SMALL-SCALE IRRIGATION SCHEMES AND LIVELIHOOD SUSTAINABILITY IN ARID AND SEMI-ARID LAND: A CASE OF MAKAROR LOCATION, WAJIR COUNTY, KENYA

BY

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DECLARATION

Declaration by the Candidate

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DEDICATION

I dedicate this research thesis to my dear sister for being a role model and her guidance in every step in this thesis.

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ABSTRACT

Irrigation has been regarded as a powerful factor for providing food security, protection against adverse weather conditions and increased prospects for employment. It also brings about stable income, greater opportunity for multiple cropping and crop diversification. In semi-arid areas of Kenya, the growth of production and commercialization of horticultural crops is linked to the increase in smallholder irrigation and adoption of new technologies. Despite this initiative, the resultant consequences have been varied, with some attaining their intended goals; while others becoming a cropper. The purpose of this study was to assess how small-scale irrigation scheme influences livelihood sustainability in Makaror location- an ASAL area. The study was steered by the following research objectives: to determine the extent that small-scale irrigation has diversified household crop-based food; to assess the extent to which small-scale irrigation has influenced the sustainability of livestock production; to find out the extent to which small-scale irrigation has enhanced family income; and to examine the influence of irrigation agriculture on livelihood assistance. The study is grounded in the perspective that valuable insights about the roles of irrigation on household livelihoods can be obtained. The study was guided by the sustainable livelihoods theoretical framework, which was developed by the Department for International Development (DFID). The study employed a concurrent mixed research design to assess the role of irrigation in poverty reduction within Makaror location. The study targeted 13400 farmers and 9 food security managers comprising of one government official working in the Ministry of Agriculture, livestock, water, and irrigation; one official from the Northern and Arid and Semi-Arid Development; and six officials each from the six NGOs working on food security in Makaror location. A sample size of 143 respondents was derived from the total target population. Purposive sampling was employed to select all agricultural extension officers. The simple random sampling technique was used to select the farmers. The study used the questionnaire and interview schedules in data collection. The pilot study was done to determine the validity of the research instruments. Data analysis employed the use of both qualitative and quantitative techniques. the study findings indicated that eighty-six percent (86%) of the respondents agreed that irrigation farming had enabled the farmers enjoy different types of food. the ninety-four percent (94 %) of the respondents agreed that cows, camels and goats are able to produce more milk due to enhanced irrigation. eighty-two percent (82%), of the respondents agreed that irrigation enabled small-scale farmers to produce surplus food which they can sell and eighty percent (80%), strongly agreed that the government has been allocating more funds in the budgets to the arid areas to be used for irrigation. The findings of this study will assist the policy makers in identifying some of the weaknesses in the existing irrigation and also lead to the development of new ways of reducing poverty. The study concludes that small-scale irrigation has played a crucial role in diversifying household crop-based food production and that diversification has contributed to improved food security in the region, reducing the dependency on rain-fed agriculture. The study recommends that there should be promotion of the cultivation of a diverse range of crops suitable for the local climate, integrated farming systems that combine crop production with livestock rearing, support value addition and post-harvest processing of agricultural products and provide training and capacity-building programs for the local community to develop skills related to irrigation agriculture, including water management, crop management, and irrigation system maintenance.

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ABBREVIATIONS AND ACRONYMS

AGRITEX: Department of Agricultural, Technical and Extension Services

AIDS: Acquired Immune Deficiency Syndrome

ASAL: Arid and Semi-Arid Areas

DFID: Department for International Development

FAO: Food and Agricultural Organization

FDRE: Federal Democratic Republic of Ethiopia

HIV: Human Immunodeficiency Virus

IFPRI: International Food Policy Research Institute

ILO: International Labour Organization

IRD: Integrated rural development

IWMI: International Water Management institute

MoFED: Ministry of Finance and Economic Development

SLA: The Sustainable Livelihood Approach

UNDP: United Nations Development Programme

OPERATIONAL DEFINITION OF TERMS

Animal husbandry: the management and care of farm animals by humans for profit, in which genetic qualities and behaviour, considered to be advantageous to humans, are further developed

Arid and semi-arid land (ASAL): these are lands in Kenya characterized by low and erratic rainfall. In this study, these regions include parts of northern and eastern Kenya.

Food security: condition related to the ongoing availability of food.

Irrigation: the artificial application of water to land to assist in the production of crops.

Livelihood Diversification: attempts by individuals and households to find new ways to raise incomes

Livelihood sustainability; refers to the ability of the local population to maintain and improve their well-being and economic security over the long term while coping with the challenges posed by the unique environmental and climatic conditions in the study area

Pastoralism: the subsistence practice in which people care for and domesticate animals, usually ungulates such as camels, llamas, cattle, reindeer, sheep, and goats.

Poverty reduction: refers to a process involving some strategies aimed at reducing the levels of poverty in a given society. This is done by increasing the availability of basic human needs or increasing disposable income required to provide for these needs. Basic human needs in this case include health care, clean water, food and education.

Poverty: state of being poor: the state of not having enough money to take care of basic needs such as food, clothing, and housing

Small-scale irrigation schemes; refer to agricultural practices and projects aimed at providing water for irrigation in arid and semi-arid lands (ASALs) of Kenya. In this study, it a means of addressing low and unreliable rainfall in ASAL areas.

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter contains the background of the study, statement of the problem, objectives of the study, research questions, and significance of the study, limitations of the study, assumptions of the study, justification of the study, conceptual framework, theoretical framework and operational definitions.

1.2 Background of the Study

Irrigation has been regarded as a powerful factor for providing food security, protection against adverse weather conditions, and increased prospects for employment. It is also thought to lead to stable income, greater opportunity for multiple cropping and crop diversification. According to Mohammedshum et al (2023), irrigation is vital for realizing the full potential of the agricultural sector and is an essential means of achieving food security in many arid and semi-arid countries, including kenya. To increase production, small-scale irrigation schemes have been introduced in several places, such as dams, check dams, diversions, springs, and wells. However, these schemes are managed poorly, and the results are unsatisfactory. Hence the contribution of these schemes does not meet the expected level.

Furthermore, access to reliable irrigation can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming. This, in turn, opens up new employment opportunities, both on-farm and off-farm, and can improve income, livelihoods, and the quality of life in rural areas (Ruttan, 2006). Generally, access to good irrigation allows poor people to increase their production and income, and enhances opportunities to diversify their income base, reducing vulnerability caused by the seasonality of

agricultural production as well as external shocks. Thus, access to good irrigation has the potential to contribute to poverty reduction and the movement of people from ill-being to well-being (World Bank, 2008).

According to Kalia et al (2021), Small-scale irrigation schemes contribute to the sustainability of livelihoods by providing opportunities for year-round agricultural activities. This diversification of income sources and greater economic security helps to reduce vulnerability among ASAL communities. Kalia et al (2021), found that small-scale irrigation schemes have emerged as a fundamental tool for enhancing livelihood sustainability and food security in arid and semi-arid lands. These schemes not only provide a solution to the challenges associated with rain-fed agriculture but also offer a pathway to more resilient and sustainable livelihoods in the face of climate change and variability.

The global water crisis has drawn worldwide attention to the urgency of achieving a more efficient use of water resources particularly in agriculture, to increase crop production and achieve world food security. Considering that a major share of the world's water resources is limited, irrigated agriculture and the role of efficient irrigation systems and techniques have recently assumed greater importance in increasing food production. India has been depending on irrigation for agriculture purpose (Dick & Rosegrant, 2001). Irrigation increases the intensity of cultivation, crop and land productivity, land-use intensity and gross crop output per unit of land, and facilitates land augmentation which in turn increases the demand for agricultural laborers. The demand for agricultural labourers helps to increase the money wage rates and number of days of employment for agricultural labourers and then increases the total earnings of agricultural laborers. In one hand, increased income increases the purchasing power of agricultural labourer On the other hand, intensive cultivation

increases the production of agricultural commodities, in turns; the price of essential commodities would go down. Eventually, irrigation not only helps to increase the real wage rates of agricultural labourer but also gives profits to the producers or farmers (Narayanamoorthy, 2001).

In sub-Saharan Africa, two thirds of the working population still makes their living from agriculture, especially commercial agriculture. According to the World Bank (2012), more than 70% of the poor people live in rural areas relying mostly on agricultural activities and sometimes mining and finishing for survival. About half of the family heads in the informal sectors are employed as peasant farmers. Population is ever increasing thus land set aside for irrigation farming has been excessively subdivided rendering most units sub-economic in Gezira irrigation scheme.

According to Alkire et al (2014), there is an increase and diversification of food production for family consumption or as a source of income is a basic prerequisite for improved household food security. Many Southern African governments began to embark on large- and small-scale irrigation schemes mainly in areas with little annual rainfall total in order to supplement water shortages. In Zimbabwe the agro-ecological zone 4 and 5 are dominated by irrigation schemes. Ruttan (2006) argued that large scale irrigation schemes comparatively are more profitable and have socioeconomic advantages than small ones. However, Chenje et al (2008) suggest that in terms of empowering the local communal people, small-scale schemes are suitable as they occupy small land readily available in the rural areas. In Zimbabwe, irrigation schemes were established as a precaution against the inherent variability of rainfall as well as to ensure that cultivation is done all year round to boost and increase food production in the country so as to alleviate poverty. More so the government's attention to the development of small-scale irrigation schemes was in a bid to meet its objectives

towards decentralizing irrigation schemes mainly in rural areas for empowerment (ILO, 2007).

The Influence of Irrigation on Livelihoods According to Chazovachii (2012), small holder irrigated horticulture had proven to be a viable and attractive option for poor farmers in developing countries. Returns from intensive irrigated horticulture even on tiny plots could greatly exceed returns from rain fed cereal production. In many developing countries, small scale irrigation schemes were counted on to increase production, reduce unpredictable rainfall and provide food security and employment to poor farmers. The study found that some of the small scale irrigation projects have been discovered primarily for income generating such as the peri-urban areas in Kumasi and Vegetable growing in Arusha Ghand. More so irrigation farming is the source of income for the disadvantaged rural people that are mostly women, widows, orphans and people living with HIV and AIDS. In Zimbabwe according to Chazovachii (2012), irrigation farming enables the growing of green vegetables, wheat, tomatoes, cotton, maize and even sugarcane among others.

Chazovachii (2012), irrigation farming contributes significantly at the household in terms of income in rural areas. Having most of the rural household unemployed, most families' income levels are relatively low and possibly not enough to acquire basic 220 commodities and services. Data from previous case studies also revealed that irrigation farming has long term economic contribution on rural livelihoods. Food production from irrigated farms is a major source of wealth creation to the extent that it is the basis for economic growth in a number of localities. The income generated provide funds for purchaser of irrigation development to make up an important and growing proportion of the products used before by processing firms.

According to Synnevag et al (2015), livelihoods comprise of assets, activities and access to these that together determine the living gained by households or individuals. Rural people move regularly between rural areas and towns or cities to seek work, market their produce and buy manufactured goods. Rural families through livelihood diversification construct a diverse portfolio of activities and social support capabilities in their struggle for survival and in order to improve their standard of living of which small scale irrigation schemes is one of the options. The sustainable livelihoods framework is designed to help understand and analyse poor people's livelihoods. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future while not condemning the natural resource base.

Regionally, Ethiopia is characterized by famine as a result of high population pressure, resource base depletion and drought that affects the rain-fed agriculture. It has been documented that low farm production and productivity resulting from use of backward technology and other productivity-enhancing modern inputs are the major reasons for rampant poverty and food insecurity in rural areas. Poverty reduction is the first millennium development goal. Poor countries like Ethiopia were expected to halve the number of people living below one dollar by the end of 2015 (MoFED, 2010). Since 1992, the Government of Ethiopia has been carrying out measures to reduce poverty in the context of a series of reform programs in the political, economic and social spheres. Thus, following government efforts, poverty has declined from approximately forty six percent (45.5%) in 1995/1996 to about thirty percent (29.6%) in 2010/2011 (MoFED, 2012). Consensus has been reached by the government and donors that any solution to further reduces rural poverty must focus on increasing the production and productivity of smallholder agriculture (FDRE, 2010). Creating access to fertilizer, improved seeds,

agricultural credit and thereby bringing significant growth in crop production is the major concern of national strategy. While technology is important, the issue of drought and rain fall variability is of paramount important. In order to address these challenges as a vital resource in agriculture, irrigation water contributes a lot in productive and livelihood activities of farmers (FDRE, 2010).

Essentially, small-scale irrigation is a crucial innovative practice in smallholder agriculture in Africa. Notably, the adoption of climate-smart agriculture practice such as small-scale irrigation farming has substantial influence since it improves farm productivity, farming systems adaptation to climate variability and change and achievement of household food security and national developmental goals, there is a lot of heterogeneity in what small-scale. According to Jayne (2004), irrigation farming in Africa is characterized by the use of simple technologies to access water for irrigation. The author further defined water access technology as any method of moving water from its source to where it was previously unavailable. This includes all types of pumps from human powered, rope and treadle pumps to liquid fuel engine-driven systems and solar powered pumps as well as gravity/river diversion methods.

In South Africa, for instance, a wide variety of such technologies has been introduced since the 1990s for small-scale irrigation development. South Africa, which is classified as a water-scarce nation, depends on agriculture for food production. Thus, the irrigation sector comprises the largest consumer of water in the country, where it accounts for approximately 62% of water utilization, but also losing 30–40%. Due to the threat of climate change and drought, efficient irrigation systems are a necessity, especially in smallholder farming where most losses occur. In essence, smallholder irrigation schemes (SIS) were developed to improve rural livelihoods through sustainable food production for food security and poverty alleviation, but these

development objectives remain largely unfulfilled. Incidentally, a review of government policy shows that although the interests and needs of smallholder farmers are high on the national agenda, there is inadequate financial support to the sector. This situation suggests that smallholder agriculture is not ideally seen as a potential driver of the economy. The South African government largely focuses on repairing irrigation infrastructure but neglects the soft components relating to capacity building. This has partly been blamed for the failure of SIS in the country. Capacity building is, therefore, among the missing links in smallholder irrigation development where substantial failures have been attributed to the lack of well-trained farmers and extension staff, especially in the field irrigation water management. Particularly, land tenure insecurity has been identified as the major institutional challenge that contributes to the dismal performance of irrigation schemes. Thus, the diversity of schemes implies that various interventions are required to address the varying farmers' needs, resources and agricultural contexts. It is, therefore, imperative for the South African government to review its priorities in revitalization of SIS. Land tenure policies that allow for an increased access to arable land should be developed urgently, alongside the promotion of alternative cropping designs that are suitable for the smallholder farming sector.

In rural Kenya, according to Ulrich et al (2012), small-scale farming in semi-arid areas livelihoods are mainly based on crop cultivation and livestock keeping. The smallholders are most affected by and at the same time shape their own region's development. Long-term solutions for such crisis is through the assistance in sustainable livelihoods and people's resilience. The longitudinal analysis and focus on livelihood dynamics is one way to comprehend longer-term change. Looking at the same households over time allows a better understanding of the conditions that keep

people in poverty and on what enables them to improve their situation and inform policies.

According to Ulrich et al (2012), for sustainable livelihoods to be achieved the future of irrigation farming in alleviating rural poverty lies not only in people but calls for intervention of interested stakeholders in rural development. Irrigation farming is possibly one of the key drivers to enhancing rural livelihoods if necessary support is given to it. The smallholders are most affected by and at the same time shape their own region's development.

According to Farah et al (2003), to feed its population and to provide capital and impetus for other forms of development, Kenya heavily depends on agriculture. Part of this agriculture is practiced in the arid and semiarid lands (ASAL), which form 80% of the country's land area and in which 25% of its population lives. Since the 1970s the development of ASAL has received increasing attention in recognition of the important contribution these areas can make to national development (GOK, 1994). Despite the efforts made to develop these areas, numerous constraints still exist.

