FACTORS INFLUENCING SUSTAINABILITY OF IRRIGATION PROJECTS IN KIBWEZI SUB-COUNTY, MAKUENI COUNTY-KENYA

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DECLARATION

This research project is my original work and has not been presented to any university or any other institution for any academic award.

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This research project has been submitted for examination with my approval as the university supervisor.

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DEDICATION

This research project is dedicated to my wife Regina, sons Michael, Peter and daughter Cecilia for the moral support they have offered me to ensure I complete the course.

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ACRONYMS AND ABBREVIATIONS

ADB	African Development Bank
ASAL	Arid and Semi Arid Lands
ASDA	Agricultural Sector Development Authority
FAO	Food Agricultural Organization
GAA	Germany Agro Agency
GDP	Gross domestic Product
ICID	International Commission for Irrigation and Drainage
IFTRI	International Program for Technology and Research In Irrigation
IWMI	International Water Management institute
JICA	Japan International Cooperation Agency
KADP	Kilimanjaro Agricultural Development Project
KADP	Kilimanjaro Agricultural Development Project
MD	Millenium Declaration
MDG	Millenium Development Goals
MENR	Ministry of Environment and Natural Resources
NIA	National Irrigation Authority
NEPAD	New Partnership for African Development
NGO	Non-Governmental Organization
USAID	United States Agency for International Development
WFS	World Food Summit
WUA	Water Resource Association

ABSTRACT

The study sought to establish the factors influencing sustainability of irrigation projects in Kibwezi Sub County. Irrigation in Kibwezi Sub County is very crucial economic activity for the provision of food to the inhabitant of the area, create employment, eradicate poverty and mitigate the problem of rural urban migration. This owes to the fact that the sub county lies in Arid and semiarid region of Makueni county-Kenya that receive annual rainfall of less than 750 mm which is inadequate to sustain crop production. The objective of the study sought to establish how water availability, technical, institutional and financial factors influence sustainability of irrigation projects in the Sub County. Survey design of the study was employed in the research. Sample size of 103 farmers both large scale and small scale was picked for interview based on where there are settled within the administrative units of Kibwezi Sub- County. Questionnaires were the data collection tools used. To establish the reliability of research instruments, test retest technique was used to test reliability of instruments. The study supervisor examined the content of the instruments and advised the researcher on its validity. For data analysis quantitative technique was employed using the statistical package for social sciences (SPSS) and results presented in tables that indicated percentages of a given attribute. The percentages were further analyzed to provide patterns and relationships from which conclusions were drawn. Linear regression model and Pearson's correlation analysis was done to analyze data. The result showed that water availability, Technology used in irrigation systems, institutional and financial factors had significant influence on success of irrigation projects in Kibwezi sub county of Makueni county-Kenya. The study therefore recommended: National and County Government to put in place policies to ensure sustainable and efficient utilization of water resource for irrigation projects, Community based organizations to be assisted to get efficient and affordable spare parts, Training of management committees on operations and maintenance of irrigation systems, Management committees to be assisted in setting up tariffs for water consumption fees that would be used in repairs and maintenance of irrigation systems. Women should be encouraged to participate in this economic activity to boost standard of living of people in this sub county.

CHAPTER ONE
INTRODUCTION

1.1 Background Information

About 30% of earth's surface is dry land and out of this only a small area has suitable environmental conditions for agricultural productions. The rest is either cold desert as seen in green lands, arctic and Antarctic region; or is hot desert that comprise of arid and semi-arid land which hardly receive sufficient rainfall to support agricultural production.

Global population is estimated at 7.3 billion (FAO, 2014) .out of this figure, one-ninth is suffering from chronic malnutrition. This represent 791 million, who live in developing countries which account for one-eighth (13.5%) of population in developing countries (FAO, 2014). The above undernourished individuals are children who suffer up to about 160 days of nutrition related illness each year. This plays a role in at least half of 10.9 million deaths each year of which 26% of these malnutrition cases are found in Africa.

In 1996, the World Food Summit (WFS) set the target of eradicating hunger on all countries with view of reducing the number of undernourished to a half by the year 2015. The Millennium Declaration (MD) promoted this target to half between 1990-2015. The fast increase in world population has resulted to pressure exerted on arable lands as people clears and sub divide the available lands for agricultural production to meet the ever increasing food demand. This has led to land fragmentation which in turn has adverse effects on agricultural production thus aggravating the food shortage.

Efforts have been put in place to reclaim land for agricultural production. In Europe dykes have been created to push sea water back thus creating land for crop production. In Africa, just like in many other parts of the world, irrigation projects have been set up to reclaim land through application of water to provide sufficient moisture for crops. Key players in Africa have been JICA, among others that have sponsored many irrigation projects in various countries such as: Kilimanjaro agricultural development project (KADP) in Moshi Tanzania (1974-1993), Water management improvement project in Nile delta in Egypts (1989-1993), Mwea irrigation agricultural development project in

Kenya (1991-1998), Agricultural machinery development for irrigated rice. cultivation in Ivory Coast (1990-1997)

Sustainable growth of agriculture production is paramount and will go a long way to ensure self food sufficiency, food security, reduce the number of undernourished, especially children and decrease poverty. This can also serve as a driving force to turn around the stagnant economic growth. In Kenya irrigation schemes have a long history running over 400 years. Irrigation projects are run by national irrigation board that was established by Act of Parliament CAP 347 laws of Kenya in 1966.The board took over running of Mwea, Hola and Perkerra irrigation schemes, and later developed Ahero, West Kano, Bunyala and Bura Schemes. Of late many others have come in various parts of country such as Turkana, Kibwezi and Tana Delta.

The area of Kenya is about 582 646 km2, 17% of which is classified as medium to high potential land with more than 700m of rainfall per year, suitable for rain-fed agriculture. The remaining 83% 0f land is classified as ASAL and cannot reliably support rain fed agriculture. This implies that for agriculture production to take place, other technologies such as irrigation and water harvesting should be used.

Agriculture contributes to about 55% of GDP and provides 80% employment and accounts for 60% of export and creates about 45% of government revenue (Ragwa et al., 1998). From the above findings it is apparent that reclaiming land for agriculture production through irrigation projects will boost food production, to meet the need of fast increasing population, create more jobs, and thus empower people especially in rural areas and stop rural urban migration.

1.2 Statement of the Problem

Committee on world food security (WFS) round table in hunger division management (Sep. 2011) FAO statistics have compiled food security indicators thus capturing various aspects of food security. In Sub Sahara countries about 214.1 million people are undernourished. This represents 23.5% of Africa population (FAO- 2014).

To alleviate this problem, a lot of efforts have been put in place to boost food security. The Nepal action plan (July 2002) shows a total of 251.3 billion dollars were assessed to be necessary to support agriculture development in Africa from the year 2002-2015. This is about 17.9 billion per year. Much of these funds were to be spent irrigation projects, reclaiming land for agriculture production.

Many of these projects once initiated and implemented collapse soon after the implementing agency pulls out. Many of them cause low or even negative returns on investment, emergency of environmental and health problems and lack sustainability (Nijman, 1991- 1992). Even projects intended to specifically enhance farmer's capacity have not succeeded. This pose as a challenge to create a sustainable irrigation project for agricultural production and expand the same to new areas to improve food security and livelihood.

Faced with climate uncertainty and fragility of ecosystems that characterize of Kibwezi irrigation and crop improvement through the use of rainwater collection techniques appear to be the most important factors to lay the groundwork for an economic and social development. Mobilization and control of water to meet the needs of irrigation and livestock become an imperative to be tackled in order to enhance food security and improve the cash income populations. The Government recognizes that the development of the country depends largely on its ability to better manage all its natural resources, by promoting a more holistic approach, more oriented towards the stakeholders, particularly rural communities.

Kibwezi sub county is located in south eastern part of Kenya, along Nairobi-Mombasa Highway; covering an area of 1,876 km2. Climate in the sub county is characteristics of semi arid land with average rainfall of between 300-700mm per year, and temperature range between 20-35^{o}c. The Sub County has an arable land of 1407 km^{2} with irrigation potential of 2219 ha, but only 769 ha are under irrigation. Population of the sub county is 177 546, with 37,054 households. (Ministry of agriculture Kiwezi Sub County report 2014). Average house hold is 6 with average farm size of 2.1 ha. Drainage systems in the

sub county include River Athi to the east, Kibwezi River, Thange River, Kambu River and Mangelete River. These rivers have substantial amounts of water in good part of the year, though water volume reduces in dry spell. According to a report (Ministry of Agriculture, Kibwezi Sub County, 2014), a lot of efforts have been put in place to alleviate food shortage rampant in the area through concerted efforts by NGO's such as Care- Kenya International, GAA, and World Vision, development partners such as Israel, USAID and Kenya government. These organizations have sponsored irrigation projects in the sub county at different times.

Once conceptualized, designed and implemented, these projects show a brighter future in achieving their goals. But soon after the implementing agency pulls out, their sustainability proves to be a challenge leading to their collapse, as happened to KIP, Wololo Wathange (Ministry of Agriculture, Kibwezi Sub County, 2014). Faced with climate uncertainty and fragility of ecosystems that characterize Kibwezi sub-county, irrigation and crop improvement through the use of rainwater collection techniques appear to be the most important factors to lay the groundwork for an economic and social development. Mobilization and control of water to meet the needs of irrigation becomes an imperative to be tackled in order to enhance food security and improve the cash income to the population. The Government recognizes that the development of the country depends largely on its ability to better manage all its natural resources, by promoting a more holistic approach, more oriented towards the stakeholders, particularly rural communities.

Much needs to be done to ensure sustainability of irrigation projects in the sub county which will go a long way in achieving the Millennium Development Goal no. 1, that aims at eradicating poverty, hunger; and empower the less advantaged by creating employment, food sufficiency and reduction of malnutrition.

1.3 Purpose of the Study

The purpose of the study was to determine the factors that influence sustainability of irrigation projects in Kibwezi Sub-County.

1.4 Research Objectives

The research was guided by the following objectives:

1. To establish the extent to which water availability influence sustainability of irrigation projects in Kibwezi County.
2. To establish how technical factors influence sustainability of irrigation projects in Kibwezi Sub-County.
3. To establish the extent to which institutional factors influence sustainability of irrigation projects in Kibwezi Sub-County.
4. To establish how financial factors influence sustainability of irrigation projects in Kibwezi Sub-County

1.5 Research Questions

The research was guided by the following questions.

