

# **Factors Influencing Sustainability of Irrigation Projects In Mukunguli Marshland Irrigation Scheme Kamonyi District**

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## **Abstract**

The study sought to establish the factors influencing sustainability of irrigation projects in Mukunguli marshland irrigation scheme in Kamonyi District. Mukunguli marshland irrigation scheme 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. The objective of the study sought to establish how water availability, technical, institutional and financial factors influence sustainability of irrigation projects in Mukunguli marshland irrigation scheme in Kamonyi. 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 they are settled within the administrative units of Mukunguli marshland irrigation scheme in Kamonyi. 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 Mukunguli marshland irrigation scheme in Kamonyi. 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 Kamonyi District.

## **Introduction**

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 represents 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 clear 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 Egypt (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. 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.

In Rwanda, small scale farmers have traditionally benefited from agricultural projects implemented by the government of Rwanda whereby the ministry in charge of agriculture has played a leading role. These projects focus mainly on food crops and livestock. The government has tried a number of extension models and styles, including the progressive (or model) farmer approach, integrated agricultural rural development approach, farm management, training and visit, attachment of officers to organizations, farming systems approaches and farmer field schools. All these approaches have emerged with varying levels of challenges on performance (MINAGRI, 2015); and irrigation projects have not been an exception.

The success rate of the agricultural related projects to their original plans, is somewhere between 30 and 50 percent. Recent data show that despite the high economic growth, poverty rates have not fallen proportionately, declining only by 3.5%, from 60.4% to 56.9% between 2008 and 2012 (MINAGRI, 2015). The continuing high levels of poverty can be attributed to low levels of growth in agricultural productivity due to poor implementation of agricultural project and fail of some agriculture project in Rwanda. Out of the 110 projects initiated in the year 2012 and 2015, among them livestock farming, horticultural farming, bee keeping and home economics, 32 of the projects were terminated due to issues related to project management such as project team, stakeholder's participation, financing, monitoring and evaluation and top management support (MINAGRI, 2015)

Despite the progress that has been made in improving project management tools and techniques, in Rwanda there is a large number of projects which have inappropriate project management strategies such as over budgeted, lack of stakeholder participation in project activities, poor project planning, poor risk management, lower level of leadership skills, inadequate of financial resources, and lack of day tracking of progress of project activities (Ndayisaba and Mulyungi, 2018). Consequently, in Rwanda, more than half of project implemented did not generate the expected outcomes, lack of continuity after the project fund withdraws the fund, community did not have ownership on that project, lack of economic and financial sustainability and also poor maintained of project. As continued to be reported the common factor under failure was that several projects fail mainly due to poor resource planning and management (Ndayisaba and Mulyungi, 2018). Out of the 110 projects initiated in the year 2012 and 2015, among them livestock farming, horticultural farming, bee keeping and home economics, 32 of the projects were terminated due to issues related to project management such as project team, stakeholder's participation, financing, monitoring and evaluation and top management support (MINAGRI, 2015). This is why this study seeks to investigate the factors influencing sustainability of irrigation projects in Mukunguli marshland irrigation scheme in Kamonyi district

The purpose of the study was to determine the factors that influence sustainability of irrigation projects in MUKUNGULI in Kamonyi District. The research was guided by the following objectives:

To establish the extent to which rain influence sustainability of irrigation projects in Mukunguli Marshland.

To establish how technical factors, influence sustainability of irrigation projects in Mukunguli Marshland.

To establish the extent to which institutional factors influence sustainability of irrigation projects in Mukunguli Marshland.

## **Literature**

Theoretical review explores theories that expound on the topic under study and which, thereby help in better understanding of the study in question while at the same time putting forth a justification for the current study.

## **Water Availability**

As at 2007, Rwanda 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). Rwanda's Vision 2050 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.

## **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. The choice of technology, whether for new development or rehabilitation of existing schemes, has been the subject of much debate over the years.

## **Institutional Factors**

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.

## **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 precluded 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 Rwanda.