In the semi-arid areas of Kenya, irrigation is largely recognized by public and private actors as a key means to improve food security and livelihoods and foster agricultural transformation. Accordingly, small-scale irrigation technologies are part of several recent visions and strategies, including Kenya's Vision 2030, the Big 4 Agenda, and the Agricultural Sector Transformation and Growth Strategy. Irrigation is also seen as a technology for reducing vulnerability to climate change. Hence, efforts to develop irrigation in Kenya are likely to receive support from a broad range of stakeholders. Notably, the growth of production and commercialization of horticultural crops are linked to the increase in smallholder irrigation and adoption of new technologies. This

provides new opportunities for improving food security and livelihoods for large numbers of poor people who might not benefit from investments in high rainfall and more favorable agro-ecological environments. Irrigation can reduce crop production risk, providing greater incentives to increase input use, increase crop yields, intensify crop production, and encourage diversification into higher valued crops. The resulting increase in marketable surplus and commercial activities has the potential to generate increased income for farmers (Kimenye, 2000).

1.3 Statement of the Problem

Ideally, small-scale irrigation is supposed to change the lives of people in arid and semi-arid areas. The food insecurity should not be there as the people are able to comfortably get fresh food from their farms. The lives of people in ASAL should not be characterized by poverty as they are able to get income right there from their farms by selling the produce. In addition to that, migration to urban areas should reduce as the youth are able to get employment in the farms directly or in industries manufacturing the agricultural produce. With enhanced small-scale irrigation systems, nomadism should be a forgotten story in the area as the inhabitants will not be worrying on how to get water and pastures for their livestock. The livestock breeds should also undergo improvement. In essence the lives of these communities should be transformed wholly and hence facilitate the realization of vision 2030. It is against this background that the researcher sought to examine how small-scale irrigation influences livelihood sustainability in ASAL.

1.4 Objectives of the Study

The main objectives of the study were to determine if small-scale irrigation schemes have enhanced livelihood sustainability in Arid and semi-arid land.

The specific objectives were:

i. To examine the extent to which small-scale irrigation has diversified household crop-based food.

ii. To assess the extent to which small-scale irrigation influences the sustainability of livestock production.

iii. To find out the extent to which small-scale irrigation has enhanced family income.

iv. To examine the influence of irrigation agriculture on livelihood assistance

1.5 Research Questions

This study sought to answer the following questions:

i. To what extent has small-scale irrigation diversified household crop based?

ii. To what extent has small-scale irrigation influenced sustainability of livestock production?

iii. To what extent has scale irrigation enhanced family income?

iv. What is the influence of irrigation agriculture on livelihood assistance?

1.6 Scope of the Study

The study was carried out in Makaror location, Wajir County, North eastern part of Kenya. Makaror location is characterized by perennial drought just as other areas of Wajir County. The study was done from May to August 2017. The study will focused on the impact of small-scale irrigation schemes in arid and semi-arid lands on the diversification of household crop-based food, sustainability of livestock production, enhancement of family income, and the influence of irrigation agriculture on livelihood assistance.

1.7 Limitation of the Study

The study anticipated the following limitations:

In some instances, the farmers had no time to fill the questionnaires as they were working in the farms. The researcher had to become patient and wait for an ample time to give out the questionnaires. This affected the response rate.

The respondents could not understand some items in the questionnaires; hence all the questionnaires could not be responded to. The researcher ensured that the respondents were briefed on the items in the questionnaire and clarification made to them on areas where they could not understand.

Respondents initially could not tell the truth for fearing that the findings would victimize them for giving out sensitive information. The researcher therefore explained to them that the research was confidential and only intended for academic purposes.

The collection of data took considerable amount of time since the area of research is/was wide. Besides, the farmers, that were respondents in this study still practiced pastoralism; the researcher had to be patient to get all the data needed.

1.8 Justification of the Study

This study is justified by the critical need to assess the impact of small-scale irrigation schemes on livelihood sustainability in arid and semi-arid lands, with specific objectives that address key dimensions of food security, economic well-being, and climate resilience. The findings are expected to provide valuable insights for both academia and policy-makers, ultimately benefiting the communities living in these regions and contributing to sustainable development efforts. Identification of roles of small-scale irrigation in livelihood sustainability was likely to point out to the Ministry

of Agriculture ways of effectively effecting necessary adjustments in policy for proper utilization of irrigation so as to change the lives of the people in arid areas.

1.9 Significance of the Study

This study is expected to provide an in-depth analysis of the role of small-scale irrigation in livelihood sustainability in arid and semi-arid areas. The stake holders such as Ministry of Agriculture officers at all levels, farmers and county government) will get ~~go~~t information on the role of irrigation on sustainability of livelihoods in Wajir County.

This study could have formed a basis for future references by other scholars and researchers in the same or related field. This is because findings from this study has added empirical information on the role of irrigation in enhancement of sustainability of livelihoods into such studies and therefore, future scholars would be able to quote or criticize the finding from the study. The finding from this study could motivate other scholars and researchers to carry out research in other areas in order to establish ways of reducing poverty.

1.10 Conclusion

This chapter dealt with the background of the study, statement of the problem, objectives of the study, research questions, and significance of the study, limitations of the study, assumptions of the study, justification of the study, conceptual framework, theoretical framework and operational definitions. Chapter two herein below will deal with literature review.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter contains the review of literature and the research gap. The chapter will start with clarifying the concept “irrigation” then go on to present literature as per the objectives of this study. Thus the following themes will be reviewed: Small-scale Irrigation has Diversified Household Crop Based Food; Small-scale Irrigation and Sustainability of Livestock Production; Small-scale Irrigation and Family Income; and Irrigation Agriculture and Livelihood Assistance. The section will end with positioning the study on a knowledge gap and conceptual framework.

2.2 The Concept of Irrigation

Irrigation refers to the process of bringing water to a vast area of land where there is limited or no water supply. Usually these vast areas of land are planted with a variety of crops and plants that need a constant supply of water for growth and survival. Like in areas where rainfall is limited and not constant, an artificial way of directing water into parts of the plant or crop field is made to ensure that these crops and plants grow and survive (Shama & Shamma, 2004).

But aside from growing crops, the process of irrigation may also be done to maintain grasslands and landscapes. In areas with very dry lands, a constant source of water supply must be in place. Irrigation systems could also be setup for re-vegetation of some areas and restore grass and other plants. Artificial water systems could also serve as protection for plants from frost during the winter season (Hope, Dixon & Von Maltiz, 2003).

The concept of irrigation was said to have originated in the desert areas of the Arabian Peninsula, particularly in countries like Egypt. Since rain is very rare in these areas, people had to resort to finding other means of literally watering their crops for agriculture. It all started with people carrying buckets of water taken from the nearest river and put the water into the crop field or some storage canal. Then this technique evolved into something more efficient with the use of a lever and a wooden pole. This early machine made it easier to lift and lower the buckets for watering the crop lands. Over time, new techniques and processes were discovered like the digging of canals that flow from the water source and directed into different parts of the crop land (World Bank, 2008). Experience in sub-Saharan Africa has shown that successful smallholders generally use simple technologies and have secure water supplies over which they have full control.

The government of Rwanda through the Ministry of Agriculture and Animal Resources in Rwanda (MINAGRI) and in conjunction with the World Bank's Development Impact Evaluation (DIME), and the University of California – Berkeley have carried out a project on the impacts and sustainability of irrigation which was conducted between 2014 and 2019 the impacts of irrigation on smallholder welfare, through the lens of the Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) project, a flagship of MINAGRI. LWH introduces sustainable land husbandry measures for hillside agriculture on selected sites and develops hillside irrigation for subsections of each site.

Lately, there has been rising interest in new innovations for carrying and applying water. Fundamentally, recent technologies that have proved to be successful are those that enhance existing farming systems as opposed to those that introduce entirely new ideas (Batchelor, Lovell, & Murata, 1993). However, these new technologies are more

expensive than traditional methods and substantially depend on external specialist support from manufacturers and distributors. Notably, distribution technologies such as sprinkle, trickle irrigation and piped connections for the more conventional surface methods, can enable farmers manage their water effectively as well as reduce wastage. These technologies have the capacity to increase productivity of water and labor. Nonetheless, they are only accessible to a smaller section of farmers who can afford to purchase them, especially those that grow cash crops such as fruits, vegetables, and flowers (Batchelor, Lovell, & Murata, 1993). Thus, these technologies are unlikely to be adopted by poor farmers.

It is, however, worth noting that there are certain low-cost modern technologies, which have been developed or modified to reduce their cost. The treadle pump is an excellent example, which was exclusively developed as a cheap pump for small-scale irrigation and continues to be modified for particular local needs and markets in Sub-Saharan Africa (Batchelor, Lovell, & Murata, 1993). The adoption of treadle pumps by smallholders to replace the daunting task of lifting and carrying water offers lessons for the introduction of other affordable irrigation technologies. Essentially, low-cost, modern technologies can assist smallholders to move from subsistence agricultural practices into growing cash crops. Success significantly depends on the capacity of small-scale farmers to take risks and embrace new technologies in circumstances where costs are high, services are inconsistent, and markets are unpredictable. All in all, the factors that influence technology uptake include well-designed technologies that are affordable and appropriate for local farming, the existence of a market-oriented demand for agricultural produce; a local private initiative that is capable of mass manufacture of reliable irrigation equipment; effective distribution networks for agricultural equipment and inputs including infrastructure, transport, and retailers.

2.3 Small-scale Irrigation and Diversification of Household Crop Based Food

Livelihood diversification refers to attempts by individuals and households to find new ways to raise incomes and reduce environmental risk, which differ sharply by the degree of freedom of choice (to diversify or not), and the reversibility of the outcome. Livelihood diversification includes both on- and off-farm activities which are undertaken to generate income additional to that from the main household agricultural activities, via the production of other agricultural and non-agricultural goods and services, the sale of waged labour, or self-employment in small firms, and other strategies undertaken to spread risk (Evans, 2009).

Livelihood diversification may take place when rural producers change the composition of agricultural products they produce. This is a natural starting point for poor rural producers with low levels of capital, who may be able to restructure their production mix more easily than to invest in other non-agricultural areas. One example of this is that of crop-livestock integration. Not only can this integration help farmers to maintain fertility through the incorporation of animal litter into soil, but the animals themselves may provide other products as well, in addition to acting as a liquid asset. All of this helps to build up or maintain agricultural production and reduce risk. This is particularly true for Africa, where the process of agricultural restructuring as part of a longer-term adaptive process has been examined in Kenya. Comparative studies have also been undertaken to examine this process of change and the causative factors underlying it. For example, Boulier and Jouve (1988) examined the evolution of farming systems as they intensified and diversified in six regions across Senegal, Mauretania, Burkino Faso and Niger, pointing out the importance of, and interaction between, population increases, developments in markets and market infrastructures, and climatic variability. Intercropping and other so-called `sustainable agricultural practices' have also been

examined in terms of the ways that they help farmers to spread risk, maintain and augment soil productivity and incomes through increasing biological diversity (Chitsiko, 2009).

A large and disparate literature, arising from a variety of disciplines, has confirmed that rural people in Africa and Asia do not normally specialize in livestock, crop or fish production to the total exclusion of other income generating activities. Rather, a majority of rural producers have historically diversified their productive activities to encompass a range of other productive areas. Motivations for such diversification are multifarious, linked with wide range of possible activities, and associated with both positive and negative outcomes. This recognition has led many researchers to represent rural livelihoods as constructed from a portfolio of resources, or activities. The literature generally concurs that while such diversification of livelihoods is common, in takes on a different nature in different contexts. It is: sometimes a means to enable accumulation for consumption and investment; sometimes employed to help spread risk, or to cope with temporary crises; sometimes an adaptive response to longer-term declines in income or entitlements, due to serious economic or environmental changes beyond local control; inevitably pursued via a range of activities that are by nature specific to the local context (in relation to resources available, culture, natural resources, climate etc.); often differentiated (types and degrees of diversification differ according to location, gender, age, class, and culture) (Adams and Mortimore, 2007).

Although livelihood diversification is an important strategy by which rural people may work to achieve sustainable livelihoods, it is one that generally operates in conjunction with other strategies which also contribute to the formation of sustainable livelihoods (Chitsiko, 2009).

In the North Eastern province of Kenya, the prevailing climatic condition does not facilitate growing of food crops. The small-scale irrigation has been beneficial to the residents. In the former years, few individuals could plant some drought resistant crops which could not even germinate at times. The irrigation has enabled them to plant crops which initially they could not even imagine they could do well in their area (Manzungu & van der Zaag, 2006).

Essentially, Manzungu and van der Zaag (2006) postulate that one of the strategies to reduce the incidence of food insecurity in smallholder communal areas which was also advocated for by the aid organizations, policymakers, academics and lay people is a production technology appropriate for low rainfall environments. The technology is in the form of smallholder irrigation schemes

Development of smallholder irrigation schemes increases the potential for more production by counteracting mid-season dry spells and some periodic dry spells. This means that the household can grow crops more than once a year in low risk associated areas than under the rain fed production. Increased production ensures high food availability at the household level due to intensification of crop production. Intensified crop production ensures increased incomes; hence, households can purchase food, ensuring household access to food.

A cost benefit analysis performed by Sithole (2005) indicated that irrigation increased household food security in the marginal to poor rainfall areas. The study also revealed that irrigation did not only improve the food security position of the level of the irrigators, but also the rest of the community benefited from these schemes. Sithole (2005) also revealed that the incomes of the irrigators were higher than the incomes of the non-irrigators. As a result of the higher incomes, the irrigation participants were in

a position to purchase grain to satisfy household requirements to make up for any shortfall in production, as compared to non-participants. Moreover, Sithole (2005) compared the incomes and yields of the irrigators and that of the non-irrigators. The results of the study indicated that the smallholder schemes were both financially and economically viable and the participants were able to meet both the capital and running costs of smallholder irrigation schemes.

There is indisputable evidence that irrigating land leads to increased productivity. Irrigation is a necessary input into the high yield varieties developed during the Green Revolution. One acre of irrigated cropland is worth multiple acres of rain-fed cropland. Globally, 40% of food is produced on irrigated land, which makes up only 17% of the land being cultivated. Terry and Ryder (2007) estimate the value of production of irrigated cropland at $625/ha/year ($95/ha/year for rain-fed cropland and $17.50/ha/year for rangelands. According to the duo, irrigated agriculture is an essential component of any strategy to increase global food supply. The benefits of irrigation have resulted in lower food prices, higher employment and a more rapid agricultural and economic development. The spread of irrigation has been a key factor behind the rear tripling of global grain production since the 1950s. Chenje et al (2008) asserts that agriculture is the backbone of Zimbabwe's economy and as such irrigation is a very important agriculture practice to the country given that the country suffered periodic droughts in 1972, 1982/3; 1991/2 and 2002/4.

Irrigation in Zimbabwe offers greater yields than dryland since more than one crop can be grown annually. According to Mushandike Irrigation scheme Annual report (1993/4) in Zimbabwe which was carried out by the department of AGRITEX for outstanding farmers, maize production on 0,5 hectares was 45 x 50kg bags, cotton production on 0,5 hectares was 27x16kg bags, wheat production on 0,5 hectares was 66x91kg bags

while sugar beans production was 10x91kg beans. This bumper harvest could not have been realized without the provision of irrigation.

According to Mutsvangwa et al (2006), vegetables and other crops affect customer's diet, health not only rural households, but also to those who buy them through local markets. Makumbe (2006) argues that more nutritious food is not only difficult, but too expensive for them. Food security is therefore likely to increase in households practicing irrigation farming. Fresh foods and other food crops as noted by Jackson et al (2007) have a special role in supplementing the diet of small children at weaning age and lowering the lack of protective foods. Rural people are therefore likely to fend for themselves when it comes to food requirements and thus maintain a decent healthy condition.

Sithole & Testerink (2003) conducted a study in Swaziland on the cropping and food insecurity aimed at evaluating how cash cropping contributed in alleviating food insecurity in Swaziland. The results indicated that it is only with irrigation that crop production can be carried out throughout the year in Swaziland. Sithole and Testerink (2003) concluded that increased crop production can be expected to encourage the establishment of more agro-industries to process the output, thereby increasing employment opportunities and purchasing power of individuals, implying capacity to purchase grain to meet the household requirements, thus increased food security

There is evidence in many regions that employment opportunities have increased after the development of irrigation systems. This can occur either because labor is needed for new land brought into production, or for land that is being double cropped and therefore requires additional labor in planting and harvesting. One example of this occurred in Borletar, Nepal. The construction of a large public works project during the

1980s has doubled total labor demand in the region, improving productivity and welfare. Production potential has increased by 300% and income by 600%, leading to increased food security for the native population (FAO, 1999).

