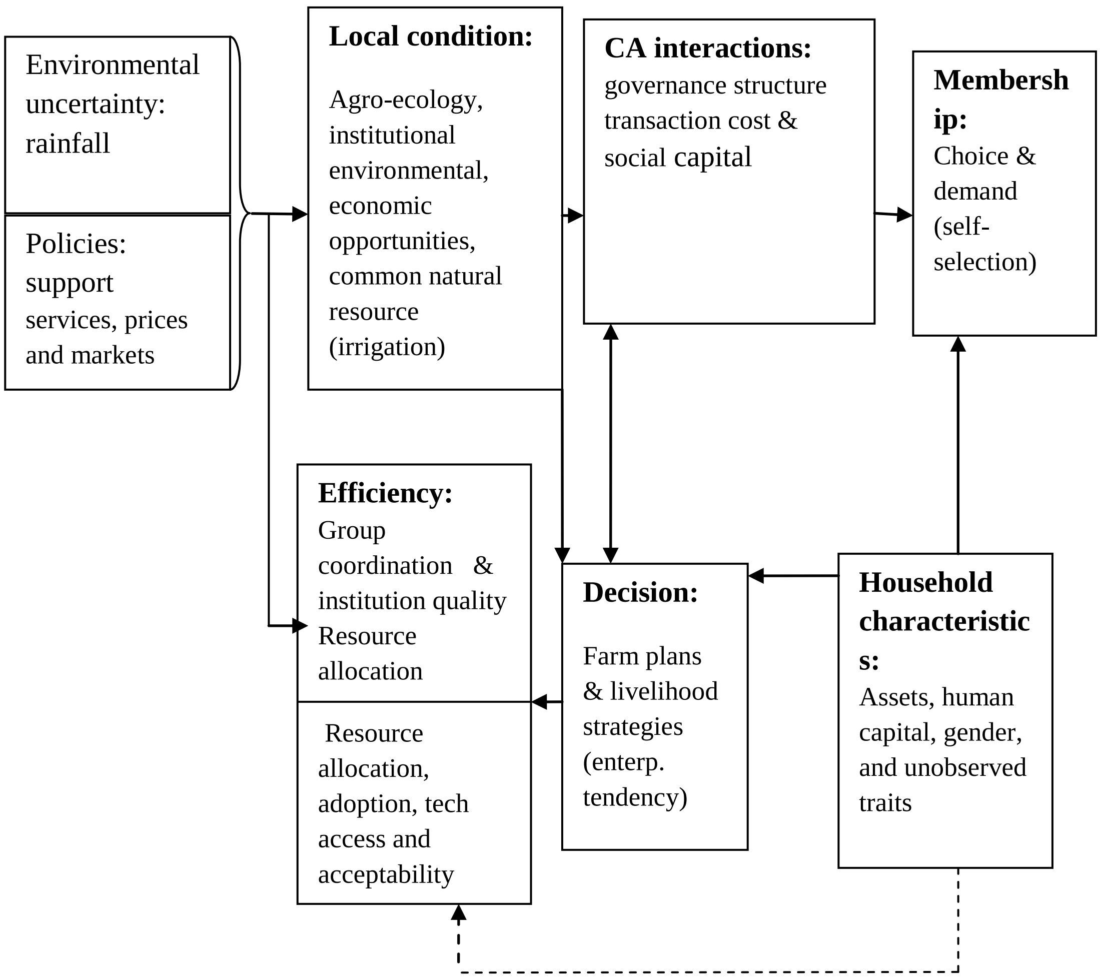

Figure 2.1: A Framework for the Analysis of Collective Action Organisation and Institutions in Irrigation Systems Management

Source: Adapted and modified from Ostrom, (2010)

Due to this multiple dimensions embodied in the process of interaction; the understanding of CA organisation and institutional quality is then guided by a combination of variables derived from different theoretical and empirical insights. The framework is based on TCE, Social Capital (SC), and neo classical economics theories with extensions and cross linkages of variables.

In Figure 2.1, reading from left to right as shown by continuous arrows, the assumption is that the external forces, which include environmental (ecological) uncertainty resulting from rainfall variability, policy issues and input-output markets, and support services conditions, and local conditions such as agro-ecology, institutional environment (formal and informal rules), economic opportunities and common natural resource condition (resource physical state), plus the internal force, (the CA interaction) constitutes the transaction costs, social capital and institutions, in addition to the household characteristics, set the scene to initiate CA interaction process, which yield the outcome.

Together, the processes trigger/generate motivation for the farming system type choices based on membership demand /self-selection effects outcome, rooted from economic argument. At the same time, household characteristics set off the decisions on farm plans and livelihood strategies or adjustments outcome with direct influence from local conditions especially ecology, economic opportunities, and institutions environment, while feedback on CA interactions are also possible.

Finally, the decisions of the farm plan and livelihood strategies, direct influence of environmental uncertainty, and partly, household characteristics as indicated by the dotted lines lead to efficiency performance of the irrigation systems in terms of group functioning/ coordination and institution quality, and physical resource allocations (transformation), technologies use (perception), accessibility outcomes, and hence CA acceptable and successfulness is achieved.

More specifically, the variables relationship is conceptualized and grouped into four key elements: (i) membership; (ii) Institution quality and rainfall & market uncertainty; (iii) Resource allocation efficiency & technology use perception; and (iv) Investment/enterprising tendency as indicated by the continuous and doted arrows in Figure 2.1. The variables are explained along with research gap in the remainder of this section.

2.5.1 Membership

The national water sector policy of 2009, and water resource management act no 11 of 2009 stipulate that membership in water resource utilization is only to a person who lives in the village or nearby water body system, and own a plot within the irrigation scheme. This implies that the boundary is restricted and hence members' recruitment is also bounded. In this regard, the selection of members' affiliation is automatic provided a person holds a plot/land within the irrigation scheme (NAWAPO, 2009).

This is in line with one of the Ostrom's design principles attribute, but such institution design has pitfalls in that it did not take into account the effect of self-selection bias- a subject in this thesis. Self-section effect can have positive or negative impact on the collective action successfulness because individuals are affiliated into membership without best recruitment criteria. It might be that individuals merely participate in the irrigation systems because of sampling bias, yet have no common interest in joining the CA, the situation which increases CA problem in the common resource.

Thus, “implicitly” or “explicitly’’ the decision whether a farmer chooses to be a member of irrigation water users’ association group in a given farming ecosystem is likely influenced by governance characteristics and transaction costs among other economic endowment, like land ownership or hiring and a priori expectation of results from the proportion of area sown over cultivated within the irrigation command. Governance characteristics can be order (e.g. cohesion or conflicts) and arrangements such as coordination, e.g. communication and monitoring strategies, which make use of formal or informal rules in the transaction relations (Williamson, 2005; Deneke et al. 2011). Thus, the framework is constructed along the utility maximization theory based on attributes of groups (e.g. coordination and regulations like social network, leadership styles and discretion e.g. frequency of meetings and accountability, and institutional design principles, e.g. collective choice like respect of laws/bylaws and compliance, as well as transaction costs such as contact, contract and control in their respective proxies (price and non-price) to identify how farmers self –select into the farming ecosystem type. Self-selection can produce endogeneity bias occurring in simultaneity way where the explanatory variable is also a function of the dependent (outcome) variable (i.e. a cause and effect.

In this setting, it is assumed that for a successful CA a farmer in the irrigation group chooses irrigation farming type, given that he/she also value or depend on irrigation farming for livelihood sustenance- implying that factors affecting selection into the type may simultaneously affect the outcome of interest. This kind of modelling enables capturing the appropriate farmers committed to participate in the irrigation systems.

2.5.2 Institutional Quality, Market Characteristics and Rainfall Uncertainty

Along this dimension, environmental uncertainty resulting from climate variations, which leads to rainfall variability, in combination with market characteristics and governance mechanisms are conceptualised as a framework to study group's institution quality. Irrigation water in Tanzania depends on rainfall to keep various irrigation schemes in different hydrological boundaries live operations. Understanding the interactions between climate variations e.g. rainfall variability levels (mm), market function characteristics e.g. output market access/outlet, prices, and managerial strategies like contact, contract compliance and control mechanisms can provide more insight on CA working and institutional quality.

The framework is centred on irrigation systems' resource attributes based on reliability and levels of rainfall, resource user's property rights and enforcement mechanisms of institution in their various forms of proxies constructed from transaction costs end point outcome of implementation results. The transaction costs end point outcome such as contact costs, control costs like number penalties implemented based on formal or informal rules enforcement, and contract outcome results such as compliance rate on agreements made.

Others included the output market characteristics like output market access/outlet and spatial output prices. These aspects are analysed in order to understand factors influencing institution quality/efficiency over time. The analytical framework is based on generalized linear regression models of panel data set. The panel data analytical approach is used because can best control for differences among irrigation schemes, which may be caused by characteristics that differ among schemes (Baltagi, 2012).

2.5.3 Resource Allocation Efficiency & Technologies use Perception

The interaction between CA and farm plans based on feedback mechanisms framed in the context of farmers' attitude/perceptions on factor inputs adoption and irrigation services access, acceptability and application is another framework. Common natural resources management theory does not explicitly indicate the conditions necessary to trigger full resource allocation and utilization efficiency (i.e. CA and farm plan resource use), apart from physical state–"abundance or scarcity of common resources". Technique that extends beyond physical state of the resource (irrigation system) to include technical capacity, and behavioural aspects (perception of technology use for resource users under CA setting) was implemented to understand the drivers of CA successfulness.

The fact that CA has both non-tangible and tangible values provides the basis for the framework. Non-tangible values can be aspects like information sharing or networking that may benefits a farmer in technology or resource use, e.g. use of CA as a bridge to access external support services. Previous studies on farmer cooperation have justified the role of non-tangible benefits in influencing willingness to cooperate (McMahon, 2015). Others have confirmed that non-tangible benefits like membership to group may enable farmers' technical knowledge to use technology (adoption) through other farmers and support services (Martins et al.

2010; Ndunda and Mungatana, 2013). Similarly, tangible values include economic incentives in form of private property after harvest (Ostrom, 2000) or well- being, using money or income as a surrogate indicator measure which motivates individual’s participation (Diener and Seligman, 2004; Kassie et al. 2012). According to social psychologists ‘‘extrinsic motivation behaviour is understood in terms of external forces such as monetary expectance, whereas intrinsically motivated individuals wish to undertake a task for its own sake’’. These factors are important as fundamental aspects in successfulness of CA, which in previous studies have not adequately been given attention in irrigation research.

Economic theory of production based on technical efficiency and allocative efficiency, combined with TCE and social capital theories were used to architecture the interactions which, was designed in terms of clustered factors: external factors determining use and accessibility conditions of irrigation services as a proxy for CA management efficiency, technology characteristics, and users behaviour (motivation and perceptions on the technologies use such as output price incentives and risk perception to understand the CA successfulness.

2.5.4 Investment/Enterprising Tendency

Finally, the fourth objective explored in detail the influence of farm household objectives on the investment enterprising tendency as an incentive for collective action (CA) coordination efficiency in the irrigation system. CA is related to management success and member patronage, at the same time most capital asset expenditures by a farmer in irrigation systems are sunk cost in case not used, or if are firm specific that have no alternative use (Aramyan et al. 2007). Accordingly, famers face dilemma in decision making because of uncertainty resulting from water management and control variations (NIPO, 2009), and disregard of bylaws (Rajabu and Mahoo, 2008), which as a result create free riding and opportunistic behavior operating environment amongst water resource users.

Alongside, household preference (which is latent and only observed by actions) usually determine the differences in livelihood strategies (plans) undertaken among resource users. These differences in livelihood strategies (driven by their objectives) are likely to be a result of largely unobserved household characteristics, expressed in terms of differences among household endowment and enterprising tendency (choices) such as investment judgment, farming orientation, inputs used, off farm activities engagement, and valuation and choice of accessible economic activities/ opportunities against irrigation system through implicit ranking.

Enterprising tendency (entrepreneurship) plays a greater role in driving organizational coordination functions of firms (Maharati and Nazemi, 2012). In its entirety, entrepreneurship covers a broad spectrum ideas and definitions ranging from occupational, innovation, and business creation to organization /coordination point of views (Hall and Sobel, 2006; Jos and Bart, 2008; Soriano, 2010).

Although, a good body of literature on entrepreneurship exist, all together, have concentrated on the role of entrepreneurship, but the contribution to the firm coordination has been neglected or else not clearly tackled. This thesis links entrepreneurship and coordination. Entrepreneurship has been defined as a judgmental decision making over deployment of assets in face of uncertainty and bringing about coordination of the firm- an irrigation system (Jos and Bart, 2008; Maharati and Nazemi, 2012). The firm (irrigation system) as an organisation is dedicated to the planning of sustainable resource utilization based on information synthesis and operating environment by the entrepreneurial founder (resource users), and is effected more by its managerial organization embedded in an institution framework of CA. Thus, The CA institution (management) and government guidelines define the property rights for entrepreneurs' resource utilization in the irrigation systems.

This research is framed within the context of combined farm household objectives, transaction costs, and governance related factors such as group leadership style to understand enterprising tendency as an incentive for coordination of CA. The enterprising tendency is measured in terms of own annual irrigation expenditures committed for irrigation farming, to imply that the price or cost (investment) of the resources used by the entrepreneur reflects the opportunity cost of their employment in other uses (Hall and Sobel, 2006). The implication is that the higher the capital asset invested the higher the motivation for ensuring firm coordination efficiency in order to safeguard losses would be for the investment made.

On the other hand, farm household objectives are operationalized in the context of economic motivation hierarchy structure as in Kallas et al., (2009), which are measured as dummy values of commercial or subsistence farming objectives. Transaction costs and governance related factors are measured in their various respective proxies. The framework is thus centered on management theory of investment that account for farm and personal characteristics (Aramyan et al. 2007), and farm household investment (e.g. Barnum and Squire, (1979) that explains the household as both producer and consumer under imperfect markets, and entrepreneurship theory, which is built in from firm and transaction cost economics theories- that portrays an organization- embedded in the institution framework of CA management (Casson, 1998; Williamson, 2005). These combined theories provided the basis to investigate the linkages between the farm household objectives and decisions on investment enterprising tendency, which is assumed as a locus of CA acceptability and economic organization coordination successfulness.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Areas

The study was conducted in the Lake Victoria water basin (LVB) in 2014 covering seven irrigation schemes hosted in each of the five districts named in brackets: Mahiga irrigation scheme (Ngudu), Igongwa (Misungwi), Nyida (Shinyanga rural), Maliwanda and Nyatwali (Bunda), and Cheleche and Irienyi (Rorya). These districts have different agro ecological system defined by different farming system zonation (FSZ) that is characterised by the interactions of cultural, agro-biological aspects like dominant soil types, rainfall distribution and socio economic factors such as input-output markets, own farmers' priority on crops cultivated and resources capabilities. Because of good correlation between local soils, parent materials, landforms, historical settlement patterns and current local farming systems, the Zonation is based on land unit approach, in which soils and physiography played a dominant role (Van Kekem, 1999). These selected districts have also more or less homogeneous characteristics on other aspects related to culture, crops grown particularly, in the irrigation schemes and the input-output market characteristics.

In terms of irrigation schemes characteristics, Mahiga, Igongwa and Nyida irrigation schemes are traditional improved schemes, whose depend on temporary rivers for their water source. Maliwanda, Cheleche, and Irienyi are also traditional improved scheme with reservoir/ dams constructed to collect rain water during the season. Nyatwali irrigation scheme is traditional, which uses electrical pump for water abstraction from the main source of water, which is the Lake Victoria; hence it is the only irrigation scheme that operates all year round in the lake zone selected schemes.

3.2 Research Design, Data Collection and Analysis

3.2.1 Research Design

A comprehensive field survey that combined two types of data generating approaches: cross sectional and panel data set (repeated observations) designs were implemented to address the different objectives. The first approach involved cross sectional design that was engaged to study the individual farmers and groups' aspects at household level.

The study relied on primary information collected to cover mainly the governance, transaction costs, technology characteristics and the social capital variables in the form of their various proxies. Farm household was used as a unit of observation for the analysis. To identify the causality, the design compared farmers participating in the irrigation farming by creating clusters during analysis: those engaged in irrigation and value CA; those engaged in both irrigation and rain fed in each of the scheme surveyed.

The second approach involved the use of longitudinal (panel data design) survey at irrigation group level, relying on secondary information recorded by irrigation group's organisation (management) over time. Group level was used as a unit of observation for the analysis. The data set covered a period of 10 years (from 2003-2012) to compare groups dynamics and individual effects (heterogeneity) on institution quality across the schemes over time period.

3.2.2 Sampling Design and Sample Size

The survey employed a multi stage sampling procedure based on two stages approach. First, purposive sampling was used to obtain a total of 7 irrigations schemes-both traditional and modern which are distributed along Lake Victoria water basin in the five districts described above.

The selection criteria for the irrigation schemes were based on the potential functional (operational) of the irrigation facilities, and age of the scheme (that is, has been working/operational for the past 5-10 years or so) in order to capture the dynamic conditions.

The second stage involved survey respondents' selection, targeting farmers involved in the irrigation farming. From each scheme, one farmer irrigation group/ water users' association- for group level analysis, and 30 farm households- participants in the irrigation farming only and those engaged in both irrigation & rain fed farming, in addition to off farm activities engagement -for individual household level analysis were randomly sampled. In total 7 irrigation groups (100% response rate), and initially 210 households were thought, however, 184 households, about 87.6% response rate was reached after data cleaning.