## **Project Management Theory (PMT)**

Believes that, it is useful to compare the development of a project management theory with another successful theory, that of thermodynamics. There are parallels between the two disciplines and, reasoning by analogy, we will be able to make some comments about the state- of the art of project management.

## **Project sustainability analysis**

The three pillars of sustainability as stated above, imply that to enhance project sustainability a rigorous sustainability analysis is needed at the time of formulation of a project or a programme. It is expected that such an analysis which is to be followed up by development of a sustainability strategy will assist in incorporating the elements of sustainability, right at the design stage of a project (Erytin, 2015). Sustainability analysis is the identification and analysis of degree of presence or absence of the factors that are likely to impact, either positively or negatively on the prospects of sustained delivery of project benefits (Erytin, 2015).

Planning for sustainability presents a tool for checking the aspects of sustainability, at the time of designing of a project. The 'Check List' which include a member of analysis, such as economic and financial analysis; social analysis etc, are important and should be undertaken to ensure incorporation of sustainability enhancement inputs during the preparation and the design stage of a project, where these analyses include the following (Erytin, 2015):

- i. Relevance
  - ii. Acceptability
  - iii. Economic viability
  - iv. Financial viability
  - v. Environmental sustainability
  - vi. Implementation and sustainability strategy
- Post-implementation operation and maintenance

The aspect of relevance refers to review of consistency (or lack of it) between the objectives of the proposed project with national, sectoral, provincial and district priorities. Quite often, it is seen that when a project is taken up without due regard to various priorities set by the government, its ability to attract required support from various parties and its capacity to operate in a conducive environment, gets severely restricted. Therefore, 'Relevancy' test is expected to help analyzing these issues and assess the relationships between the proposed actions and their consistency with different priorities that have been set by the government (Erytin, 2015).

Acceptability issues relate to the level and degree of acceptability of a project to the community, the local representatives, the executing agency etc. Weak acceptability by anyone or more of these parties has the risk of compromising long term sustainability of a project. Economic/Financial viability refers to economic and financial profitability of project induced products and services. For these products to be of benefits, both to the producers as well as the economy the product cost must reflect real market costs and the product prices, the real market prices and that the latter should be consistently higher than the former. In some cases, the project induced products and services may not reflect the market cost and nor the price which may mean that which the project will benefit the direct participants or the target population; then it will incur economic losses at the national level (Erytin, 2015).

It is now widely recognized that under the current situation of globalization and liberalization, any project induced products which cannot be produced and sold under market determined cost and prices and cannot earn profit under these conditions, are neither likely to be sustained nor would these be beneficial to the economy. Environmental sustainability relates to project induced environmental impacts both positive and negative. If negative impacts are foreseen and no mitigation measures are planned, then ultimately the project may yield benefits at a reduced rate or worse still and depending on the extent of environmental costs, such negative impacts may in fact contribute to the net losses to the economy (Erytin, 2015).

According to Erytin (2015), implementation and Sustainability strategy refers to consideration of project management arrangements including a clear implementation period, a well-defined implementation plan with clearly defined functions and responsibilities and necessary provisions having been made. Weak project management and inadequate sustainability provisions contribute to implementation problems which than weakens the project sustainability.

Post implementation operation and maintenance (O&M) refers to management support (either by the executing agency or the community or both) required after implementation of a project. Quite often projects tend to encounter sustainability problems due to weak or inadequate O&M support. The sustainability analysis is to be followed by development of a sustainability strategy, so as to ensure that all sustainability enhancing elements are incorporated right at the design stage of a project (Erytin, 2015).

### **Empirical Review**

In 2013, Chizimba focused on the sustainability of donor funded projects in Malawi. The findings from the study suggested that a project is said to be sustainable if only it has an in build exit strategies and also if sustainability is to be achieved, the intervention should engage the community and build capacities of local government for effective delivery of project benefits. He demonstrated that to achieve this, working in partnership and or collaboration was not an option is must in any intervention. The study also recommended

that, the community needed to be fully informed about the project exit strategies. The study put more emphasis on the community involvement but mainly focused on information giving while for the project to be sustainable the community was supposed to be involved in all phases of project cycle including in designing the exit strategy so as to maintain and strengthen the intervention impact.