Land values in a region are a function of the productive potential of the land. The development of irrigation systems allows farmers to grow higher yields of existing crops, or more profitable cash crops. Because of this, the benefits to landholders of irrigation development can be large. A 1997 study in Kenya and Zimbabwe showed that the average net increase in income from irrigation was $150 - $1000 per family farm (FAO, 1999). One question of importance in developing countries is that of land security. Areas where land rights are ill-defined will have lower benefits accruing to the local population than those areas with well-defined rights.

According to Terry and Ryder (2007), small holder irrigated horticulture had proven to be a viable and attractive option for poor farmers in developing countries. He further asserted that returns from intensive irrigated horticulture, even on tiny plots could greatly exceed returns from rain fed cereal production. In many developing countries, small-scale irrigation schemes were counted on to increase production, reduce unpredictable rainfall and provide food security and employment to poor farmers. The same sentiments were echoed by Mujere, Chazovachii, Chifodya, and Mushuku, (2010) when they asserted that some of the small-scale irrigation projects have been discovered primarily for income generating such as the peri-urban areas in Kumasi and Vegetable growing in Arusha Ghand more so irrigation farming is the source of income for the disadvantaged rural people that are mostly women, widows, orphans and people living with HIV and AIDS. According to Jackson et al (2007), a survey of horticultural production in Zimbabwe showed that irrigation farming enables the growing of green vegetables, wheat, tomatoes, cotton, maize and even sugarcane.

Makate et al. 2016 defined crop diversification as the introduction or development of additional crops to the existing farming system. The concept of crop diversification is the addition of more crops to the existing cropping system.

In northern part of Kenya, livestock keeping particularly camels whose water consumption is little is the main economic activity. With the introduction of small-scale irrigation, people are slowly beginning to venture into other activities such as crop farming. They are growing vegetables and other food crops

The research findings show that irrigation indeed led to the diversification of crops. It however fails to address the reason why w is still insufficient in terms of food production. In my analysis it seems the findings are exaggerated. Studies should be done however to uncover the underlying issues. The farmers owing to their insufficient knowledge could be planting crops which are not suitable to the type of soil found in the area. It is a paradox situation since people residing in such areas do not have something to show.

2.4 Small-scale Irrigation and Sustainability of Livestock Production

According to Vision 2030, Kenya's economic blueprint for the next 17 years, the country's chronically food insecure arid and semi-arid regions need special attention to help them develop. Vision 2030 calls for the provision of water, infrastructure, pasture, fodder and veterinary services; establishing strategically located disease-free zones to increase livestock productivity and quality; unifying the efforts of different ministries and other stakeholders to coordinate development of the region; and putting more land under cultivation (Kimenye, 2000).

Livestock is an important livelihood option for smallholder farmers in Ethiopia. With increasing, trends in demand for livestock products, both globally and locally, the

importance of livestock for income generation will increase. Currently exploitation of these opportunities is highly constrained by shortage of feed resources. Continuity of feed supply in Ethiopia is constrained by the seasonality of rainfall, a constraint that could potentially be overcome through small-scale irrigation (Weber & Jensen, 2004).

ILRI experts conducted a review of feed-related constraints to livestock production and potential for integration of fodder into small holder irrigation both from global and local perspectives. An expert consultation was also conducted to gain a better understanding of the key issues. As practical experiences of fodder irrigation in Ethiopia are very limited, information gathered from the literature and expert consultations were triangulated through a simple online consultation. The online consultation involved about 30 targeted respondents who have a background in irrigation, livestock and feed resources at local and international level. The survey posed a few focused questions probing their experiences on irrigated fodder in Ethiopia, factors that contributed to success/failure of integrating fodder to small-scale irrigation, technologies that were most commonly applied and how successful they were in contributing to farm livelihoods (Evans, 2009).

Deserts in Rajasthan and Gujarat account for over 80% of the arid zone in India. These regions are characterized by poor natural resource base, perpetual drought, very high temperature and very low precipitation, scarcity of water, low content of organic matter and presence of soluble salt in the soil. Rearing of cattle, goats, sheep and camels is most common but less productive. Permanent pastures are highly degraded and neglected. Many of these pastures do not have any basal plant cover. Increased pressure has led to disappearance of many plant species and there is a decline in biomass yield. Such a situation forces people to migrate to other areas for survival. Mostly men migrate

while women left in villages face a difficult life owing to scarcity of water, fuel and fodder (FAO 2003).

As a strategy, it was decided to utilize the existing natural resources judiciously by conserving every drop of scarce water, strengthen the livestock-based farming system, and improve the degraded community pastures through promotion of silvipasture, increasing land productivity and income through various inventions like agro-horticulture, agro-forestry and diversified improved agriculture. The interventions were also aimed at creating more productive assets both at family and at the community level (World Bank, 2008).

Livestock production systems should undergo more radical changes than crop production if expectations from this sector are to be fulfilled. Under the impact of the raising demand, output would need to increase considerably faster for animal production (4.7%) than crop production (3.6%) (Manzungu, 2004). The increasing trend observed in livestock output are mainly achieved through the increasing number of livestock but not productivity per head. The increase in number of livestock coupled with increase in human population has resulted in shrinkage of grazing lands and animals are limited to graze on overgrazed communal lands (if any), road side and aftermath grazing and limited supplementation of straw. Besides, soil erosion and deforestation has worsened the situation. One of the contributing factors to poor soil fertility, land degradation and erosion is the free grazing of animals (FDRE, 2010).

In western and eastern Hararghe, the study identified the main reasons for the success of zero grazing in the area, such as the culture and better awareness of zero grazing; a favorable cropping system; a sorghum/maize based farming system during main rainy season, targeting animal feed; the existence of inter cropping practices (perennial-

annual, annual-annual); availability of perennial cash crops in crop lands, and the existence of intensive crop production; reliable and remunerative market and market outlet for fattened animals; small livestock number and fattening orientation; habit of using oxen for short time and then fattening for sale; minimum crop cultivation practices; availability of replacement oxen from market and the availability of good local breed for fattening. The use of small-scale irrigation has enabled many farmers in the area to realize their potential (Ruttan, 2006).

Desert families rear 2-10 goats with a mix of breeds like Marwari and Sirohi in India. The productivity of these breeds is low with 200-500ml milk production per day. To improve the quality of the existing breeds, cross breeding with 'Sindhi' breed of goat was promoted. Sindhi breed has several advantages. This breed depends on open grazing and is known for twin production. The yield of milk and meat is also high. One Sindhi breed buck per 10 households was provided for cross breeding. This has resulted in substantial improvement in quality of goats in a cluster. One-year-old goats, with body weight of 60-80 kg, fetched around Rs 2000. Each family has sold at least 3 kids a year and earned a good income (Dick & Rosegrant, 2001). On the other hand, the livestock management in Ethiopia is mainly based on extensive grazing of communal grazing lands and arable lands. Animals grazing communal lands are believed to perform poorly (low milk yield, short lactation length, late age at first calving and long calving interval, poor growth rate, low fertility) which is a reflection of nutrition, health and breeding related problems (MoFED, 2012).

The small-scale irrigation has changed the lives of pastoral communities and other small-scale farmers in most African countries. However, studies need to be done on why despite such efforts, the animal breeds have not changed as expected. It can be concluded that production has improved but it is not commendable. It is thus critical to

find out whether the small-scale irrigation is indeed achieving its desired outcome. Even in the midst of the irrigation practice, in Ethiopia and Kenya, it is still a common occurrence to find the livestock dying as a result of drought. Overall, it be deduced that the small-scale irrigation has led to the sustainability of the livestock.

2.5 Small-scale Irrigation and Family Income

Farmers in poor areas have suffered from chronic poverty and severe food insecurity being vulnerable to climatic changes and depend on variable rainfall. This is mainly attributed to a low level of agricultural productivity. Such low producing areas are characterized by persistent rural poverty, and increasing population pressure has often resulted in a vicious circle of poverty and environmental degradation. As many of the low productivity areas have untapped water resources, irrigation development is being suggested as a key strategy to enhance agricultural productivity and to stimulate economic development (Von Braun et al., 2008).

Chamber (2004) based on some empirical studies confirms that reliable and adequate irrigation increases employment, i.e., Landless laborers as well as small and marginal farmers have more work on more days of the year, which ultimately contributes to food security. A study conducted in 10 Indian villages in different agro-climatic regions show that increasing irrigation by 40 percent was equally effective in reducing poverty (reducing food insecurity) as providing a pair of bullocks, increasing educational level and increasing wage rates. Kumar (2003) also stated that irrigation has significantly contributed to boosting India's food production and creating grain surpluses used as drought buffer. A study by Hussain *et al*. (2004) confirms that access to reliable irrigation water can enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from

farming. This in turn opens up new employment opportunities; both on farm and off-farm, and can improve incomes, livelihood, and the quality of life in rural areas.

A study by IFAD (2005) states that in Ethiopia, the construction of small-scale irrigation schemes has resulted in increased production, income and diet diversification in the Oromia and Southern Nation and Nationalities People (SNNP) regions. According to this study, the cash generated from selling vegetables and other produce is commonly used to buy food to cover the household food demand during the food deficit months. The same study further added that during an interview conducted with some farmers, it was disclosed that the hungry months reduced from 6 to 2 months (July and August) because of the use of small-scale irrigation. Moreover, the increase in diversity of crops across the schemes and the shift from cereal livestock system to cereal-vegetable-livestock system is starting to improve the diversity of household nutrition through making vegetables part of the daily diet. A study conducted by Peacock (2005) also identified that in Tigray region irrigated agriculture has benefited some households by providing an opportunity to increase agricultural production through double cropping and by taking advantage of modern technologies and high yielding crops that called for intensive farming (Mudima, 2008).

According to a study carried out on five irrigation schemes in Zimbabwe, the schemes were found to act as sources of food security for the participants and the surrounding community through increased productivity, stable production and incomes. The same study reported that farmers participating in irrigation schemes never run out of food unlike their counterparts that depend on rain-fed agriculture. A cost benefit analysis performed by Sithole (2005) indicated that irrigation increased household food security in the marginal to poor rainfall areas. The study also revealed that irrigation did not only improve the food security position of the level of the irrigators, but also the rest of

the community benefited from these schemes. Sithole (2005) also revealed that the incomes of the irrigators were higher than the incomes of the non-irrigators. As a result of the higher incomes, the irrigation participants were in a position to purchase grain to satisfy household requirements to make up for any shortfall in production, as compared to non-participants. Furthermore, Sithole (2005) compared the incomes and yields of the irrigators and that of the non-irrigators. The results of the study indicated that the smallholder schemes were both financially and economically viable and the participants were able to meet both the capital and running costs of smallholder irrigation schemes.

Additionally, Sithole and Testerink (2003) conducted a study in Swaziland on the cropping and food insecurity aimed at evaluating how cash cropping contributed in alleviating food insecurity in Swaziland. The results indicated that it is only with irrigation that crop production can be carried out throughout the year in Swaziland. Sithole and Testerink (2003) concluded that increased crop production can be expected to encourage the establishment of more agro-industries to process the output, thereby increasing employment opportunities and purchasing power of individuals, implying capacity to purchase grain to meet the household requirements, thus increased food security.

According to Wein et al. (2007) a comparison of income earned from small-scale irrigation and that earned from dryland farming or from non-skilled work in Zimbabwe industries revealed that small-scale irrigation farmers earned more. In comparative analysis between irrigators at Nyanyadzi irrigation scheme in Zimbabwe and their dry land counterparts, irrigators' investment was estimated to be between $150 and $200 while dry land farmers' investment was estimated to be lower than $100. This indicated that irrigators were in a better position to invest in capital items than non-irrigators because of higher incomes. Irrigation developments have made it possible for other

rural infrastructure to be developed in areas which could otherwise have remained without roads, telephones, schools and clinics. According to Webb (2011) in the study of irrigation schemes in Chakuda Village in Gambia, small irrigation schemes have resulted in increased income that was translated into increased expenditure, investment, construction and trade. At the village level, increased material wealth manifested in the form of construction of a large mosque built through farmers' donations and an improvement of the village clinic. At household level increased wealth could be seen in fifty-five houses built in the village and fourteen with corrugated metal roofing. Irrigation agriculture is an essential component of any strategy to increase global food supply. The benefits of irrigation have resulted in lower food prices, higher employment and a more rapid growth.

In an economic analysis study carried out by Webb (2011) on smallholder irrigation scheme in Gambia, it was revealed that the increased income from irrigation resulted with increased expenditure, construction, investment and trade. A cost benefit analysis carried out by Paraiwa (2005) showed that irrigation schemes can play an important role in developing a cash economy for rural communities by making it possible for viable cash income to become accessible to a fairly large number of individuals.

Irrigation farming contributes significantly at the household in terms of income in rural areas. Having most of the rural household unemployed, most families' income levels are relatively low and possibly not enough to acquire basic commodities and services. People in Mutambara confessed that their project enables members to earn an income which enables them to meet some of their basic needs, (Makumbe, 2006). Cash earned from the sale of food is used to cover household needs like cooking oil, paraffin and others. It also enables members to meet educational needs of their children, such as exercise books and tuition fees. Data from previous case studies also revealed that

irrigation farming has a long-term economic contribution on rural livelihoods. According to Manzungu, (2004), food production from irrigated farms is a major source of wealth creation to the extent that it is the basis for economic growth in a number of localities. The income generated provide funds for purchaser of irrigation development to make up an important and growing proportion of the products used before by processing firms. In 2000, Mutare Hotel was buying 15kg pockets of caucus per week from Mutema irrigation farm in Manicaland (Moll, 2004). It is, however, worth noting that co-operation rarely exists in rural areas and where they exist they may not be productive enough to attract large firms. This should not however, force one to conclude that irrigation farming does not have any positive bearing on rural livelihood no matter how small they might be (Mudima, 2008).

In conclusion, various scholars have pointed out that the lives of people in ASAL areas have improved when compared to the pre irrigation period. This is not true because many people residing in such areas are living in debilitating conditions. For instance, it is in such areas that malnourished children are found. Since the condition is not any better, much need to be done in order to be concluded that indeed the small-scale irrigation has improved the livelihoods of the people

2.6 Irrigation Agriculture and Livelihood Assistance

An increasing number of private sector groups, including water user associations and other NGOs, are taking over some public sector irrigation responsibilities. The inclusion of water users in irrigation planning, management and ownership is proving to be an effective method for increasing irrigation system efficiency in many cases. Studies throughout the world demonstrate that user participation in irrigation services improves access to information, reduces monitoring costs, establishes a sense of ownership among farmers and increases transparency as well as accountability in

decision-making (Mudima, 2008). NGOs undertake a wide range of water-related functions, from developing projects for rural water supplies and minor irrigation to fostering water user associations for water management purposes. Some NGOs encourage farmers to try new technologies, for example the catchment protection and sprinkler irrigation techniques introduced by the Aga Khan Rural Support Programme in Gujarat, India.

The World Bank has been supporting the government of Malawi in it is effort to promote sustainable growth in agricultural productivity. The Irrigation, Rural Livelihoods and Agricultural Development Project (IRLADP) supported irrigation farming through the integrated provision of hardware, mainly irrigation infrastructure, and software, mainly local and institutional capacity building.

The Rwanda Development Organisation (R.D.O) was established in 1995 as a non-profit making organisation. It has a vision of sustainable development for the Rwandan community who have to enjoy a good standard of living with the ability to satisfy their basic as well as secondary needs, they have strived to empowered communities with the necessary expertise and skills needed. This was possible with the collaboration of government ministries, UN agency and other stakeholders (R.O.D bulletin of July-December 2019).

Many NGOs stem from local initiatives and operate as independently funded and self-managed groups. These organizations bring fresh views, new ideas and participatory working methods to other areas of development policy and practice. Much of their success is attributed to their local knowledge as well as their interest in and experience of regional conditions. They have been particularly active in promoting the interests of poor and disadvantaged groups through articulate and forceful advocacy and service

provision. In addition, the local base of NGOs may allow them to reach vulnerable or remote groups which are exceptionally difficult to reach with conventional public schemes (Moll, 2004).