3.2.3 Data Collection Methods

The empirical results presented in this thesis are based on two types of data collection methods: primary cross sectional data set, obtained at household level; and longitudinal/panel data set (repeated observations over the same unit of analysis), which is secondary data set obtained at group level records in each irrigation scheme.

3.2.3.1 Panel Data Set Collection

The panel data set collected was unbalanced (i.e. data were not observed/recorded for each group in the irrigation scheme in every time period considered) obtained to address objective two. Data collection was done in a total of seven irrigation schemes drawing information from water users groups in each irrigation scheme. Data were collected using a well-prepared record sheet (form), which obtained recorded information by the scheme over the period of ten years (2003-2013).

The main panel data set collected were obtained in the form of ‘’end point implementation outcome of transaction costs’’ (contract, contact and control mechanisms) in their various forms of proxy**.**

3.2.3.2 Primary Cross Sectional Data

This data set consisted of household information to address objectives 1, 3 and 4, which were transformed and constructed to suit answering each objective. A household survey was implemented involving face-to-face interview using structured questionnaire to capture information from the household head involved in the irrigation farming. Where the head of household was not available, a spouse or household member involved in the irrigation farming was interviewed to represent the household head. Data types collected are presented in the remainder of this section (3.2.3.3) along with analysis method for each objective.

3.2.4 Data Analysis Methods

The analysis of data has used a variety of methodological approaches employing different econometric techniques to answer each of the specific objectives**.** In the following section the particular data types and analysis method are described along with the objective addressed.

3.2.4.1 Objective One: Heckman Two Step Sample Selection Technique

Objective one aim was to explore the determinants of how farmers self-select into irrigation farming types, and describe their characteristics and effects on CA. Heckman sample selection technique was employed to answer this objective. Based on the theoretical foundation of self-selection analysis technique as described by Heckman, (1979), the dependent variable data type was constructed to suit two step choices: choice made in accordance with farmer types as the first step, and measurement of those farmers who chose the farming type if they value/ depend on the choice based on their observed and unobserved characteristics (abilities, preferences and attitudes).

The outcome variable (farming type) (y_1) data were measured as dummy variables; either the farmer chooses/select into type or not (coded as 1= irrigation and 0= otherwise), given that they value the choice or not as measured in perceived responses on irrigation rreliance (y_2) defined as 1= depend on irrigation, 0= otherwise.

The independent variables were constructed from data set/information related to household characteristics, and irrigation group characteristics. The former included measurements of the appreciation of non-tangible benefits like information sharing (in frequency), farmer to farmer helpfulness, and “respect for the law” or commitment, and the latter included proxies for group regulations/ management (transaction costs) and governance (leadership style and managerial discretion) like number of meetings convened, and contract compliance rates which were captured in a likert scale technique in the survey based on factor reduction analytical approach to ascertain individual's commitment behaviour on O&M in a CA setting.

The analysis involved estimation of probit Heckman selection model, which controls for self- selection to identify factors that explain the choices made by farmers. The idea is that factors affecting selection into the type may simultaneously affect the outcome of interest; this situation motivated the use of probit Heckman selection model. Probit models are based on utility maximization theory, which is centred on consumer preferences. Based on utility maximization, we assume that the optimal expected utility $U = 1$ if the utility exceeds a certain threshold level of preference for the choices made by the farmer given that they value such particular choice.

The modelling proceeds in a sequential process, where individuals first decide whether to choose in the farming type under question (y_1) based on the underlying and unobserved expected utility y*. After the choice is made, then decide whether to value the choice or not (endogenous variable, y_2), again based on unobserved expected utility y*. The analysis proceeded by implementing the two- step procedures as proposed by Heckman (1979).

Mathematically, the model is represented as;

$$y_1 = 1(x_1\beta_1 + e_1) \text{ ....(1)}$$

$$y_2 = 1(x_2\beta_2 + e_2) \text{ .... (2)}$$

Where, equation (2) is the sample selection equation and y_1 is observed only when $y_2 = 1$

x_1, x_2 = vectors of explanatory variables, which require at least one variable in x_2 that determines selection, should not be in x_1

e_1, e_2 = is a zero mean unit variance bivariate normal random variable with corr $(e_1, e_2) = \rho$

β_1, β_2 = parameters to be estimated.

3.2.4.2 Objective Two: Mixed Effect Linear Model

This objective aimed at understanding how and to what extent the governance/ institution mechanisms implemented like contact, control based on property right enforcement legitimacy, market characteristics, and rainfall variability affect the institutional quality (compliance) in the group over time. Mixed effect modelling technique was employed to analyse the data to answer the objective.

Data types required were generated from panel set recorded in repeated backward observations for the period of 10 years (2003-2012), which were obtained from schemes' records. The data set consisted of ex-post transaction costs, and other external factors like market characteristics and rainfall variability, which were constructed to suit mixed effect linear regression model to identify factors influencing institutional quality within and between irrigation schemes. Main data were based on ex-post TCs, which have various forms: the cost of contracting (compliance); cost of negotiating or search (contact); and the cost of establishing and functioning of the governance structures dealing with resolving various disputes (control) (Petrovic and Krstic, 2011). The dependent variable was thus constructed from contract agreement end point implementation outcome indicator result, measured in compliance rate (percent) on operation and maintenance of infrastructure and water supply services.

The independent variables, included outcome indicator results derived from contact/coordination elements, such as presence or absence of water distribution calendar (dummy), clear existence of information sharing mode such as farmer to famer network, frequency of communication (numbers of meetings). Other independent variables included the cost of functioning of governance (Control) variable outcome indicator, like number of sanctions implemented through formal and informal mechanisms (number of penalties) such as fines, court cases, and other punishments. Trend of number of farmer participants in different groups over time, market characteristics e.g. irrigation output market access-proxied by market distance (km) and quantity sold (kg), output prices, rainfall variation over time (measured in mm on annual backward looking trend), and presence of institutional support services (number/frequency of extension services), and periods (years) were also captured as independent variables.

The analysis used panel data set. The panel data analysis is suitable in this setting because the interest is on describing changes over time. Also, since observations on the same scheme (cluster) are likely to be similar than observation in other scheme, therefore, the analysis should take into account the intra cluster (intra scheme) correlation rather than assuming independence among all observations. Accordingly, panel data analysis technique was implemented to allow controlling for variables, which cannot be observed or measured such as differences in practises or cultural factors across the scheme (individual/entity heterogeneity), and variables that change over time (Baltagi, 2012).

Economists studying institutional aspects in irrigation systems (e.g. Mosha et al. 2016) run into problem by using cross section design in which each individual (entity) provides different scales of response, rendering interpersonal or enter- entity responses meaningless, as opposed to the panel data where the metric used for individual entity is time invariant. In this case, the time invariant accounts for any specific effects that are not included in the regression such as the unobservable entrepreneurial or management skills. Thus the use of panel analysis is best suited in this objective function.

Various methods/ techniques of panel data analysis have been published (Wooldrige, 2010; Baltagi, 2012). Example of panel data analysis techniques include the fixed effect, random effect, mixed effect models and dynamic panel like Allellano and Bond panel analysis. Fixed effect and random effect linear models are basic technique frequently used in the panel data analysis. Fixed effects are designed to study causes of change within the individual or entity, while random effect studies across entities. The Fixed effect technique allows endogeneity of all the regressors with individual effects. In contrast, random effect assumes normal distribution and that the variations between entities are uncorrelated with the independent variables included in the model with the random individual effects. Mixed effect linear model is a combination of fixed effect and random effect model that permit random parameter variations to depend on observation (Baltagi, 2012).

As the aim is to study the impact/changes of intuitional quality within and across the schemes over time, thus mixed effect model technique was implemented in this analysis. Mixed effect is particularly useful in this setting because it encompasses both fixed effect and random effect. The fixed effect such as the mechanism of governance (leadership style) and the random effect is the differences for the irrigation schemes (entity).

Mathematically, the mixed effect model as specified by Cameron and Trivedi (2010) is represented as;

$$y_{it} = \alpha_i + \beta X_{it} + ux_{it+}\varepsilon_{it} \quad \text{...(3)}$$

Where,

$y_{it} =$ the dependent variable for entity, i and time, t

$\alpha_i =$ n-entity specific intercept (for long panel with few individuals can be parameters estimated by running separate regressions

X_{it} = independent variable

$\beta =$ Parameter (coefficient) to be estimated

$u_{it} =$ random effect slopes for the predictors

$\varepsilon_{it} =$ error term

The model was estimated by maximum likelihood (ML) method using STATA 11

3.2.4.3 Objective three: Technical and Allocative efficiency

Again, this objective was based on cross sectional data set aimed at assessing the effect of CA arrangement for shared irrigation resources utilization on farmers' allocation of factors of production and technologies use/adoption.

Data were constructed and grouped into external and internal efficiency conditions in resource utilization. The external efficiency conditions encompassed aspects, which reflect the congruency conditions of resource utilization efficiency. They included external efficiency; technology characteristics; and user behaviour motivation. These were then linked to data measuring internal efficiency (input –output relations) in a production frontier context that capture technical efficiency (TE) and allocative efficiency (AE).

The external efficiency data were measured by constructing cropping intensity (CI) index (area sown over total area cultivated-ratio), management and leadership aspects in irrigation services provision (e.g. group leadership- dummy, good or otherwise) as a proxy indicator on use and access for irrigation facilities. Technology characteristics data were irrigation soil fertility status (dummy, good/fertile or otherwise), proximity/distance from homestead to the irrigation scheme (km), land owned in the irrigation command area (acres). Resource users' behaviour motivation data included risk perception on the use of irrigation scheme (dummy, risk averse, or otherwise prefer). Other variables were constructed based on interactions between age and capital, and non-tangible benefits like use of CA as a bridge for external service support and income earning from irrigation farming.

Other data included output and inputs (fertilizers) prices, and percent of time allocated for irrigation faming management (%). Transaction costs related data were grouped into information and knowledge (contact) such as number of meetings (frequency/number), irrigation training attendance (dummy, yes or otherwise), communication/travel cost in regard to irrigation issues (TZS). Demographic data such as age (years), sex (dummy, male or otherwise) and education level (category) were also captured.

The internal efficiency data were constructed based on input-output relations in a production function context to measure TE and AE scores. Data set type required for TE and AE included harvested output/yield (kg), and inputs used such as fertilizers, labour all measured in quantities (kg or number), water allocation/distribution into plots/field (dummy, good or otherwise not).

The analysis of this objective three involved two estimation techniques. First, TE was estimated using stochastic frontier analysis (SFA) technique, which estimated the production function and TE inefficiency model in a single stage using Frontier 4.1. The production function also produced the output elasticities, and the technical inefficiency effects (determinants of technical inefficiency).

Second, AE of factor inputs were computed based on coefficients generated by OLS estimation of Cobb Douglas production function. The two estimation techniques are mathematically formalized separately as follow:

3.2.4.3.1 Allocative Efficiency (AE)

The AE modelling follows Essilfie et al. (2011) using Cobb-Douglas production functional form and is specified by

$$y = AX_i^{\beta i}{}_i X_n^{\beta n} \qquad \text{…(4)}$$

Where, y = rice yield output (bags)

$X_i \ldots X_n =$ Inputs used (quantities measured in their respective units)

$A =$ Constant

$\beta_i \ldots\ldots \beta_n =$ Parameters to be estimated

Equation (4) can be written in its linear form for OLS estimation to compute the marginal value product (VMP) for each factor of production as in equation (5).

The Cob-Douglas production function linear form is given by:

$$\ln y = \ln A + \sum_{i=1}^{n} \beta \ln X_i + \varepsilon_i \ldots\ldots (5)$$

Where,

$y =$ Output

$X_i =$ Inputs

$\varepsilon =$ error term

$A, \beta =$ are parameters to be estimated

The VMP is defined from equation (5) above, using the coefficient estimates to generate marginal physical product (MPP) of the ith factor, it is written as:

$$MP_i = \frac{\partial y}{\partial X_i} = \beta_i \frac{y}{X_i} \ldots\ldots (6)$$

Where,

$y =$ is the geometric mean (mean of natural logarithm) of the output

$X_i =$ Geometric mean (mean of natural log) of inputs,

$\beta_i =$ is the estimated coefficients of inputs

Thus, the VMP of input is obtained by multiplying the MP by the output price, P_y.

$VMP_i = MP * P_y$ …………………………………………………………….......(7)

The allocative efficiency (AE) = $\frac{VMP_{xi}}{MFC_{xi}}$ ………............. (8)

But farmers under imperfect markets are price takers, hence the marginal cost of inputs (MFC) approximates the price of the factor P_{xi}. The AE is therefore given by:

AE= $\frac{VMP_{ix}}{P_{xi}}$ …………………………………………………………………......... (9)

Three scenarios can be observed for decision of resource allocation as follows:

If $\frac{VMP_{xi}}{MFC_{xi}} > 1$ the input is under used

If $\frac{VMP_{xi}}{MFC_{xi}} < 1$ the input is over used, and

If $\frac{VMP_{xi}}{MFC_{xi}} = 1$ the input is efficiently allocated in the system

3.2.4.3.2 Technical efficiency

To model TE the standard stochastic production frontier model is used. It is given by:

$Y_i = f(X_i \beta_{(k)}) e^{v_i - U_i)}$ ………………………………………………………… (10)

Where, Y_i = is the output of the i-th farm

X_i = denotes a row vector of inputs used by the i-th farm

$\beta_{(k)}$ = vector of unknown parameters to be estimated

v_i = symmetric random error identically distributed as $N(0, \sigma^2{}_{vk})$

u_k = is a non-negative random variable assumed to account for technical inefficiency and assumed to be independently and identically distributed, and truncations at zero of the normal distribution with mean $\mu_{i(k)}$ and variance $\sigma^2{}_{u(k))}$.

The TE of i-th farm is then obtained by:

$$TE_i = \frac{Y_i}{e^{X_i \beta^k + V_I}} = e^{-u_{ii)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(11)}$$

Cobb-Douglas production functional form using MLE method was employed to estimate TE using Frontier 4.1.

3.2.4.4 Objective Four: Two Stage Least Square Method

The fourth objective aimed at identifying how varying farm household objectives affect the extent of entrepreneurship of a household in enhancing CA coordination in irrigation systems. The data set consisted of farm household level information, which is cross sectional. These data were constructed to suit addressing the simultaneity bias of variables with an interdependence mechanism, where the independent variable- farming objective (commercial or subsistence)/treatment and the outcome of interest (dependent variable)- investment expenditures-a proxied as enterprising tendency, both are endogenous.

Data type used for the structural equation dependent variable, investment expenditures (*Inv)* was indirectly measured as own annual/private total irrigation expenditures /investment made in the irrigation farming during the cropping period to account for real capital asset use (total cost in Tanzania shillings –logged to make normal distribution), that was as a proxy for measuring the extent of enterprising tendency. The independent variable- farm household objectives (FO*)*, which is also endogenous in the structural equation, was measured as a dummy variable- whether the farmer is commercial/semi-commercial or subsistence oriented. Exogenous variables were identified and constructed to serve as instruments for X_1 (assumed to influence farmer objectives/ orientation, (FO)- these included output quantity marketed, proximity/distance to the irrigation schemes, output market distance (all measured in km), and transaction costs mainly contact costs measured in monetary value of contact/communication e.g. phone & travel costs (Tzs), and number (frequency) of meetings. Other instrumental variable data included were saccos service access (dummy), farming support services -which included extension service support (dummy), soil fertility status in the irrigation scheme (dummy), off farm activities engagement (dummy), household labor force availability (number of eligible member for farming), and irrigation type (dummy). The exogenous variables included in the structural equation were, sex (dummy), ownership of land within the irrigation scheme (dummy), group leadership style(dummy), non-tangible benefits like information sharing (categorical), trust (dummy), experience in irrigation farming (years), contact/communication cost (Tanzania shillings/currency).

To analyse the data**, i**nstrumental variable (IV) strategy was implemented. Different estimators such as Generalized Method of Moment (GMM), Limited Information Maximum Likelihood (LIML) and Two Stage Least Square (2SLS) exist in estimating variables with endogeinety as described above (Verbeek, 2012). To control for the endogeneity problem, this study adopted a 2SLS because has advantage over other estimators described above in that it is computationally simple such that does not require the use of optimisation algorithms (i.e. can estimate parameters even if cannot be solved analytically from the first order conditions). It can also perform better under small sample (Verbeek, 2012), and it is efficient in the class of all IV estimators (Wooldrige, 2010).

Mathematically, the 2SLS modelling proceeds in the following two steps:

First, the structural equation is specified as:

$Y_i = \alpha_{10} + \beta_{11} X_1 + \beta_{12} X_2 + e_i$ ………………………………………………… (12)

Where, Y_i = endogenous outcome variable (log of total annual investment cost (Tzs) made in irrigation farming during the season

$X_1 = X1_i$ = Independent variables which is endogenous- farm household objective (FO)- (dummy- 1= commercial or 0= subsistence oriented farmer)

X_2 = Independent variables which are exogenous (personal characteristics: age, sex, ownership of land in the irrigation scheme, trust, experience, group leadership style/discretion, and non-tangible benefits- measured as defined above.

$\beta_1, \beta_{2,}$ = Parameters to be estimated

e_i = error term which is assumed to be correlated with the endogenous variable

Second, some variable(s) Z (instruments), which influence $X1_i$, but does not influence Y_i are found. Correspondingly, the equation follows by including all exogenous variables from equation (i) above.

It is written as:

$$X1_i = \alpha_{20} + \beta_{31} Z_i + \beta_{32} X_2 + e_i \text{ ....(13)}$$

Equation (13) allows generation of new values/ predicted value for the variable $\overrightarrow{X1}_i$, such that

The predicted value $\overrightarrow{X1}_i$ can now be substituted for $X1_i$ in equation (12) above for estimation.