Another study on sustainability was done by Deogratias (2013) who studied community participation in and sustainability of national water projects in Chalinze, Tanzania. The study was conducted in Chalinze whereby 130 respondents were selected to obtain both quantitative and qualitative data. Structured questionnaires, focus group discussions, observation, interview of key informants and documentary reviews were used to obtain relevant information. Checklists and observation kits were used for interviews and focus group discussion and observation. The findings show that, the community participation in planning and implementation of Chalinze Water Supply project was poor; as well as monitoring mechanism of operation and management and community participation on decision-making was not satisfactory. This study by Deogratias (2013) does not explain how the poor participation of the community affected the project. This way, it may be difficult to reach conclusive decisions.

Diana (2009) did a study on sustainability of development projects. Diana (2009) studied management and regulation for sustainable water supply schemes in rural communities in Tanzania and revealed that community participation and ownership have a valuable role to play in achieving sustainability but can also create other challenges. How realistic then is participatory decision making where community members have little understanding on various management and technological options and their implications on the long run. However, Diana (2009) did not explore exactly what role community participation and ownership played in the sustainability of these projects.

The Government of Rwanda (GoR) has embarked upon a global poverty reduction program. The Ministry of Agriculture aims, through the Rural Sector Support Project (RSSP), to revive the rural economy and improve the quality of life of the poor living in rural areas. The objective of marshland development is to establish effective mechanisms to facilitate farmers' adoption of efficient and sustainable technologies and practices so as to profitably manage marshlands and encourage and develop private operators' abilities to contribute to the construction and maintenance of hydro-agricultural infrastructures.

The overall objective of the study is to undertake a comprehensive detailed technical study for the execution of Hydro-Agricultural Rehabilitation works for Mukunguli marshlands: Agro-socio-economic surveys, soil and topographic surveys, hydrology study, technical design of the irrigation and drainage networks, river intakes and irrigation structures, access roads and cost estimates of the project as well as formulation of recommendations. The preparation of all documents and reports making up the provisional and the final dossiers