Water is not an easy sector in which to promote cooperation, but the potential gains are high, which makes renewed efforts worthwhile. Resolution of many water allocation and development problems requires a common willingness to forego personal benefit for the social good. Government efforts to promote personal sacrifice through economic policies, laws and regulations that require self-restraint, such as water rationing or optimum groundwater pumping regimes, have seldom proved effective. On the other hand, with their close local contacts and skills in group mobilization and cohesion, NGOs can provide the institutional leadership required to bring about socially optimum solutions (Morrill & Wohlenberg, 2007).

Supporting the rapidly increasing population and ensuring the economic growth in the dwindling landholdings of high- to medium-potential lands will require the use of technologies, which will ensure the intensification of production in such potential lands and the opening of new lands in the ASAL areas. This is possible only with the use of irrigation technologies. Food security is the major output of irrigation development activities. However, this cannot be achieved without sustainable water resources management. The new thinking currently gaining ground is the integration of irrigation water management within the broader context of integrated water resources management. This is understandable because irrigation is a major user of water. In Kenya, irrigation uses over 69 percent of the limited developed water resources (Torori et al., 1995) and despite this massive water consumption, the performance of irrigation projects has not been impressive. Food shortages are a recurrent problem, which cannot be solved through rain-fed agricultural production alone, without irrigation

development. In Kenya, food insecurity continues to loom, not to mention the existing water crisis. As demand for food increases, more and more water will continue to be used in an attempt to alleviate persistent food shortages. Available water resources are diminishing, leading to conflicts over water uses and among water users. The increasing demand for water for the domestic and industrial sectors is expected to continue (Mwendera, Manyatsi, Magwezi & Dlamini, 2002).

The situation is even gloomier in the ASALs, where water scarcity is the main constraint to agricultural development. The problems posed by inadequate water supply are aggravated by population growth, environmental degradation, and competition over the use of limited natural resources and increasing water demand. There is a need to develop immediate, practical and sustainable solutions to address the twin problems of inadequate water and food insecurity (Ngigi, 1999). The government has realized this need and a number of government and donor interventions have been undertaken, especially in the vast drylands, though with limited success.

The government does not have a very positive role to play in building and managing irrigation schemes, whether they be large or small. The Kenya experience demonstrates that farmers do much better when they build, own and operate the schemes themselves. Public, large and small schemes perform much more poorly than private schemes in which farmers feel they have more at risk. (Farmers begin with very high expectations in government-built schemes and are quickly disillusioned when things do not work and assistance is not forthcoming. The government does have a critical role to play in creating an enabling environment for technology development and uptake for small-scale irrigation (Moll, 2004).

The government should develop policies and regulations that influence irrigation equipment manufacture, importation, promotion and servicing. Lower priced imports and joint manufacturing arrangements should be encouraged· It should develop policies and mechanisms to facilitate access to credit by small farmers. Extension service training and provision of other technical support services, such as training on small-dam construction, scheme design and the production of manuals for the design and management of micro-dams and water diversion structures should be availed to farmers (Chitsiko, 2009).

Despite the fact that arid areas have continually get assistance from both the governments and the non-governmental organizations, the impact has not been felt. The government's efforts have not borne fruits because of lack of planning and coordination. In several instances the budgetary allocation to them is normally minimal hence. The donor funds on the non-governmental organizations are not utilized well.

2.7 Theoretical Framework

The study was guided by the sustainable livelihoods theoretical framework as illustrated in figure 2.1. Essentially the sustainable livelihoods framework conceptualizes livelihoods in a holistic way. This approach captures the numerous complexities of livelihoods, and the opportunities and constraints that they are subjected to. Notably, these opportunities and constraints are shaped by several factors, ranging from national or global level trends and structures over which people have no control, and may not even be privy to, to more local institutions and norms and the assets to which individuals or households have direct access.

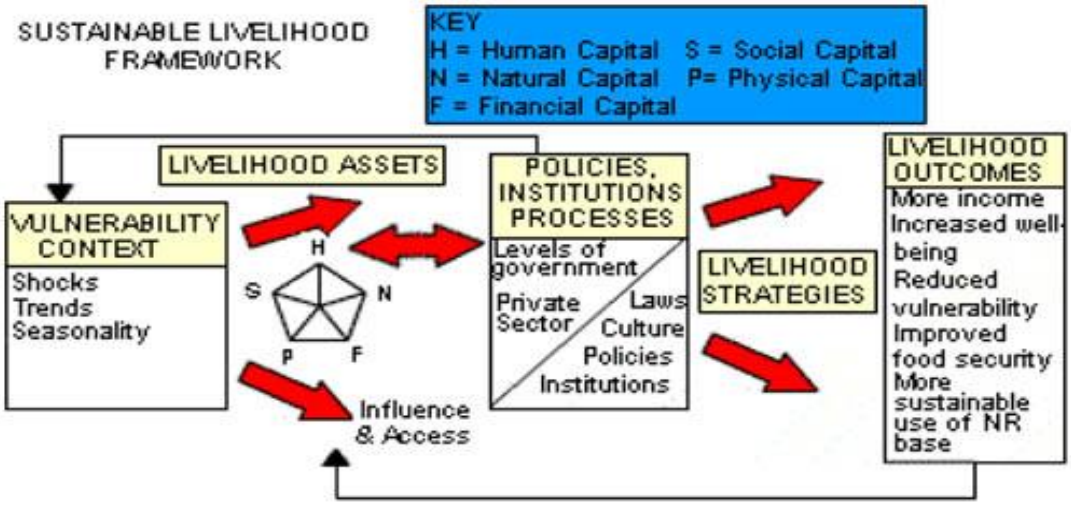


Figure 2.1: The sustainable livelihoods theoretical framework

The Sustainable Livelihood Approach (SLA) is a development-oriented intervention that has been in existence since the late 1990s (Morse et al., 2009). Fundamentally, it was devised as a central concept of the United Kingdom's Department for International Development's (DFID) strategy in the early days of the New Labour government. Notably, the need to focus on sustainable livelihoods was initially launched in the 1997 White Paper on global development, which read in part: "…refocus our international development efforts on the elimination of poverty and encouragement of economic growth which benefits the poor (Morse et al., 2009). We will do this through support for international sustainable development targets and policies that create sustainable livelihoods for poor people, promote human development and conserve the environment" (DFID, 1997, as cited in Morse et al., 2009). Thus, it is imperative to ascertain what the DFID intended to achieve with these sustainable livelihoods.

One definition is provided by Chambers and Conway (1992, as cited in Morse et al., 2009) some years before the White Paper states that "a livelihood comprises the, assets, capabilities (assets, resources, stores, and claims) and activities needed for a means of living. In essence, a livelihood is sustainable if it can withstand and recover from shocks

and stress, preserve or enhance its assets and capabilities, and provide opportunities for sustainable livelihood for the next generation; it is also supposed to contribute to the net effect of benefits to other livelihoods at both the local and global settings and in the short and long-term" (Chambers & Conway, 1992, as cited in Morse et al., 2009). In this interpretation, several strands coalesce. On one hand, there is a requirement for livelihood to be able to recover from "stress and shocks" but also to be able to "maintain and enhance" capabilities and assets into the future. A key element in this resilience to stress and shocks is the diversification of the elements that comprise a livelihood.

Before the publication of the White Paper, Carney (1998) provided a simpler vision, which had resonance with the Chambers and Conway perspective. According to Carney, a livelihood comprises the assets and capabilities (including both social and material resources) and activities required for a means of living. When merged with sustainability, a livelihood is sustainable when it can cope with, and recover from shocks and stresses, and still maintain or enhance its assets and capabilities both now and in the future, while not undermining the natural resource base.

Fundamentally, the SLA is an example of the multiple capital approach which considers sustainability in terms of available capital (human, social, natural, physical, and financial) and an examination of the vulnerability context (trends, stresses and shocks) in which these assets exist. The Sustainable Livelihood Approach (SLA) is highly relevant and suitable for a study on whether small-scale irrigation schemes have enhanced livelihood sustainability in arid and semi-arid lands. SLA is a framework for understanding and analyzing livelihoods in a holistic and comprehensive manner. SLA considers various dimensions of livelihoods, including economic, social, human, natural, and physical capital. In arid and semi-arid regions, livelihoods are complex and multifaceted, often involving diverse income sources and strategies. Small-scale

irrigation can impact all these dimensions. SLA also emphasizes the vulnerability context in which people live and the strategies they employ to enhance their resilience. In arid and semi-arid areas, vulnerability to environmental shocks, such as droughts, is common. Small-scale irrigation can serve as a resilience-building strategy by reducing this vulnerability.

SLA encourages understanding the various livelihood strategies people employ and how these strategies may evolve over time. Small-scale irrigation can be a key livelihood strategy in these regions, promoting diversification beyond traditional subsistence agriculture. Therefore it supports an outcome-oriented analysis to assess the sustainability and effectiveness of these irrigation initiatives in improving the well-being of local communities.

Notably, there are five principal assets (or capitals) suggested as crucial to livelihood and they are presented as a pentagon in Figure 2.2.

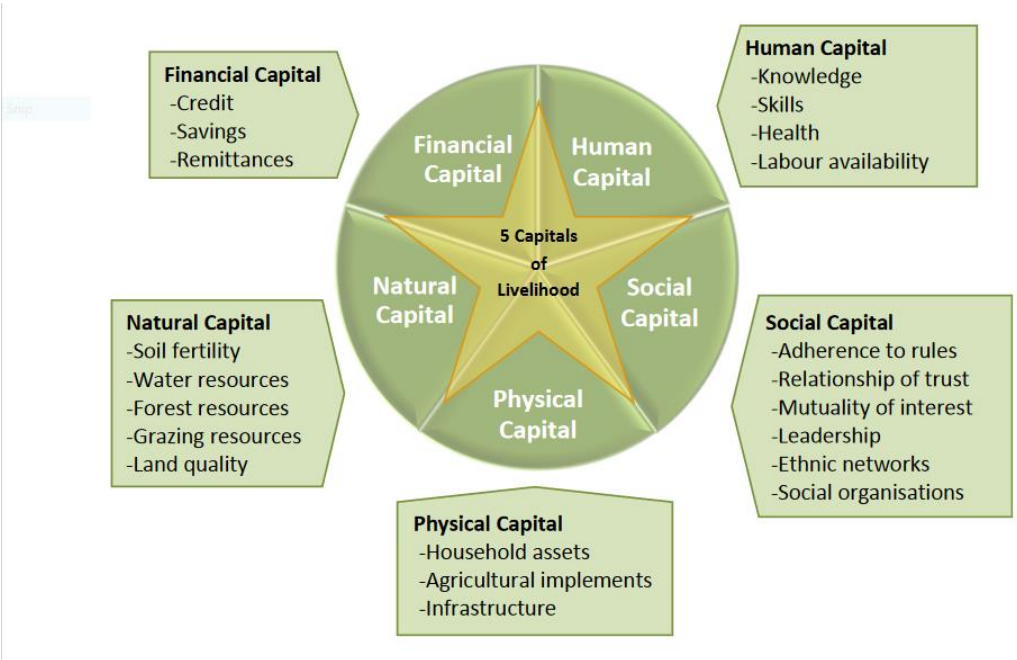


Figure 2.2. Five capitals of the sustainable livelihood framework (Source: econstor.eu)

The five livelihood capitals, namely human, social, physical, natural, and financial capital form the basis for the investigative tool of the sustainable livelihood framework. **Human capital** in arid and semi-arid lands of Kenya represents the knowledge, skills, health, and education of individuals. It plays a crucial role in livelihoods and is justified as a primary focus over other capitals. It is differentiated from other frameworks by its particular relevance to the unique challenges and opportunities found in these regions. A study by the United Nations Development Programme (UNDP) in 2020 emphasized the importance of human capital in ASALs for adaptive knowledge and skills, including knowledge of drought-resistant crop varieties and livestock management practices. This knowledge is critical for coping with climate variability.

In ASALs, health challenges are prevalent due to limited access to healthcare services and safe drinking water. A report by the Kenya National Bureau of Statistics (KNBS) in 2019 highlighted the significance of health and nutrition in enhancing the resilience of ASAL communities. The educational level of individuals can greatly influence livelihood options. A paper by Njuguna and Gathenya in 2021 discussed how education is a key determinant of livelihood diversification, as individuals with higher education levels are more likely to explore non-agricultural livelihood opportunities.

Human capital is of significant importance in ASALs due to its role in adaptive knowledge, health, education, and livelihood diversification. It is differentiated from other frameworks by its focus on adaptive skills, health and nutrition challenges specific to ASALs, the role of education, and the importance of indigenous knowledge in enhancing resilience. Essentially, human capital defines the skills, knowledge, labour ability, and good health, which enable people to pursue diverse livelihood strategies and realize their livelihood objectives (Sayer & Campbell, 2003). Human capital is a

keystone within the SLA since the other capitals partially depend on the human capital as a basic requirement.

Social capital, just like human capital, is difficult to grasp with distinctive indicators. Notably, social capital represents the social resources, including informal networks, relationships of trust, and membership of formalized groups that facilitate co-operation. (Sayer & Campbell, 2003). The nature of social capital is usually shaped by the social class of the stakeholder, which is often influenced by age, gender or caste. When certain stakeholders are enlisted into a network or group, others may be excluded, which can result in an interference of development. The high local value of the social capital clearly derives of its capacity of compensating calamities or shortage of other capitals. However, the potential of communal solidarity signifies the high local value of this capital, clearly indicating a strong correlation between social capital and poverty. Apparently, studies indicate that the involvement into village organizations leads to an enhancement of income.

Social capital is a justified choice over other capitals due to its critical role in building resilience, resource sharing, and problem-solving in these challenging environments. A study by Njuki et al. (2011), published in the journal "Agriculture and Human Values," highlighted the role of social capital in enhancing community resilience in ASALs. Strong social networks enable communities to pool resources and respond collectively to challenges such as drought and food insecurity.

Social capital also plays a crucial role in facilitating resource sharing, especially during times of need. A report by the International Livestock Research Institute (ILRI) (2016), discussed how social networks are instrumental in sharing livestock and other resources among pastoralist communities. Social capital is of paramount importance in ASALs

due to its role in building community resilience, resolving conflicts, and facilitating resource sharing. It is differentiated from other frameworks by its community-centered approach, the focus on conflict resolution and cooperation, the emphasis on collective responses to shocks, and the influence of indigenous practices and social norms.

Physical capital is a measure for the existence of physical requirements needed to support livelihood in a sense of infrastructure. The role of this asset can be seen in the context of opportunity costs, where an existing accessible infrastructure releases either labour or provides time as a resource, for example education (Sayer & Campbell, 2003). Natural capital applies, especially for resource dependent communities, whereupon the stock of all livelihood activities are built on. This capital applies to rural communities, with a high proportion for poor stakeholders, an essential value which in fact is prone to calamities. Usually, these calamities are caused by natural processes e.g. floods, fires, seasonal storms, earthquakes.

Physical capital is justified over others due to its essential role in enhancing resource management, water access, and protection against harsh climatic conditions. The Kenya National Drought Management Authority (2017), emphasized in a report the significance of physical capital in terms of water infrastructure in ASALs. This includes the construction of dams, boreholes, and water storage tanks to improve access to clean water, which is often a challenge in these regions.

Research by the International Institute for Environment and Development (2020), highlighted the importance of climate-resilient housing and shelter in ASALs. Physical capital in the form of well-designed housing can provide protection against extreme weather conditions, enhancing the safety and well-being of communities.

A study by Kimani and Gatuguta (2019), published in the "Pastoralism: Research, Policy and Practice" journal, discussed the role of physical capital in the form of livestock management tools, such as animal enclosures and feed storage facilities. These tools are vital for pastoralist communities in ASALs. Physical capital in ASAL-specific frameworks often emphasizes the need for infrastructure that can withstand extreme climatic conditions, such as prolonged droughts or heavy rainfall. This is a distinctive feature of ASALs due to their unique environmental challenges. Physical capital in ASALs is also focused on improving access to water, given the prevalent water scarcity in these regions. Water infrastructure is a critical component that differentiates ASAL frameworks from others.