1. To what extent does waters supply influence sustainability of irrigation schemes in Kibwezi Sub County?
2. How do technical factors influence the sustainability of irrigation projects in Kibwezi Sub County?
3. To what extent do institutional factors influence irrigation projects in Kibwezi Sub County?
4. How do financial factors influence sustainability of irrigation projects in Kibwezi Sub County?

1.6 Significance of the study

The study findings would be useful to both National and County Governments, NGO's, Donor Organization, Development Partners, the Private sector as well as researchers. To National and County Government, the findings would be useful in developing a policy document, strategies and standards and guide lines to address sustainability issues influencing irrigation projects in the sub-county and nation at large. This would go a long way in promoting agricultural production in ASAL and reduce malnutrition which is prevalent in these areas, thus empowering the rural population. It would also create employment (both direct and indirect) thus address the problem of rural urban migration.

To donor organizations and development partners, the finding would point out areas of weakness experienced in project implementation and take over for correction, thus ensure the intended objectives are met. This would result in increased funding of similar projects in other areas. The finding would also be useful to private sector interested in investing in irrigation project as well as to researchers. It would also be useful in ensuring the achievement of MDG's and the Kenya Vision 2030.

1.7 Basic Assumption

The research assumed that all the irrigation projects were well designed and implemented. Climatic, Edaphic and political factors had little effect on sustainability of the irrigation projects. It also assumed that respondents answered the questions correctly and truthfully.

1.8 Limitations

The study was generalized due to social – cultural issues found in various parts of the county. Another limitation was literacy level of sample population which affected understanding of subject matter. The nature of soils found in the sub county was different from other areas so had some effect on crops performance. The time was not sufficient so was forced to seek assistance for administering the questionnaires to the farmers. Some areas were inaccessible due to poor road network.

1.9 Delimitation of the Study

The study targeted both the small scale and large scale farmers who produce various crops through irrigation in the sub county. This activity has been practiced in the area for quite some time. The study aimed at establishing the influence of water availability, technical factors, institutional factors and financial factors on sustainability of irrigation projects.

The study was conducted in the months march, April and may of 2015. This is the time of the year when the area receive low rains through insufficient for crops growth. This

means less water is applied to crops unlike what would happen in dry spell from months of July to November. Data collected at this time of the year especially about quantities of water needed for crops may not give a true representation of what would be required especially in dry period. Data collected from other factors under investigation i.e. financial, technical and institutional provided the actual picture of situation on the ground.

1.10 Definition of Significant Terms used in the Study

Irrigation project: an intervention where water is artificially applied to provide sufficient moisture in the soil for crops growth.

Sustainability: refers to operationally function irrigation system where crops are growth continuously giving high yields for a prolonged period of time.

Arid and semi-arid lands: area that receive low amount of rainfall hardly sufficient for crops production.

Edaphic factors: these are properties/characteristics of soil in a given area.
Evapo-transpiration: term that denote loss of water from both soil and from plants.

Financial factors: the financing process that is rising and maintenance of adequate funds for irrigation project, tariff setting, mode of payment and management of funds.

Institutional factors: established structures for management, knowledge base, and technical know how, incentives, awareness, and strategy for capacity building.

Technical Factors: Refer to technology used to supply water to crops, quality of material availability of spare parts, physical design and equipment used.
Water Availability: Refers to quantities of water at disposal to be applied to crops at any given time

1.11 Organization of the Study

The research was organized into five chapters.

Chapter one discusses introduction of the study; that include background information of study, statement of the problem, purpose of the study, research objectives, research questions. It also highlights the significance of the study, basic assumptions, limitations, and delimitations, definition of significant terms and organization of the study. Chapter two highlights literature review. It is sub divided into eight parts as follows:- Introduction, first, second, third and fourth objectives, describes theoretical framework, conceptual frame work and explanation of variables in the conceptual frame work.

Chapter three discusses research methodology. It starts with introduction, research design, target population, sample size determination and sampling procedure. Data collection methodologies, validity, reliability of instruments for data collection, data analysis techniques, ethical consideration and operational definition of variables are discussed. Chapter four provide data presentation, analysis, interpretations and discussion. Chapter five gives summary of findings, then conclusion is drawn. Recommendation of for the policy to be adopted is highlighted, and then lastly recommendation for further studies is proposed.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Irrigated agriculture has made a major contribution to food production and food security throughout the world: without irrigation much of the impressive growth in agricultural productivity over the last 50 years could not have been achieved. Nevertheless it is widely accepted that the overall performance of 'irrigation and drainage' (also implying reclamation and water control) investments has too often fallen short of the expectations of planners, governments and financing institutions alike (Report No. 13676, A Review of World Bank Experience in Irrigation, Operations Evaluation Department, World Bank, Washington DC, 1994). Inadequate consideration of institutional constraints and poor planning for implementation and lack of commitment to the success of the project by governments and users. In the case of irrigation investments these problems are manifested in poor project management, both at implementation and thereafter, and poor operation and maintenance resulting from inadequate budget allocations or from rent seeking by users and officials.

These core problems usually give rise to, or are accompanied by, a host of other technical, social and economic problems, such as: Implementation delays and cost overruns; Premature degeneration of civil works and equipment; Unreliable water supplies, or over-irrigation, water logging and salinity; Social problems, including problems of organization, equity, land tenure and gender exclusion; Lower than expected output values, due to poor technical performance or reflecting over-optimistic price projections by planners.

According to Kumar (2006) sustainability concerns are being expressed that the input levels have to be continuously increased in order to maintain the yield at the all level. This poses a threat to the economic viability and sustainability of crop production. A sustainable farming system is a system in which natural resources are managed so that potential yield and the stock of natural resources do not decline over time. However each of the components of sustainable agriculture is complex and some quantifiable measures

are needed to check whether a farming system is sustainable or not. Due to the multidimensional nature of the concept of sustainability, the difficulties in determining specific threshold values for this dimension are not over emphasized.

The overall performance of many irrigation projects is disappointing. Evaluations document, a wide range of problems, including: cost and time overruns; poor management; the non-realization of full, planned benefits; adverse environmental and health impacts; and the exacerbation of inequities in the existing social and economic distribution of assets among farmers (FAO, 2014).

2.2 Water Availability

As at 2007, Kenya was classified as a chronically water scarce country with a freshwater endowment of only 552 cubic meters per capita compared to the conventional universal minimum of 1,000 cubic meters. This per capita availability is projected to fall to 235 cubic meters by 2025 as the population increases, and could even be less, if the resource base continues to deplete (MEMR, 2010). Kenya's Vision 2030 has listed eight challenges for the water sector one of which is "Increasing the amount of irrigated land". The Agricultural Sector Development Strategy for 2009-2020 (ASD) has also listed "improvement of water management and irrigation development" as a strategic requirement for building a dynamic agricultural sector.

Water is becoming scarce simply because of a limited national endowment, the growing needs of rapidly increasing population, as well as serious water resources degradation. In addition to this scarcity, Kenya is highly vulnerable to rainfall variability: droughts are now endemic and floods occur quite frequently. This is despite the fact that Kenya's socio-economic development goals are highly dependent on availability of good quality and quantity water. Sustainable utilization, development and management of water resources fundamentally underpin the achievement of long-term socio-economic goals.

Agricultural production in Kenya is heavily dependent on rainfall. The main constraint to development, income generation and food security in the ASAL areas (which comprises 84% of the total land area in Kenya has inadequate water. Irrigation is especially pertinent in the face of recurrent droughts, floods and prolonged dry spells, which cause food insecurity and famines in the country and have to be mitigated. To promote all year round agriculture and enhance food security, maintenance, construction and rehabilitation of existing dams, pans, and drilling of more boreholes and development of irrigation schemes is of critical importance.

The opportunities for growth through irrigation, drainage and water storage are immense in Kenya. The country has an irrigation potential of 539,000 ha (based on surface water availability) and a drainage/flood protection potential of 600,000 ha, of which only 110,000 ha (20%) of irrigation and 30,000 ha (5%) of drainage have been developed. However, the rate of irrigation development in the country has been slow, with expansion of new irrigated/drained area attaining about 5,000 ha per year, which is equivalent to a growth rate of less than 0.5%. The arid and semi arid lands (ASALs) alone have 9.2 million hectares of land which have the potential for crop production if irrigated. This irrigable area is equivalent to the total farmland in high and medium potential areas in the country (National irrigation and drainage policy, 2009). Since the limiting factor is water, the national irrigation potential can be substantially increased through water harvesting and storage, the exploitation of ground water resources and improvement in water use efficiency. The future growth and development of the agricultural sector will heavily depend on the innovative use of the ASALs, and irrigation will increasingly play an important role in the intensification of agricultural production.

With regard to the aforementioned, the Government has continued to finance initiatives that aim to boost agricultural production particularly by irrigation. As per the first medium term plan of Vision 2030, some flagship programmes were set up. Escalating demand pressure on water resources during the past decade is only one of the concerns for policy-makers. Both watersheds supporting water resources and the land base supporting irrigated agriculture are becoming degraded. Industrial and domestic pollution

are affecting irrigated agriculture, while sedimentation washed from denuded hillsides is filling up irrigation reservoirs and small tanks. At the same time, improper irrigation practices are causing water logging, salinization, soil erosion and water pollution which directly affect other irrigators.

FAO (2014) estimates that of the 237 million ha currently irrigated, about 30 million ha are severely affected by salinity and an additional 60 million to 80 million ha are affected to some extent. UNEP recently reported that the rate of loss of irrigated land from water logging and salinity is 1.5 million ha per year. Millions of hectares of irrigated land, from Morocco to Bangladesh and from northwestern China to central Asia, suffer from this progressive condition. Salinity-affected areas as a percentage of total irrigated area is estimated to be 10 percent in Mexico, 11 percent in India, 21 percent in Pakistan, 23 percent in China and 28 percent in the United States.

Salinity is caused by a combination of poor drainage and high evaporation rates which concentrate salts on irrigated land; it mainly occurs in arid and semi-arid regions. Even good-quality irrigation water contains some dissolved salt and can leave behind tonnes of salt per hectare each year. Unless this salt is washed down below the root level, soil salinity will result. A number of factors influence salinity, including the water table depth, the capillary characteristics of the soil and management practices regarding the amount of water applied in excess of plant evapo-transpiration to leach the salts.

Irrigation can raise groundwater levels to within a metre or so of the surface, which results in secondary salinization when the groundwater brings to the surface dissolved salts from the aquifer, subsoil and root zone. If seepage and horizontal recharge exceed evaporation and natural drainage, then groundwater levels rise, eventually causing water logging. In arid areas where the upward movement of water and evaporation exceeds downward percolation and where the groundwater, soil or irrigation water contains some salt, the buildup of salt in the soil surface layers will eventually reach toxic levels.