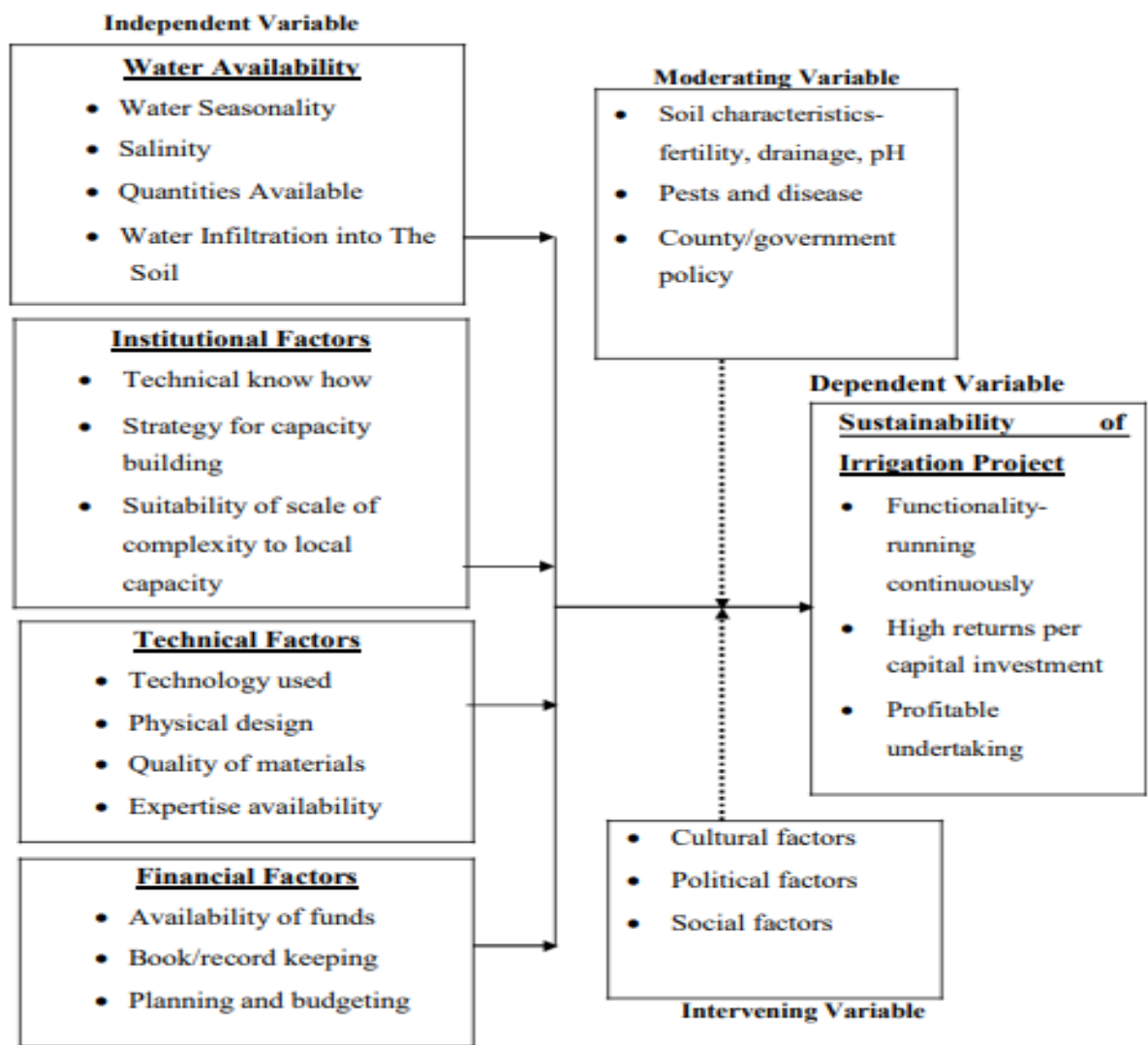
### **Sustainability Theory**

This study is supported by the sustainability theory. The concept sustainability can be traced back to 1970 and later popularized by World Commission on Environment Development (WCED) a branch of United Nations. The argument in the theory is that the resource in the environment that we live is finite. In the WCED report namely our common future, the concept sustainable development and sustainability began to take shape and later became popular with environmental conservation. According to WCED, sustainable development is a development that meets the needs of current generation without compromising the ability of future generation to meet their own needs (WCED, 1987).

In the context of this study therefore, the concept sustainability is about people being able to maintain and sustain the project or programme outcome by their own assets or resources while not compromising the needs of future generation. Sustainable development is a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs and expectations (CEC, 2013). Theory of sustainable development holds that in order for one to know what is a sustainable development, knowledge of what is important for the viability of the systems and how that contributes to sustainable development is necessary. When assessing the community capacity in managing projects understanding sustainability issues is important. The capacity of a community to manage a project in itself is an indicator of sustainability. When considering the protagonist of sustainability theory, any capacity building strategies need to examine the interconnected nature of both the local and larger networks which is also a systematic factor. The theory of sustainable development further indicates that the concern of sustainable development is management of the process of change, not on setting an end goal with fixed outcomes. Sustainable

development theory suggests that human and social capital should be treated much like natural resources. Efficient and effective use of these resources provides long-term, sustainable benefit to local communities (CEC, 2013). Hence, this study borrows ideas from sustainable development theorist emphasis that capacity assessment is crucial foundation for community participation in development projects

### Conceptual Framework Diagram



### Methodology

According to Trochim and William (2006), research design refers to the overall strategy that you choose to integrate the different components of the study in a coherent and logical way, thereby, ensuring you will effectively address the research problem. It is actually a blueprint for the collection, measurement, and analysis of data.