Financial capital may often be accumulated from two different sources; one source can be represented by available stock in the form of cash or equivalent available assets as livestock, the other source is characterized by the external inflow of money which originates of labour income, pensions, remittances or other types of financial liabilities (Sayer & Campbell, 2003). Within the five capitals, the financial capital enables people to adapt to different livelihood strategies. It sets the precondition for the creation or improvement of other capitals than financial capital. Fundamentally, all these capitals will vary in terms of their resilience to different types of shock and the intensity of that shock.

Financial capital is justified over others due to its crucial role in diversifying livelihoods, investing in resilience-building activities, and providing a safety net in the face of shocks. A study by Odhiambo et al. (2017), emphasized that financial capital enables individuals in ASALs to diversify their livelihoods by investing in small businesses and non-agricultural activities, reducing their vulnerability to climate-related shocks.

The importance of access to credit in ASALs was highlighted in a report by the United Nations Development Programme (UNDP) (2018), financial capital, including credit facilities, allows communities to invest in income-generating activities and recover from shocks.

A research paper by Guliye et al. (2019), discussed how savings and investments from financial capital are instrumental in building resilience. Communities can invest in assets, such as water storage infrastructure or livestock, to cope with climate variability. ASAL frameworks often highlight the importance of access to credit as a key component of financial capital, given its role in enabling investments and recovery from shocks. In other contexts, the focus on credit may vary. Financial capital is differentiated from other frameworks by its focus on vulnerability to climate shocks, the significance of credit, investments in resilience, and the promotion of livelihood diversification specific to ASALs. Literature and references from Kenya provide valuable insights into the significance of financial capital in ASALs and its distinction from other livelihood framework

Natural capital refers to the stock of renewable and non-renewable natural resources and ecosystems that provide a wide range of goods and services that support human well-being. This includes resources such as forests, water, soil, minerals, and biodiversity. ASAL communities heavily rely on natural capital for their livelihoods. This includes grazing lands for livestock, water sources for both humans and animals, and arable land for agricultural activities. Natural capital in ASAL-specific frameworks acknowledges the scarcity and fragility of natural resources in these regions, making their sustainable management a priority.

In essence, it is also imperative to examine the policy and institutional context within which these capitals exist. While some capitals may be vulnerable to certain shocks, it may be that authorities are able to act and limit any resultant damage, or perhaps provide recompense (Morse et al., 2009). Whereas assets may be damaged through flooding, publically owned structures may be installed to reduce the possibility of the disaster occurring. Likewise, there may be publically sponsored extension services available to supplement the knowledge base of farmers or dispense advice and help with irrigation systems. Notably, government services are not the only factor that needs to be considered in this regard since there may be non-governmental or other private agencies at hand to provide support for livelihoods. It is only when all of these is considered that it becomes possible to formulate strategies that can help enhance livelihoods (i.e. generate positive livelihood outcomes). Essentially, the assumption is that all planned outcomes would provide feedback to bolster livelihood assets and make them more resilient. Therefore, SLA can be considered in several different ways as observed by Farrington (2001, as cited in Morse et al., 2009).

Firstly, there is a set of principles guiding various development interventions (be they community-led or otherwise). The bottom-line is the fact that an intervention must be evidence-based as opposed to being instigated in top-down manner without adequate knowledge of the community. Secondly, there is an analytical framework that helps understand what is operational and what is feasible. Thus, the logic in this case is to appreciate the available capitals, their vulnerability, and the contribution of institutions. This logic provides an operational framework that can serve as the foundation for an analysis. Thirdly, an overall developmental objective should be in existence. In this case, development is construed to be the improvement of livelihood sustainability by

making capital less vulnerable, or by enhancing the contributions that some capitals can make, or even by improving the institutional context.

It is these three aforementioned sets of principles, an analytical and an objective framework, which explain the popularity of SLA. However, like all other initiatives in post- World War II development era, SLA did not originate from a vacuum but from the evolution of several older trends and ideas. There are sentiments, in this regard, of an influence from the United Nations Development Programme's (UNDP) Human Development approach, which heavily borrowed from the work of economist Amartya Sen and his writing on capability. The underlying notion is that human development is a process of enhancing people's choices. Fundamentally, these choices could be infinite and transform over time. Nonetheless, all levels of development emphasize the three core aspirations: people to lead long and healthy lives, people to acquire knowledge, people to have access to the requisite resources that guarantee a decent standard of living. The unavailability of these essential choices basically makes other opportunities to remain inaccessible.

The UNDP Human Development Report of 1990 emphasized that enlarging choices can be realized by widening the capital base, by education for instance. There are also concessions in the idea of sustainable development despite with an unambiguous focus on people, wherein the development process is required to meet the needs of the present generation without compromising the interests of future generations. Nonetheless, the concept of sustainable development covers a broader area than just the protection of natural resources and the physical environment. In essence, it also includes the protection of human lives in the future. In any case it is people, not plants or trees, whose future interests need to be protected.

The livelihoods approach prioritizes people by putting them at the centre of development. In principle, people, rather than resources or the governments that serve them, are the primary concern. Adhering to this notion implies that support should be accorded to resource management or good governance. However, the underlying motivation of enhancing people's livelihoods should determine the nature of the support and provide the rationale for evaluating its success.

Notably, the HDR phrase "it is people, not trees, whose future options need to be protected" can be misleading in the thought that the environment is of secondary importance. Essentially, the SLA does not aim at facilitating human development at the expense of the environment. Much as it starts with people, it does not compromise on the environment. Indeed, one potential strengths of the livelihoods approach is that it mainstreams the environment within a holistic framework (Carney, 1998, as cited in Morse et al., 2009). Short-term survival and not the sustainable management of natural capital (water, soil, or genetic diversity) is the primary concern of people living in abject poverty.

Since the DFID believes in sustainability, it must consequently liaise with people in rural areas to help them understand the positive or negative contribution that their livelihoods are making to the environment, thus promoting sustainability as a long-term objective. Therefore, indicators of sustainability will be required. It is in some occasions mentioned that human development as proposed by UNDP has more in common with the earlier basic needs approaches to poverty measurement and alleviation than to Sen‟s vision of capabilities (Ravallion, 1997, as cited in Morse et al., 2009). Basic needs are a relative term that covers approaches based on the belief that humans need a basic set of resources (water, food, shelter etc.) to survive. How these needs can vary depend upon the party defining basic needs.

Nonetheless, the SLA was conceived before the UNDP's human development concept and includes influences from what was known as new household economics in the 1980s and its focus on household income generation, expenditure and labour, despite recognized limitations to perceiving households in such mechanical terms. The major shortcoming of economic and structural-functional approaches to the household is the assumption of the role of ideology. The socially specific factors that approximate households are ideally typified not just as clusters of task-oriented activities, which are organized in variable ways, and not just as places to live, eat, work and reproduce, but as social markers and sources of identity. Essentially, they are premised on structures of cultural relevance and differential power (Guyer & Peters, 1987, as cited in Morse et al., 2009).

There are also similarities from the relatively macro-scale field of integrated rural development (IRD), which was largely in vogue between the 1960s and 1970s, amongst notable funders, such as the World Bank (Morse et al., 2009). The International Fund for Agricultural Development (IFAD) has funded 22 projects that involved irrigation activities between 2000 and 2015 with a value of USD $1.3 billion many impact assessments have recently been conducted on small-scale irrigation projects from various organizations in a number of countries. IFAD has assessed the IRPEP and PASIDP projects in the Philippines and Ethiopia respectively, and funded an external impact assessment of IFAD's AD2M project in Madagascar. Reviewed together, these recent studies provide three key lessons for future projects. Literature on IRD is colossal and does not require an in-depth review in this case. However, it is worth noting that the manifestation of IRD often assumed the form of enormous projects implemented over 5 years or more, and covering regions of the larger nation with staff derived from government agencies, a form of decentralization. Thus, agricultural development also

needs effective infrastructure such as adequate health care and roads. Healthcare significantly depends on good quality and quantity of water supply, which the IRD project also addresses. The prime assumption is that a segment cannot be considered in isolation, but should be a part of an integrated whole. If the word segment is replaced by capital or asset, then IRD would appear to share substantial similarities with SLA.

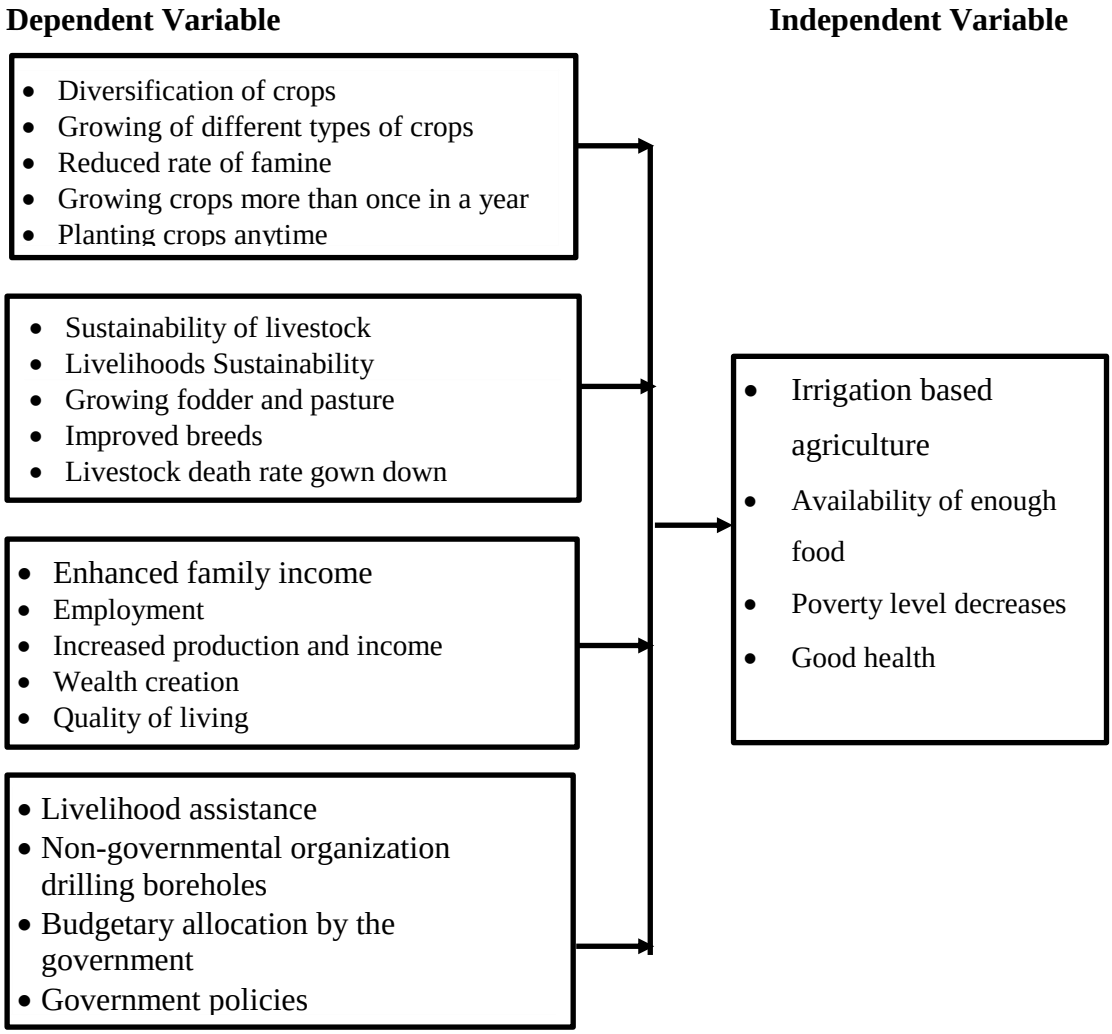


Figure 2.3: Conceptual Framework

Source; researcher, 2023

The study uses dependent variables of diversification of crops, sustainability of livestock, enhanced family income and livelihood assistance. On the **Diversification of Crops,** diversification was measured by considering both the number of different crop

species and their relative abundance in the cropping system. This variable was operationalized through encouraging farmers to plant multiple crop varieties that include food crops, cash crops, forage crops, and drought-resistant varieties. Promote intercropping and crop rotation to enhance diversification.

On the Growing of Different Types of Crops, the variety of crop types grown was measured by categorizing crops into groups (e.g., food crops, cash crops, forage crops, and drought-resistant crops) and calculating the number of categories represented in the farming system. This was operationalized through promoting cultivation of different crop types based on local agro-ecological conditions, market demand, and climate-resilience goals. Provide training and resources for farmers to experiment with new crops.

Reduced Rate of Famine: the measurement was through assessments on the recording of the frequency and severity of food shortages, malnutrition rates, and community-based data on household food availability. This was operationalized by implementing strategies such as improved water management through irrigation, drought-resistant crop varieties, and conservation agriculture to enhance food security and reduce the risk of famine.

Livelihood Sustainability: This is capturing the overall well-being and resilience of communities in arid and semi-arid lands. It can be measured through various indicators, including income levels, food security, and access to basic services, earnings from agriculture, livestock, non-farm activities, and remittances, community resilience. This can be operationalized by developing a set of measurable indicators and methodologies to assess the well-being and resilience of communities in these challenging environments by conducting household surveys to collect data on income levels,

expenditure patterns, asset ownership, and livelihood strategies. Ensure representative sampling to cover various segments of the population evaluate natural resource management practices, including water source sustainability, land use, and regular data collection and analysis.

Growing Crops More Than Once in a Year, was measured through tracking the cropping cycles per year by recording the planting and harvest dates of crops and calculating the number of cycles achieved and operationalized through the **i**ntroduction of small-scale irrigation schemes and encourage farmers to adopt multiple cropping cycles by providing access to water resources and guidance on crop scheduling.

Planting Crops Anytime was measured though assessment of the flexibility of planting times by recording whether planting schedules are adjusted based on climate forecasts and weather conditions and operationalized by promoting climate-smart agriculture practices and the use of weather forecasts to guide planting decisions. Encourage farmers to adapt planting times to changing climatic conditions.

The success of these initiatives should be monitored through regular assessments and community feedback. These efforts aim to enhance livelihood sustainability in ASALs by improving food security, crop production, and adaptive capacity in the face of climate variability.

On the **Enhanced Family Income, this can** be measured by tracking changes in household income before and after the implementation of small-scale irrigation schemes and operationalized through family income, the irrigation schemes should aim to increase agricultural productivity by providing access to water resources and supporting farmers in adopting high-value crops or crop rotation.

On the Employment, it can be measured by assessing the number of new jobs created directly or indirectly as a result of the irrigation schemes and operationalized through various projects including irrigation projects which focus on labor-intensive practices and include training programs for farmers, thereby creating employment opportunities in the agriculture sector.

On the increased Production and Income, this can be assessed by comparing crop yields, livestock production, and overall household income before and after implementing the irrigation schemes and operationalized by providing farmers with access to irrigation technologies, seeds, and training on modern farming techniques to boost production and income.

Wealth Creation can be measured by evaluating changes in assets and savings over time, such as land ownership, livestock numbers, and savings accounts and operationalized through **p**romotion of financial literacy and savings programs, which enable families to invest in assets, secure their livelihoods, and build wealth over time.

Quality of Living can be measured through indicators like access to clean water, improved housing, education levels, and healthcare services and operationalized through irrigation schemes which should contribute to improved living standards by enhancing access to water, supporting income for better housing, and enabling investments in education and healthcare.

2.8 Conclusion

This chapter contained the review of literature as per the objectives of this study. This chapter also highlighted the theoretical and conceptual framework. Chapter three herein below will deal with research methodology.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter covers the research design to be used, target population of the study, the sampling design and sample size, data collection instrument, validity and reliability of the study, data procedure and data analysis.

3.2 The Research Area

The study was done at Makaror location, Wajir County, which is located in North Eastern Kenya. The county covers an area of 56,685.8 sq Km. It has a mean annual temperature of 28°C with rainfall amounts ranging between 250mm and 700mm per annum in different parts of the county. Notably, the main economic activity in Wajir County is pastoralism with some agro-pastoralism being practiced in the Northern part of the county. Wajir County is located in North Eastern Kenya, it borders the following counties; Mandera to the North and North East, The Republic of Somalia to the East, Garissa to the South and South West, Isiolo and Marsabit to the West, and the Republic of Ethiopia to the North West (Wajir county website, 2015).