Countries suffering from water logging and salinity face a dilemma. They cannot force abandonment of affected lands because of the growing populations that depend on them, but neither can they afford to drain the lands. The cure for rising water tables is drainage and improved water management to reduce percolation, but drainage is expensive and improved water management requires both on-farm investment and the training of extension personnel and farmers

Political pressures often prevent the implementation of apparently sensible and fair reforms for water services. Where water is regarded as a special commodity or has emotional or religious importance, governments are reluctant to charge farmers for irrigation. Policy-makers often find it extremely difficult to raise sufficient revenue to match even their priority needs. The practical effects on traditional public service activities may be harsh. Water has been one of the first sectors to feel the effects of budget-saving efforts and changing resource availability. However, it is unlikely to be treated more austerely than other areas.

2.3 Technology

For irrigation systems to be sustainable, they require proper management to avoid salinization and must not use more water from their source than is naturally replenishable (Tardieu, 2004). Otherwise, the water source effectively becomes a non-renewable resource. Improvements in water well drilling technology and submersible pump, combined with the development of drip irrigation, and low pressure pivots, have made it possible to regularly achieve high crop yields in areas where reliance on rainfall alone had previously made successful agriculture unpredictable. However, this progress has come at a price. In many areas, such as the Ogallala Aquifer the water is being used faster than it can be replenished.

According to FAO Technical Paper N. 11 (1996) Common sense dictates that the choice of technology for irrigation should be based on its appropriateness for the cropping patterns intended and should also consider cost-effectiveness. Irrigation engineers have in the past tended to overlook an additional need: for the technology also to be matched to

the level of sophistication or operational capacity of the users. It has become increasingly obvious that the design process must start from a consideration of how the users will operate the system; this should then be designed to provide the optimum combination of efficiency in water use and cost effective operation and maintenance. Equally important, the designer must consider how the user will cultivate his land, and the implications that this may have for scheme layout. Thus it may be that the design which involves the lowest investment cost per hectare may not be the most cost effective solution if it also involves large numbers of staff for its operation, or if, because of operational difficulty, it cannot be utilized to capacity. On the other hand, a design to improve water use efficiency on a traditional irrigation system by the introduction of "modern" water control structures may not result in overall efficiency gains if the users reject the modern controls in favour of their traditional proportional dividers.

The choice of technology, whether for new development or rehabilitation of existing schemes, has been the subject of much debate over the years. While most irrigation engineers would now agree that the starting point for design must be ease of operation, they still tend to polarize into two camps. One sees the problem largely as overcoming the hydraulic instability of extensively-gated manually operated systems; it sees the solution as the modernization of these systems, adding automatic downstream control structures and other feedback mechanisms designed to achieve hydraulic stability. The other accepts the reality of farmer damage in wet season drought and so favors designs based on cruder and more robust structures; the possibility of just-on-time, demand-based, delivery of water to crops is foregone, in the hope of preserving the civil works from interference.

2.4 Institutional Factors

Improvement in irrigation performance depends on good government, or governance. This may be an obvious assertion, but what exactly does the term mean for irrigation? There are four main elements of governance which can be considered at the national or the local level: the legitimacy of government; its accountability, its competence; and its respect for human rights and the rule of law.

According to World report on Governments and development in Washington, DC (1992), Legitimacy refers to the way in which a population gives consent to be governed, how they are consulted and whether the consent can be withdrawn. Accountability of politicians and officials is tested by how they explain their role and decisions, provide information and can be held responsible for their behavior. A government demonstrates competence in formulating policies and translating them into action in a timely and effective way. Governments who respect human rights establish a framework of known laws, applicable to all, without bias or corruption, with limits on and protection against the exercise of arbitrary power. We can illustrate how these four elements of governance might affect irrigation with simple examples.

When a new project is planned, are those living in the area consulted about the design of the scheme? Are there recognized representative groups of farmers, including women? Are the office holders elected and accountable to the members? Do these groups participate in decisions that affect them? For example, if a groundwater irrigation project threatens the availability of drinking-water from hand pumps, are self-help groups informed and invited to make representations

Are the financial plans of the irrigation scheme made public and arrangements made to explain them to farmers? Are there performance criteria with audit arrangements to ensure that officials adhere to the rules and, if they fail to perform satisfactorily, call them to account? Are officials responsive?

Can the professional staff prepare accurate budgets and effectively deliver services such as timely canal maintenance? Are there arrangements for training them or replacing them with competent officers if they fall short of their duties?

Is there a clear legal framework to regulate groundwater abstraction to prevent over pumping of the aquifers? Is it enforced? Can pollution by industry or by saline water from upstream drainage projects be regulated? Are illegal extractions by farmers at the head of canals monitored and offenders charged by legal processes that are fair, timely, and objective and without discrimination on grounds of race, gender or minority status?

In the early 1970s, the NIA's top management diagnosed correctly that farmer organizations were crucial to effective irrigation management and, therefore, committed the NIA to developing and extending the responsibilities of irrigators' associations. The NIA's willingness to renounce its traditional authority was a key factor in this process. In 1974, the NIA was established as a public corporation and ceased to be part of a government ministry. It was given a five-year lead-in period in which to become financially self-sufficient in terms of its operating budget. The NIA's semi-independent status set the scene for farmer-financed irrigation and the devolvement of management tasks to farmers.

The NIA did not transform itself overnight. The participative approach was first tried in the mid-1970s with smaller-scale "communal" irrigation systems that were traditionally managed by farmers. The end of the 1970s saw the development of a methodology to maximize farmer participation based on two pilot projects. Lessons learned were then incorporated into plans to manage the large-scale "national" irrigation systems jointly. Almost 20 years on, the transformation of the NIA from a top-down bureaucracy continues.

How has the NIA motivated farmers to participate in and pay for irrigation, to commit time to maintenance, to liaise with the NIA and to plan for the future? The NIA experience illustrates some important preconditions for farmer participation: teaming community organizers and engineers in order to integrate social and technical activities into one process; involving farmers in all project activities from the very beginning, thereby building up their organizational skills; modifying NIA policies and procedures that obstruct farmer participation; allowing enough time for farmers to mobilize and organize themselves before new construction activity.

In a study by Rukunga et al (2006) noted that while women seem to have played an equal and active role in design and implementation stage, key leadership positions are held by men, a few women are represented in the committees. I n some part reluctance of women to take on more active roles is due to their commitments although there appear to

be a notion among men that the position are more demanding for women. For irrigation projects to succeed there is need for women involvement and participation in all levels of management right from decision making through implementation to supervision of all activities.

There is need for to provide additional institution support to the community management structure (Rukunga et al., 2006). This support can be in form of information and training to fill the gaps such as those required for maintenance works, skill training, establish administrative and financial systems or even ensuring compliance with national legislation.

He further noted that lack of support services like access roads, market outlets, electricity, have contributed to declining pace of projects like irrigation projects in Kenya. Small holder irrigation development that entails devising of a technical , social and economic productive systems that guarantees farmers goals of increased level of income, increased level of food security, employment and general improvement of their standard of living through effective management systems is vital.

2.5 Financial Factors

Construction and operation costs for irrigation projects have risen steadily over the past four decades as the world's best land and most of the readily available water supplies have been developed.

Majority of farmers especially those in small holder scale category lack financial resources to invest in irrigation project (Peacock, 2005). To access credit facilities farmers are required to provide collaterals by financial institutions. This coupled with the risk the financial institutions experience finds it cumbersome and expensive to administer such credits, so many small scale farmers are procluded from obtaining those credit facilities (Small and Carruther. 1991). The inadequacy to access those credit facilities has slowed down the development of small holder irrigation development in Kenya.

According to FAO Technical Paper N. 11 (1996); Farmer-managed irrigation schemes of a few hundred square metres to a several thousand hectares are developed, operated and maintained by individuals, families, communities, or local rulers and landowners, independently of government, and generally for the production of basic food or fibre crops and vegetables for local markets. Examples may be found throughout the world, from small plots of paddy in Southeast Asia, shallow tube wells in the Indo-Gangetic Plain, tank irrigation systems elsewhere in South Asia, Qanat systems in Iran, Afghanistan and Pakistan, the swamp and flood recession areas with partial water control in Sub-Saharan Africa, to spate irrigation systems in Southern Arabia. Some of these systems are hundreds of years old, in which case they are often referred to as traditional irrigation.

According to FAO Technical Paper N. 11 (1996), the above discussion focuses on irrigation development in formal systems and takes no account of the existence, in various parts of the world, of large areas of informal or traditional irrigation. These, by definition, have been developed on the initiative of farmers rather than governments, and have continued their existence in the same way. Traditional irrigation systems are often characterized by poor water control, and consequent low cropping intensities and yields. In many cases improved water control can be achieved at comparatively low cost, and is often easily justified by the incremental production that can be achieved as a result. Thus, given that in some countries the area under traditional irrigation far exceeds the area under formal irrigation, the scope for obtaining increased food production from these systems could be significant. The identification of opportunities for such improvements may therefore be a priority for planners. However, it must also be noted that the most important feature of these systems is local initiative, responsibility and control; proposed improvements should avoid inadvertent transfer of responsibility to government.

Apart from traditional irrigation systems, other opportunities exist for low cost irrigation, particularly for localized irrigation, including systems based on the use of clay pots for the storage and gradual release of irrigation water. These, and other similar devices, often bring nutritional benefits to local communities because they are generally used for fruit

and vegetable production. They make efficient use of scarce water, but are in general unsuited to large-scale food production.