Equation (12) is re- written as:

$$Y_i = \alpha_{10} + \beta_{11} \overrightarrow{X1}_i + \beta_{12} X_2 + \left(e_i + \beta_{11} \overrightarrow{u}_i \right) \text{ ....(14)}$$

Equation 14) was estimated using linear regression (OLS method) using STATA version 11 computer statistical program.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Farm households, Irrigators Groups and Irrigation Systems Characteristics

4.1.1 Households Characteristics

Table 4.1 summarises farmers and households' characteristics in the surveyed districts. The survey considered gender group categories, which covered both male household head (80.3%), and female household head (19.7%) responsible in the farming decision making. In terms of civil status, the sampled population showed that many individuals were married staying with their spouse (86.4%) and a few had their spouse away (3.8%). About 4.9 % were widow, and 2.7% were separated/ divorced, while a few were single (2.2%). Many farmers involved in the survey had standard seven primary level of education (73.2%), and farming (37.6%) being the main household occupation to sustain their livelihood, and a few were engaged also on other off farm activities like running small non- agricultural business such as shops/kiosk (33.7%), and provision of casual labour for both on farm and non- farm activities such as masonry (11.6%), and other activities like livestock sales and fishing (7.7%).

The average family size was 7.9 members composed of an average of 2 adult males, 2 adult females, 3.2 children, and 0.86 old persons above 64 years. The organisation of labour type used in irrigation farming was based on individual household labour supply on own farm/plot crop production, which was in three categories: family labour (68%), hired (22.9%), and exchange group labour (9%). Exchange group labour is one where by farmers work in alternating pattern for each farmer field or any activity in the community in return for payment in kind- usually food a got or cattle is slaughtered for this function. Family labour was mainly used at initial farm preparatory stage, and general farm management. Hired labour was used mostly at weeding stage, or harvesting and transportation. Exchange group labour was occasionally used especially where availability of family and hired labour is compromised and when one wishes to catch up the season because of un reliability of rainfall, which is a key determinant of irrigation operations/working. All farmers in all irrigation schemes surveyed grown paddy/rice crop perhaps because of biophysical suitability or the importance of rice as food staple and cash earning crop. The farmers' perception of soil fertility status for the plots in the scheme were –63% poor and 37% considered the soil fertility to be good.

Table 4.1: Famer and Household Characteristics

Variable	Mean	Percent
Farmer Characteristics		
Age (years)	44	-
Gender:		
Male		
Female	-	80.33
Education level (years):	-	19.67
Primary education	2.9	73.2
Primary drop out	-	12.02
Secondary education	-	2.19
Secondary drop out	-	2.73
Post-secondary/college/university	-	3.2
No formal education		6.56
Household characteristics		
Family size (persons)	7.9	-
Household member eligible for farming (persons)	3.9	-
Household average annual income (off farm) Tzs	1 306	
Household with land ownership in irrigation command area (acres)	689.4	88.7
Household hiring land (%) and average land (acres) hired in irrigation command area	2.1	42.7
Percentage share of household income generating activities:		
Farming	0.7	37.6
Non-agricultural business (small business)	-	33.7
Casual labour supply	-	11.6
Others (livestock sales and fishing)	-	7.7

4.1.2 Irrigation System and Group Characteristics

4.1.2.1 Irrigation Systems Characteristics

Irrigation systems characteristics were more similar in all schemes surveyed. Most irrigation systems were organised in such a way that farming was on individual household basis rather than share cropping (collective farming). Production cycle was seasonal mainly during rainy season with exception of irrigation scheme that abstracts water from Lake Victoria such as Nyatwali in Bunda district, which operates all year round for about 2-3 times production cycles per year.

All irrigation schemes were traditional improved with farm structures not well mechanised to allow water use efficiency because canals were not or sometimes partly lined (cemented), having no weir structures to control flow and distribution of water on farm plots, and they all used flooding type approach for irrigation water distribution- the method which does not guarantee water use efficiency in relation to crop water requirement. The main sources of water for irrigation (catchment area) were rivers (73.4%), Lake Victoria (21.7%) and rain water harvest in some irrigation schemes with reservoirs/dams, like Maliwanda in Bunda, and cheleche and Irienyi schemes in Rorya districts (4.9%).

The average irrigation schemes command area was 719 acres with a std of 684.6, implying that farmers had no wide variation of land in the irrigation schemes. The total area under cultivation in the irrigation scheme ranged from 100 acres to 1052 acres with an average of 590 acres. The irrigation groups consisted of an average total number of 285 members with a std of 69.1 farmers involved in the irrigation farming. These members were chosen on the basis of possession of land or else hiring in the land within the schemes.

Table 4.2: Irrigation Systems Characteristics

Variable	Mean
Average size of the scheme (acres)	719
Average area under irrigation farming (acres)	590
Sources of irrigation water for the irrigation schemes:	**Percent (%)**
Permanent river	73.4
Lake	21.7
Dam/reservoir	4.9

4.1.2.2 Irrigator Groups (Water users) Characteristics

Irrigators groups also known as Irrigation water users Association (WUA) were found in each irrigation scheme to enable efficient exploitation of water resources in a sustainable and beneficial way for every member. Ideally, it was sought that each WUA must possess water right permit to have the right for water use and efficiency resource management. The water right permit is usually granted in a group basis by the water basin authority under the Ministry of water and Irrigation. The process of water right permit issuance is made easy through decentralized water basin offices available at zone levels in the country. In the Lake Zone it is referred to as the Lake Victoria water basin (LVB) covering the surveyed districts.

However, most of the groups visited in all irrigation schemes about 80% operated without water right permit (Table 4.1), while a few those with formal water right permit could not even pay the annual fee to the authority for reasons that the abstracted water does not justify fee payment because the authority itself does not have enough water for allocation in dry and rainy periods since all schemes rely on availability of rainfall -which is erratic, and do not have reservoir for irrigation water storage. In each scheme, there was one large farmer group consisting of an average of 285 members with their institutional arrangement and management. However, almost all groups were not formally registered.

Table 4.3: Irrigator Groups Characteristics

Variable	**Mean**
Average current number of irrigation water users per scheme	285
	Percent (%)
Irrigation group with water right permit	20
Farmers perception on soil fertility status in irrigation scheme:	
-Good	37
-Low /poor	67

4.2 Impact of Irrigation Member Farmers' Self-Selection Effects on CA

Self-selection in this context refers to the tendency of farmers engaged in irrigation farming to make choices that are relevant to their preferences in respect to the farming system types- irrigation and rain fed, and the surrounding available livelihood opportunities. The choice is usually influenced by economic opportunities surrounding them based on observed and un observed (heterogeneity) characteristics. In this respect, specific identification of self-selection factors is crucial in understanding irrigation farmers' behaviour and developing recruitment and retention strategies for irrigators CA members committed to work with greater impact in the irrigation systems.

A number of explanatory variables in an exclusion restriction (to avoid collinearity problem) were included in the regression model with sample selection to determine farmers' behaviour, examine the effects/impact of self-selection on the choice of farming type and hence, implicitly reflect CA commitment. The null hypothesis that the decision for farmers to self-select into farming type does not base on TCs (contact, contract & control), economic opportunities in the area and perceptions of non-tangible benefits like socio network such as reciprocated information sharing was also tested. The summary descriptive statistics and definition of variables used in the Heckman selection model -two step regressions are presented in Table 4.4.

Table 4.4: Summary Statistics and Definition of Variables used in Heckman Two Step Regressions

Variable	Definition	Unit measure	Mean	Std
type1irrg	irrigation farming ecosystem choice: 1= irrigation farming, 0= otherwise	Dummy	0.917	0.28
Totfarmlan	Total farmland size owned (acres)	Acres	2.53	2.46
Age	Age of respondent	Years	44.09	12.00
Sex	1=male, 0= female	Dummy	0.803	0.39
Hhlabor	Number of members eligible for farming at household	Number	3.93	2.23
Educ	Respondent's education level 1= standard7, 2= secondary, 3= tertiary	Categorical	2.95	1.01
Trust	Trust in group members regarding irrigation resources utilization: 1= yes, 0= no	Dummy	0.95	0.19
Irigntyp	Irrigation type depended 1= modern, 0= traditional improved	Dummy	0.16	0.37
Farmsacspt	Farmers financial support from saccos 1=yes, 0=no	Dummy	0.25	0.43
Imprvseed	Use of improved seed1= yes, o=no	Dummy	0.73	0.44
Soilirrgat	Soil fertility status in irrigation farm land: 1= fertile soils, 0= otherwise	Dummy	0.37	0.48
Totincome	Total household income (Tanzania shilling)	Tanzania shilling (currency)	1 804 523	165141 9
Econoprtnit	Recognize economic opportunities availability 1=yes, 0 otherwise	Dummy	0.64	0.48
Irrgreliab	Irrigation farming reliability: 1= depend on, 0= no	Dummy	0.73	0.45

Irgnetareason	Irrigation net area sown: acres	Acres	2.13	2.15
nontangible	Non tangible benefits: information sharing, 2=farmer to farmer helpfulness,3=producer marketing power, 4= use of CA as bridge for external support	Categorical	0.8	0.40
Irrgdist	Distance of irrigation scheme from the homestead: km	Km	2.11	3.43
Irrgtrain	Irrigation technologies training acquisition: 1= yes, 0= no	Dummy	0.75	0.43
Irigposition	Position/location of farmer plot in the irrigation scheme: 1=head, 2=middle, 3=tail	Categorical	2.12	0.66
Factor1	Respect of public services provision /contributions: likert scale	Likert scale	6.12	1
Factor2	dodging contributions: likert scale	Likert scale	-2.43	1
Factor3	Violation of rule: likert scale	Likert scale	3.95	1
Contrnmcst	Contract agreement compliance measured in non-monetary cost contribution payment of rice bags after harvest:	Number of rice bags	3.97	5.46
Gpleader	Group leadership: 1= good/satisfactory,0= no/bad	Dummy	0.65	0.47
Rulework	Working of rules and enforcement 1= good, 0 = bad	Dummy	0.64	0.48

Consistently, the Heckman two step sample selection regressions results are presented in Table 4.5. The data set contains missing values therefore, observations with missing data were removed, and hence, only a sample of 67 observations remained for the econometric estimation. The Wald chi square test for the model fit indicates significant differently from zero at less than 1% level (Chi-square probability = 0.000).

Furthermore, the correlation factor (inverse mills ratio) result for the model is positive and significant at less than 5 % level (p=0.028) providing evidence for the presence of self-selection, hence suggesting that the irrigation farming ecosystem choice (*type 1 farmer*) is a non-random choice. The positive numerical value for the inverse mills ratio suggest that there are positive selection effects in these data and those who select into the irrigation farming rely most on the ecosystem than a random drawing from the population with comparable characteristics. Therefore, the unobserved factors that make choice more likely tend to be associated with higher level of irrigation farming participation choice-implicitly CA commitment.

On the basis of these results the null hypothesis was rejected in favour of the alternative, and concludes that farmers self-select into farming ecosystem types (*type 1 farmer*) on the ground of TCs (contact, contract & control), and the site specific attributes of the TCs such as economic opportunities in the area and perceptions of non-tangible benefits like using CA as bridge for support services access which may increase or reduce the participation morale in the irrigation farming, besides unobserved characteristics not directly measured. Specifically, the first stage (outcome) regression results are informative in understanding the characteristics of individual farmers engaged in the irrigation farming (*type1 farmer*).

Five factors (variables) were significant in explaining irrigation farming ecosystem choice. The variable **age** coefficient is negative and significant at 10% level indicating that younger farmers are more likely to choose irrigation farming ecosystem type1 than would old farmers do.

A one pecent (in year) increase in age of a farmer is likely to reduce participation in the irrigation farming choice by 0.5%, probably because younger farmers are energetic with less household responsibilities and also commercial oriented, so could afford complying with the CA social contract arrangements without dodging, since they value the resource for their livelihood development and sustenance.

The coefficient for the variable **sex** had a positive sign and significant at less than 1% level suggesting higher probability of men than women to participate in irrigation farming. Being a man farmer the likelihood of participation choice in the irrigation farming increases by 22% compared to the counterpart women farmers. A possible reasoning is probably due to the traditional and customary patterns in the African setting in general, and Tanzanian in particular -that men have higher influence on the access and control of resources and the responsibility to ensure household security. Men can also endure- in case of havoc arising for the irrigation facilities use amongst WUA members, besides having opportunities to attend various trainings than women would do.

The coefficients for the variable education level (**educ)** categorised into: primary level; secondary level; and tertiary (college and University) levels all had positive signs and significant at less than 1%; 5% and 10% respectively. These results suggest that education is an important determinant of farming ecosystem choice, with primary level individuals having higher likelihood of choosing and relying on type1 farming ecosystem, followed by secondary level and lastly those with tertiary education level. The higher probability of choosing type 1 (irrigation farming ecosystem) for individuals with primary level of education is perhaps the fact that farming is their main occupation as opposed to the more educated individuals like those with secondary and tertiary levels who are more likely to seek and easily secure other formal employment /jobs elsewhere.

The variable trust of individuals in irrigation group and leadership (**trust**) coefficient had a positive sign and significant at less than 1% level, suggesting that increase in trustworthy is likely to increase choice and reliance of type 1 farming ecosystem. The reasoning is straight forward that farmers require exclusive rights and benefits realization on the use of resource without reasonable doubt arising from group or resource management.

The coefficient for the variable soil fertility status in the irrigation command area (**soilirrgat**) had a positive sign and significant at less than 5% level. A one percent increase in soil fertility status in the irrigation scheme is likely to increase farmers' participation choice by 11%. Soil fertility status is an asset specific attribute of TC in the form of site specific, which can increase or reduce TC. These results are not surprising; having fertile soils in the irrigation land increases the probability of farmers' participation because farmers are sure of realizing higher yields and benefit from good soils, hence this calls for irrigation land improvement in order to reduce the transaction costs related to attrition, which had an implication on efforts exerted for the maintenance of infrastructures and contract compliance on operations and contributions. This point to the need of research and extension advisory services to enhance technologies and good agricultural practices applications. It can be through technologies development and training.

The economic opportunities variable (**econoprtnity)** paints an interesting picture as an attribute that influence transaction cost in the farming ecosystem choice (irrigation participation and reliance). The coefficient is negative and not statistically significant. Though it is not statistically significant, in economics, results suggest that increasing availability of economic opportunities access in the area reduces the likelihood of farmers to participate in the irrigation farming, perhaps because they can be engaged and earn their livelihood from other available wider economy stream sources. This has an implication on the importance of irrigation resource to the users. These results conform to the findings by Ostrom, (2010) that if the resource is not important to the users then the likelihood of managing it efficiently might be doomed.

The variable related to SACCOS/financial support for farmers (**farmsacsupt**) coefficient had a positive sign and not statistically significant. Though it is not statistically significant the positive sign suggests that the irrigation farming ecosystem choice is likely influenced by existence of SACCOS/ financial support rendered to farmers to enhance capital investment. This is particularly important because irrigation farming requires capital investment to meet operations and maintenance aspects and other own production and marketing costs obligations. These results therefore point to the need of a clearly well managed finance-irrigation schemes linkage model to support farmers fully participation in the irrigation farming ecosystem.

The sign for the variable irrigation type **(irigtnype)** defined as 1= modern and 0= tradition was negative and not significant. Despite the fact that irrigation type variable did not matter in influencing choice, the results suggest that farmers in tradition irrigation systems were less likely to choose and rely on irrigation farming ecosystem-implicitly were not likely to value the irrigation system, and consequently the CA, perhaps because of un reliability of the physical availability of water resources for most of irrigation schemes depending on rainfall, which is also erratic - the situation that pre dispose farmers at production risks. These results point to the need of improving irrigation schemes hardware to enhance efficient and reliable physical resource use.

The coefficient for the variable improved seed use (**imprvseed)** is negative and not statistically significant. Though not statistically significant, the results highlight the effects in opposite direction on the choice of irrigation ecosystem. The possible explanations can be probably because improved seeds are not readily available in the formal seed system making it difficult and sceptical to rely on. Other explanation can be because improved seeds require intensive inputs use and management, which is laborious, and require human skills, which farmers are lacking, hence adding up another transaction cost attributes.

On the other hand, the requirement of reliable water for plot inlet and drainage at different stages of crop growth such as at planting stage, fertilizer application and harvesting to ensure good practices is labour and cash intensive. At the same time inputs are expensive that farmers cannot afford to comply with in a recommended packages and hence resulting into low returns compared with irrigation investment made, or it can be that improved seeds have no preferred traits for production, marketing and consumption.

The coefficient for the variable total household income (**totincome)** had a positive sign and but not statistically significant. Although not statistically significant, the sign for the coefficient indicates that individual farmers with high total income were likely to choose for irrigation farming ecosystem. A one percent increase in household total income were likely to choose participation in irrigation farming by

29.3%. These results are not surprising because irrigation farming requires intensive capital investment both cash and non-cash.

The variable coefficient for total household farmland (**totfarmland)** is negative and not statistically significant. However, though not statistically significant, results indicate that a one-percent increase of total farm land size in the irrigation scheme command area is likely to cause farmers not to choose the irrigation farming ecosystem participation by 0.7%, which is significantly low index of choice. The implication is that households with bigger total farmland were less likely to engage fully in the irrigation farming and hence collective activities commitment, perhaps because a bigger land ownership can be rented out to other farmers and in return earn the income at low transaction costs, i.e. without direct participation in the collective action activities. These results calls for equitable land allocations among farmers to ensure full participation and ownership of irrigation resources.