Makoror location in Wajir County is a suitable study area for researching the impact of small-scale irrigation schemes on livelihood sustainability in arid and semi-arid lands due to its representative environmental conditions, relevance to agriculture, and potential policy implications. The results obtained from this area can provide valuable insights into how such schemes can enhance resilience and improve the well-being of communities in challenging climates. The study area is as shown in Map in figure 3.1.

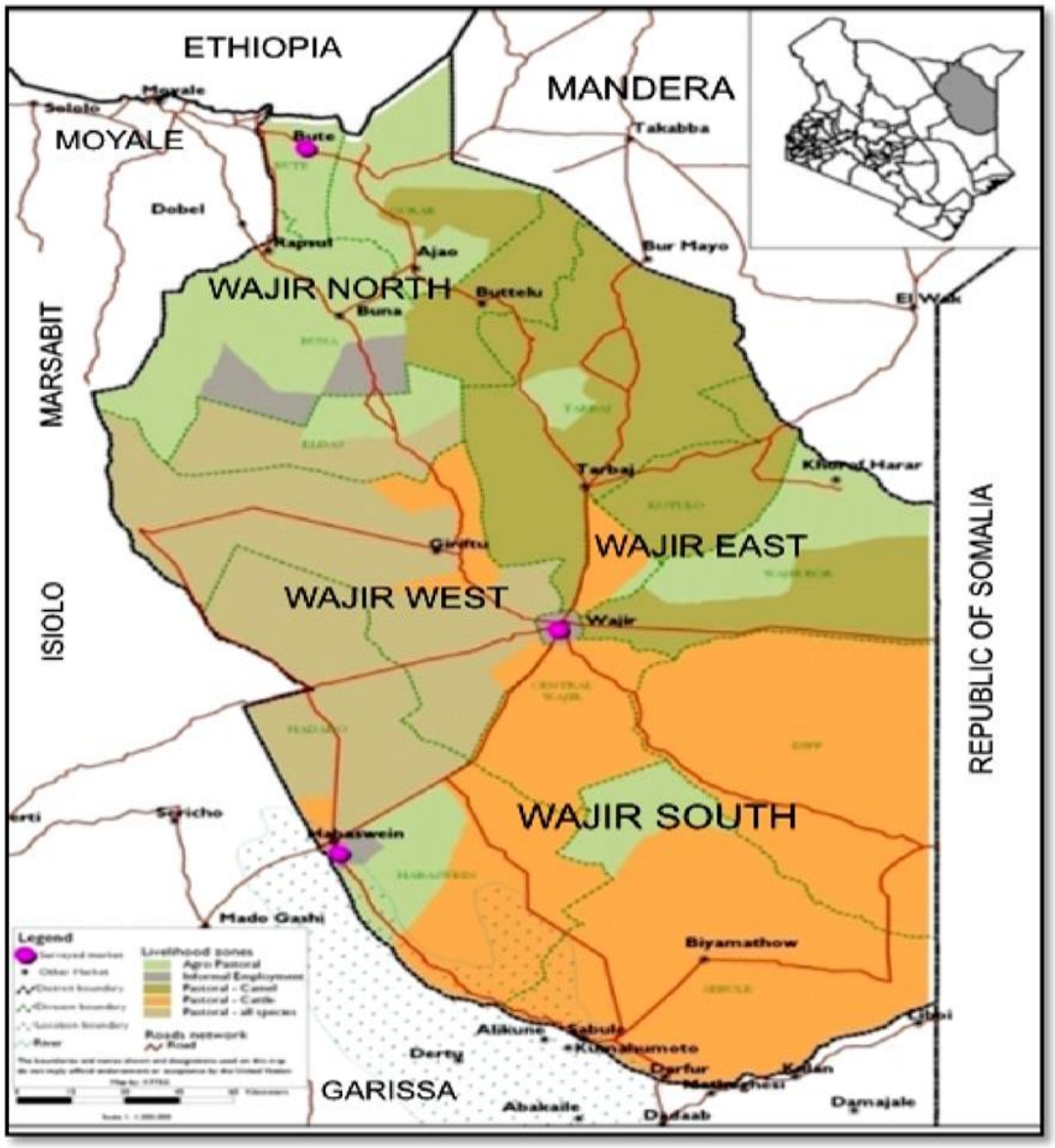


Figure 3.1: Map showing Wajir County

3.3 Research Design

The study employed a concurrent mixed research design. The purpose of this concurrent mixed methods study is to better understand a research problem by converging both quantitative and qualitative data. In this approach, the quantitative instruments were used to measure the relationship between the independent variables and the dependent variables. At the same time in the study, the central phenomenon was explored using qualitative interviews.

3.4 Target Population

The target population for this study comprised locals (community members) of Makaror location in Wajir County. According to 2009 census, Makaror location had approximately 38,262 with 45% of them being females while 55% males (Mars Group Kenya, 2013). This population was organized into villages with each village containing about 100 people. Village elders head the villages. The village is further organized into households led by the eldest male person in the family. Out of the population in Makaror, it is estimated that there are 13400 farmers (Mars Group Kenya, 2013). The study thus targeted 13400 farmers. Additionally, to get objective findings, the researcher also targeted food security project managers operating in Makaror. They included one government official working in the ministry of agriculture, livestock, water, and irrigation, one official from the Northern and arid and semi-arid development, ten field agricultural extension officers and six officials each from the six NGOs working on food security in Makaror location. The total target population for this study was 13400 people. The researcher excluded minors in this study, as they were not adequately informed of the issues concerning food security in that location.

Table 3.1 Target Population

Statement	*Target Population*
Farmers (Men, women and youths)	13400
NGO officials	6
Northern and arid and semi-arid development official	1
Ministry of Agriculture(field extension officers)	2
Total	13409

Source: Wajir county government office

3.5 Sample Size and Sampling Procedures

The sample size of the study was arrived at where whole population was stratified into two strata; one representing the 13600 local community members and the other representing the 9 officials/professionals. It is suggested that you choose a number closer to the minimum if there are limited resources and time and, if you only need a rough estimate of the results. The population was sampled from one administrative sub location which included the households which was determined using Purposive sampling technique. 9 food security managers were also sampled using purposive sampling technique. The total sample size for this study comprised of 143 respondents as illustrated in Table 3.2:

Table 3.2 Sampling Frame

Respondents	Sampling Procedure	Sample size
Farmers	1/100*13400	134
Food security managers	Purposive sampling	9
Total		143

Source; Researcher 2023

The researcher used a mixture of several sampling techniques to sample the population. First, the whole population was stratified into two strata; one representing the 13400 local community members and the other representing the 8 officials/professionals. Individuals from the stratum representing officials/professionals were sampled through census, as they were few and had information of value to the study.

The communities living in Makaror location are organized into villages that comprise several homesteads occurring in a cluster-like setting. Purposive sampling was used to select respondents from each of these villages. Purposive sampling was employed to select all the food security managers. The simple random sampling technique was employed to select farmers. In this technique, each member of the population had an

equal chance of being selected as subject. Moreover, one of the best things about simple random sampling is the ease of assembling the sample (Kombo, and Tromp, 2007). The entire process of sampling was done in a single step with each subject selected independently of the other members of the population.

3.6 Research Instruments

The researcher used interview schedules and questionnaires to collect data

3.6.1 Interview Schedule

The study employed the respondent type of interview where the interviewer retains total control throughout the process. The interview schedules in this case were administered to the food security managers. Interviews were used to collect qualitative data from the 9 government and NGO officials/professionals managing or overseeing food security projects in Makaror location. Since this groups comprised a major stakeholder in establishing small-scale irrigation schemes in Makaror location, they had more information concerning the effects of the irrigation schemes. As such, interviews enabled the researcher collect adequate information concerning effects of small irrigation schemes in relation family income and external livelihood assistance. The interviews were structured and were administered by the researcher. The interviews were through face-to-face. The researcher had prepared the interview questions based on the research objectives.

The researcher identified and selected participants who met the criteria for the study. This involved purposive sampling. The interviews were conducted in person by asking questions and recording responses. During the interviews, the researcher followed the interview schedule which is annexed herein and marked Appendix III.

Babbie (2010) argues that though interviews collect in-depth and adequate data, they are expensive to administer, and are difficult to analyze. A researcher may also experience difficulty in accessing the respondents to be interviewed particularly if they have busy schedules.

3.6.2 Questionnaires

The questionnaires are the best instruments for collecting data. They are cheap, easy to understand and one can the exact data without any manipulation. The women and men were categorized to form 15 groups. They were then being issued with questionnaires. A structured questionnaire was used to collect quantitative data. The questionnaires were structured such that they offered choices from which the researcher could choose.

The researcher administered this questionnaire since most of the respondents could not read and write in national languages. Questionnaires allow respondents to address the study's questions at their own flexibility. Questionnaires are also easy to analyze since the questions have limited respondents from which the respondents must choose. On the contrary, researcher-administered questionnaires formed an expensive process, as the researcher had to recruit interpreters to read the questions out to locals and record their responses. The researchers had designed a set of questions and prompts that are relevant to the research objectives. The questions are organized logically and coherently to ensure that the questionnaire flows smoothly and that all necessary information is collected. A copy of the questionnaire in annexed herein and marked Appendix II

3.7 Validity and Reliability of Research Instruments

Validity and reliability are fundamental concepts in research that pertain to the quality and accuracy of research instruments and measurements. According to Taherdoost

(2016), Validity and reliability of the research instruments are crucial for ensuring that the data collected is meaningful, consistent, and trustworthy.

3.7.1 Validity of the Research Instruments

According to Taherdoost (2016), validity refers to the extent that the instrument measures. The questionnaires to be used in this study were pre-tested through a pilot study before actual data collection. This enabled a revision of the questionnaire, if need be, before actual data collection. The pilot study was done to determine validity. It was done in Wajir West sub County because it neighbors Makaror location and they share the same socio-economic factors. The district gave an almost identical result to those from farmers in Makaror location. The results from piloting assisted in restructuring the questions in the questionnaire that will not be clear to the respondents. Validity was tested through expert opinion where the supervisor assisted the researcher to determine whether the questionnaire answers all the research objectives; thereby ensuring that relevant data was collected. The opinion of the expert (supervisor) played a very significant role in determining the validity of the research instrument.

3.7.2 The Reliability of the Research Instruments

Reliability of research instruments ascertains the degree to which a particular measuring procedure gives similar results of a number of repeated trials. According to Mugenda Mugenda (2003), the reliability of an instrument is the measure of the degree to which a research instrument yields consistent results or data after repeated trials. The study employed the Cronbach's alpha coefficient to measure the internal consistency of the questionnaire. As a general rule a value of $\alpha > 0.7$ will be determined reliable enough for each of the data sets where α is the item being tested for reliability

A reliable criterion is stable or reproducible. Reliability is a measure of how consistent the results from a test are (Kombo and Tromp, 2007). The study employed the use of test retest method; whereby the questionnaires were administered to two different respondents at different times. This involved identifying a group of respondents to administer the first test. Afterwards, another was administered with the same questionnaires. The two results were then correlated and variations, if any, detected. This ensured that the questionnaires measure what they were supposed to measure (Kothari, 2007).

3.8 Data Collection Procedures

The researcher acquired a permit from the institution to conduct the research. The permit was used to get permission from the food security managers so as to administer the interview schedule to them. Appointment dates were set with the food security managers about the actual days of data collection. The researcher distributed the questionnaires on the set days and collected them immediately after the exercise to ensure efficiency in data collection.

3.9 Ethical Consideration Issues

The researcher acquired a permit from the University and NACOSTI to conduct the research. The permit was used to get permission from the county and from the food security managers so as to administer the interview schedule to them.

The researcher agreed to comply with the following principles which aimed at protecting the dignity and privacy of every individual who, in the course of the research work carried out under the project, was requested to provide personal or commercially valuable information about themselves or others (hereinafter referred to as a subject of research):

Before an individual becomes a subject of research, he/she was notified of the aims, methods, anticipated benefits and potential hazards of the research; his/her right to abstain from participation in the research and his/her right to terminate at any time his/her participation; and the confidential nature of his/her replies.

No individual became a subject of research unless he/she was given the notice referred to in the preceding paragraph and provides a freely given consent that he/she agrees to participate. No pressure or inducement of any kind shall be applied to encourage an individual to become a subject of research.

The identity of individuals from whom information is obtained in the course of the project was kept strictly confidential. At the conclusion of the project, any information that reveals the identity of individuals who were subjects of research shall be destroyed unless the individual concerned has consented in writing to its inclusion beforehand.

No information revealing the identity of any individual was included in the final or in any other communication prepared in the course of the project, unless the individual concerned has consented in writing to its inclusion beforehand.

The researcher had trained the research assistants on the importance of issues of confidentiality and objectivity as they carry around the research process.

The researcher acquired authority to do research from the University and The National Commission for Science, Technology and Innovation before proceeding to the field.

3.10 Data Analysis

Data collected were organized, coded and entered directly into SPSS version 20. This statistical tool aided the researcher to perform summary statistics and graphical presentations of the results. The analysis employed the use of both qualitative and quantitative techniques. Qualitative techniques (thematic analysis) was employed

where responses from the interview schedules were discussed in themes that relate to the objectives of the study. In quantitative analysis, the researcher used descriptive statistics such as frequencies, percentages and means to analyze the data. Thereafter, linear correlation data analysis was employed.

3.11 Conclusion

This chapter covered the research design, target population, the sampling design and sample size, data collection instrument, validity and reliability of the study, data procedure and data analysis. Chapter four will deal with data analysis, presentation and interpretation.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0 Introduction

This chapter gives details on the background information, data analysis, presentation and interpretation.

4.1 Demographic Characteristics

This chapter gives details on the background information, data analysis, presentation and interpretation following the findings made by the researcher. The study had 92 questionnaires targeting the same number of respondents. 134 out of the 134 questionnaires were filled meaning that the study had a 100% response rate. The research assessed the background information of the respondents in an effort to ensure that sampling was effectively done. The responses were as presented below. The researcher sought to establish the gender of the respondents so as to establish whether there was gender bias among the respondents. The findings were as presented on table 4.1.

Table 4.1 Gender of the Respondents

Gender	Frequency	Percentage
Male	80	59.7
Female	54	40.3
Total	134	100

Source; Research Data

Table 4.1 indicates that a majority, sixty percent (60%) of the respondents were male, while forty percent (40%) were female. This could be interpreted to mean that there was no bias based on the gender of the respondents.

The researcher sought to establish ages of the respondents to establish whether the respondents met the right age threshold. The findings were as presented on table 4.2:

Table 4.2 Ages of the Respondents

Age	Frequency	Percentage
18-30 years	14	10.400
31 – 45 years	59	44.00
46- 55 years	46	34.30
Over 55	15	11.20
Total	**134**	**100.00**

Source; Researcher 2023

Table 4.2 reveals that majority, forty-four percent (44%) of the respondents were aged between 31-45 years, thirty-four percent (34%) of the respondents were aged between 46-55 years, eleven percent (11%) of the respondents were aged over 55 and another eleven percent (11%) of the respondents were aged 18-30 years. This was interpreted to mean that all the age groups participated in the irrigation farming. The researcher sought to establish the number of years the respondents have practiced Irrigation. The findings were as presented on table 4.3:

Table 4.3 Number of Years the Respondents have practiced Irrigation

Age	Frequency	Percentage
Less than 2 years	52	38.8
3 – 5 years	61	45.5
6- 10 years	21	15.7
Over 10 years	0	0
Total	**134**	**100**

Source; researcher 2023

Table 4.3 reveals that majority, forty-six percent (46%), of the respondents had practiced irrigation farming for 3-5 years, thirty-nine percent (39%) of the respondents had practiced for less than 2 years and fifteen percent (15%) of the respondents had practiced for 6-10 years. This was interpreted to mean the researcher collected the information from all the farmers.