2.6 Theoretical Framework

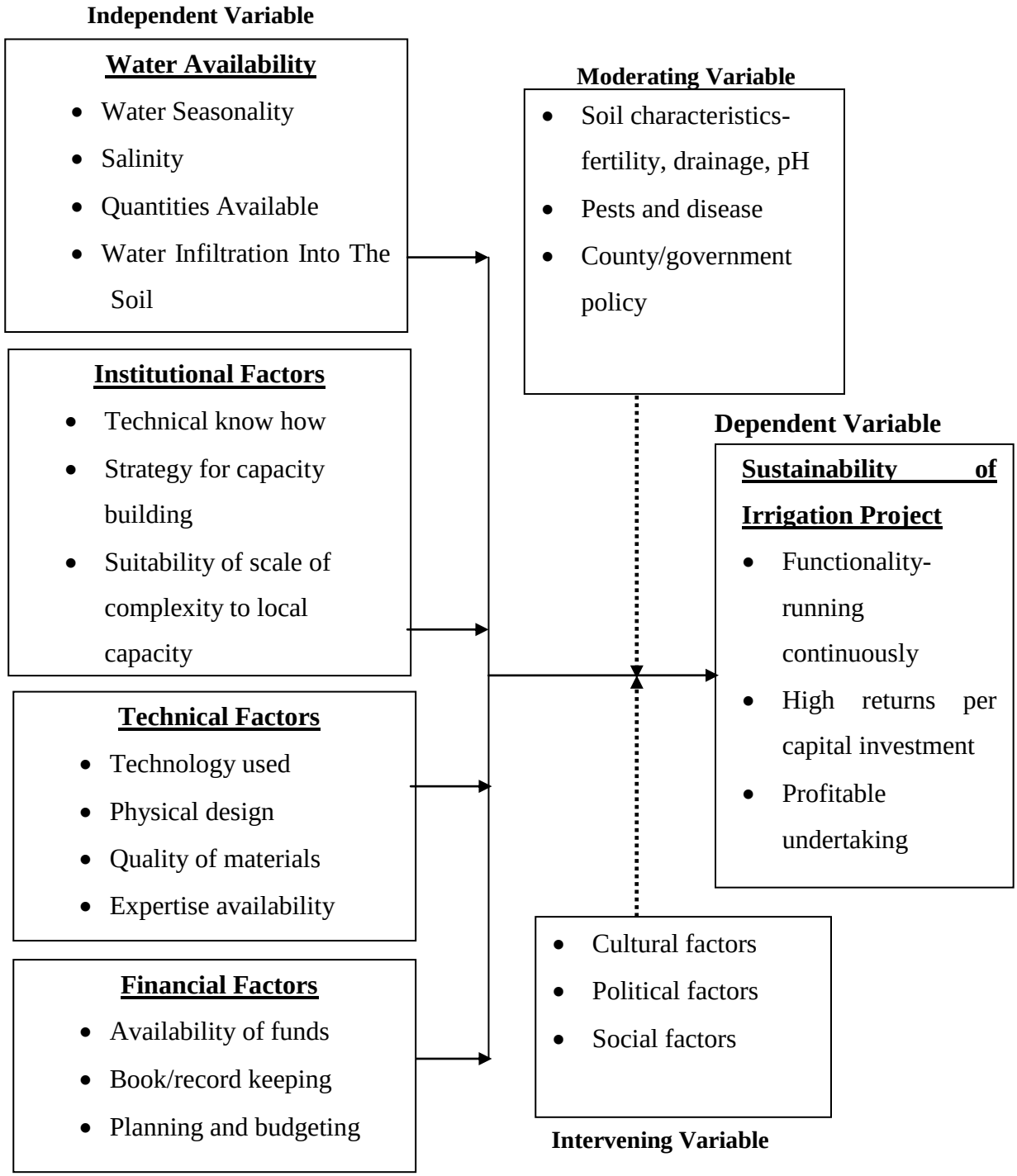
For major changes to be effected and good performance of irrigation projects to be realized there is need for relevant training of staff on areas of specialty ;such management, book keeping and technical areas of operation. Good management structure also adds value to effective operations in running of irrigation projects. Many organizations in different countries such as Kenya, Ghana and Ethiopia have used this approach which has resulted to successful implementation and management of irrigation projects.

Members in a given community where the proposed project is to be implemented are identified for training dependency one level of education. These prepare them to take over the management of project. Some times specialized technical or professional advice is support is needed members are advised to seek this from national or county government staff specialized in the area of need.

There should also be good marketing structure, mode of payment for products, goods mechanism of record and book keeping as well as any other operation in the field.

The diagram below shows conceptual framework about the relationship between the independent, moderating, intervening and dependent variables.

Figure 2.1: Conceptual Framework Diagram



2.7 Explanation of Relationship of Variables in Conceptual Framework

Conceptual framework has identified four types of variables namely independent, dependent, moderating and intervening as shown in the diagram.

Independent variables, water availability comprises of technical know how strategy for capacity building, suitability of the scale of complexity to local capacity, incentives and gender fairness. Third independent variable is technical factors that comprise of quality of materials to be used, physical design, technology chosen, availability of spare parts and skilled labour needed to undertake operations in the project. The fourth independent variable is financial factors. This comprise of inadequacy of funds, embezzlement and misappropriation of funds, planning and budgeting, record of financial books and documents.

These independent variables have direct effect on dependent variable which includes sustainability of project factors as continuous running of irrigation project. Its overall performance as indicated by yields obtained and profitability level (revenue) generated by the project. Conceptual framework also identifies moderating factors such as soil fertility, pest and disease, national and county government policies. Also identified are harvesting factors which include cultural, social and political which may have effect on independent variable affecting sustainability of irrigation project.

The sustainability is dependent variable it entails continuous running of irrigation project, its overall performance depicted by yields obtained and profitability level (revenue) generated by the project.

Conceptual frame work also identifies moderating factors such as soil fertility pests and disease government/county policies. Other factors identified are intervening factors such as cultural, social, political that may have effect on overall performance of irrigation project.

2.8 Gaps in Literature Review

Gaps identified in literature review is that most of research work focus mostly on overall performance of irrigation projects without paying attentions to sustainability of these irrigation projects. Another gap is gender representation in overall management of irrigation project as women are rarely included or involved in mainstream management of project but only given less involving jobs so the immense potentials are not utilized which could see the project perform better.

2.9 Summary of the Literature Review

Literature review identified major factors that influence sustainability of irrigation projects which has been listed as water availability, technical, institutional and financial factors. These factors would have to be addressed if irrigation projects have to be profitable undertaking worth the amount of funds involved and the publicity they attract both at county and national level.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the methodology used in the study. It is sub divided into seven sections namely; research design, target population, sampling or the respondent of the study, the research instruments, methods of data collection, procedure and methods of data analysis and ethical issues.

3.2 Research Design

The study used survey design to establish factors affecting sustainability of irrigation projects. The first step in the study explained those questions that were answered which enabled data collected to be relevant to the study (Mugenda and Mugenda 2003). This type of study sought to obtain information that explains an existing phenomenon from people's perception, attitude, values and behaviors. From these answers of respondents the researcher was able to obtain frequency of a particular attribute from which percentage perception of that attribute was calculated. The problem under study must have had social, economic or even political impact on population. It was a quick and cheap method, especially if the researcher has time constants. The method was chosen as it could adequately give information on attributes like altitude, values and behavior which are qualitative in nature

3.3 Target Population

Population is defined as an entire group of individuals, events or objects with common observable characteristics (Mugenda and Mugenda 2003), from which a sample is taken for measurement. The target population was all farmers both small and large scale currently undertaking this type of farming in the sub county. It was established that there were 138 farmers currently undertaking the type of farming in the sub county (Ministry of Agriculture report, Kibwezi Sub County, 2014)

3.4 Sample Size and Sampling Procedure

A sample is a set of individuals selected from the target population which is intended to represent the population in a research study.

3.4.1 Sample Size

A big sample size will provide more accurate and reliable information (Mugenda and Mugenda 2003). Based on this fact the fact the study used Krejcie and Morgan (1970) table below to arrive at sample size. The target population of the study was 138 farmers undertaking irrigation in the sub county, so based on this table the sample size was 103.

Figure 3.1: Table for Determining Sample Size

Table for determining sample size of a known population											
N	S	N	S	N	S	N	S	N	S	N	S
10	10	85	70	220	140	440	205	1200	291	4000	351
15	14	90	73	230	144	460	210	1300	297	4500	354
20	19	95	76	240	148	480	214	1400	302	5000	357
25	24	100	80	250	152	500	217	1500	306	6000	361
30	28	110	86	260	155	550	226	1600	310	7000	364
35	32	120	92	270	159	600	234	1700	313	8000	367
40	36	130	97	280	162	650	242	1800	317	9000	368
45	40	140	103	290	165	700	248	1900	320	10000	370
50	44	150	108	300	169	750	254	2000	322	15000	375
55	48	160	113	320	175	800	260	2200	327	20000	377
60	52	170	118	340	181	850	265	2400	331	30000	379
65	56	180	123	360	186	900	269	2600	335	40000	380
70	59	190	127	380	191	950	274	2800	338	50000	381
75	63	200	132	400	196	1000	278	3000	341	75000	382
80	66	210	136	420	201	1100	285	3500	346	1000000	384

Source: Krejcie and Morgan (1970)

Note: N= population size **S**= sample size

3.4.2 Sampling Procedure

The study used multi stage sampling technique. In this technique the sample frame is divided into clusters based on administrative units such as divisions, locations then sub locations. The farmers in a given sub locations were serialized, then a sample farmer was picked from every third count repeatedly until all farmers in that sub location were sampled This was done only in the administrative units where irrigation was practiced. This procedure was repeated in all sub locations to arrive at the sample size. The technique though time consuming was accurate and more reliable.

3.5 Data Collection Instruments

Data collection was done using questionnaires. This is a research tool that gathers data from a large sample (Kombo 2006). These are used to obtain information about the population in the sub county. Each questionnaire was divided three sections. The first section addressed personal information of respondents; the second section addressed the status of the project in the sub county and the third addressed factors influencing the sustainability of irrigation projects in the sub county namely: water availability, institutional factors, technical factors and financial factors. The questionnaires unveiled information on both dependent and independent variables which gave answers to research questions.

3.6 Validity and Reliability of Instruments

Reliability and validity of instruments used for research is discussed here.

3.6.1 Validity of Instruments

This refers to the accuracy of data obtained during a research about the variables being studied. (Mugenda and Mugenda 2003) Accuracy or the meaningfulness is the degree to which results obtained from analysis of data represented in the phenomena of study. Joppe (2000) says validity determines whether the researcher truly measures what it indented to measure or how truthful the research results are.

Validity was determined by the extended to which instrument measured what it purported to measure. According to Wintersein (2008), content validity depends on the experts in the field. Expert judgment was used to assess the content validity of the instruments by discussing the results with the supervisor and other experts in the field. Pre testing of research instruments (questionnaires) was done to address standardization and avoid ubiquities.

3.6.2 Reliability of Instruments

This is the stability and consistency with which the data collection instruments measure the consent (Mugenda and Mugenda 2003). Joppe (2000) says reliability is the extent to which results are consistent over time and research instruments are reliable if the results of a study can be reproduced under a similar methodology. The commonly used tests for reliability are test-retest and split half reliability.