The selection regression results indicated that several factors are important determinants of farmers' self-selection into farming types. The model fit and correlation factors results as described above have confirmed the presence of sample selection. The variable household labour (**hhlabor**) coefficient was positive and significant, suggesting that households with greater number of members eligible and engaged in farming self-select into the irrigation farming type, perhaps because they can have a freedom of labour division ''without compromising'' to meet household's tasks and compliance with CA social contractual arrangement as per irrigation group organisation requirement. Farmers can also self-select with respect to non-tangible benefits, which has options which included: farmer to farmer helpfulness (reciprocity information/material sharing), and use of CA as a bridge to acquire external services support like research, extension advisory services, and business development.

The sign for the coefficient of the variable non-tangible benefits (**non tangible**) particularly, the option for use of CA organisation as a link/bridge for external support was positive and statistically significant. A one percent increase of the use of CA organisation as a link for external support is likely to make farmers choose and exert effort in irrigation farming commitment by about 27%. This can be particularly important for those farmers committed and strategically wish to receive external support services to boost their efforts for livelihood improvement. These findings point to the need of strengthening public private partnership model of collaboration that aim at enhancing support services, particularly focus on business development and chain wide collaboration.

Working of rules variable in the irrigation group (**ruleworkdumy**) coefficient had a positive sign and statistically significant. The positive sign indicates that farmers evaluate the implementation and enforcement of rules in relation to their benefits would be realized in the irrigation systems. In this respect, farmers self-select on the basis of ‘’ perceived’’ good functioning of the rule, and hence irrigation ecosystem choice is, as a result observed. Therefore, the impact of this self-section might be compliance of irrigation contract arrangement because they respect the authority as a result of good rules and enforcement, hence abide by irrigation CA activities participation and contributions. Rules enforcement varies between groups and leadership styles across the irrigation schemes, and hence important aspects in explaining non-random choice depending on individual farmer’s preference and attitude. These results point to the need of carefully screening/choice of group members and leaders those would implement and enforce the rules to the expectation of perceived good rule in the irrigation systems. The good rules and enforcement as perceived by farmers are characterised by fair consideration of resources distribution and accountability of coffers to the benefit of all members.

The variable irrigation net area sown (**irignetarea**) is also an important determinant for self-selection. The coefficient is negative and significant at less than 5% level. A one percent increase of acreage net area planted crops in the irrigation plot is likely to cause a huge negative impact of about 54. 3% reduced effort exertion for irrigation collective activities. The implication is that farmer self-select based on the net irrigation area sown crops such that farmers with large net area sown do not value participation on irrigation farming, which explicitly indicates less commitment on CA social contract agreements.

As such irrigation farming ecosystem (type 1) is not observed. This is not queer because farmers are rational and thus evaluate implicitly the cost-benefits of CA participation, and perhaps availability of household labour force as compared to other available economic opportunities with respect to transaction costs involved. In other words, the impact for this self-selection might be associated with low morale/motivation to choose for the type1- irrigation farming ecosystem in that regard. These findings therefore call for equitable distributions and allocation of tasks requiring CA in the irrigation schemes depending on individual farmer’s area sown crops rather than equal CA work distribution.

Trust variable (**trust**) in group members and leaders had a coefficient with positive sign and statistically significant. Results indicated that irrigation farming ecosystem choice was observed on the ground of trust. A one percent increase in trust among members and leaders in the irrigation collective action is likely to influence self-selection into irrigation participation by 31.3%. Trust plays an important role in social interactions, particularly in enhancing the provision of public good services.

These findings are similar to other studies like Kreps, (1990), and Sene, (2012), which also indicated that trust reduces TCs, and predict/ encourage participation in local public goods production. The impact of this self-selection might be encouragement of individual farmer who chooses irrigation ecosystem type 1 to cooperate in a voluntary way for the activities in the public goods provision such as in irrigation schemes, reduce free riding, and hence respect of the law in the CA. However, because trust manifestation for an individual is not easy to predict /show, this points to the need of devising fair mechanisms for resources distribution and accountability, which might be used as proxy indicator for trust.

On the other hand, farmers also self-select into irrigation farming type on the ground of irrigation position of plots in the irrigation schemes, which were based on options of: head ender, middle and tail ender. The coefficient for the variable irrigation position (**irigposition)** tail ender option is negative and significant at less than 5% level. A one-percent increase of the distance in the irrigation position towards tail end reduces observation participation of irrigation farming choice by 23.7%. Farmers are less likely to choose irrigation farming ecosystem when they are positioned at the end part from the head part source of water. This is perhaps because of the fact that being at the end part from water source pre dispose one at lower chance of having sufficient water required for the crops- more especially in a poor water management and control, hence irrigation farming choice is not observed for the tail enders. The impact for this might be free riding, dodging contributions and violation of rules set forth. This calls for fair resource distribution amongst WUA members. Other options for the variables of head ender and middle had coefficients with positive sign and insignificant.

The variables related to attitudinal behavioural factors- computed in a factor reduction analysis approach with options, which included: respect of public services provision in form of frequency contributions (Factor1); dodging contributions (Factor2); and violation of rules (Factor 3) were important determinants for farmer self-selection into farming types.

The variable respect of public services contributions (**Factor1)** coefficient had positive sign and significant at less than 5% level. Attitude related to frequent contributions and respect of public service provision is relevant for commitment in the irrigation farming ecosystem under CA. Amongst CA members, a one percent increase in the behaviour of respect and compliance on contributions set is likely to cause self-selection into the irrigation farming choice by 14.8%. The impact of this self-selection is relevant for retaining CA members committed to participate in the irrigation farming ecosystem- type1.

Self-selection with respect to dodging contributions (**Factor2**) is equivalent to free riding and opportunistic behaviour. Free riding is maximization of own welfare without compensation of others' efforts such as dodging contributions to these efforts, whereas opportunistic behaviour occurs when actors deliberately take advantage of the situation in pursuit of self-interest at the expense of others, which can be cheating or hide of relevant information. Farmers with non-commitment behaviour or those worry contributions because of mismanagement albeit relying on irrigation farming ecosystem might self-select into type. A one percent increase in dodging contribution is likely to influence self-selection into irrigation farming by 8.2%. The impact of this self-selection is important for CA members' recruitment and understanding contributions/ compliance rate. It is also important in developing mechanisms for control, which are enforceable with less cost.

The coefficient of the variable violation of rules (**Factor 3)** is negative and significant at less than 5% level. A one percent increase in the violation rules reduces the likely that farmers will self-select into irrigation farming by 29.1%. The implication is that an increase of farmers with attitude towards violation of rules such as diversion of irrigation water and other disobedience of laws/bylaws are likely to discourage other innocent farmers from fully participation in the irrigation farming. Other variables, like compliance on the contract for contribution payments in kind (**contrnmcst**) and irrigation technologies training (**irrgtrain**) were not statistically significant, but indicated positive effects towards self-selection into treatment (type 1 farming ecosystem).

The study concludes that irrigation farming ecosystem choice (*type 1 farmer*) is a non-random choice, and hence selection of members for organised CA establishment should base on factors such as families with greater number of members eligible and engaged in farming at household much as market for labour is imperfect; non tangible benefits, particularly using organised CA as a bridge (network) to help farmers get support from various external service providers in implementing sustainable farming practises and take part in post- harvest agribusiness activities downstream in a value chain management perspectives; good working of rules in the irrigation group; and stimulate attitude related to frequent contributions and respect of law on public service provision through good leadership and rules enforcement because were found to be positive and significantly influenced self-selection into treatment.

On the other hand, factors which impose negative effects/challenges that discourage farmers from fully exerting commitment effort contributions in the irrigation farming ecosystem were: dodging contributions (factor2), and violation of rules/ bylaws (Factor3), which were also relevant for farmers' self-selection. These factors should be accounted for because their impacts are important for understanding CA members' incomes ability and motivation, recruitment strategy for public services provision, and development of less costly control mechanisms. They are also important in understanding setting up contribution level/amount affordable by all members through public-private partnership involvement to enhance compliance rate.

Overall, the major contributions of this study in the existing empirical literature are twofold: First, the use of novel approach of Heckman selection model in addressing the problem of collective action establishment and survival of collective action for irrigation systems performance, and other emerging economic development efforts involving the commons and public service provision. This approach has not been applied in the irrigation systems context to my understanding. Second, the use of irrigation systems management data by farmers under CA is also relevant for the empirical evidence in Tanzania and other developing countries, since the use of groups (WUA) by many authors and practitioners is generally considered a strategy to efficient irrigation performance (NIPO, 2009), which is not the case because their establishment does not account for self-selection effects amongst members. The present study concludes that selection of group members for a successful CA to enhance irrigation performance should base on non-random recruitment based on self –selection factors described above.

Table 4.5: Heckman Two Step Selection Model Regression Analysis Estimates

Variable	Coefficient	SE	Z value
type1irrg			
Totfarmland	-0.0069	0.0159	-0.43
Age	-0.0049	0.0029	-1.68***
Sex	0.2223	0.0766	2.90*
Hhlabor	0.0082	0.0131	0.63
Educ: primary	0.2254	0.0815	2,76*
Secondary	0.3945	0.1822	2.17**
College	0.2459	0.1313	1.87***
Trust	1.2542	0.2154	5.82*
Irigntyp	-0.1711	0.1607	-1.06
Farmsacspt	0.0955	0.9525	1.00
Imprvseed	-0.1277	0.1368	-0.93
Soilirrgat	0.1103	0.0550	2.00**
Totincome	2.93	2.65	1.10
Econoprtnity	-0.0487	0.0884	-0.55
Const	-0.4365	0.2358	-1.85***

Irrgreliab			
Irgnetareason	-0.5426	0.2449	-2.21**
nontangble: information sharing			
use of CA as bridge	-1.2407	6.5486	-0.19
	2.7261	1.1415	2.39*
Hhlabor	0.3463	0.2087	1.66***
Trust	3.1257	1.687	1.85***
Irrgdist	0.0173	0.2105	0.08
Irrgtrain	1.0182	0.9972	1.02
Irigposition: headender	-	-	-
middle	0.0527	0.8032	0.07
tailender	-2.3710	1.0495	-2.26**
	-	-	-
Factor1	1.4812	0.6924	2.14**
Factor2	0.8233	0.4260	1.93***
Factor3	-2.9112	0.9641	-3.02*
Contrnmcst	0.0226	0.0506	0.45
Gpleader	-0.0131	0.0094	-1.4
Ruleworkdumy	1.7707	0.8322	2.13**
Totincome	-2.56	3.71	-0.69
Lamda	0.1613	0.7361	2.19**
Constant	-3.1527	2.2699	-1.39
Wald Chi^2: 84.87			
Prob> Chi^2: 0.0000			
N: 67			

Notes: Significance levels: * = p<1%, ** = p<5%, and ***= p<10%

4.3 Factors Influencing Institution Quality of CA in the Irrigation Systems

This section presents results for the analysis of objective two, which aimed at identifying the determinants of institution quality changes over time in the irrigation systems under CA organisation setting. Table 4.6 presents descriptive statistics and definition of variables used for the mixed effect model. From the table, the between std statistics for the dependent variable (compliance) is bigger than the within implying that the variations of (compliance) institutional quality is bigger between the schemes.

Table 4.6: Summary Statistics and Definition of Variables used in the Mixed Effect Model Regression

Variable	Definition	Unit measure	Mean	Std		
				Overall	between	Within
Dependent						
Compliance	Institutional quality of CA	Number of farmers turning up (comply) over the years	166.02	94.0	94.93	31.61
Independent						
Watercalendar	Presence of water distribution arrangement calendar	Dummy (1=yes, 0= no)	0.37	0.5	0.45	0.25
infosharemode	Information sharing mode like farmer to farmer network	Dummy (1=yes, 0= no)	0.85	0.4	0.37	0.00
Meeting	Number of meetings held pertaining to irrigation collective action issues annually/seasonally	Number	2.5	1.6	1.19	1.09
Extsuport	Extension advisory services support frequency offered to farmers	Number	14.13	31.9	32.98	8.32
controlguard	Presence of control guard in the irrigation scheme	Dummy (1=yes, 0=no)	0.44	0.5	0.52	0.11
Monitoringhrs	Hous spend on monitoring the irrigation scheme	Hours	13.04	18.3	17.5	8.4
formalpenalt	Control mechanism implemented to constrain adverse human behaviour through court cases and formal charges prosecution within the village	Number of penalties	0.06	0.3	0.07	0.27
Infopenalt	Control mechanism implemented informally through sanctions or self-enforcing to restrain	Number of penalties	1.73	3.32	3.11	1.61

	adverse human behaviour in the irrigation scheme					
Qtysol	Output quantity sold as a proxy for market access and product demand at scheme level	Bags	1095.14	1376.	1227.61	763.78
Mktdist	Proximity to the output market distance as a proxy for market access	Km	6.94	17.3	7.8	0.18
Outputprice	Output price per unit (bag)	TZS	55945	18721.8	12255.3	14829.2
Timet	Time period for event occurrence	Years	2007.5	2.89	0	2.89
rainfall	Rainfall amount over years	Mm	63.75	25.64	0	2.5.64
infpenty*time	Interaction between informal penalty and time	Number	3471	6669.5	6251	3239.9
Exttime	Interaction between extension advisory service and time	Number	28384.9	63995.5	6623.3	16759.9
Quantprice	Interaction between quantity sold and output price	Number	7.49e+07	1.10e+08	9.25e+07	6.8e+07
Raintime	Interaction between rainfall and time	Number	127950	51459.8	0	51459.8

Several field studies on common resources management indicate that successful communities in resource management under CA typically exhibit well defined rules, the ability to monitor resource extraction and punish deviators, have existence of mechanisms for conflict resolution and a forum for discussion (Bandiera et al. 2005). At the same time scholars, (Gibbon and Robert, 2013) agree that good organisation appears together with institutional features. In this regard, the ability to cooperate in a collective action particularly, in the irrigation systems (common resource) is a key determinant for efficient economic performance due to institutional quality. Yet, there is little evidence of how governance mechanisms such as contact and control, and external factors like market characteristics and rainfall variability affect institutional quality of CA in the irrigation schemes (Andrew et al. 2015). This shortcoming is analysed in this section using panel data set related to ex-post transaction costs (contract compliance, control and contact outcomes) as well as market characteristics, and rainfall variability. The analysis tested the null hypothesis that transaction costs, market factors and rainfall characteristics do not influence institutional quality in irrigation group members.

The mixed effect linear regression results with random intercepts are reported in Table 4.7. The null hypothesis was rejected (p= 0.0000) and concluded that output market factors (output prices, market distance, and quantity sold as a proxy of market access), rainfall variability characteristics and transaction costs do matter in the institutional quality (compliance) influence in the irrigation systems.

The full mixed effect model likelihood ratio (LR) test results indicated that the random coefficients between and the fixed effect within irrigation schemes have statistically significant variation (p= 0.017). Taking the estimated results for the overall intercept- for both fixed and random effects of 54.99 percentage points as a baseline (reference), the findings showed that the institutional quality (compliance) may vary (increase or decrease) by a standard deviation of 18.19 across the schemes (Table 4.7). Consistently, six variables were important determinants of (compliance) institutional quality within and across the irrigation schemes.

The coefficient for the variable information sharing (**infosharemode)** among farmers within and between irrigation schemes had a positive sign and significant at less than 1% level. As time goes on, for every increase of information sharing strategy by 1 percentage point the institutional quality level increases by 216%. This is expected because information is power and enables farmers to learn and obtain technical knowledge, technologies and market information easily and at less cost through interaction networking amongst farmers. The implication is perhaps that as time passes by then farmer to farmer network relations is strengthened because of frequent interaction and hence reduced TCs. Other studies on transaction cost have also confirmed the reduction of transaction costs due to frequent interaction (Groenewegen et al, 2010).

The coefficient for the variable related to formal penalty (**formapenalt)** had a positive sign and significant at less than 1% level. Implementation of formal penalty such as court cases and or taking culprits to the village executives influenced compliance. An increase of one percent level formal penalty influence compliance by 20%, implying that farmers respect or fear most the formal procedures like court cases.

On the other hand, the coefficient for informal penalt (**infopenalt**) was negative and significant at less than 5% level, implying reduction of institution quality as time passes by, perhaps informal rules implementation is biased amongst farmers as time of interactions among farmers' increases. Frequent interactions create closeness relations and sometimes friendships, which may cause biased rules enforcement and implementation. Other studies have established that a combination of formal and informal rules provide good results on institution efficiency (Moshi et al, 2016).

The coefficient for the market characteristics variable such as quantity sold (**qtysold**) was positive and significant at less than 10% level. This is obvious because as output quantity increases implies that the produced products have demand and farmers have market access. A one percent increase in the rice quantity sold increases the institution quality by 2.3%. At the same time, the coefficient for market distance (**mktdist**) was negative and significant at less than 10% level. These results imply that when market distances increases by one percent the institutional quality declined by 59.8 % over time. Market distance has big impact over institution quality improvement because producers need benefit out of the produced outputs and hence these results point to the need of market access improvement.

The coefficient for the interaction variable (**infopenalt*time)** had a positive sign and significant at less than 5% level. The result indicates that there is positive correlation between informal penalty and time. As time goes on, informal penalty improves the institutional quality level. A one percent increase in informal penalty implementation over time improves institution quality by 95.7%. This is perhaps because of frequent interaction or due to “tit for tat” (Binmore, 2007), and hence trust among them is built.