This study adopted a descriptive cross-sectional study design. The study involved collection of data at a single point in time in the target population. Descriptive means that the study will be able to describe a phenomenon as it is without doing any form of manipulation

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 Mukunguli Marshland in Kamonyi District.

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

A big sample size provides more accurate and reliable information (Mugenda and Mugenda 2003). The target population of the study was 103 farmers undertaking irrigation in Mukunguli Marshland.

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 location were serialized, and then a sample farmer were picked from every third count repeatedly until all farmers are 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 it is time consuming, was accurate and more reliable.

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 area. Each questionnaire was divided in three sections. The first section addressed personal information of respondents; the second section addressed the status of the project in Mukunguli and the third addressed factors influencing the sustainability of irrigation projects 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.

Data Processing, Analysis and Presentation: It involves the transformation of the observation gathered from the fields into the system of categories and the transformation of the categories into codes to quantitative analysis and tabulation. The data was analysed with a focus on the association between the independent variable (determinants) and dependent variable. The data was collected from the aid of questionnaires was analysed using descriptive statistics in order to generate mean, frequency tables and percentages. The standard statistical package for social sciences (SPSS 23.0) was applied. The regression analysis was used to test the relationship between the variables.

Descriptive statistics: Descriptive statistics involves the use of means, relative frequencies and standard deviation, tables and other graphical presentations as appropriate. This was used to present the data collected for ease of understanding and analysis. Measurement of variables was used and carried out with the aid of Statistical Package for Social Sciences (SPSS) version 3.72 Empirical Model

$$SIP_i = \beta_0 + \beta_1 WA_i + \beta_2 IF_i + \beta_3 TF_i + \beta_4 FF_i + \beta_5 SC_i + U_i$$

Were

$\beta$  =Beta

SIP=Sustainability of Irrigation project

WA=Water availability

IF= Institutional Factors

TF=Technical factors

FF=Financial factors

SC= Soil characteristics

U=Error term

### Summary of Research Findings

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 Frws 100000 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%.

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 impact negatively to sustainability of these projects.

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%)

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 MC 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.

## **Financial Factors**

Financial factors in any intervention play 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). 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 Frws. 200000, 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.

From the findings its evident that majority of respondents are males 51% which point 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 Mukunguli-Nyanza District have not benefited from immense labor 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 Nyanza.

## **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 resource is available in wet season, with hardly any for



projects in dry season. According to agricultural development sector (2010-2021) 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. Rwanda is classified as chronically water scarce with 552 cubic meters per capita as compared to conventional 1000 cubic meter, this per capita has continued to deplete if good policies are not put in place (MINAGIRI, 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 Mukunguli-Nyanza District.

### **Technology**

For irrigation projects to be sustained, they need proper water management systems. Mugume TD (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 patterns 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 is 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.

### **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 is no established structure for water management. This implies that each individual use as much water as they wish with little consideration of their neighbors. Most farmers have no formal training in both water resource management and on how to run projects as an economic intervention.

Rukunga (2006) points out those 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.

### **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 Frws. 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 these 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 Rwanda. Therefore, there is need to establish a sound water tariff managed by Mukunguli Community 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 Mukunguli Irrigation Scheme.

## 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 in case of any breakage. This will greatly influence sustainability of the projects.

Subscription for water use by those involved in the projects would 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 would enable high degree of the projects sustainability to enhance the intervention run at increased economic gain to the community.

## Recommendations

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

- Capacity building of management committees through training on management, operation and maintenance of projects.
- 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 Mukunguli marshland irrigation scheme self-reliant.
- Mukunguli marshland irrigation scheme to be assisted in getting outlet of affordable spare parts, this can be done by networking these outlets by relevant leaders.
- National and county government to put in place policy to ensure sustainable and efficient utilization of water resource.

Environmental and climate change to be considered in the design for water supplies to ensure water sustainability in the long run.

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