3.7 Methods of Data Analysis

Data was analyzed using both qualitative and quantitative techniques. For quantitative data entry and analysis, the statistical package for social sciences (SPSS) was used. The data was presented in tables that indicated percentages of a given attribute. These percentages were then analyzed systematically to provide trends patterns and relationships from which conclusions were drawn. For qualitative data, systematic analysis of data given was done to arrive at meaningful and useful conclusion.

3.8 Ethical Issues

Ethics is an integral part in research, so strict ethical consciousness was adhered to. This included confidentiality and privacy of respondents which was protected by keeping information provided confidential. Consent to offer information by respondents was first addressed before any form of method for obtaining information was administered.

3.9 Operational Definition of Variables

The figure below shows operational definition of variables

Table 3.1: Operational Definition of Variables

Objective of study	Variable	Indicators	Measurement scale	Data analysis tool
To establish how water availability influence sustainability of irrigation project	Independent variable Amount and quality of water	% of community members who feel the quantity and quality of water for irrigation is sufficient	Nominal	Percentage
To establish how technical factors influence sustainability of irrigation project.	Independent variable access to spare parts, technology used, design, quality of material	% of community member who feel spare parts are available. % of members who feel technology used and physical design is good. % of community members who feel quality of materials used is good.	Nominal	Percentage
To establish how institutional factors influence sustainability of irrigation project	Independent variable Structure of management, knowledge base, skill needed and capacity building Gender representation	% of community members to manage the project % of community who feel women participation will increase sustainability % of members with needed skills.	Nominal	Percentage
To establish how financial factors influence sustainability of irrigation project	Independent variable Availability of funds Book keeping Planning and budgeting	% of community members who feel funds are adequate % of member who feel accounting of funds is done well % of community members who feel planning and budgeting is good % of community members who feel that funds are used well.	Nominal	Percentage

CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

In this chapter the key issues related to data presentation, analysis and interpretation have been discussed. This chapter is presented in three different sections. All the sections present study responses regarding factors affecting sustainability of irrigation project in Kibwezi Sub County. First, the research response rate has been computed and presented for each section. Secondly, the demographic characteristics of the participants have been described. Thirdly, the findings on the four key objective areas of the study have been presented and interpreted. The responses were analyzed using descriptive and inferential statistics. The data has been presented in tables.

4.2 The Study Response Rate (Responses from Farmers of Kibwezi Sub County)

Out of 103 questionnaires which had been administered to the interviewees, 82 of them were returned for analysis. This translates to 80.0 percent return rate of the respondents. Overall, the response rate was considered high and adequate for the study as shown in Table 4.1.

Table 4.1: Distribution of the Respondents by Responses Rate (Farmers)

Response Rate	Frequency (F)	Percentage (%)
Returned	82	80.0
Not Returned	21	20.0
Total	**103**	**100.0**

4.3 Demographic Characteristics of the Respondents

The respondents in this section of the study were farmers drawn from Kibwezi Sub County who undertake irrigation were of different categories. The farmers are categorized by gender, age, education, occupation and monthly income.

The summary of the farmers of Kibwezi Sub County distribution by their gender is given in Table 4.2

Table 4.2: Distribution of Farmers by Gender

Gender	Frequency (F)	Percentage (%)
Male	61	59.0
Female	33	32.1
No response	9	9.0
Total	**103**	**100.0**

According to the data shown in Table 4.2, out of 103 farmers who participated in the study, the majority 61 (59.0%) were males while 33 (32.1%) were female. The findings could be an indication that most of the farmers were males. The few number of women involved in this economic activity may negatively influence the sustainability of the projects. This is due to the fact that their enormous potential is not put into productive economic use.

The distribution of the farmers by age is given in Table 4.3

Table 4.3: Distribution of Farmers by Age

Age	Frequency (F)	Percentage (%)
26-35 years	15	14.1
36-44 years	43	42.3
Above 45 years	41	39.7
No response	4	3.8
Total	**103**	**100.0**

It is evident from the data shown in Table 4.3 that, majority of the farmers 43 (42.3%) fell under the age bracket of 36-44 years, 41 (39.7%) were aged above 45 years, and 15 (14.1%) were aged 26-35 years. The findings reveal that farmers comprises of young and middle aged people. This finding shows that farming is undertaken by young energetic people, well versed with modern farming technologies, who can influence positively the success of this economic activity.

The distribution of the farmers by education level is given in Table 4.4

Table 4.4: Distribution of Farmers by Education Level

Academic Achievements	Frequency (F)	Percentage (%)
No school	1	1.3
Primary incomplete	5	5.1
Completed primary	12	11.5
Secondary incomplete	23	21.8
Secondary complete	43	41.0
Tertiary institution	18	17.9
University level	1	1.3
Total	**103**	**100.0**

The results in Table 4.5 indicate that, majority 43 (41.0%) of the farmers have attained secondary level of education, 23 (21.8%) have not completed secondary school, 18 (17.9%) have attained tertiary education, 12 (11.5%) have completed primary level of education, 5 (5.1%) have not completed primary level of education, 1 (1.3%) have attained university level of education and 1 (1.3%) have not attended school at all. The findings point that majority of farmers have attained basic education. These points out that having attained the basic education majority can easily understand various methods and new technologies in farming which can greatly influence positively the sustainability of irrigation projects.

The income level of the farmers is given in Table 4.5.

Table 4.5: Income Level of Farmers

Income	Frequency (F)	Percentage (%)
Less than KSh 2,000	15	14.1
Ksh2,000-6,000	28	26.9
Ksh 6,000-10,000	49	47.4
More than Ksh 10,000	12	11.5
Total	**103**	**100.0**

It is evident from the data shown in Table 4.5 that majority of the farmers 49 (47.4%) receive an income of more than Ksh 10,000, 28 (26.9%) receive an income of Ksh 2,000-6,000, 15 (14.1%) receive an income of less than Ksh 2,000 and 12 (11.5%) receive an income of Ksh 2,000-6,000. This is an indication that most farmers have insufficient

income to support profitable irrigation undertaking. This may impact negatively to the sustainability of irrigation projects, as they may not have enough funds to purchase the necessary inputs.

4.4 Status

The availability of an irrigation project in this sub location is shown in Table 4.6.

Table 4.6: Availability of an Irrigation Project in this Sub County

Availability	Frequency (F)	Percentage (%)
Yes	98	94.9
No	5	5.1
Total	**103**	**100.0**

It is evident from the data shown in Table 4.6 that majority of the farmers 98 (94.9%) who participated in the study agreed that there is irrigation project in this sub county while 5 (5.1%) disagreed. This shows that irrigation is major economic activity. This is supported by the fact that the area receives insufficient rainfall to support rain fed crop production.

The operation of the irrigation project is given in Table 4.7:

Table 4.7: Operation of the Irrigation Project

Operations	Frequency (F)	Percentage (%)
Yes	58	56.4
No	45	43.6
Total	**103**	**100.0**

The findings in Table 4.7 show that majority of the farmers 58(56.4%) who participated in the study agreed that the irrigation project is operational while 45 (43.6%) disagreed. The findings points out most of the irrigation projects are operational. It also shows that a big number of projects have stalled. This is an indication that there are challenges that force many of these projects to stall and if the challenges can be discovered and solved then this can influence positively to the sustainability of the projects.

The cause of the project stall is given in Table 4.8.

Table 4.8: Cause of Project Stall

Cause	Frequency (F)	Percentage (%)
Lack of water	35	33.3
Poor management	19	18
Lack of funds to buy inputs	15	15
Political interference	0	0.0
No response	34	33
Total	**103**	**100.0**

The findings on Table 4.8 indicate that majority 35 (33.3%) of the farmers indicated that the project could have stalled because of lack of water while 19 (18%) indicated that the project could have stalled because of poor management, while 15(15%) have stalled due to lack of funds to buy inputs. The findings indicate that water unavailability is the major cause of project failure followed by poor management then lack of funds for acquisition of inputs.

This is a clear indication that water availability, management and financial difficulties experienced by the farmers have direct influence on sustainability of irrigation projects.

The source of the water for irrigation is given in Table 4.9.

Table 4.9: Source of Irrigation Water

Source	Frequency (F)	Percentage (%)
River	79	76.9
Dam	13	11.5
Wells	5	5.1
Boreholes	0	0.0
Both river and boreholes	1	1.3
No response	5	5.1
Total	**103**	**100.0**

The findings on Table 4.9 indicate that majority 79 (76.9%) of the farmers agreed that they get their water from the river, 13 (11.5%) get their water from the dam. 5 (5.1%) get their water from wells and 1 (1.3%) get their water from both river and boreholes. The above findings show that rivers are the major source of water for irrigation. All rivers in the sub county are seasonal as the area receives low rainfall. This points to the

inadequacy of water for irrigation projects that result to many of them stalling. The water inadequacy greatly influences the sustainability of irrigation projects in the sub county.

4.5 Water and Availability

This section looks at the water and its availability which is one of the objectives of the study.

The size of the farm where the farmers practice irrigation is given in Table 4.10.

Table 4.10: Size of the Farm

Size	Frequency (F)	Percentage (%)
Less than 1 acre	67	65.4
2-5 acres	25	24.4
5-10 acres	4	3.8
More than 10 acres	1	1.3
No response	5.	5.1
Total	**103**	**100.0**

The findings on Table 4.10 indicate that majority 67 (65.4%) of the farmers indicated that the size of their farm is less than 1 acre, 2-5 acres 25 (24.4%), 5-10 acres 5 (3.8%) and more than 10 acres 1 (1.3%). The findings show that most farmers carry out irrigation in small scale of less than one acre. This could be as a result of shortage of sufficient water for a large scale undertaking.

The availability of water throughout the year is given in Table 4.11.

Table 4.11: Availability of Water throughout the Year

Availability	Frequency (F)	Percentage (%)
Yes	17	16.7
No	82	79.5
No response	4	3.8
Total	**103**	**100.0**

It is evident from the data shown in Table 4.11 that majority of the farmers 82 (79.5%) who participated in the study indicated that they do not have water throughout the year while 17 (16.7%) agreed. The findings are in line with National irrigation and drainage policy, (2009) who note that water is becoming scarce simply because of a limited national endowment, the growing needs of rapidly increasing population, as well as serious water resources degradation. In addition to this scarcity, Kenya is highly vulnerable to rainfall variability: droughts are now endemic and floods occur quite frequently. This is despite the fact that Kenya's socio-economic development goals are highly dependent on availability of good quality and quantity water. Sustainable utilization, development and management of water resources fundamentally underpin the achievement of long-term socio-economic goals.

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The adequacy of the water to support crops throughout the year is given in Table 4.12.