Other variables were not significant. The coefficient for the variable frequency of meetings (**meeting**) attended regarding irrigation farming issues had a positive sign and not significant. Though not significant, results indicate that a one percent increase in frequency of meetings increases institution quality/compliance by 16.9%. A plausible explanation can be that attending meetings enhances information and communication such that farmers internalize the institutions for compliance. Meetings are the transaction cost related to contact and coordination to enhance efficiency economic activity implementation.

The coefficient for the variable presence of control guard for the resource boundary (**controlguard**) was positive and not significant. Though not significant the positive sign indicates a positive effect on enhancing institution quality. A one percent increase of the presence of control guard to monitor the scheme boundaries increases compliance /institutional quality by 178.9% within the scheme. Thus irrigation schemes with control guard had intuitional quality (compliance) higher than ones without guards. However, increasing presence of control guard is costly, hence less cost based mechnisim has to be devised to ensure institution quality. This can be through institutional arrangement such that there is self enforcing by cultivating trust amongst farmers through good leadership and accountability. This result conforms to Ostrom's (2010) institutional design principle that clearly defined boundaries of resource appropriators is a pre-condition for a successful common resource management. Thus defining resource boundaries and ensuring control guard rather than focusing exclusively on physical characteristics of the resource may enhance institutional quality.

Other variables included in the model such as presence of water distribution calendar (**watercalender**) had coefficient with negative sign showing a regative relationship effect on the institutional quality. Though not statistically significant, a one percent increase in the water distribution calendar organisation reduces the institutional quality by 159.6%. This is perhaps because of biasedness in water allocation and distribution among farmers, or inadequate water allocated such that farmers disobey the calendar of distribution arrangement. This calls for improvement on the administrative strategy employed on water management and control.

The coefficient of the variable extension service support (**extsuppot**) was also positive and non-significant. Though not statistically significant, the coefficient had positive effect on institutional quality such that a one percent increase in the frequency of extension advisory service support increases institutional quality by 1657.9%. within the scheme. Extension service support is an asset specific attribute of transaction cost that influence human capital development, and hence reduce farming management TCs related to sysnthesis of information and bounded rationality on negotions with regard to irrigation resource utilization.

The coefficient for the variable related rainfall (**rainfall**) had a negative sign and not significant. Though not significant it had greater effect on institutional quality. A one percent increase in rainfall- mm, reduces the institution quality by 1085%. This is obvious, because under high rainfall farmers have no need of water for irrigation hence reduces compliances/ institutional quality.

The time trend/treatment effect coefficient (**timet**) was negative and non-significant, though not significant indicates that the institutional quality reduces over time. The reduction of institutional quality (compliance) is probably due to rainfall variability which directly affect negatively water availability in the irrigation schemes, hence farmers decide to violate rules because of self-interest behaviour and survival for the fittest.

The coefficient for the interaction variable between quantity sold and price (**qnty*price**) was negative and not significant. A one percent increase in quantity sold and prices go down or vice versa reduces the institution quality greatly by 145%. The results indicate negative correlation between quantity sold and prices as quantity increases the prices go down and vice versa, hence institutional quality reduces, implying that commodity price is important in leveraging institutional quality and compliance stability.

Similarly, the output price coefficient **(outputprice**) is positive and non-significant, but the sign indicates that output price contributes positively on institution quality increase. Other variables included like monitoring hours for the irrigation scheme (**monitoringhrs)** and the interaction between monitoring hours and informal penalty (**monhrs*infopenalt**) were positive and non-significant. The results indicate positive relations, as monitoring hours for the irrigation scheme increases, informal penalty increases and so does the institution quality level improves over time. This is perhaps defaulters are easily identified in this guard monitoring mechanisms. However, there is an inevitable costs increase in terms of personel hours to ensure the institutions are manintained. So the TCs for the irrigation systems management are high.

On the other hand, the interaction between extension support and time (**extsup*time)** coefficients was negative and non-significant, indicating negative correlation. As time goes on extension services support reduces, and hence institutional quality. The reduction of extension services support is perhaps because extension advisory service provided does not meet the farmers need. It might be that extension services are biased provided amongst farmers or else sometimes farmers do not respect the extension agent because of frequent interaction and monotonic extension advise delivery mode.

Table 4.7: Mixed Effect Linear Model Regression Results

Variable	Coefficient	SE	Z value
Individual level fixed effect			
Watercalendar	-15.9567	16.09	-0.99
Infosharemode	216.1934	69.04	3.13*
Meeting	0.1693	4.13	0.04
Extsuport	165.7959	111.79	1.48
Controlguard	17.8872	40.06	0.45
Monitoringhrs	0.0992	0.47	0.21
Formalpenalt	20.1430	12.20	1.65***
Infopenalt	-1931.07	976.04	-1.98**
Qtysold	0.02259	0.013	1.81***
Mktdist	-5.9804	3.48	-1.71***
Outputprice	0.00067	0.0005	1.42
Timet	-2.0537	3.65	-0.56
infpenty*time	0.9571	0.48	1.97**
monhrs*infopenty	0.8063	0.62	1.31
ext*time	-0.0830	0.06	-1.49
quanty*price	-1.45e-07	1.81e-07	-0.80
rain*time	0.0539	0.051	1.04
Rainfall	-108.515	103.71	-1.05
Constant	4125.804		
Random effect intercepts	**Estimate**	**SE**	**p (LR)**
Standard deviation	54.99	18.19	0.0017
N= 70			
n of groups= 7			
Log likelihood=-337.965			
Prob> chi2 = 0.0000			

Note: Significance levels: * = p<1%, ** = p<5%, and ***= p<10%

Another reasoning might be because of the government's budgetary disbursement constraints that directly affect extension services working environment. The budget has not been always reaching to 100% when compared to the approved against actual expenditures, although the allocation trend has increased in nominal terms since 2003/2004 fiscal year (Gabagambi, 2013).

4.4 Productivity, Technical Efficiency and Factor Inputs Allocation in Irrigation Systems

4.4.1 Overview

This section reports the results of productivity and efficiency parameters (technical efficiency and allocative efficiency) to answer objective three, which aimed at assessing the effect of collective action (CA) on technical efficiency, and allocative efficiency. The hypothesis that collective action does not affect farmers' technical efficiency and allocation of production factors in the irrigation scheme was rejected.

The section therefore outlines the productivity parameters measurement of the production function in two scenarios: first, reports the parameters such as output elasticity, technical efficiency and determinants of inefficiency. Second, presents the scores for the allocative efficiency to explain whether production factors (resources) are optimally, under or over allocated by farmers in the irrigation systems under CA management.

4.4.2 Production Frontier, Output Elasticities and Technical Efficiency

This section presents the productivity and efficiency parameters estimated using stochastic frontier analysis for the translog production function, which was estimated by MLE method, and the allocative efficiency for the factor inputs allocation in the irrigation systems estimated by ordinary least square for the Cobb Douglas production function.

4.4.2.1 Descriptive Statistics and Definition of Variables used for the Production Function

Table 4.8 provides definition and summary statistics for the variables used for the stochastic frontier analysis (SFA) of the production function and technical efficiency estimations. The table indicates that the average yield produced by farmers was 39.8 bags per hectare. The bag weighed an equivalent of an average of 90kg paddy rice. The average seed amount used in the production of rice was 16.4 kg per ha, with big variations ranging from 5kg to 60 kg. The average amount for the fertilizers normally used by farmers was 199 kg per ha, also far below recommendations (ibid), and average number of days used to work on irrigation farming were 153 person days, with a wide variation ranging from 1 to 1003 person days per ha. The working days include all full range of activities from farming to pre and post-harvest management such as harvesting, transportation, threshing, drying, packaging and so on. Other inputs used were capital investment, which were directly used in irrigation farming such as labour costs with an average amounting to 5 014 Tanzania shillings, though there were a wide variation ranging from 2 400 to 3 050 500 Tanzania shillings. The strategy for water distribution in the plots/field was rated for satisfaction (good, fair or unfair) as inputs to satisfy crop-water requirement for the cropping period, which averaged to 1.8. Other variables included in the model of technical inefficiency effects are shown in Table 4.8 along with their summary statistics.

Table 4.8: Definition of Variables used in the SFA for the Production Function and Technical Inefficiency Model

Variable	Description	Measure	Mean	Std	Min	Max
Output:						
Yield	Rice yield harvested per ha	Bags**	39.8	78.1	1	864
Inputs:						
Inputseed	Seed amount used per ha	kg	16.4	8.8	5	60
Inputfert	Fertilizer amount used per ha	kg	199.5	1006	25	1000
Labour	Number of days worked per ha	Person day	153.2	738	1	1003
Capitalinv	Cash investment cost	TZS	501434	397123	2400	305050
Water distribution	Satisfaction of water distribution in plots as inputs	categor	1.8	0.63	1	4
Variables affecting deviation of output from frontier:						
Sex	Sex of farmer decision maker in farming	Dummy	0.8	0.39	0	1
Age	Age of farmer(years)	Years	44.09	12	17	80
Educ	Education level of farmer	Category	2.9	1.01	1	7
Irrgland	Irrigation land owned in the scheme	Acres	2.1	2.06	0.2	20
Irrigdist	Distance from home to the irrigation scheme	Km	2.1	3.2	0.2	42
Irrgtrain	Acquisition of irrigation technology training	Dummy	0.75	0.43	0	1
Gpleader	CA group leadership style in the scheme (1=good,0=bad)	Dummy	0.65	0.47	0	1
Nofmeeting	Frequency of meetings related to irrigation issues per cropping period	Number	10.8	15.3	0	52
Expirrig	Experience in irrigation farming	Years	8.8	5.3	1	29
Soilirrgat	Soil status/fertility in the scheme(1=good, 0=otherwise)	Dummy	0.37	0.48	0	1
Riskpercept	Risk perception on the irrigation	Dummy	0.64	0.71	0	1

	technology/resource use(1=high risk, 0= no risk)					
Price/kg	Output price per unit kg	Kg	1017	1028	0	833.33
LN-age*capital	Interaction effect between age and capital(years*income-TZS)	Number	1.9*	1.7*	0	9.5*
LN-NTB*incomeirrg	Interaction effect between non tangible benefits like use of CA for external support access and income (dummy* income-TZS)	Number	2644991	1.7*	0	1.8*
LN-contactcost	Contact/communication cost such as phones and travel cost	TZS	5772	30950	0	305000
LN-CI	Index of cropping intensity as a proxy of good governance in the irrigation system	Index number	0.948	0.219	0	2
Prcfym	Cost of manure input (FYM)	TZS	2771.7	15183	0	120000
Prcdap	Cost of fertilizer input (DAP)	TZS	24016	35686	0	200000
Prcurea	Cost of fertilize (UREA)	TZS	28159	33642	0	100000
Prctsp	Cost of fertilizer (TSP)	TZS	492.3	6634	0	90000
Prcminjingu	Cost of fertilizer (Minjingu)	TZS	540.8	4104	0	40000
%totirgmgt	Percent total time devoted for irrigation farm management	Percent	70.6	37.5	0	180

Note: **a bag of paddy is equivalent to an estimated 90 kg weight; *=times 10^7

4.4.2.2 Production Function Estimation Results for the Production Frontier Technical Efficiency, Output Elasticity and Technical Inefficiency Effects

The maximum likelihood estimates (MLE) of the parameters of the stochastic frontier production function and the technical inefficiency model were simultaneously estimated in a single stage using Frontier 4.1 statistical package

(Battes and Coelli, 1995). Table 9 reports the statistical tests to confirm the appropriateness of SFA in the frontier production function. Kumbhakar and Lovell (2000) explain the variation of outputs from the frontier attributed by the technical inefficiency that it ranges between 0 and 1. If gamma, $\gamma \rightarrow 0$ implies that there is no inefficiency in the model and the traditional average response function can be estimated by OLS method. The results in Table 9 for this thesis indicate that the variance parameter gamma is close to one ($(\gamma = 0.99680)$ and significant at 1% level, implying that the inefficiency effects are likely to be significantly high in the analysis of the output (yields) for the sampled farmers in the irrigation system. In other word, 99.6% of the inefficiency is due to technical inefficiency and only 0.4% due to random error. The generalized likelihood ratio test is significant at 1% level, rejecting the null hypothesis that inefficiency effects are absent, or that they have simpler distributions.

Table 4 9: MLE Estimates for the Production Function Frontier and Technical Inefficiency Model

Variable	**Coefficient**	**SE**	**t- statistic**
Production frontier			
Constant	0.5444	0.3540	15.37
Inputseed	-0.5287	0.1938	-27.28*
Inputfert	-0.2163	0.1214	-17.80*
Labour	0.1003	0.9290	108.06*
Capitalinv	0.7604	0.2582	0.29
Water distribution	0.9844	0.3816	0.25
Technical inefficiency model			
Constant	-0.1370	0.2552	-0.54
Sex	0.5546	0.3941	14.07
Age	0.2209	0.5519	0.40
Educ	-0.3824	0.5923	-0.64
Irrgland	-0.1943	0.3057	-63.54*
Irrigdist	-0.3752	0.2581	-14.53

Irrgtrain	0.1224	0.6115	20.02**
Gpleader	-0.4166	0.4673	-89.15*
nof meeting	0.4073	0.1426	28.55*
Expirrig	0.1110	0.2475	0.44
Soilirrgat	0.3918	0.3885	10.08*
Riskpercept	0.6245	0.9532	0.65
Price/kg	-0.1497	0.9010	-16.61*
LN-age*capital	0.1188	0.3294	36.06*
LN-NTB*incomeirrg	-0.7073	0.2497	-28.32**
LN-contactcost	0.2843	0.2419	0.12
LN-CI	0.4370	0.1106	39.49*
Prcfym	0.1188	0.3272	36.31
Prcdap	0.1635	0.2171	0.75
Prcurea	0.9560	0.2657	35.97*
Prctsp	-0.1456	0.2192	-0.66
Prcminjingu	0.5188	0.3259	15.91
%totirgmgt	-0.8852	0.4042	-21.89
Variance parameters			
Sigma square	0.1165	0.17	65.57*
Gama	0.9968	0.14	683.58*
Log likelihood function = 53.90			
LR 285.46*= 0.0000			
Mean technical efficiency = 0.66			

Note: significance levels: * p<0.01, **p <0.05, ***p<0.1

4.4.2.3 Output Elasticities and Return to Scale

The results of the production function estimates to measure output elasticities and technical efficiency (TE) were obtained for the major common inputs used by farmers in rice production under irrigation farming in the study districts. The major inputs used were seed, fertilizer, labour, capital, and water allocation (distribution) strategy based on calendar of water distribution in the plots/fields (Table 9).

Coefficients results for the estimated output elasticities for all inputs were as expected, with exception of negative signs for seed and fertilizer inputs. The coefficients for seed and fertilizer were negative and significant, indicating that perhaps low quality and poor seed varieties were used, more over at un recommended rates. Similarly, on fertilizers probably were used under poor farming conditions like drought or flood, or else were applied at un recommended rates, which lowered the yields. The output elasticities with respect to inputs were: seed (-0.52), fertilizer (-0.21), and labour (0.1), which was positive and significant indicating positive relationship on the proportional of labour employed and the yields of output produced though very smaller.

Nevertheless, all inputs elasticities were inelastic. Capital and water distribution were not significant, implying not important in influencing the yields produced, perhaps because most farmers use family labour, and the capital most employed included implements like ox ploughs usually owned by many households, and little or non-cash use in their farming activities, hence capital did not matter, resulting into under capacity utilization of irrigation scheme (resource). Also, it might be because irrigation scheme depends on rainfall availability to keep functional. Though not significant, as expected, water distribution/allocation into plots/field was found to have highest elasticity (0.98), followed by capital (0.76) confirming the positive relationship with output production (yield).

The return to scale computed as the sum of output elasticities of all inputs is estimated to be 1.11, implying that on average rice production farmers in the irrigation exhibit an increasing return to scale. Farmers are still operating at region one of the classical production function, which starts with zero inputs use-an irrational behaviour, and choosing their goal inconsistently with maximization of returns. However, if all factors were increased by 1% rice production (yields) would increase by 1.11% (Table 4.10).

Table 4.10: Output Elasticities for all Inputs used

Input variable	Elasticity
Seed	-0.52*
Fertilizer	-0.21*
Labour	0.1*
Capital	0.98
Water distribution in plots/fields	0.76
Total return to scale (RTS)	**1.11**

Note: significance levels: * p<0.01, **p <0.05, ***p<0.1

4.4.2.4 Production Technical Efficiency

Table 4.11 provides results of the technical efficiency distribution by class across all irrigation schemes surveyed. The mean technical efficiency scores per irrigation scheme showed great variations among the schemes, with Igongwa and Nyida having the highest scores. The highest technical efficiency score in Igogwa and Nyida irrigation schemes is probably due to favourable weather conditions and technological differences among the schemes. However, observational trend studies would be crucial to follow up the changes over time in order to draw conclusive recommendations.

Overall, the production technical efficiency score of farmers ranged from a minimum of 11% to a maximum of 97 % with a mean of 66 %. These results suggest that there is still a room in most of the schemes to improve the technical efficiency among farmers by increasing production on average by 34% from the current state of technologies and inputs used in these irrigation schemes, allocating better their disposable resources.