4.2 Small-scale Irrigation and Diversification of Household Crop Based Food

The researcher sought to investigate the how small-scale irrigation has diversified household crop-based food. The results of the study are in table 4.4

Table 4.4: Small-scale Irrigation and Diversification of Household Crop Based Food

Statements		SA	A	UD	D	SD	M
The effects of irrigation small scale farming	F	54	50	7	14	9	3.9
	%	40.3	37.3	5.2	10.4	6.7	78
The effect of Small-scale irrigation on of food insecurity	F	30	61	11	24	8	3.3
	%	22.4	45.5	8.3	17.9	6	66
The crops grown more than once in a year	F	58	48	22	5	1	4.2
	%	43.3	35.8	16.4	3.7	0.7	84
Effect of Irrigation farming on crop production	F	49	53	7	16	9	3.9
	%	36.6	39.6	5.2	11.9	6.7	78
Benefits of Small-scale irrigation on farmers	F	70	46	8	10		4.3
	%	52.2	34.3	6	7.5		86
The farmers are able to grow the crops any time	F	72	38	5	14	5	4.0
	%	53.7	28.4	3.7	10.4	3.7	80

Source; Researcher 2023

According to table 4.4, the findings indicated that, eighty-six percent (86%), of the respondent strongly agreed that the irrigation has enabled the farmers enjoyed different types of food, eighty-four percent (84% of the respondents strongly agreed that the residents can grow crops more than once a year; eighty percent (80%) of the respondents strongly agreed that the farmers are able to grow the crops any time; seventy-eight percent (78%) of the respondents strongly agreed that the small-scale irrigation has enabled the increases the crop yields; while seventy-eight percent (78%) of the respondents strongly agreed that the irrigation has enabled them to plant crops which initially they could not even imagined could do well in their area Additionally, sixty-six percent (66%) of the respondents strongly agreed that small-scale irrigation has reduced incidences of food insecurity.

It is clear from the study findings that majority- eighty-six percent (86%) of the respondents agreed that the irrigation farming increases the crop yields. This implies that irrigation enabled the farmers in growing variety of crops which have a higher yield. The scarcity of water is now a thing of the past and the area now enjoys plenty of food.

Majority of the food security managers in Makaror location said that the small scare irrigation had enabled the residents diversify household crop-based food. The farmers were able to grow different types of food. Initially before the introduction of the irrigation, farmers could only depend on the drought resistant crops which could not even do well. With irrigation, the farmers could grow nearly all kinds of food at any given time without worrying about the prevailing climatic conditions. The yields of the crops have gone up tremendously.

One of the respondents, said "small scale irrigation is a miracle we have been praying for. Imagine now we can plant crops which we were not able to in the past. May Allah bless the people who made this a reality?"

Another one said "The introduction of new crops has helped us to stabilize our food stock and increase our incomes"

The two respondents have been practicing irrigation for 7 years and last years they have received seedlings they never had before from the county government department of Agriculture (15th May 2015 at Makaror village).

The findings are consistent with Rukuni et al (2010) who postulated that the development of smallholder irrigation schemes increases the potential for more production by counteracting mid-season dry spells and some periodic dry spells. This means that the household can grow crops more than once a year in low risk associated

areas than under the rain fed production. Increased production ensures high food availability at the household level due to intensification of crop production. The study results are in agreement with Sithole (2005) who asserted that irrigation increased household food security in the marginal to poor rainfall areas. The study also revealed that irrigation did not only improve the food security position of the level of the irrigators, but also the rest of the community benefited from these schemes. Essentially, these findings concur with the SLA's blueprint for elimination of poverty and encouragement of economic growth which benefits the poor (Morse et al., 2009). Notably, irrigation is part of support for international sustainable development targets and policies that create sustainable livelihoods for poor people and promote human development.

4.2.1 Small-scale Irrigation and Sustainability of Livestock Production

The researcher sought to investigate the how the small-scale irrigation influences sustainability of livestock production. The findings are as illustrated in table 4.5

Table 4.5: Small-scale Irrigation and Sustainability of Livestock Production

Statements		SA	A	UD	D	SD	M
The effects of irrigation on farmers growing fodder and pastures	F	56	37	11	20	10	3.8
	%	41.8	27.6	8.2	14.9	7.5	76
The effect of Small-scale irrigation on provision of water for their livestock	F	28	55	14	24	13	3.5
	%	20.9	41	10.4	17.9	9.7	70
Improved breeds on sustainability of livestock	F	77	37	12	4	4	3.4
	%	57.5	27.6	9	3	3	68
The increased milk production from; cows, camels and goats	F	71	44	10	6	3	4.7
	%	53	32.8	7.5	4.5	2.2	94
The quality meat from the livestock	F	23	39	16	39	17	3.1
	%	17.2	29.1	11.9	29.1	12.7	62
The consumption of the improved breeds	F	71	33	19	7	4	4.2
	%	53	24.6	14.2	5.2	3	84

Source; Researcher 2023

The study findings as shown in table 4.5 revealed that, ninety-four percent (94%), of the respondent strongly agreed that the cows, camels and goats are able to produce more milk; and eighty-four (84%) of the respondents strongly agreed that the improved breeds which require a lot of water can do well in the arid areas as a result of the irrigation. Besides, seventy-six percent (76%) of the respondents strongly agreed that small-scale irrigation had enabled the farmers to grow fodder and pastures, as seventy percent (70%) of the respondents strongly agreed that the farmers have been able to get water for their livestock hence this reduced the livestock deaths, Additionally, sixty-eight percent (68%) of the respondents strongly agreed that the farmers have been able to rear improved breeds; while sixty-two percent (62%) of the respondents strongly agreed that the livestock can now produce quality meat.

From the study findings, it is evident that majority of the respondents- ninety-four percent (94%) - strongly agreed that the cows, camels and goats are able to produce more milk. This was interpreted to mean that irrigation had enabled the livestock access not only water but also the feeds.

The interviewed food security managers assert that the sustainability of the livestock production had been made possible by the small-scale irrigation. With irrigation, the farmers were able to plant fodder and pastures which the livestock feed on. The death that is occasioned by drought had been reduced. The North eastern people whose lives depended on livestock were now enjoying additional benefits of irrigation.

A community elder said “The tears we used to shed every other time during drought had been reduced. For a pastoralist, losing livestock is the hardest blow. A part of us go with the departed animals. Livestock to us is our identity’’.

Another respondent said “We can now store the fodders and pastures during the raining season and feed our livestock’s; before irrigation we had never thought of it as when draught hit us we could feed boxes to our livestock.”

The two respondents have migrated from Wagalla ward in 2011 after a severe drought killed all their livestock and came to live in Makoror village as internal displaced persons, in 2012 they have started irrigation and have received help of goats, cattle, seedling and agricultural equipment’s from the county government department in 2013. In 2015 when the research was carried out they had stocks of grass they were saving during the dry season.

The study findings are in agreement with the SLA’s natural capital theory that posits that especially for resource dependent communities, whereupon the stock of all livelihood activities are built on (Sayer & Campbell, 2003). The findings also reiterate Kimenye’s (2000) opinion that Vision 2030 calls for the provision of water, infrastructure, pasture, fodder and veterinary services; establishing strategically located disease-free zones to increase livestock productivity and quality; it also calls for unifying the efforts of different ministries and other stakeholders to coordinate development of the region using all means - including putting more land under cultivation

4.2.2 Small-scale Irrigation and family Income

The researcher sought to investigate the how the small-scale irrigation has enhanced family Income. The results are as illustrated in table 4.6

Table 4.6: Small-scale Irrigation and Family Income

Statements		SA	A	UD	D	SD	M
Effects of Irrigation on employment	F	61	42	12	14	5	4.0
	%	45.5	31.3	9	10.4	3.7	80
Effects of Small-scale irrigation schemes on production and income	F	26	58	25	20	5	3.6
	%	19.4	43.3	18.7	14.9	3.7	72
Consequences of wealth creation as a result of irrigated farms	F	46	42	16	21	9	3.7
	%	34.9	31.3	11.9	15.7	6.7	74
The crops and livestock effects on farmers in providing for their families	F	36	48	17	21	12	3.6
	%	26.9	35.8	12.7	15.7	9	72
The production of surplus food	F	61	37	21	13	2	4.1
	%	45.5	27.6	15.7	9.7	1.5	82
Farming as a solution for unemployed youths in the area	F	56	40	15	19	4	3.9
	%	41.8	29.9	11.2	14.2	3	78

Source; Researcher 2023

The findings from table 4.6 revealed that, eighty-two (82%), of the respondent strongly agreed that the small-scale farmers were able to produce surplus food which they could sell, as eighty percent (80%) of the respondents strongly agreed that irrigation increased employment. Besides, seventy-eight (78%) of the respondents strongly agreed that the unemployed youths in the area could indulge in farming, as seventy-four (74%) of the respondents agreed that food production from irrigated farms was a major source of wealth creation. Additionally, seventy-two (72%) of the respondents strongly agreed that small-scale irrigation schemes had led to an increased production and income as 72 % of the respondents strongly agreed that the crops and livestock had enabled the farmers to comfortably provide for their families. From the study findings, it is evident that majority- eighty-two percent (82%) - of the respondents strongly agreed that the small-scale farmers can produce surplus food which they can sell.

According to the food security managers, the small-scale irrigation has enhanced family income in Makaror village. The crop yields and animal production went up hence improving the lifestyles of the residents. The farmers can now grow many crops which

initially they could not. This resulted in surplus production. They could then sell the surplus food to those who could not have. The proceeds from the farm can then be invested in other areas. Some people had even started engaging in cash cropping. The youths have even gained employments from it and become productive. The farmers have even been trading the surplus food to schools to pay off school fees for students which earlier they were not able to do as the common crops could be easily grown at the school.

The findings from the study are in agreement with the SLA framework which reiterates the need to pursue economic growth that enabled the poor to have sustainable livelihoods (Morse et al., 2009). Sithole and Testerink (2003) also concur with the study findings in their assertion that increased crop production can be expected to encourage the establishment of more agro-industries to process the output, thereby increasing employment opportunities and purchasing power of individuals in households implying the capacity to purchase gran to meet the household requirements thus to increase food security.

The findings are also in tandem with Chambers and Conway (1992, as cited in Morse et al., 2009) who established that sustainable livelihoods approach emphasized activities such as irrigation, which led to livelihoods that could withstand and recover from shocks and stress, preserve or enhance its assets and capabilities. It could also provide opportunities for sustainable livelihood for the next generation; besides this could contribute to the net benefits to other livelihoods at both the local and global settings and in the short and long-term. Notably, people in Mutambara confessed that their project enabled members to earn an income which enabled them to meet some of their basic needs.

One of the respondents said "Small scale irrigation has enabled us to grow enough food and we sell the surplus to buy goods we are not able to grow like sugar". She started irrigation in 2014 where she has attested to have made a total of Ksh 50,000 from the sales, she has prided herself to have joined group of women who were engaging merry-go fund which was her dream.

Another respondent had this to say; "This has really helped us to sell our surplus and comfortably pay school fees for our children which was hard to do before the irrigation" Mohamed has been doing irrigation from 2012 after he lost all his livestock in 2011 drought, this has enabled him to pay the school fees of his 2 children who are in high school.

4.2.3 The influence of Irrigation Agriculture on Livelihood Assistance

The researcher sought to investigate the impact of irrigation agriculture on livelihood assistance. The findings are as portrayed in table 4.7

Table 4.7: The Impact of Irrigation Agriculture on Livelihood Assistance

Statements		SA	A	UD	D	SD	M
NGOs undertake a wide range of water –related functions	F	54	36	17	20	7	3.8
	%	40.3	26.9	12.7	14.9	5.2	76
The government plays a critical role in creating an enabling environment for technology development	F	29	37	26	30	12	3.3
	%	21.6	27.6	19.4	22.4	9	66
The government develop policies and regulations that influence irrigation equipment manufacture, importation, promotion and servicing	F	43	48	20	18	5	3.8
	%	32.1	35.8	14.9	13.4	3.7	76
The NGO's have drilled boreholes to be used for irrigation	F	46	49	16	17	6	3.8
	%	34.3	36.6	11.9	12.7	4.5	76
The government and other stakeholders provide training to the farmers	F	42	44	19	20	9	3.7
	%	31.3	32.8	14.2	14.9	6.7	74
The government allocates some money to the arid areas to be used for irrigation	F	43	55	27	6	3	4.0
	%	32.1	41	20.1	4.5	2.2	80

Source; Researcher 2023

According to table 4.7, the study findings revealed that majority of the respondents- eighty percent (80%) - strongly agreed that the government allocates some money to the arid areas to be used for irrigation, as seventy-six percent (76%) of the respondents strongly agreed that NGOs undertake a wide range of water –related functions. Also, seventy-six percent (76%) of the respondents strongly agreed that the government developed policies and regulations that influenced irrigation equipment manufacture, importation, promotion and servicing; while seventy-six percent (76%) of the respondents strongly agreed that the NGO's have drilled boreholes to be used for irrigation. Besides, seventy-four percent (74%) of the respondents strongly agreed that the government and other stakeholders provides training to the farmers; additionally, sixty-six percent (66%) of the respondents strongly agreed that the government played a critical role in creating an enabling environment for technology development.

It is clear from the study findings that, majority- eighty percent (80%) - of the respondents strongly agreed that the government allocated some money to the arid areas to be used for irrigation. The findings can be interpreted that people in ASAL areas faced a myriad of problems to an extent it warranted the interventions of the government and the NGOs.

The food security managers said that NGOs undertook a wide range of water –related functions. The NGOs and the government had done a great job in enabling the area attain a lot of developments through irrigation. The NGO's in particular through their grass root participation had done a lot in ensuring that the lives of the people in ASAL areas changed. The County Government of Wajir through the agricultural department had undertaken various training on farmers; they had provided tools and constructed various dams.

The study findings are consistent with the SLA's social capital aspect that defines the social resources, including informal networks, relationships of trust, and membership of formalized groups that facilitate co-operation. (Sayer & Campbell, 2003). The nature of social capital in this case is shaped by the government initiatives and interventions through policy which promote the realization of sustainable livelihoods. The research findings are also in agreement with Paraiwa (2005) who asserted that NGOs undertake a wide range of water-related functions, from developing projects for rural water supplies and minor irrigation to fostering water user associations for water management purposes. Some NGOs encourage farmers to try new technologies, for example the catchment protection and sprinkler irrigation techniques introduced by the Aga Khan Rural Support Programme in Gujarat, India. Notably, Farrington (2001, as cited in Morse et al., 2009) observed that government services are not the only factor that needs to be considered in the SLA since there may be non-governmental or other private agencies at hand to provide support for livelihoods. Therefore, SLA can be considered in several different ways.

Mohamed said "I have received this tractor from the County Government although it is for a group of 5 of us but it has helped us, we have also received 5 days training on how to operate the tractor and they normally do the repairing if it breaks down".

One respondent said "I have received from arid land NGO seeds which helped us to grow crops that I never used to grow for example these passions I have never seen but look how beautiful and tasty they are".

Table 4.8: Correlation Table

		Crop based food	livestock production	Family income	External livelihood assistance
Crop based food	Pearson Correlation	1	.133	.159	.319**
	Sig. (2-tailed)		.127	.066	.000
	N	134	134	134	134
livestock production	Pearson Correlation		.133	1	.247**
	Sig. (2-tailed)		.127		.004
	N	134	134	134	134
Family income	Pearson Correlation		.159	.247**	1
	Sig. (2-tailed)		.066	.004	
	N	134	134	134	134
External livelihood assistance	Pearson Correlation	.319**	.367**	.426**	
	Sig. (2-tailed)	.000	.000	.000	
	N	134	134	134	134

**. Correlation is significant at the 0.01 level (2-tailed).

Source; Researcher 2023

The study findings revealed that there is a significant relationship (.000) between the small-scale irrigation and external livelihood assistance. This can be interpreted to mean that the external livelihood assistance offered to the farmers to facilitate irrigation-based agriculture enabled many farmers to grow different varieties of crops at any time to increase and diversify the crop production. The study findings are in agreement with FAO (1999) assertions that in the Northeastern province of Kenya, the prevailing climatic conditions does not facilitate adequate growth of food crops. The small-scale irrigation has been beneficial to the residents. In the former years, few individuals could plant some drought resistant crops which could not even germinate at times. The irrigation has enabled them to plant crops which initially they could not even have imagined could do well in their area.