Table 4.12: Adequacy of the Water to Support Crops throughout the Year

Adequacy	Frequency (F)	Percentage (%)
Yes	16	15.4
No	83	80.8
No response	4	3.8
Total	**103**	**100.0**

It is evident from the data shown in Table 4.12 that majority of the farmers 83 (80.8%) who participated in the study indicated that the water is not adequate to support crops

throughout the year while 16 (15.4%) agreed. The drainage of the area is mainly seasonal rivers that only have sufficient water during the rainy season. This coupled with fact that the major source of water for irrigation projects is river, and then there is hardly sufficient water for the projects. This has negative influence on sustainability of the projects.

The alternative source of water to support crops is given in Table 4.13.

Table 4.13: Alternative Source of Water to Support Crops

Alternative	Frequency (F)	Percentage (%)
Yes	5	5.1
No	81	78.2
No response	17	16.7
Total	**103**	**100.0**

Table 4.13 reveals that majority of the farmers 81 (78.2%) who participated in the study indicated that there is no alternative source of water to support crops while 5 (5.1%) agreed. The study sought to find out what can be done to solve the problem of water shortage for crops. The responses given include: building wells, dam construction and excavation to trap and acts as water reservoirs for irrigation, and drilling boreholes.

4.6 Technical Factors

This section looks at the technical factors which is an objective of the study. This is the technology employed in water distribution in the projects.

The application of water to the crops is given in Table 4.14.

Table 4.14: Application of Water to the Crops

Application	Frequency (F)	Percentage (%)
Canal	81	78.2
Drip	15	15.4
Underground pipes	0	0.0
Overhead irrigation	0	0.0
Canal and drip	3	2.6
No response	4	3.8
Total	**103**	**100.0**

The findings on Table 4.14 indicate that majority 81 (78.2%) of the farmers agreed that the water is applied using a canal, 15 (15.4%) through the drip and 3 (2.6%) through the

canal and drip. The findings support FAO Technical Paper N. 11 (1996) which notes that for irrigation systems to be sustainable; they require proper management to avoid salinization and must not use more water from their source than is naturally replenishable. Otherwise, the water source effectively becomes a non-renewable resource. Improvements in water well drilling technology and submersible pump, combined with the development of drip irrigation, and low pressure pivots, have made it possible to regularly achieve high crop yields in areas where reliance on rainfall alone had previously made successful agriculture unpredictable.

The usage of the piping system to convey water to the farm is given in Table 4.15.

Table 4.15: Usage of the Piping System to Convey Water to the Farm

Usage	Frequency (F)	Percentage (%)
Yes	92	89.7
No	8	7.7
No response	3	2.6
Total	**103**	**100.0**

It is evident from the data shown in Table 4.15 that majority of the farmers 92 (89.7%) who participated in the study agreed that they use piping system to convey water to the farm while 8 (7.7%) disagreed. The findings point out that the major technology for water conveyance in the farms is pipping. This is a better method compared to canal which result high loss of water through evaporation and seepage, which in turn aggravates already a bad situation of water shortage.

The make of the pipes is given in Table 4.16

Table 4.16: Make of the Pipes

Make	Frequency (F)	Percentage (%)
Plastic	95	92.3
Aluminium	1	1.3
No response	7	6.4
Total	**103**	**100.0**

The findings on Table 4.16 indicate that majority 95 (92.3%) of the farmers indicated that the pipes are made of plastic while 1 (1.3%) indicated that the pipes are made of

aluminum. Plastic pipes are cheaper as compared to metallic ones. The challenges farmers face from this type of pipes is that they become brittle when exposed to hot sun or destruction by rodents. Their usage by a large number of farmers has meaningful sustainability of the projects.

The availability of technicians to offer support for the irrigation systems is given in Table 4.17.

Table 4.17: Availability of Technicians to offer Support for the Irrigation Systems

Technicians	Frequency (F)	Percentage (%)
Yes	16	15.4
No	82	79.5
No response	5	5.1
Total	**103**	**100.0**

It is evident from the data shown in Table 4.17 that majority of the farmers 82 (79.5%) who participated in the study indicated that there are no technicians to offer support for the irrigation systems while 16 (15.4%) agreed. The unavailability of qualified technician to repair the water systems implies that they are attended by unquailed staff that tampers with them thus shortening their life span. This influences negatively to the sustainability of the projects.

The competency of the technicians to handle breakages of irrigation systems is given in Table 4.18.

Table 4.18: Competency of the Technicians to Handle Breakages of Irrigation Systems

Competency	Frequency (F)	Percentage (%)
Yes	13	12.8
No	85	82.1
No response	5	5.1
Total	**103**	**100.0**

Table 4.18 reveals that majority of the farmers 85 (82.1%) who participated in the study indicated that there are no competent technicians to handle breakages of irrigation systems while 12 (12.8%) agreed. The explanations given for the No response include

that there are local artisans who help handle breakages of irrigation systems. The local artisans may not have adequate technical knowhow which may result to poor workmanship hence influencing negatively to the sustainability of the projects.

The availability of spare parts for the irrigation system is given in Table 4.19.

Table 4.19: Availability of Spare Parts for the Irrigation System

Spare parts	Frequency (F)	Percentage (%)
Yes	82	79.5
No	14	14.1
No response	7	6.4
Total	**103**	**100.0**

It is evident from the data shown in Table 4.19 that majority of the farmers 82 (79.5%) who participated in the study agreed that there are spare parts available for the irrigation system while 14 (14.1%) disagreed. The availability of the spare parts is an indication that water systems can get fixed whenever a breakdown occur without delays. This greatly influence sustainability positively.

The affordability of spare parts for the irrigation system is given in Table 4.20.

Table 4.20: Affordability of Spare Parts for the Irrigation System

Spare parts	Frequency (F)	Percentage (%)
Yes	84	82.1
No	11	10.3
No response	8	7.7
Total	**103**	**100.0**

It is evident from the data shown in Table 4.20 that majority of the farmers 84 (82.1%) who participated in the study agreed that the spare parts are affordable for the irrigation system while 11 (10.3%) disagreed. With the spare parts going at reasonable prices the only challenge farmer's face is inadequacy of funds to acquire them when needed.

4.7 Institutional Factors

This section looks at the institutional factors which is an objective to the study.

The regulation of water for the irrigation system is given in Table 4.21

Table 4.21: Regulation of Water for Irrigation

Regulation	Frequency (F)	Percentage (%)
Yes	21	20.5
No	79	76.9
No response	3	2.6
Total	**103**	**100.0**

Table 4.21 indicated that majority of the farmers 79 (76.9%) who participated in the study indicated that the water for irrigation is not regulated/managed while 21 (20.5%) agreed. The findings are in line with World report on Governments and development in Washington, DC (1992) who contends that improvement in irrigation performance depends on good government, or governance. This may be an obvious assertion, but what exactly does the term mean for irrigation? There are four main elements of governance which can be considered at the national or the local level: the legitimacy of government; its accountability, its competence; and its respect for human rights and the rule of law.

The person who regulates/manages the water supply to the farm is given in Table 4.22.

Table 4.22: Regulation/Management of Water Supply to the Farm

Regulation	Frequency (F)	Percentage (%)
CBO	13	12.8
Private	69	66.7
Water management committee	8	7.7
Government agency	1	1.3
NGO	0	0.0
No management available	1	1.3
No response	11	10.3
Total	**103**	**100.0**

The findings on Table 4.22 indicate that majority 69 (66.7%) of the farmers indicated that the water supply to the farm is regulated/managed privately, 13 (12.8%) indicated that the water supply to the farm is regulated/managed by CBOs, 8 (7.7%) by water management committee, 1 (1.3%) by government agency and 1 (1.3%) indicated that there is no management available to regulate/manage the water supply to the farm. With high management of water under private individual there may not be a proper supervision of

the resource. This calls for strengthening of community based organizations to eversee the role, for efficient supply of water. This would greatly influence the sustainability of the projects.

The role of this management structure in place is given in Table 4.23.

Table 4.23: Roles of this Management Structure in Place

Roles	Frequency (F)	Percentage (%)
Collect water user fee	1	1.3
Repair water supply systems when broken	3	2.6
Over see the water system	20	19.2
No response	79	76.9
Total	**103**	**100.0**

The findings on Table 4.23 indicate that majority 20 (19.2%) of the farmers indicated that the roles of the management are to oversee the water system, 3 (2.6%) to repair water supply systems when broken and 1 (1.3%) to collect water user fee. Establishment of organizational structure where individuals are given specific roles would result to smooth running of water supply systems thus influence the sustainability of the projects.

The availability of committees trained to handle water management systems is given in Table 4.24.

Table 4.24: Availability of Committees Trained to Handle Water Management Systems

Committees	Frequency (F)	Percentage (%)
Yes	11	10
No	42	41.7
No response	50	48.3
Total	**103**	**100.0**

It is evident from the data shown in Table 4.24 that majority of the farmers 42 (41.7%) who participated in the study indicated that there are no committees trained to handle water management systems while 10 (10%) agreed. The findings show there are no trained committees. Lack of skills to handle water management systems may have led to

inefficiency in running of these systems hence their failure thus influence on sustainability of the projects.

The improvement of these management committees to handle management systems is given in Table 4.25.

Table 4.25: Improvement of these Management Committees to Handle Effectively Water Management Systems

Management systems	Frequency (F)	Percentage (%)
Train them	22	21.8
Privatize water supply	5	3.8
No response	76	74.4
Total	**103**	**100.0**

It is evident from the data shown in Table 4.25 that majority of the farmers 22 (21.8%) who participated in the study indicated that the management committees should be trained to handle effectively water management systems while 5 (3.8%) indicated they should privatize the water supply. Many respondents supported training of management committees. This would equip them with necessary skills to run the systems for efficient water supply to the projects. This see many of the projects performing better hence improve their sustainability.

4.8 Financial Factors

This section looks at financial factors which is an objective of the study. Good funding is very fundamental to any profitable undertaking.

The availability of external financial support for the irrigation system is given in Table 4.26.

Table 4.26: Availability of External Financial Support for these Irrigation Projects

External financial support	Frequency (F)	Percentage (%)
Yes	9	9.0
No	91	88.5
No response	3	2.6
Total	**103**	**100.0**

It is evident from the data shown in Table 4.26 that majority of the farmers 91 (88.5%) who participated in the study agreed that there is no external financial support for these irrigation projects while 9 (9.0%) agreed. The findings are in line with Griliches (1964) who notes that majority of farmers especially those in small holder scale category lack financial resources to invest in irrigation projects.