Table 4.11: Farmer TE Score Distribution by Class Per Irrigation Scheme

	Percent proportion of farmers by scheme						
TE score by class	Igongwa	Mahiga	Nyatwali	Mariwanda	Cheleche	Nyida	Irienyi
1: (0.11-0.31)	6.9	7.1	17.2	7.1	0	0	3.3
2: (0.32-0.52)	0	28.6	10.3	42.9	29.4	3.3	33.3
3: (0.53-0.73)	3.4	21.4	51.7	7.1	52.9	23.3	36.7
4: (> 0.74)	89.7	42.9	20.7	42.9	17.6	73.3	26.7

4.4.2.5 Determinants of Technical Inefficiency in the Irrigation Systems

Based on the variance parameters estimates (gamma and sigma –square) in Table 4. 9 regarding the technical inefficiency structure. Five factors were identified to have positive effects relations on reducing technical inefficiency of farmers in the irrigation schemes surveyed.

The coefficient for the variable ownership of irrigation land (**irrgland**) was negative and significant at 1% level, which indicates that farmers with ownership of land within the irrigation scheme command area tend to be less inefficient. This is perhaps because the land owned can be improved with certain rather than fear of eviction if the land is rented in. These results are supported by the findings from Gerstter et al. (2011), which confirmed that land ownership has greater impact on productivity through greater land investment for improvement and also credit access, in places where the land is regularized with title deeds.

The governance related variable, group leadership style and discretion (**Gpleader**) had a negative coefficient and significant at 1% level, implying that increasing good governance on the group leadership reduces farmers' technical inefficiency in the irrigation scheme. This is expected because good leadership encourage others to work, but also good leadership is a key to improvement of performance.

The output price coefficient (**price/kg)** is negative and significant at 1%, indicating that increasing output price reduces inefficiency in the irrigated rice production. The plausible explanation is obvious that price is an incentive for supply response accounting for farm management that is motivated by encouragement of best combination of inputs use and substitution of income earning to leisure. These results point to the need of strengthening market incentives through effective policies that will improve farm output profitable market access.

The coefficient for the variable regarding interaction effects between non tangible benefits and income (**NTB*income**) was negative and significant at 5% level. This implies that as the non-tangible benefits increases the effect of income on reducing technical inefficiency increases. In other word, non-tangible benefits (use of CA as network for external service support access) has positive relationship with income earning, hence efficiency would be increased by the interaction of these variables.

Other variables grouped into information and knowledge such as frequency of meetings (**nofmeeting**) and irrigation training (**irrgtrain**) had coefficients with positive sign and significant at 1% and 5% level respectively, indicating that the increase of technical inefficiency is positively influenced with the increase in the frequency of meetings convened, perhaps frequency of meetings reduce farm working time. Also the results indicate that an increase in irrigation training increases technical inefficiency. This is contrary to the assumption that training (non formal continued education of farmers) enhances efficiency and productivity (Padhy and Jena, 2015). The increase in technical inefficiency is perhaps due to farmers failing to take advantage of opportunities in the irrigation system to move up the factors of production along the expansion path (Weir, 1999). This could be a result of risk aversion behaviour farmers have or due to bad CA organisation and management experienced rather than lack of information synthesis. However, the coefficient for the variable related to risk perception (**riskpercept)** was positive and insignificant, and hence did not matter in influencing technical inefficiency.

The interaction variable related to age and capital (**Age*capital**) had a coefficient with positive sign and significant at 1% level, indicating that as farmers get older the effect of capital increases technical inefficiency in irrigated rice production. The fertilizer inputs prices (**prcfym, prcdap, prctsp and prcminjingu**) had coefficients with positive sign coefficients and not significant, with the exception of UREA (**prcurea**), which had a positive sign and significant at 1% level. The results imply that are increased of technical inefficiency with the use of such inputs, perhaps because not used in the best combination to balance the nutrients required.

Demographic variables, **age** and **sex** were positive and insignificant, while formal education level (**educ**) was negative and insignificant. Though education was insignificant, it indicated had a positive influence in reducing technical inefficiency, which conformed to other studies related to the importance of education in improving efficiency and productivity (King and Palmer, 2006).

4.4.2.6 Allocative Efficiency of Factor Inputs in the Irrigated Rice Production

Cob Douglass production function linear form was obtained by estimating OLS regression for the major inputs used in the rice production (seed, fertilizer, labour, capital, and water distribution timing strategy satisfaction of crop water requirement in the plots), which was imputed on cost/price basis to compute marginal physical product (MPP) and the value of marginal product (VMP) for each input to ascertain the AE. The prices for seed, fertilizer and labour inputs were based on the average market prices, while average capital invested was used as the price for capital. Price for water distribution satisfaction was imputed based on the cost or contributions payable by a farmer per cropping season as water right charges in the scheme, where farmers normally paid one bag of paddy rice, which was converted to the equivalent sales market price of 45 000 TZS. Michael et al. (2014) estimated the irrigation water price in the production of rice in Pangani, Ruaha and Rufiji water basin authorities to be 32 250 TZS per ha.

Results of the marginal physical product (MPP), value of marginal product (VMP), marginal factor cost (MFC) and allocative efficiency (AE) of each input used for rice production in this study are summarized in Table 12. The MPP for labour was the highest, which indicated that additional labour (a person day) can increase rice yield by 0.75, equivalent to 67.5 kg per ha. On the other hand, all other inputs were negatively correlated with the rice yield output. An increase of 1 kg of seed is expected to decrease the rice yield by 0.28, equivalent to 25.4 kg per ha, of a paddy bag weighing on average 90kg, perhaps because most farmers do not use recommended rates since they use inferior seed, but also avoid risks due to rainfall/

water uncertainty. Increase in 1 kg of fertilizer is also expected to decrease rice yield by 0.428, equivalent to 38.5 kg. The decrease in yield is probably due to poor nutrient balance applied for the fertilizers input used, because most farmers used only UREA fertilizer. Similarly, increase in capital value, and water distribution are expected decrease the yield by 0.428 (38.5kg), and 0. 754 (67.8kg) respectively, meaning that additional value of capital and water use do not reflect rice output returns in the irrigation systems.

The allocative efficiency (AE) of all inputs shown in Table 10 are less than 1, indicating that seed, fertilizers, labour, capital and water distribution are over used. These results confirm that farmers do not optimally allocate resources in the irrigation systems, despite several technical trainings related to irrigation technologies and good agricultural practices directed towards irrigation schemes. Farmers can optimally increase outputs by best combining inputs for nutrient balances and improvement of access to profitable output markets. This can be enhanced through comprehensive farmer field schools in a value chain development framework in the irrigation schemes.

Table 4.12: MPP, VMP, MFC and AE Estimates

Inputs	**MPP**	**VMP**	**MFC**	**AE (VMP/MFC)**
Seed	-0.283177478	-283.177478	2500	-0.113270991
Fertilizer	-0.428034489	-428.0344889	1500	-0.285356326
Labour	0.757297041	757.2970411	3800	0.199288695
Capital	-0.000423423	-0.42342314	5000	-8.46846E-05
Water distribution	-0.754479465	-754.4794651	45000	-0.01676621

4.5 The Link between Farm Household Objectives and Investment Enterprising Tendency in Irrigation Scheme: Implications on CA Coordination Efficiency

4.5.1 Overview

Using 2SLS approach by correcting the endogeneity of farm household objectives and investment, the study examined the effect of farm household objectives- measured in terms of farmer orientation, (market oriented or subsistence) on investment enterprising tendencies as measured by individual private own annual expenditures implied in irrigation systems operating under CA management. The summary statistics and definition of variables used in the 2SLS regression are presented in Table 4.13.

Table 4.13: Definition and Summary Statistics for all Variables used in the 2SLS Regression

Variable	Definition	Unit measure	Mean	Std
loginv	Annual own expenditures	Tanzaniashilling (currency)- logged	12.6	1.3
Famobject	Farm household objectives	Dummy-(1= commercial,0 =subsistence)	0.82	0.38
ownlandirrg	Land ownership in irrigation command area	Dummy (1=yes, 0= no)	0.88	0.32
Gpleader	Leadership governance style in the group	Dummy- (1= good, 0= bad)	0.65	0.47
Nontangible	Non tangible benefits	Dummy1=information &external service access,0= none	0.8	0.4
Trust	Trust in group members and leadership	Dummy(1=trust, 0= none)	0.95	0.19
Expirrig	Experience in irrigation farming	Years	8.8	5.3
Contactcost	Contact monetary costs	Tanzania shillings (currency)	9078.7	38482.6
Sex	Sex of respondent(farmer)	Dummy (1=male, 0 = female)	0.80	0.39

irrgreliability	Irrigation physical characteristics(water) reliability	Dummy (1= reliable, 0= not reliable)	0.72	0.44
sacosaccess	Sacos (financial service) accessibility	Dummy(1= accessible, 0=not accessible)	0.22	0.41
rateirrh2o	Rate of irrigation water distribution	Category(=good, 2=satisfactory, 3= poor)	1.69	0.65
Offarm	Off farm activities engagement	Category(1= salaried,2=casual labour,3=small business 4= non)	3.09	1.78
Farmsucsupo	Farm service support obtained	Dummy (1=yes, 0= none)	0.25	0.43
Quntityirrmar	Output quantity marketed	Bags	100.5	358.15
Distancemark	Proximity/distance to the market	Km	5.59	7.42
Hhlabor	Household member eligible for working on farm/labour force	Number	3.9	2.2
Soilirrgat	Soil irrigation fertility level in the irrigation scheme	Dummy (1= fertile, 0= not fertile)	0.37	0.48
Irigtnypedum	Irrigation type	Dummy (1= modern, 0=traditional improved)	0.16	0.37

4.5.2 Results of 2SLS and Tests of the Endogeneity

The data contains missing values that were list wise deleted in a complete set analysis and only 38-sample size remained for the final analysis. Before presenting the regression results, tests of validity of instruments and endogeneinety were performed to provide evidence of the choice of the model.

The Durbin-Wu Hausman specification test results for endogeneity rejected the null hypothesis that farm household objective variable **(famobject)** is exogenous and concludes that the variable **famobject** and investment (**loginv**) are all interdependent (endogenous), hence the use of 2SLS is appropriate in order to correct the endogeneity problem and establish the causality. The test results are presented in Table 4.14.

Empirical results from 2SLS regression indicate that overall, the instruments are jointly significant as indicated by the chi square value (p> 0.000 and R^2. The variable farm household objectives (**famobject**)-a dummy variable measured as 1= commercial oriented, 0= subsistence oriented farmer had a coefficient with positive sign and significant at less than 5% level. The results suggest that farm household objectives, notably commercial oriented production promotes positively investment enterprising tendency in irrigation scheme under CA. That is, a one percent increase in commercial orientation for a farm household increases investment on own annual irrigation expenditures (enterprising tendency) by 210% than their counterpart subsistence oriented farm households in a similar irrigation scheme.

Thus, the empirical results show the importance of accounting for farm households' objectives in promoting enterprising tendency in a CA setting and other collective entrepreneurship, such as any agricultural cooperative organizations. The implication is that commercial/market oriented farm households have an incentive to ensure coordination which is reflected in the positive investment made, as in the willingness to pay for services.

These results are supported by other studies which indicated that the diversities in farmers' objectives and livelihood strategies explained the observed differences in allocative and technical efficiency levels of farmers (Berkhout, 2009). Further, these results point to the need, particularly in strengthening capacity of farmers on the aspects related to agri- business chains participation to enhance their capital investment for commercial oriented production objectives. This is important particularly in enhancing incentives for CA working in the irrigation scheme.

At the same time, however, farm household objectives tend to be influenced by other exogenous variables designated as “excluded instruments” such as output quantity marketed, output market distance, access to financial services /saccos (sacosaccess), off farm support services (off farm support), soil fertility status in the irrigation scheme land (soilirrgat), irrigation type -whether tradition improved or modern (irigtypedumy) and household labour force availability. The significance of endogeneity test (Table 4.14) confirmed that the assumed exclude instruments are valid and correctly excluded from the equation, implying that the variables are relevant, positively and significantly influence enterprising tendency.

The included exogenous variables in the structural equation like trust in group members and leadership (**trust)** was significant at 10% level, and positively influencing the investment (enterprising tendency). The results for the variable trust is also supported by other scholars e.g. Fafchamps (2002), pointing that trusting others enables economic agent to operate more efficiently, besides, it is essential for both economic exchange and public good delivery. Fafchamps, (2012) also argues that trust can reduce transaction costs, encourage respect of contract, and facilitate cooperation. Thus, in this respect a one percentage point increase in trust of farmers exerted to members and leaders in a group of CA in the irrigation scheme supports and encourage investment enterprising tendency by increased own expenditures of farm household in the irrigation farming by 254%, and so increased coordination efficiency.

The coefficient for sex variable (**sex)** had positive sign and significant at less than 5% level, indicating that male farmers have positive effect on supporting increased investment expenditure allocation in the irrigation farming under CA. In other words, a one percent increase in being a male farmer, increases investment and enterprising tendency by 148% for own annual expenditures in irrigation farming for commercial oriented production than are female farmers, perhaps because of the cultural setting usually adapted in the most Tanzanian households that men are the main decision maker and responsible for in most of households.

The variable experience in irrigation farming (**expirrig**) was significant at 10% level and negatively correlated to influencing investment enterprising tendency. A one percent point increase in experience reduces the investment enterprising tendency by 10.6%, implying that experience in irrigation farming does not matter in making investment venture decisions, perhaps because entrepreneurship venture is associated with judgmental decision under uncertainty over deployment of assets (Jos and Bart, 2008; Klein, 2009), hence these farmers had bad experience with the historical information regarding the firm / resource operating environment.

The coefficient for the variable of transaction cost related to contact and information search cost in monetary value (**contactcost)** had a negative sign and significant at 1% level. The results indicate that a one percent increase in information search or contact cost reduces investment enterprising tendency by 0.002%. Though, the impact of reduction was not in such a significant impact, it had an implication on coordination incentives, particularly in the management organizations because information reduces the imperfections in the economic system. These results are supported by other studies e.g. Casson, (1998) pointing that the instrumental importance of contact and information is on coordination, hence an increase in contact cost is likely to reduce coordination incentives as implied in the extent of enterprising tendency.

Other variables, like ownership of land in the irrigation scheme command area (**ownlandirrg**) was negative and not significant. Though not statistically significant the results indicate that farm household not owning land in the irrigation scheme command area had a disincentive in injecting capital investment, and so do CA coordination. It is acknowledged that ownership of resources is an important incentive for improvement (Kemper and Schumacher, 2014), hence it is obvious that non land owner household were likely not to honour the and under supply efforts on CA. This present study therefore suggests redistribution of land within the irrigation schemes to enhance CA successfulness.

The coefficient for the group leadership style variable (**gpleader**) had a negative sign and not significant. Though not significant, it had an indication that a one percent increase in bad group leadership discretion reduces an incentive for CA coordination as proxed by annual expenditures by 19.6%. Bad leadership undermines own private investment expenditures and contribution efforts supply to the public good provision, hence depress CA successfulness via low willingness to invest in the irrigation schemes.

The coefficient for the variable non-tangible benefits (**non tangible**) such as aspects related to information sharing and use of CA as a bridge to access external support was not significant and negatively correlated to investment enterprising tendency. A one percent increase in non-tangible, notably use of CA to access external support and information sharing is likely to reduce investment by 25.3%. This is perhaps farmers have no information and knowledge regarding external support through CA organization, or had bad experience with support provided through collective action due to unequal benefit sharing. These results point to the need of strengthening and improvement of the negatively correlated variables to enhance incentives for enterprising tendency (Table 4.14).

Table 4.14: Summary of 2SLS Regression Estimated Results

Variables: **Dependent log**(*inv)*			
Independent	**coefficient**	**SE**	**Z value**
Famobject	2.10975	1.09	1.93**
Sex	1.48664	0.63	2.35**
Ownlandirrg	-0.06924	0.91	-0.08
Gpleader	-0.19679	0.68	-0.29
Nontangible	-0.25378	0.34	-0.74
Trust	2.54401	1.44	1.76***
Expirrig	-0.10662	0.06	-1.91**
Contactcost	-0.00002	4.99	-4.65*
Constant	8.58139	2.11	4.05*
Endogeneity test:	**Durbin Wu Hausman specification test:**		
	Durbin (score) chi^2 (1) = 11.5231 (P value =0.0007)		
	Wu-Hausman F(1, 28) =12.186 (P value = 0.0016)		
Instrumented:	Farm household objectives		
Excluded instruments:	Irrgreliability, sacosaccess, rateh20, offarm, farmsacsuport, quantityirrmarkt, distancemarket, hhlabor,soilirrgat,irigtnypedumy,		
N=38			
Wald chi^2 (8)=45.09			
Prob> chi^2=0.0000			
R^2=0.4551			

Notes: Significance levels: * = p<1%, ** = p<5%, and ***= p<10%

CHAPTER FIVE

CONCLUSSION AND RECOMMENDATIONS

5.1 Conclusion

The main conclusion which can be drawn in this study is that collective action in rice irrigation systems management involve higher transaction costs with regards to contact, control, and contract compliance. The higher TCs are aggravated by asset specificity: site asset specificity like soil fertility, water availability and distribution since most of irrigation schemes depend on rainfall, and human capital asset specificity in form of number of labour involved, irrigation technologies application knowldege, improved seed and other inputs (fertilizers, labour and capital) use, and market oriented production, which were important TCs attributes detected increasing or decreasing CA successfulness outcome of interest.

Specifically, the conclusion can be categorised into four variants: First, irrigation farming ecosystem choice (*type 1 farmer*) is a non-random choice motivated by several factors influencing self-selection effects. Hence, selection of members for organised CA establishment should base on factors such as families with greater number of members eligible and engaged in farming at household much as market for labour is imperfect and mechanisation is rudimental; non tangible benefits, particularly using organised CA as a bridge (network) to help farmers get support from various external service providers in implementing sustainable farming practises; and good working of rules in the irrigation group is important to stimulate attitude related to frequent contributions and respect of law on public service provision through good leadership and rules enforcement.