To access credit facilities farmers are required to provide collaterals by financial institutions. This coupled with the risk the financial institutions experience finds it cumbersome and expensive to administer such credits, so many small scale farmers are precluded from obtaining those credit facilities. The inadequacy to access those credit facilities has slowed down the development of small holder irrigation development in Kenya.

The availability of spare parts for the irrigation system is given in Table 4.27.

Table 4.27: Source of External Financial Support

Source	Frequency (F)	Percentage (%)
Government	3	2.6
NGO	7	6.4
No response	93	91.0
Total	**103**	**100.0**

It is evident from the data shown in Table 4.27 that majority of the farmers 7 (6.4%) who participated in the study agreed that the source of external financial support is NGOs while 3 (2.6%) indicated that it is the government. The big number of farmers have indicated that they don't get any financial support. It was also seen that many of them have very low income. This limits their ability to acquire inputs and influence the sustainability of the projects.

The adequacy of financial support to run the project is given in Table 4.28.

Table 4.28: Adequacy of Financial Support to Run the Project

Adequacy	Frequency (F)	Percentage (%)
Yes	0	0.0
No	18	17.9
No response	85	82.1
Total	**103**	**100.0**

It is evident from the data shown in Table 4.28 that majority of the farmers 18 (17.9%) who participated in the study indicated that the financial support is not adequate to run the project. Although little financial support is provided to a limited number it is inadequate. If a source funding can be provided, the farmers could be empowered to finance their undertaking thus improve the sustainability of the projects.

The other alternative to source funds for the project is given in Table 4.29.

Table 4.29: Other Alternative to Source Funds for the Project

Other alternative	Frequency (F)	Percentage (%)
one	8	7.7
Loans	7	6.4
Grants	3	2.6
Savings	78	76.9
No response	7	6.4
Total	**103**	**100.0**

The findings on Table 4.29 indicate that majority 78 (76.9%) of the farmers indicated that the other alternative to source funds for the project is savings, none 8 (7.7%), loans 7 (6.4%) and grants 3 (2.6%). Most farmers rely on their saving which is hardly adequate. This impacts negatively to the sustainability of the projects.

The availability of subscription fee for water used in the projects is given in Table 4.30

Table 4.30: Availability of Subscription Fee for Water used in the Projects

Subscription	Frequency (F)	Percentage (%)
Yes	11	10.3
No	65	62.8
No response	28	26.9
Total	**103**	**100.0**

It is evident from the data shown in Table 4.30 that majority of the farmers 65 (62.8%) who participated in the study indicated that there is no subscription fee for water used in the projects while 11 (10.3%) agreed. With no subscription fees for water usage would mean no funds available for its management. This would lead to poor services which would have negative influence on the sustainability of the irrigation projects.

The payment of the subscription is given in Table 4.31.

Table 4.31: Payment of the Subscription

Payment	Frequency (F)	Percentage (%)
Ksh 50-100	0	0.0
Ksh 100-150	1	1.3
Ksh 150-200	3	2.6
Ksh 200-250	1	1.3
Ksh 250-300	4	3.8
No response	94	91.0
Total	**103**	**100.0**

The findings on Table 4.31 indicate that majority 4 (3.8%) of the farmers indicated that they pay Ksh 250-300, 3 (2.6%) pay Ksh 150-200, 1 (1.3%) pay Ksh 100-150 and 1 (1.3%) pay Ksh 200-250. From the findings it is evident little money is collected as subscription fees. This is inadequate to run the water systems implying poor supply of water to the projects.

The collection of the money is shown in Table 4.32.

Table 4.32: Collection of the Money

Collection	Frequency (F)	Percentage (%)
Government	4	3.8
Committee	5	5.1
Individuals	0	0.0
Care takers	0	0.0
No response	94	91.0
Total	**103**	**100.0**

It is evident from the data shown in Table 4.32 that majority of the farmers 5 (5.1%) who participated in the study indicated that the money is collected by the committee while 4 (3.8%) indicated that the money is collected by the government. It is evident that the little money collected as subscription fees is done by committees and government agencies. There is need to establish and strengthen committees where they don't exist to collect water usage fees, which would used for running irrigation systems. This would influence the sustainability of the irrigation projects.

4.9 Correlation Analysis

As part of the analysis Pearson's Correlation Analysis was done on the independent variables and the results were as shown on Table 4.33.

Table 4.33: Correlation Analysis

		Water availability	Technical factors	Institutional factors	Financial factors
Water availability	Pearson Correlation	1			
Technical factors	Pearson Correlation	-.017	1		
Institutional factors	Pearson Correlation	.619**	.011	1	
Financial factors	Pearson Correlation	.358**	.087	.392	1

The Pearson's correlation co-efficient of factors that affect sustainability of irrigation projects in Kibwezi sub-county and institutional factors is 0.619, technical factors (0.017) and financial factors is 0.358. These coefficients imply that there exists a positive influence of institutional factors (61.9%), technical factors (1.7%) and financial factors (35.8%) to factors that affect sustainability of irrigation projects in Kibwezi sub-county. This positive influence suggests that when one factor increases, the other factors that affect sustainability of irrigation projects in Kibwezi sub-county increases.

CHAPTER FIVE
SUMMARY OF FINDINGS, DISCUSSION, CONCLUSION AND RECOMMENDATIONS.

5.1 Introduction

This chapter presents the summary of research findings, conclusion and recommendations.

5.2 Summary of Research Findings

This section gives the summary of research findings.

5.2.1 Demographic Characteristics

Majority of respondents were males 59%, while females were 32.1%. This is an indication that most of house hold heads were males. Based on the age bracket, majority of respondent were aged between 36- 44 years (42.3%), followed by those aged above 45 years which represent 39.7%. This figure indicates that most of the respondents who are involved in the economic activities (irrigation) are males aged above 36 years. It is also evident that majority of respondents have attained secondary education (41%). So literacy level is high at this area, but majority earn less than khs10, 000 per month. Irrigation is a major undertaking in the area as indicated by high percentage of 94% of those interviewed, but it is evident that most of projects have stalled as pointed out by the high percentage of 43.6%.

5.2.2 Water Availability

Water availability is a major contributing factor to the sustainability of irrigation projects. Most of the project have stalled (40%) due to lack of water. The major source of water for these projects is rivers (92%), followed by dams (14%). Most of the river in the area are seasonal hence unreliable to supply sufficient water throughout the year for sustainability of the projects. This is also confirmed by the fact that most of the farm are of less than one acre (65%). Majority of respondents (95%) said they lack water throughout the year for their projects, and 80.8% said the water which is available is inadequate. This confirms the high failure of the irrigation projects. This impacts negatively to sustainability of these projects.

5.2.3 Technical Factors

Majority of the respondents (78.2%) use canals to supply water to their projects, followed by drip. A big number of respondents use plastic pipes (89.7%).Only a small number (1.3%) use metallic pipes. A big number of respondents (79.5%) cannot access a qualified technician to repair /maintain their irrigation systems. The technicians who are available (82.1%) are not competent to handle /repair these irrigation systems. The spare parts are quite available (75.5%) at a reasonable cost (82.1%).

5.2.4 Institutional Factors

Majority of respondents (76.9%) indicated that water for irrigation projects is not regulated. Where regulation is done, majority do it privately (66.7%). A small number (12.8%) have established CBO, while water committees' account for only (7.7%), and government agents account for only (1.3%).A small number of respondents oversee repair of water system (2.6%). Majority of respondents reported that water committee's role is to oversee the water systems. A small number collect water user fee. Majority of committee members (41.7) are not trained to handle water management systems, only a small number (10%) have formal training for this role. Majority of respondents (21.8%) agree that water committees' members should be trained for affective management of water systems.

5.2.5 Financial Factors

Financial factors in any intervention plays a pivotal role in its success, as it enables acquisition of all the necessary inputs .Majority of respondents (88.5%) indicated that they lack external financial support to run the projects. Only a handful (9%) gets support. NGO account for the highest external source of financial support (6.4%), with government accounting for only (2.6%). The said finances are not adequate as shown by (91%) of respondents who get the support. Majority rely on their own savings (92%). Which and again is not adequate. Subscription for water usage in quite low (2.6%) and majority pay less than kshs 300/- done by CBO. This confirms that the funds for management of water system is inadequate thus negatively affecting the sustainability of the irrigation projects by women , which aggregates the situation .Majority of those

interviewed lie between 35-44 years which is the age actively involved in economic activities. Most of them earn income of less than Kshs. 10,000/- , which means they are unable to meet their financial requirements for sustainability of irrigation projects such as water subscription fee and purchase of spare parts for irrigation systems. Although many people are involved in irrigation activities most of these are done on a very small scale of less than one acre. This implies that the several fairly needs and also same economic invest in the irrigation projects.

5.3 Discussion

5.3.1 Demographic Characteristics of Respondents

From the findings its evident that majority of respondents are males 51% which points out that only a few women 32.1% are actively involved in irrigation projects. This negatively influences the sustainability of the projects as most of rural population is composed of women. This implies that projects in the sub County have not benefited from immense labour force provided by women. Majority of farmers interviewed lie in age bracket of 34-44 years and majority have attained secondary education 41%. This points out that the irrigation is done by energetic and literate group which could spur economic development in the sub County.

5.3.2 Water Availability

For sound irrigation projects, water is of paramount importance as it plays a pivotal role in crops performance. It should be available at the right quantities and at the right stage of crops growth for optimum production. Although many farmers 94.9%, attempt to get into this economic activity that seem to have promising returns, most the projects fail (40%). This is associated with lack of water, as much of it is obtained from seasonal rivers which account for 92%. This implies that the resources is available in wet season, with hardly any for projects in dry season. According to agricultural development sector (2010-2020) improved water harvesting through construction of earth dams, and borehole would lead to improvement of irrigation projects. National irrigation and drainage board (2009) stated that there are 9.2 million hectares that have potential for crop production if irrigated. Kenya is classified as chronically water scarce with 552 cubic meter per capita

as compared to conventional 1000 cubic meter, this per capita has continued to deplete if good policies are not put in place (MENR, 2010).

The study reveals that 95% of farmers lack water to sustain their irrigation projects throughout the year. It is therefore important for county and national government to develop policy in view of harvesting water in wet season to be used in irrigation if they are to be run sustainably for economic gain by the local community of Kibwezi Sub County.

5.3.3 Technology

For irrigation projects to be sustained, they need proper water management systems. Targient (2004) states that there is need for natural replenishment of water, otherwise it becomes a non-renewable resource. Proper technology to convey water to fields, with minimal loss will lead to increased sustainability of irrigation projects.

FAO technical paper No, 11 (1996) points out that choice of technology for irrigation should be based on appropriate use of crop patters and cost effectiveness. The level of technology should match the operational sophistication of capacity of users. Based on the research findings, most farmers use canals to convey water to irrigation projects 81%, while only a few 15% use drip pipes. This points out that a lot of water is wasted through evapo-transpiration and seepage. Most of staff charged with running of water systems are not trained as only 15% have formal training. This negatively influences sustainability of the projects. Only a small number of farmers use plastic pipes that have a shortcoming of becoming brittle if exposed to the sun. Drip irrigation is suited to areas with water scarcity. So there is need to trained technical staff to effectively manage the water systems, through installation of modern water saving technology such as drip systems. This will ensure sustainable use of the resources which would in turn lead to sustainability of irrigation projects in the sub County.

5.3.4 Institutional Factors

Increased irrigation performance depends on good management. According to World report on Government and Development in Washington DC (1992) people in a given area should give consult on projects to be done in their locality. Irrigation plans should be made public and there should be clear legal framework to regulate underground water abstraction to prevent of over-pumping of aquifer.

According to NIA (1970) farmers' organization are more important in effective management of irrigation systems. The study has revealed that there are no established structure for water management. This implies that each individual use as much water as they wish with little consideration of their neighbours. Most farmers have no formal training in both water resource management and on how to run projects as an economic intervention. As has been ascertained by majority there is need to train CBO on the stated areas above.

Rukunga (2006) points out that women play a very role in rural development as they make majority of rural population. The study shows that only 32.1% of women are involved in the projects. Due to high potential of women who make up the rural population, their involvement in projects will lead to increased sustainability of these irrigation projects.

5.3.5 Financial Factors

According to Peacock (2005) construction and operation costs of irrigation projects has greatly increased over decades. Majority of farmers especially in small scale holder category lack financial resources to invest in projects. The study has unveiled the same trend as most farmers in the sub County earn less than Kshs. 10,000 which is too low to provide sufficient funds for irrigation projects. Only a small number got assistance (17.9%). There are no water subscription fees. Farmers cannot access financial credits as this needs collaterals which they don't have. Small and Caruther (1991) state that lack of access to credit facilities has slowed down irrigation development in Kenya. Therefore there is need to establish a sound water tariffs managed by CBOs for water use which

would be used to fund for repairs and maintenance of irrigation systems. Some soft credit facilities should be availed to farmers for the said purpose. This would greatly increase sustainability of irrigation projects in the sub County.

5.4 Conclusion

Based on the objectives and findings of the study the following conclusions were made. Based on the first objective, continuous supply of adequate water is paramount to high sustainability of irrigation projects. This can be achieved through construction of dams to collect the commodity during rain period to be used in dry spell. Based on the second objective the technology used for supply of water to the projects should be cost effective. It should be available on demand. There should also qualified technical staff to repair and maintain the water systems. Spare parts should also be availed to facilitate a quick fix incase of any breakage. Tis will greatly influence sustainability of the projects.

The study has also concluded that sustainability of irrigation projects can be achieved through establishment of community structure for water resource management. This is in view of putting in place policy by stake holders such as CBO, NGO and government as regards the above stated purpose. These would regulate and continuous supply of adequate water for projects throughout the year On institutional factors, management of CBO can improved through training, establishment of structures for water resource utilization, women representation in all aspects of irrigation project management can greatly enhance sustainability of the projects.

Subscription for water use by those involved in the projects will ease the financial constant, hence avail funds for expenses of the water system through purchase of relevant spares parts for the system. Once put in place the above state factors will enable high degree of the projects sustainability to enhance the intervention run at increased economic gain to the community.

5.5 Recommendation

The following recommendations are suggested for enhanced improvement of sustainability of irrigation projects:-

1. Capacity building of management committees through training on management, operation and maintenance of projects.
2. Management committee to be assisted by bodies such as National government in setting tariffs for water consumption fees to be used for repairs and maintenance of water systems. This will make CBO's self-reliant.
3. CBO to be assisted in getting outlet of affordable spare parts, this can be done by networking these outlets by relevant leaders.
4. National and county government to put in place policy to ensure sustainable and efficient utilization of water resource.
5. Environmental and climate change to be considered in the design for water supplies to ensure water sustainability in the long run.

5.6 Suggestions for Further Research

1. Analysis water related characteristics such as water salinity which may have effect on crop performance.
2. Impact of gender in management of irrigation projects especially women involvement.

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APPENDICES

Appendix I: Letter of Transmittal

Daniel C.M Masya
P.O Box 138-90136
Nzeeka.

Dear Sir/Madam,

I am a student of university of Nairobi pursuing a Degree of Master of Arts in Project Planning and Management. Am carrying out a research on factors affecting sustainability of irrigation project in Kibwezi Sub-County.

You have been related to provide some important information concerning the study. I therefore request to interview you; by asking a few questions pertaining the study. The information to be provided will be with utmost privacy.

Your cooperation will be highly appreciated.

Yours faithfully,

Daniel C.M Masya.
L50/76988/2014

Appendix II: Farmers' Questionnaire

You have been requested by a student of Nairobi to support him on data collection on factors affecting sustainability of irrigation project in Kibwezi Sub County. The information will be treated with utmost confidentiality.

SECTION A: DEMOGRAPHIC

1. Gender of respondent Male ( ) Female ( )
2. Division _____
3. Location _____
4. Sub Location _____
5. What is your age in years?

a) 26-35

b) 36-44

c) Above 45

6. Number of households members

Male _____ Female _____

7. What is your highest level of education?

a) No of school ( )

b) Primary incomplete ( )

c) Complete primary ( )

d) Secondary incomplete ( )

e) Secondary complete ( )

f) Tertiary institution ( )

g) University level

Other specify

8. What is your occupation?

a) Farming ( )

b) Business ( )

c) Teacher ( )

d) Civil servant ( )

Other specify ( )

9. What is your monthly income?

a) Less than Kshs. 2,000 ( )

b) Between Kshs.2,000-6,000 ( )

c) Between Kshs.6,000-10,000 ( )

d) Above Kshs. 10,000 ( )

SECTION B: STATUS

10. Is there irrigation project in this sub county?

a) Yes ( )

b) no ( )

c) Don't know ( )

11. Is the irrigation project operational?

a) Yes ( )

b) No ( )

c) Don't know ( )

12. If answer is (NO), what do you think caused the project to stall?

a) Lack of water ( )

b) Poor management ( )

c) Lack of funds to buy inputs ( )

d) Political interference ( )

13. Have you ever practiced irrigation activity?

a) Yes ( )

b) No ( )

14. If (YES) where did you get water for irrigation?

a) River ( )

b) Dam ( )

c) Wells ( )

d) Bore holes ( )

SECTION C: WATER AVAILABILITY

15. What is the size of your farm that you practice irrigation?

a) Less than 1 acre ( )

b) 2-5 acres ( )

c) 5-10 acres ( )

d) More than 10 acres ( )

16. Do you have water through out the year?

a) Yes ( )

b) No ( )

17. If answer is no, is there alternative source of water

a) Yes ( )

b) No ( )

18. If answer is yes, state the alternative _____

19. What do you think could be done to solve the problem of water shortage for crops

_____

_____

_____

20. Are there other farmers in your sub location who practice irrigation?

a) Yes ( )

b) No ( )

21. If yes, how many are they in your sub county?

_____

22. How do they solve the problem of water shortage for their crops?

_____

23. Are spare parts for the systems available?

a) Yes ( )

b) No ( )

24. Are there spare parts affordable?

a) Yes ( )

b) No ( )

SECTION D: TECHNICAL FACTORS

25. How is water applied to crops?

a) Canal ( )

b) Drip ( )

c) Underground drainpipes ( )

26. How is the method you use suitable to your farm?

_____

27. Have you ever used piping system to convey water to your farm?

a) Yes ( )

b) No ( )

28. If yes, what are the pipes made of:

a) Plastic ( )

b) Aluminum ( )

c) Galvanized iron ( )

29. Are there technicians to offer support services for their irrigation systems

a) Yes ( )

b) No ( )

30. Are competent technicians to handle breakages of irrigation systems?

If yes briefly explain

_____

_____

_____

If no briefly explain

_____

_____

_____

SECTION E: INSTITUTIONAL FACTORS

31. Is water for irrigation regulated/managed?

a) Yes ( )

b) No ( )

32. Who regulates/manages the water supply to the farm?

a) C BO ( )

b) Private ( )

c) Water management committee ( )

d) Government agency ( )

e) Ngo ( )

f) Other specify ( )

33. What are the roles of this management structure in place?

a) Collect water user fee ( )

b) Repair water supply systems when broken ( )

c) Over see the water system ( )

34. Are these committees trained to handle water management systems?

a) Yes ( )

b) No ( )

35. What should be done for these management committees to handle effectively water management systems?

a) Train them ( )

b) Private water supply ( )

SECTION F: FINANCIAL FACTORS

36. Is there external financial support for the irrigation projects?

a) Yes ( )

b) No ( )

37. If yes, what is the source

a) Government ( )

b) NGO ( )

38. Is this financial support enough to run the project?

a) Yes ( )

b) No ( )

38. If no, what other alternative do you source funds for the project.

a) None ( )

b) Loans ( )

c) Grants ( )

d) Savings ( )

e) Others ( )

39. Is there subscription fee for water used in irrigation projects?

a) Yes ( )

b) No ( )

40. If yes, is it paid on monthly or weekly and how much

a) Kshs.50-100 ( )

b) Kshs.100-150 ( )

c) Kshs. 150-200 ( )

d) Kshs.200-250 ( )

e) Kshs. 250-300 ( )

41. Who collects the money

a) Government agent ( )

b) Committee ( )

c) Individuals ( )

d) Care takers ( )

Appendix III: Interview Guide

1. What are the sustainability rates of irrigation projects in Kibwezi Sub-County?

2. What are management structure commonly used in irrigation projects in Kibwezi

3. Do these manage structure have sufficient capacity to manage the irrigation projects.

4. What are the institutional factors affecting sustainability of irrigation projects in Kibwezi Sub County.

5. Are there technical factors affecting sustainability of irrigation projects in Kibwezi, what are they

6. Are there financial factors that affect sustainability of irrigation projects in Kibwezi, name them?

7. Does the community get some support from Government or any other institution?

8. How are finances meant for these projects managed?

9. In your opinion, what do your think can be done to ensure sustainability of irrigation projects in Kibwezi Sub County.