On the other hand, factors which impose negative effects/challenges that discourage farmers from fully exerting commitment effort contributions in the irrigation farming ecosystem were: dodging contributions (factor2), and violation of rules/ bylaws (Factor3), which were also relevant motivation for farmers' self-selection. These factors should be accounted for because their impacts are important for understanding CA members' incomes ability and motivation, and recruitment strategy for public services provision. They are also important in understanding setting up contribution level/amount affordable by all members to enhance compliance rate.

Second, the study examined the determinants of institutional quality. The conclusion is that transaction costs, particularly information sharing among farmers (contact) and control/ formal penalty as well as market characteristics such as increased output quantity sold significantly influenced institution quality. On contrary, increased market distance, presence of water distribution calendar amongst farmers, and rainfall variability negatively influenced institutional quality. In other word, their increase reduces the level of (compliance) institution quality there by increasing TC related to control.

Third, the irrigation system operating environment (CA organisation and transaction costs) affect the productivity in terms of technical and allocative efficiency of factors of production. The study concluded that the technical efficiency reached at an average of 66% indicating there is a potential to increase the efficiency by 34% using best combination of inputs and existing technologies by improving the CA organisational management. Households with land ownership within the command area, and group characteristics of good governance (group leadership), interaction between non tangible benefits like use of CA as network for external support services and income (i.e. income generating activities in the scheme), and output prices have greater impact on improving technical efficiency.

On the other hand, variables related to training, transaction costs such as frequency of meetings and contact costs like phone (information) or travel costs increased technical inefficiency. The allocative efficiencies of production factors are not optimal. There are no incentives for best combination of inputs/factor resources utilization in the irrigation schemes because all inputs were overused. This can be attributed to (i) un organised CA operating environment, which make farmers fail using resources to move along the expansion path despite of several trainings offered in the irrigation schemes (ii) poor input-output markets for the commodity under question in the study area (iii) uncoordinated training and knowledge transfer related to good agricultural practices and irrigation technologies.

Fourth, the study concluded that farm household objectives, particularly commercial/market oriented production objective is an incentive for CA coordination efficiency in the irrigation systems, as is reflected in the level of enterprising tendencies (like the willingness to pay for the service) measured by investment value committed. Other exogenous variables designated as “excluded instruments” which positively and significantly supported the farm household commercial/market oriented objective, such as output quantity marketed, market distance, access to financial services /saccos, off farm support services (off farm support), soil fertility status in the irrigation scheme land, irrigation type, and household labour force availability had the greatest support in policy prescription for CA coordination.

5.2 Recommendations

5.2.1 Policy Recommendations

The following four broader policy recommendations are drawn from the findings in this thesis.

(i) Streamline irrigation members' selection criteria for collective action recruitment in the irrigation systems

The water sector policy provides for the guidelines and issuance of common water rights permit for eligible irrigator members' recruitment for irrigation farming, allowing for any person holding plots within the scheme. This criterion is sufficient to prevent some eligible committed farmers to participate in the irrigation farming because it is not guaranteed that a person owning a plot within the irrigation scheme is willing and committed to participate fully in irrigation collective action. Evidence from this research on how farmer self-select into farming ecosystem types indicate that farmers self-select into irrigation farming ecosystem on the basis of several factors, which include ability of household family labour force supply, potential to use the collective action organisation as a linkage network to access external service support that link to postharvest and agribusiness chains among others. Thus selection of irrigator members for effective and successful CA should take into account such recruitment criteria. In other words, the pre-condition to successful CA is the recruitment of household with high labour force engaged in farming selected in a non-random fashion, and clearly linked CA organisation with other functions such as networking and agri-business management for the produced outputs in the irrigation scheme.

(ii) Strengthen irrigation schemes' institutional quality

To address the current variations of institution quality between and within the schemes management, formal penalties for defaulters in form of court cases or local level formal procedures implementation like charging criminals to the local authority e.g. to the village executive officers should be strengthened because have shown positive relationship with increase in institutional quality level. This can be achieved through well drafted irrigator group members' constitutions, which are enforceable. Enforcement is usually accompanied by good leadership, transparency, trust and accountability. Thus the constitutions made should be recognised at macro level irrigation management authorities and government judiciary level. Other areas which require attention in order to enhance institutional quality include increased output quantity sold, and reduction of output market distance, as well as informal penalties. These variables have indicated strong influence on institutional quality (compliance).

(iii) Enhance agricultural technologies and good agricultural practices use in the irrigation systems

Good agricultural practices and technologies exist for enhancing production technical and allocative efficiencies for input factors. Research findings in this thesis have revealed inefficiencies in production and input factor resource allocation that is caused by weak external environment, a proxy for CA. The internal efficiency improvement can be achieved through introduction of mechanisation to overcome the high number of household members to work in the irrigation farming. It can also be through capacity building to improve technical efficiency and allocative efficiency, which all together were identified to be at sub-standard levels. At the same time, the external efficiency (CA) improvement is crucial to enhance internal efficiency (technical and allocative efficiency) improvement.

(iv) Build enterprising tendency among irrigator farmers

Entrepreneurship is the key driver to enhance organisation coordination and investment in the irrigation schemes. Results have indicated positive relationship between farm household objectives- particularly market oriented production and investment tendency under risky environment of water uncertainty management in the irrigation systems. Thus, building enterprising mentality amongst farmers by carefully accounting for farm individual household objectives will enhance coordination and successfulness of CA. This can be done through developing comprehensive training program for CA management that is especially tailor made of building trust among member farmers, and taking into account market oriented production, which positively influenced enterprising tendency, and encouragement of good governance (group leadership)- which was a disincentive for individual own investment in the irrigation.

5.2.2 Recommendations for Further Research

The research that has been undertaken for this thesis has highlighted several issues on which further research would be important. Several areas where information (gaps) identified were highlighted in the literature review, whilst some of these gaps have been addressed in this thesis, but others remain.

In particular, observational studies on trends for the CA members' recruited behaviour for irrigation farming, enterprising tendency and technological change over time have not been covered. Further research might for example look into trends and dynamic aspects in the irrigation systems under collective management.

Much as this thesis has focused at only micro level, further research can also look into the linkages between micro level institutions and compatibility to the macro level institutional linkages. What are the missing or failed policies, how do macro level institutional arrangement support or deter micro level institutions successfulness.

Further, this research has used transaction costs, mostly implied as proxies due to difficulties of their measurement; further research might consider conducting a research to establish standard measure of various key transaction costs.

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APPENDICES

Appendix 1: Questionnaires used for Cross Section Data Collection

1: Identification Information

Date of Interview: _ _ _ _ / __ _ / _ _ _ _

Name of enumerator ……………………

Region: ------------------------ District: ------------------------

Ward: --- Village: --------------------------------

Irrigation scheme name:…………………………………….

Type of irrigation scheme: 1= tradition, 2= modern……………………………….

Water catchment area: 1=Lake Victoria, 2= River, 3= underground, 4= others ………………………

Water basin zone: ………………………………………

Respondent's phone number……………………………………

2: Farm Household characteristics

2.1 Household beneficiary on irrigation scheme farming participation: 1= participating household, 0 = Non participating household----------------------

2.2 Name of household head (respondent) responsible for decision making in the farming operations ………………………………

2.3 Sex of household head (respondent) responsible for decision making in the farming operations: 1= male, 0= female ………………………..

2.4 Age of respondent …………………………years.

2.5 Number of years the respondent is consecutively permanently living in the village without migration/mobility……………….years

2.6 Indicates the number of members at household: No. of adult females>15 [ ] Number of adult males above 15 yrs [ ] Number of members below 15 years [ ] Number of members above 64 years [ ]

2.7 Number of members on the farm household eligible for farm labour supply …………….

2.8 Total time allocated between off farm and irrigated farm: Total time per season……………..hrs/days, Time allocated for irrigated farm and collective activities……………………..hrs/days, time allocated for off farm activities ………………….hrs/days.

2.9 Type of labour used for irrigated farm works: 1=family labour: hours…………days………………, 2= hired labour: hours………… days……………, 3= exchange labour: hours……………days……………….

2.10 Type of labour used for rain fed farm works: 1= family labour: hours………………days…………………., 2= hired labour: hours………… days…………………., 3= exchange labour: hours……………days……………….

2.11 Marital status of respondent: 1=Married living with spouse, 2=Married but spouse away, 3=Divorced/separated, 4=Widow/widower, 5=Not married, 6= others ……………..

2.12 Respondent's education level: 1=No formal education, 2= primary drop out, 3 =Primary level (std vii), 4=Secondary drop out, 5=Secondary level (ordinary), 6=Secondary level (advanced), 7=Tertiary (college/university)……………

2.13 Indicate other off farm activities you are involved: 1=none, 2= Salaried employment, 4= small enterprises/business 5=Casual labourer, 6=Other (Specify)………………………………..

2.14 Estimate the total annual amount earned from off farm activities: …………………………Tzs

3 Farmer's attitude and self selection into groups & farming types

3.1 Are you a member of collective action irrigation group: 1= yes, 0= no…………..

3.2 **Type 1 farmer:** Rice Farming ecosystem depended for rice production: 1= fully rain fed agriculture, 0= otherwise…………………

3.3 **Type 2 farmer:** Rice Farming ecosystem depended for rice production: 1= fully irrigated farming, 0 = otherwise………………….

3.4 Did you grow rice on rain fed ecosystem farming for the last cropping season 1=yes, 0= no………………………

3.5 Did you grow rice on irrigated ecosystem farming for the last cropping season 1=yes, 0= no………………………

3.6 For the rainfed farming ecosystem in (3.2) above indicates acreage grown rice under this ecosystem for the last cropping season.………………………………..acres

3.7 For the irrigated farming ecosystem in (3.3) above indicates acreage grown rice under this ecosystem for the last cropping season……………………………….acres

3. 8 *Type* 3 farmers: *Rate the following attitudinal statements towards irrigation farming commitment in a collective action:*

3.8.1 The current organisation and function of collective action for irrigation farming is good for encouraging members to work together in a committed way: 1= strongly disagree, 2= Disagree, 3= Agree, 4= strongly agree…………..

3.8.2 In order to obtain high yields and benefits in the irrigation scheme you need to do something including cheating, stealing water, and violation of collective action rules: 1= strongly disagree, 2= Disagree, 3= Agree, 4= strongly agree…………..

3.8.3 In general, do you have desire and willingness to engage in irrigation farming and respect collective action contractual agreements and commitments there in: 1= strongly disagree, 2= Disagree, 3= Agree, 4= strongly agree…………..

3.8.4 Irrigation farming and collective action rules are biased/ designed to benefit certain irrigation group members. *Therefore it is useless to respect the collective action rules and regulations*: 1= strongly disagree, 2= Disagree,3= Agree, 4= strongly agree………………….

3.8.5 Do you frequently contribute all required membership fee and labour in a collective action for irrigation farming as per regulations and rules set out: 1= strongly disagree, 2= Disagree, 3= Agree, 4= strongly agree…………………………

3.8.6 Do you believe that membership fee and other compulsory contributions in a collective action for irrigation farming are useless because you do not depend much on irrigation scheme for your food and income: 1= strongly disagree, 2= Disagree, 3= Agree, 4= strongly agree……………………...

3. 9 What attributes drives you to consider most in choosing an irrigation group membership to join: 1= group of familiar associate members/neighbours, 2 = join any group with members from elsewhere ……………………………….. 3= 0thers (specify) ……………………………..

3.10 Indicates the annual percent compulsory contribution of collective action efforts for irrigation operations both monetary and non monetary:
Total Labour days/hours required per season…………days/hrs, amount contributed……….days/hours;
Total monetary required per season…..……………………..Tzs; amount contributed ………………………Tzs
Total in kind payment after harvest ……………………Bags or kg; amount contributed………………………………bags or kg

3.11 Based on your preferences, indicate the preferred acceptable annual percent compulsory contribution of collective action efforts for irrigation operations both monetary and non monetary you would like to contribute:

Total Labour days/hours required per season…………days/hrs, amount contributed……….days/hours;
Total monetary required per season…..……………………..Tzs; amount contributed ………………………Tzs
Total in kind payment after harvest ……………………Bags or kg; amount contributed………………………………bags or kg
3.12 Give reasons in 3.11 above……………………………………………………………………………… ……………….

……………………………………………………………………………………… ……………………………………….

3.13 Other membership to famer organisations/clubs or associations in the community

Type of association for which is a member **Code A**	HH individual who is a member **Code B**	Association/group functions **Code C** (rank 3)	Year joined	Entry fee (Tzs)	Annual subscription (Tzs)	Number of attended meetings per year	still a member to date 1=yes, 0 no	If not a member now indicate year stopped	Reason for leaving the group membership **Code D**

Code A = 1, SACOS, 2= producer marketing group,3= local administrated, 4= agric production group, 5=others ………………..

Code B= 1= Household head, 2=spouse, 3=son/daughter, 4=parent, 5= Grandchild, 6= others ………………………..

Code C = 1= produce/livestock marketing, 2= input access/marketing function, 3=seed production and marketing, 4= farmer research group, 5= farmer extension group, 6= local administration, 7 =others……………………………………………..

Code D = 1= resigned for personal reasons sake, 2= the organisation was not useful, 3= group management not good, 4= unable to pay annual subscription, 5= finished activities required joint action, 6= others ………………………………………………

3.14 Type 4 farmer: Do you have rights to access irrigation water through formal water rights permit granted? 1= yes, 0 = no…………………………………………

3.15 If no in (3. 14) above how do you access irrigation water for your irrigated farm? 1= use water without permit, 2= bribe water distribution committee or block leaders, 3= dodge some contributions/payments 4= steal water ………………………

3.14 Please indicate whether you 1= strongly disagree, 2= Disagree, 3= Agree, 4= strongly agree in the following statements in 3.16. 1; 3.16.2; 3.16.3 & 3.16.4 respectively:

3.16.1 Without dodging some contributions in collective action - irrigation farming is not worthwhile (profitable) venture ……………………………………………

3.16.2 We are required to participate in all collective action contributions to make irrigation scheme functional and sustainable for the betterment of our livelihood on food and income……………………………………..

3.16.3 I worry to pay all contributions in a collective action organisation because fund are misused or benefits few members …………………………………………

3.16.4 I do participate in all contributions even if misused because the scheme is the only resource I depend for livelihood- food and income……………………………

3. 17 What tasks do you normally perform jointly in a collective action for irrigation farming operations: 1…………………………………………..,
2……………………………………..,
3……………………………………………..,
4………………………………………, 5…………………………………..
3. 18 What areas/tasks other than those in (3.13) above are performed individually but require collective action in the irrigation farming operation: 1……………………....2……………………..3…………………………………
………..,4………………………………………………,
5……………………………………

Give reasons for your responses in (3. 14) above……………………….…………

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

3.19 What are the potential non tangible benefits of collective action in your farming operations?

1= technology and information sharing, 2= personal farmer to farmer helpfulness 3= Produce marketing power, 4= Use of collective action group as a link to external agents for services supports, 5 others (specify)………………………………… (*Note: more than one answer is acceptable*).

3.20 How do you perceive the working of rules and laws regarding the collective action in the group for irrigation farming operations?

1= Good, 2= fair, 3 = discourage cooperative behaviour…………………………

4. Irrigation group characteristics, transaction costs /management, and governance

4.1 How does the process of group formation for irrigation water users association is crafted: 1= need of farmers themselves to solve common interest (demand driven), 2= crafted and introduced by government/ external agents in order to be granted water right permit (supply oriented)……………………….

4.2 Do you trust the interactions with fellow members on issues pertaining to irrigation resource utilization and collective action: 1= yes, 0= no

4.3. If no in (4.2) above give reasons: 1…………………………2………………

3…………………………………………………

4.3 Indicates the number of years (experience) of membership in the irrigation water users group………………………….. years

4.4 What are the conditions required to join an irrigation group membership: 1= entry fee, 2= entry and annual fees, 3=resident of the village within the scheme, 4= land holding within the scheme, 5= others (specify) ………………………………………………………………………………………

………………………………………………………………………………………
…………………………………… (*Note: more than one response is acceptable)*

4.5 Are you aware of the rights and duties/obligations you are supposed to fulfil as a member of a collective action in the irrigation farming operations: 1=yes, 0= no

4.6 if yes in (4.4) above mention them: (i) Rights as a member……………………………………………

………………………………………………………………………………………
………………………………………………………………………………………
…………… (ii) Obligations/duties as a member…………………………………..

………………………………………………………………………………………
……………………………………………………

……………………………………………………………………………………………
…………………………………………………

4.7 How do you rate the group leadership/governance style in fulfilling your expectation on irrigation services provision: 1= good, 2= fair, 3= unfair……………………………….

Give reasons for your response in (4.6) above: 1…………………,2…………………

3………………………….,4………………………………………., 5…………………………………………….

4.8 How do you rate the irrigation water distribution manner in meeting crop water requirement of your irrigated plots/ farm: 1= satisfactory, 2= fair, 3= poor ……………………………

4.9 What costs are involved in fulfilling agreement (contract signing) to access water and irrigation services (both monetary and non monetary: monetary e.g. travel cost) Tzs……………………….; non monetary e.g. Labour/time spent on negotiation agreement …………….. Hours/days

4.10 Average costs and time spent on contact issues and information search/ sharing related to irrigation farming matters e.g. use of phones or time spent on meetings: Tzs …………………… time hours/days……………………

4.11 Average number of frequency of meetings for irrigation activities per season/year …………………………………

4.12 Average number of frequency of irrigation extension technical services support provided during cropping season …………………………………

4.13 Does your group organization/leadership has modes for linking up (network) with service providers on irrigation services: 1= yes, 0 = no……………………..

4.14 If yes in (4.11) above indicates the networking modes: 1……………………

2……………………………………………,3……………………………………
……….., 4…………………………………

4.15 What are the costs you incur/contributes in a collective group to enhance the networking modes mentioned in (4.13) above (monetary and non monetary costs): Tzs or time (hours): 1……………………………………………, 2………………………………….., 3……………………………

4
……………………………………………………………5……………………

4.16 Does your irrigation group management have employed security guard for monitoring violations at the scheme on irrigation operations: 1= yes, 2= no…………………………………

4.17 if no in (3.15) above how do violations of regulations and procedures at the scheme are controlled: 1= self enforcing by all members, 0 = none……………………………

4.18 Do you directly pay or contributes any costs for monitoring violations in the irrigation management safeguard: 1= yes, 0= none …………………………

4.19 If yes in (4.17) above indicates the monitoring/safeguard costs directly contributed: monetary Tzs…………………. and non monetary (time/effort-hours/days………………………

5 Irrigation farming resources utilization, technologies perception and adoption

5.1 Estimated total land allocated for growing rice at the household ____________ acres:

(i) Lowland rain fed ecosystem………………………….. acres
(ii) Lowland irrigated ecosystem…………………………. acres
(iii) Upland rain fed ecosystem………………………………acres

5.2 Do you own land within the irrigation scheme command area: 1=yes, 0= no………………………..

5.3 Average land holdings owned and hired for irrigation farming: Owned………………..acres,

Hired …………………………… acres

5.4 Indicate the land hiring costs per acre in the irrigation scheme command area………………………………. Tzs

5.5 indicates in the table below the use of various farm inputs for the irrigation farming in the system

Inputs	Quantity applied (kg/litres/number)/acre	Purchase prices/cost per unit (Tzs)	Input market distance (km)	Perception of technology /input use
5.5.1 Fertilizer use 1= Yes, 0= No:…………				
4.5.2. Type of fertilizer (1 = FYM, 2 = DAP, 3=Urea, 4 = TSP, 5= Others_________)				
4.5.3 Cost of fertilizer application/labour ***(Tzs)***				

5.5.4 Use of chemicals: 1= Yes, 2= No : If no, skip				
5.5.5 Types (1= Insecticide, 2 = Herbicides, 3=fungicide 4= Others………………..				
5.5.6 Cost of chemical application/labour ***(Tzs)***				
5.5.7 Use of improved rice seed 1=yes, 0= no				
5.5.8 Rice varieties types (1=SARO5, 2 = Tai 3= Komboka 4= Others…………….				
5.5.9 Cost of improved seed application/sowing labour ***(Tzs)***				
5.5.10 Farm Labour use1= family 2= hired, 3=both family and hired, 4= others………………….				
5.5.11 Total cost of labour ***(Tzs)***				
1. hired				
2. family				
3. shared/ in kind				

5.6 Fill in the subsequent question for External factors determining use and accessibility of irrigation services (proxied by cropping intensity-CI):

5.6.1 Total irrigation farm land cultivated ………………………………….. acres

5.6.2 Net area sown on irrigation farm land cultivated ……………………. Acres

5.6.3 Rules and arrangement for water distribution and accessibility: 1= Good, 0= poor………

5.6.4 Management strategies employed to provide irrigation services at the irrigation group: 1= good, 0= poor ………………………….

5.6.5 In (5.6.4) list the management strategies employed to provide irrigation services to users 1………………………………………………….. 2……………………………………., 3………………………

4……………………………………………….5………………………………………………6……………………………

5.7 Technology characteristics and irrigation farming knowledge

5.7.1 Distance of the irrigation scheme from the homestead (proximity) ……………………km

5.7.2 Have you ever received any technical Irrigation farming training skills: 1=yes, 0 = no………………………………

5.7.3 Technical ability to implement and manage irrigation farming 1=yes, 0= no…………………

5.7.4 Do you have the knowledge of field levelling for efficient irrigation water application 1= yes, 0 no ………………………

5.7.5 Do you know crop water requirement for your irrigated crops 1= yes, 0= no…………………

5.7.6 What is the location of your irrigated farm within the scheme along the canal 1= head end, 2= middle, 3 end/ tail……………………………………………….

5. 7.7 On what interval / timing do you apply water for your irrigated crops 1= morning & evening, 2= morning time, 3= evening time, 4, any time including after noon…………………….

5.7.8 Irrigation scheme characteristics: 1= lined cemented canal, 0 = earth canal……………………………

5.7.9 Do the scheme has division boxes for distribution of water from canal to the field 1=yes, 0 = non………………………….

5.7.10 Do the scheme designed with the drainage system for recycling away used water 1=yes, 0 =non…………………………

5.7.11 What are the water lifting devices application used in the irrigation farming: 1= water pumps, 2= Pump house 3= water can, 3= others (specify) ……………………………………

5.7.12 Indicate the interval/number of days for water distribution rotation (shifting water) from other canal into your canal (plot) ……………………………………….

5.7.13 What is the status of irrigation scheme reliability for your irrigation farming during the season: 1=Reliable, 0= not reliable ………………………….

5.7.14 If the scheme is not reliable in (5.7.13) give reason why: …………………

……………………………………………………………………………………

5.7.15 If the scheme is not reliable in (5.7.13)above what are the adjustment or copping strategies employed for livelihood sustenance…………………………………………………………………………
……………………………………………………………………………………
…………………………………………………………………………………

5.7.16 Indicates the factors fostering (both pull and push factors) irrigation technology adoption

(a) Push (motivating) factors: ………………………………………………………

....
....
....

(b) Pull (discouraging) factors: ……………………………………………………

……………………………………………………………………………………
………………………………………..

……………………………………………………………………………………
…………………………………………

5.8 Household motivation for irrigation facilities use AND marketing

5.8.1 Do you have SACOS or any financial service organisation support for enhancing your farming operation 1= yes, 0= no …………………………..

5.8.2 Do you have access to SACOS/financial organisation's loan for enhancing your irrigation farming 1= yes, 0= none

5.8.3 Indicate the amount of loan borrowed for use in irrigation farming last season………………………………..Tzs

5.8.4 Total rice yield obtained from rain fed ecosystem production …………………………… bag

5.8.5 Total rice yield obtained from irrigated ecosystem farm land ……………………………..bags

5.8.6 Average rice Output market prices …………………………………………… Tzs per bag
5.8.7 Quantity of irrigated rice output marketed …………………………….. bags
5.8.8 Quantity of rain fed rice output marketed ………………………………bags
5.8.9 What type or form of rice product was sold 1= paddy, 2= milled rice , 3= both……………………..
5.8.10 Who are the most frequent buyers of your rice produce 1= consumer or other farmer, 2= rural assembler (vendors), 3= middle men, 4= urban grain traders, 5= rice millers, 6= exporters, 7= others…………………………………
5.8.11 Common place of selling of your rice produce 1= farm gate, 2=village weekly market, 3= town market, 4= Factory/mill, 5= others……………………………….
5.8.12 Average market distance for the output/rice sold ………………………….. Km
5.8.13 Mode of transport to the market 1=bicycle,2= hired truck, 3=public transport, 4= carts, 5=head,=6 others……………
5.8.14 Indicates the transport time to the market for produce marketing ………..hrs
5.8.15 Indicates the transport cost for marketing produce per unit …………………………………………..Tzs per bag
5.8.16 indicate the kind of sell for your produce 1= loose, 2= packed …………………………………..
5.8.17 Indicate the sells tax, levy or charges incurred………………………Tzs
5.8.18 Soil fertility status of the irrigation rice farm land: 1= good, 2= fair, 3= poor………………………
5.8.19 Soil fertility status of the rain fed rice farm land: 1= good, 2 fair, 3= poor
5.8.20 Crops grown for irrigation farming: 1= rice, 0= others ………………… (Specify)
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
5.8.21 What crop type would you like to grow in the irrigation scheme …………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
…………………………………………………………………………………..
5.8.22 Duration at which irrigation farming operations is performed 1= seasonal, 0= all year round …………………………………………..

6. Irrigation farming investment choices and enterprising tendency

6.1 Irrigation farming objectives: 1= commercial/ marketable surplus, 0 =subsistence …………

6.2 Household asset ownerships:

6.2. 1 Number of livestock owned: 1 cattle………………………. 2 Shots (sheep & goat)………………
3 Poultry …………………………… 4 others…………………………
6.2.2 Irrigation mechanisation used: 1=Ox plough 2= power tiller, 3= tractor 4 = Others ………
6.2.3 Irrigation farm equipment ownership 1= yes, 0 no…………………………….

6.2.3 If yes in (6.2.3) above indicate in the table below the number and type of irrigation equipments owned including total annual expenditure for irrigation farming invested:

Type of asset/irrigation equipment	Number owned	Original value (Tzs)	Year bought	Useful life (years)	Number hired	Hiring cost per season (Tzs)	Other own annual total variable expenditure investment in irrigation farming (Tzs) **e.g** electricity, fuel, compulsory fees, land improvement

6.3 Valuation and ranking of livelihood opportunities in the region/area

6.3.1 Do you know any other economic opportunity other than irrigation resource for farming, which you can exploit for your livelihood in this area/village: 1= yes, 0= no

6.3.2 If yes in (6.3.1) above list the potential non farming opportunities available: 1……………………..

2……………………………………………..3…………………………………4 ………………………………………

5…………………………………………………6………………………………………7…………………………………

6.3.3 For the potential livelihood opportunities mentioned in (6.3.2) above valuate and rank in the table below the importance for livelihood contributions against irrigation resources

s/n	Livelihood opportunity available	Livelihood (food & income) contribution valuation score: 1= low, 2= medium, 3 = high	Livelihood importance contribution rank	Perceived level of risk 2 = high 1= moderate 0= low	Reasons	Does the livelihood opportunity accessible to you? 1= yes, 0= no
1	Irrigation resource (scheme)					
2						
3						
4						
5						
6						

6.3.4 For the total household income earned per year indicate the proportions invested for farm and non- farm enterprises: estimated total income…………………Tzs; proportion farm investment……………….(Tzs) or %; and proportion non- farm investment ………………(Tzs) or %

6.3.5 Indicate what type of investment was made for the proportions allocated for farm and nonfarm investments in (6.3.4) above: Farm investment made: 1………………………..2………………………….3………

4……………………..5…………………………..6…………………………………

Non Farm investment made: 1……………………………2…………………………………3……………………

4……………………………………..5………………………………………..6 …

Thanks, & lets cooperate to solve the social dilemma of the commons ‘‘things will work out badly if everybody behaves antisocially’’

Appendix 2: Questionnaires used for Panel Data Collection

(a) IDENTIFICATION INFORMATION

1.1. Date of interview/data collection ______________________________

1.2. Data collected by____

1.3. Region____

1.4. Basin zone____

1.5. District____

SECTION 2: Group dynamics and institutional quality

PART ''A'': BASIN LEVEL

2.1 Basin information and water management and control

2.1.1 Hydrology characteristics of basin water sources: 1= Lake Victoria basin, 2= river 3= internal drainage, 4= Dam, 5= Rainfall__________________

2.1.2 Amount of rainfall trend for the past 10 years (mm)

2003--------------------

2004--------------------

2005--------------------

2006--------------------

2007--------------------

2008--------------------

2009---------------------

2010---------------------

2011---------------------

2012---------------------

2.1.3 How is the market process for water rights permit granting conducted?

____

____

____

____

2.1.4 Indicates in the table below the qualification conditions and associated costs for granting water rights permit to irrigation water users:

	Water right Permit type	Absolute total Cost* (Tzs)	Conditions required to qualify securing water right permit	Annual fee (if any) Tzs	Average number of days required to process up to granting a permit	Lifespan/duration of tenure of water right permit (months)
1						
2						
3						
4						

Notice:
* list the associated items for the absolute total costs:______________________________

____

2.1.5 Indicates in the table below the demand trend for irrigation water rights permit for resource users for the past 10 years:

s/n	Time (Year)	Type of permit	Water right permit cost (Tzs)	Number of applicants (groups)	Irrigation system* 1=modern 2=tradition 3= both	Number of permit issued for irrigation systems*	
						1	2
1	2003						
.							
.							
11	2013						

2.1.6 Water rights permit annual fee/levy collection trend and compliance rate

s/n	Year	Number of water rights permit granted to irrigation Groups	Number of groups complied annual fee payment	Percent compliance	Reasons for compliance rate
1	2003				
.					
.					
.					
11	2013				

2.1.7 Water allocation and conflict resolution made over time in different selected schemes and/or groups (indicates in the table below)

Year	Name of scheme /irrigation group	Area served water by the scheme (ha)	Number of farmers served irrigation water	Water allocated per year (abstraction) Mm^3	Ways of enforcing agreement on water use	Number of water users conflicts reported per year	Number of conflicts resolved Formal/informal	
2003								
.								
.								
2013								

2.1.8 What other costs-both monetary and non monetary are involved in conflict resolution negotiations amongst parties?_____________

____

____
____

2.1.9 Describe the Information distribution structure of interaction between water basin authority and water users for enhanced water management and conflicts among water users (irrigators): *who knows what; when, and how?*

____
____

2.1.10 Do the above information help to enforce contract agreement over time period?

1= yes, 0 = otherwise____________________________

2.1.11 If no in (1.1.10 above) give reasons:
____

____
____
____

2.1.12 What other information/ effects on enhancing water management are not included in the optimizing process or rule of thumb results in the decision making of water users?

____

PART ''B'': IRRIGATION SCHEME LEVEL FOR GROUP ANALYSIS

2.2 Irrigation scheme characteristics, Institutions, and Transaction costs for irrigation water services provision and management at scheme level

2.2.1 Region_____________ District_______________Ward___________ Village_________

2.2.2 Name of irrigation scheme______________________,

2.2.3 Type of irrigation scheme: 1= traditional 2= modern ______________

2.2.4 Irrigation scheme canal characteristics: 1= lined cemented canal 2= non lined un cemented canal_________________________

2.2.5 Do the scheme has division boxes for distribution of water from canal to the field 1=yes, 0 = non

2.2.6 Do the scheme designed with the drainage system for recycling away used water 1=yes, 0 =non

2.2.7 Age of irrigation scheme service provision since started operation: 1= less than 5 years 2= more than 5 years______________________

2.2.8 Duration at which the scheme is functional per year: 1= seasonal, 2 = all year round __________

2.2.9 Total number of irrigation water users groups authorised to access water in the scheme ________________________

2.2.10 Name of authorized irrigation water users groups **with** water right permit, and year started/formed organisation: 1_______________(year______),
2_______________(year____), 3_________________(year______),
4___________________(year________),

2.2.11 Name of authorized irrigation water users groups **without** water right permit, and year started/formed organisation: 1_______________(year______),
2_______________(year____), 3_________________(year______),
4___________________(year________),

2.2.12 Total area served irrigation water by the scheme________________________ ha

2.2.13 Total number of villages/ wards served by the scheme____________________

2.2.14 Average farm size holdings per farm household served by the scheme________acres

2.2.15 Production organisation within the scheme: 1= individual, 0= group ______________

2.1.16 irrigation method used 1= surface flooding with pump house, 0 =otherwise (specify)
____
____

2.2.17 Number of farmer participants trend in different groups over the past 10 years within the scheme

s/n	Group name	Year	Number of irrigation farmer participants in the group
1		2003	
		2004	
		.	
		.	
		2013	
2		2003	
		.	
		.	
		2013	
3		2003	
		.	
		.	
		2013	

2.2.18 Conditions for property rights (water rights permit) ownership status: 1= member of water users' group, 2= individuals not members who can pay fee, 3 = anybody not necessarily member of water users' group provided belongs to the community, 4= others (specify)________________________

2.2.19 What other terms of contracts are specified in the water rights permit granted for both parties (i.e, granter and grantee of the water rights)

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2.2.18 What is trend on Contract agreement compliance related to operation and maintenance of infrastructure and other fee payments/contributions as specified in the water rights permit granted to different irrigation groups/users in the scheme

Group name	year	Season 1= rainy 2= dry	Total number of members per group	Number of members complied on OM	Number of members complied on other fee/contributions	Percent compliance
	2003					

	.					
	.					
	2013					

2.2.19 What is trend on contact, coordination, and information sharing related to water distribution, management and control for water users in different irrigation groups within the scheme

Group name	Year	Presence of water distribution calendar: 1= yes, 2= No	mechanisms for regulating water allocation at individual farm outlets 1= formal guard, 2= self enforcing	Information sharing mode: 1= meetings, 2= others	Number of meetings related to irrigation affairs per year	Average number of participants' attendance per year	Average number of frequency of irrigation extension technical services support provided
	2003						
	.						
	.						
	.						
	2013						

2.2.20 Indicate the trend on control mechanisms implemented over time to enforce property rights, and compliances on water accessibility, and management for water users in different irrigation groups within the scheme

Group name	Year	Presence of security guard for monitoring violations at the scheme: 1= yes, 2= no	Monitoring costs contributed (both monetary(Tzs) and time/effort hour) Tzs hours		Number of penalties/fine implemented through formal & informal means: formal informal	
	2003					
	.					
	.					
	.					
	.					
	.					
	2013					

2.3 Irrigation outputs (rice) market characteristics as a proxy of resource importance for users' livelihood

Group name	Year	Average Quantity produced (total)	Average Quantity sold (total)	Distance to the market	Output market price per unit (bag/kg)
	2003				
	.				
	.				
	.				

	.				
	.				
	.				
	.				
	2013				

Thanks for your cooperation