From the findings, it is conclusive that there is a significant relationship (.000) between small-scale irrigation and for sustainability of livestock production. The findings can be interpreted that the establishment and popularization of with small-scale irrigation by the government and other non-governmental organizations has served to enhance livestock production. The camel, goats and sheep did not lack water in the very dry spells.

The study revealed that there is a significant relationship (.000) between small-scale irrigation enhanced families. This was interpreted to mean the income of the farmers increased greatly after the introduction of the small-scale irrigation in the region. The government and the NGO's helped the residents by facilitating irrigation. The findings are in agreement with a study by IFAD (2005) states that in Ethiopia, the construction of small-scale irrigation schemes has resulted in increased production, income and diet diversification in the Oromia and Southern Nation and Nationalities People (SNNP) regions.

4.3 Conclusion

This chapter dealt with the demographic characteristics of the respondents, data analysis, presentation and interpretation. Chapter five will deal with summary, conclusion and recommendations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The aim of this study as articulated in chapter 1 has been to explore the small-scale irrigation schemes and livelihood sustainability in arid and semi-arid land: a case of Makaror location, Wajir County, Kenya. The specific objectives to this study were:

i. To examine the extent to which small-scale irrigation has diversified household crop-based food.
ii. To assess the extent to which small-scale irrigation influences the sustainability of livestock production.
iii. To find out the extent to which small-scale irrigation has enhanced family income.
iv. To examine the influence of irrigation agriculture on livelihood assistance.

These four objectives herein above have been achieved through interviews and questionnaires with research participants. The concepts that emerged in relation to the research questions and objectives include; that majority of the respondents had practiced irrigation farming, that majority- eighty-six percent (86%) of the respondents agreed that the irrigation farming has increased the crop yields, that majority of the respondents- ninety-four percent strongly agreed that the cows, camels and goats are able to produce more milk. This was interpreted to mean that irrigation had enabled the livestock access not only water but also the feeds, some of the respondents strongly agreed that the small-scale farmers were able to produce surplus food which they could sell and the respondents strongly agreed that the government allocated some money to the arid areas to be used for irrigation.

These concepts provide stakeholders with new knowledge of how small-scale irrigation schemes and livelihood sustainability in arid and semi-arid land. The knowledge provide opportunity for reexamination of current policy on irrigation schemes and livelihood sustainability in arid and semi-arid land.

5.2 Summary of the Findings

On objective 1, the findings indicated that majority- eighty-six percent (86%) - of the respondent strongly agreed that the irrigation farming increased the crop yields; similarly, eighty-four percent (84%) of the respondents strongly agreed that the residents could grow crops more than once a year as eighty percent (80%) of the respondents strongly agreed that the farmers are able to grow the crops all year round. Additionally, seventy-eight percent (78%) of the respondents strongly agreed that the small-scale irrigation had enabled the farmers enjoy different types of food; while seventy-eight percent (78%) of the respondents strongly agreed that the irrigation had enabled them to plant crops which initially they could not have imagined could do well in their area. Besides, sixty-six percent (66%) of the respondents strongly agreed that small-scale irrigation had reduced incidences of food insecurity.

On objective 2, the majority ninety-four percent (94%) of the respondent strongly agreed that cows, camels and goats were able to produce more milk; additionally, eighty-four percent (84%) of the respondents strongly agreed that the improved breeds which require a lot of water could do well in the arid areas as a result of the irrigation. Besides seventy-six percent (76%) of the respondents strongly agreed that small-scale irrigation had enabled the farmers to grow fodder and pastures' while seventy percent (70%) of the respondents strongly agreed that the farmers had been able to get water for their livestock and this reduced the deaths of livestock. On top of that, sixty-eight percent (68%) of the respondents strongly agreed that the farmers had been able to rear

improved breeds as sixty-two percent (62%) of the respondents strongly agreed that the livestock can now produce quality meat.

On objective 3, majority of eighty-two percent (82%) of the respondent strongly agreed that small-scale farmers are able to produce surplus food which they could sell; while eighty percent (80%) of the respondents strongly agreed that irrigation increased employment also seventy-eight percent (78%) of the respondents strongly agreed that the unemployed youths in the area could indulge in farming all year round, as seventy-four percent (74%) of the respondents agreed that food production from irrigated farms is a major source of wealth creation. In addition, seventy-two percent (72%) of the respondents strongly agreed that small-scale irrigation schemes have resulted in increased production and income and in fact seventy-two percent (72%) of the respondents strongly agreed that the crops and livestock had enabled the farmers to comfortably provide for their families.

On objective 4, the study findings revealed that majority of the respondent's eighty percent (80%)- strongly agreed that the government allocated some money to the arid areas to be used for irrigation; in the same vein, seventy-six percent (76%) of the respondents strongly agreed that NGOs undertook a wide range of water related functions. Similarly, seventy-six percent (76%) of the respondents strongly agreed that the government developed policies and regulations that influenced irrigation equipment, importation, promotion and servicing. Besides seventy-six percent (76%) of the respondents strongly agreed that the NGO's have drilled boreholes to be used for irrigation, as seventy-four percent (74%) of the respondents strongly agreed that the government and other stakeholders provided training to the farmers last but not least sixty-six percent (66%) of the respondents strongly agreed that the government played a critical role in creating an enabling environment for technology development.

5.3 Conclusion

It can be concluded that the small-scale irrigation played a very vital role in the production of food in ASAL areas with some level of diversification and sustainability. The residents got the opportunity of planting the food crops all year round. They were able to grow crops perceived to be only grown in the regions with the high levels of rainfall. The food insecurity in the area went down. Notably, small-scale irrigation falls under natural capital in the SLA framework, where focus is on sustainable livelihoods through enhanced provision of water to build resilience in food production through enhancement of both livestock and crop farming for resource dependent communities, where upon the stock of all livelihood activities are built on. This capital applies to rural communities, with a high proportion for poor stakeholders, an essential value which in fact is prone to calamities such as drought.

The Northern part of Kenya is known for pastoralism. The residents pride themselves in keeping camels, cows and goats. Small-scale irrigation has enabled them improve their livestock. The livestock do not have to be taken to far places in search of water and pasture. The breeds are even improved. The SLA's human capital theory applies in this case as more pastoralists acquire the skills, knowledge, labour ability, and good health that enable them to pursue diverse livelihood strategies and realize their livelihood objectives.

One could argue that the lives of the people living in ASAL areas were completely changed for the better when the small-scale irrigation was introduced in the area. The youths who are jobless could gain employment by indulging themselves in farming. The residents were able to obtain income from the farm produce. Notably, the sustainable livelihoods framework conceptualizes livelihoods in a holistic way, where it captures the numerous complexities of livelihoods, and the opportunities and

constraints that they are subjected to. Thus, development efforts under SLA focus on the elimination of poverty and encouragement of economic growth which benefits the poor.

It is clear from the study that the external assistance has a lot of impact on irrigation. The government has tried to help the residents of ASAL areas. The NGOs have done a great job in helping the people in ASAL areas. Essentially, the SLA emphasizes a multifaceted approach to sustainable livelihoods. Notably, government services are not the only factor that needs to be considered in this regard since there may be non-governmental or other private agencies at hand to provide support for livelihoods. Therefore, a combined stakeholder effort makes it possible to formulate strategies that can help enhance livelihoods

The findings further revealed several significant implications for policy, practice, and further research in the context of small-scale irrigation in arid and semi-arid areas. The study found that small-scale irrigation has played a crucial role in diversifying household crop-based food production. This diversification has contributed to improved food security in the region, reducing the dependency on rain-fed agriculture. The introduction of small-scale irrigation has allowed communities to cultivate a wider variety of crops, thus reducing vulnerability to food shortages during dry spells.

Small-scale irrigation has had a positive influence on the sustainability of livestock production. The availability of water resources for irrigation has ensured a more consistent supply of forage and water for livestock, leading to improved livestock health and increased productivity. This has implications for the economic well-being of households that rely on livestock for their livelihoods.

The study indicates that small-scale irrigation has significantly enhanced family income in Makaror. Increased agricultural productivity and the sale of surplus produce have contributed to improved household incomes. This extra income can be invested in education, healthcare, and other critical aspects of livelihood improvement. Small-scale irrigation has facilitated livelihood assistance by creating opportunities for the development of small businesses related to agriculture, such as selling agricultural inputs, processing farm produce, and providing irrigation-related services. This has led to the growth of the local economy and improved livelihoods beyond just agricultural production.

5.4 Recommendations

Based on the study findings the following recommendations were suggested in bid to improve the livelihoods and sustainability of the small scale farmers in ASAL areas;

i. Promote the cultivation of a diverse range of crops suitable for the local climate. This can be achieved through training and providing farmers with seeds for various crop types, including drought-resistant and high-value crops. Also encourage the cultivation of traditional and indigenous crops that are adapted to the local environment. This can preserve local food traditions and enhance dietary diversity.

ii. Promote integrated farming systems that combine crop production with livestock rearing. The availability of irrigation water can support the cultivation of forage crops, which can serve as feed for livestock. Implement efficient water management practices to ensure a consistent water supply for both crops and livestock. Encourage the use of water-saving techniques and technologies.

iii. Support value addition and post-harvest processing of agricultural products. Training and facilities for processing, packaging, and marketing can help increase the income generated from agricultural produce

iv. Provide training and capacity-building programs for the local community to develop skills related to irrigation agriculture, including water management, crop management, and irrigation system maintenance.

REFERENCES

Alkire, S., Chatterje, M., Conconi, A., Seth, S., & Vaz, A. (2014). Poverty in rural and urban areas: Direct comparisons using the global MPI 2014.

Asheley,C., & Carney, C. (2009). *Sustainable Livelihoods: Lesson from Early Experiences.* London. Australia Pvt Ltd, Harare.

Batchelor, C. Lovell, C. & Murata, M. (1993). Micro irrigation techniques for improving irrigation efficiency on vegetable gardens in developing countries. In Proceedings of workshop on micro-irrigation, 2 September 1993. 15th Congress on irrigation and drainage, The Hague, ICID. pp. 31-39.

Chazovachii, B. (2012). The impact of small scale irrigation schemes on rural livelihoods: the case of Panganai irrigation scheme Bikita District Zimbabwe. *Journal of Sustainable Development in Africa*, 14(4), 217-231.

Chenje, M., Solar, C., & Manzungu, E. (2008). *The State of the Environment in Zimbabwe.* Harare.

Chitsiko, R. (2009). An Innovative and Highly Successful Scheme. *Grid Network Magazine,* FAO. Commonwealth Publishers.

Dick, M., & Rosegrant, W. (2001). Overcoming Water Scarcity and Quality Constraints. A 2020 Vision for Food, Agriculture and the Environment. IFPRI, Washington D.C., USA.

Ellis, F. (2000). *Rural Livelihoods and Poverty Reduction Policies*. London, Routledge.

Evans, R. (2009). From small farms to supermarkets. In: S.A. Breth. (ed). *From subsistence to sustainable agriculture in Africa.* Mexico City: Sasakawa Africa Association.

FAO (2003). Trade Reforms and Food Security. Conceptualizing the Linkages. Food and Agriculture Organization.

FAO, (1996). Agriculture and Food Security. World Food Summit, November 1996, Rome: Food.

FAO, (1999). Poverty Reduction and Irrigated Agriculture. International Programme for Food.

FAO. (2002). The State of Food Insecurity in the World 2001. MSU International Development Working Paper No. 15, from Zimbabwe. University of Zimbabwe Publication Office, Harare.

Farah, K. O., Nyariki, D. M., Noor, A. A., Ngugi, R. K., & Musimba, N. K. (2003). The socio-economic and ecological impacts of small-scale irrigation schemes on pastoralists and drylands in Northern Kenya. *Journal of Social Sciences,* 7(4), 267-274.

FDRE (2010). Ethiopia's Agricultural Sector Policy and Investment Framework (PIF) 2010- 2020. Federal Democratic Republic Government of Ethiopia, Ministry of Agriculture and Rural Development.

Goldsmith, W., & Blakely, J. (2009). Separate Societies: Poverty and Inequality in American Cities. Philadelphia: Temple University Press.

Guliye, A. Y., et al. (2019). Savings and Investments in ASALs: Building Resilience through Financial Capital. *Journal of Development and Agricultural Economics*, 11(1), 1-12.

Hansen, N. (2007). *Poverty and the Urban Crisis. Bloomington: Indiana State University*. Harare, May 30, 1995. Zimbabwe Farmers Union.

Hussain I, Giordano M, & Munir A (2008). *Agricultural water and Poverty in sub-Saharan Africa.* Villars-sur-Ollon, Switzerland.

International Institute for Environment and Development (IIED). (2020). Climate-Resilient Housing in ASALs: A Study on the Importance of Physical Capital in Enhancing Community Well-being.

International Labour Organisation (ILO). (2007). Employment by sector. Irrigated Wheat Yields. A Case Study of Chinyamatumwa Irrigation Scheme in Zimbabwe. *Journal ofSustainable Agriculture.*

International Livestock Research Institute (ILRI). (2016). Harnessing Social Capital for Livestock Research and Development in ASALs: A Report on the Role of Social Networks in Resource Sharing among Pastoralist Communities.

Jayne, S. (2004). Market-oriented Strategies to Improve Household to Food Experience. *Journal of the American Economic Association*

Kalia, A., Shukla, G., Mishra, D., Mishra, B. P., & Patel, R. R. (2021). Comparative trend analysis of mustard in Bundelkhand Region, Uttar Pradesh and India. Indian *Journal of Extension Education*, 57(1), 15-19.

Kenya National Bureau of Statistics (KNBS). (2019). Significance of Health and Nutrition in Enhancing the Resilience of ASAL Communities.

Kenya National Drought Management Authority (NDMA). (2017). Enhancing Water Access in ASALs: A Report on the Significance of Physical Capital in Water Infrastructure Development.

Kimani, J., & Gatuguta, J. (2019). Livestock Management Tools in ASALs: Insights from Pastoralist Communities. Pastoralism: *Research, Policy and Practice*, 9(1), 2.

Kimenye, L. (2000). Case study of factors affecting horticultural production and marketing in Kibwezi

Kombo, K., & Tromp, L. (2006): Proposal and Thesis Writing: An Introduction. Nairobi: Paulines Publications.

Kothari, C. (2007). Research Methodology, methods and techniques. India, K.K. Gupta.

Lyson, A., & Falk, W. (2005). Forgotten Places: Uneven Development and Underclass in Rural America. Lawrence: University of Kansas Press.

Makadho, L. (2007). *Water and Agriculture in Zimbabwe Policy and Management options for the Small Holders.* Mount Managed Cash Cropping.

Manyatsi, A. (2004). Small-scale Irrigated Agriculture and Food Security in Swaziland.

Manzungu, E. (2004). Farmers' Elected Bodies and Smallholder Irrigation in Zimbabwe. Harare, Weaver Press

Meinzen-Dick, R., Makombe, G., & Sullins, M. (2003). Agro-economic Performance of MMET.

MoFED. (2012). Progress Towards Eradicating Poverty. An Interim Report on Poverty Analysis Study

Mohammedshum, A. A., Mannaerts, C. M., Maathuis, B. H., & Teka, D. (2023). Integrating Socioeconomic Biophysical and Institutional Factors for Evaluating Small-Scale Irrigation Schemes in Northern Ethiopia. Sustainability, 15(2), 1704.

Moll, H. (2004). *Small Holders and Relationship Clusters with Rural Institutions.* Weavers Press, Harare.

Moriarty, P. & Butterworth, J. (2003). *The Productive Uses of Domestic Water Supplies: How Water Supplies Can Play A Wider Role.*

Morrill, R., & Wohlenberg, H. (2007). *The Geography of Poverty*. New York: McGraw Hill.

Morse, S., McNamara, N., & Acholo, M. (2009). Sustainable livelihood approach: A critical analysis of theory and practice. Geographical Paper No. 189. Department of Geography, University of Reading, UK.

Mugenda, O., & Mugenda G. (2003). *Research Methods: Quantitative and Qualitative Approaches*. Nairobi: ACTS Press

Mujere, N., Chazovachii, B., Chifodya, G., Mushuku, A. (2010). *Evaluating Factors Influencing the Variation Of water distribution*. London: Routledge.

Mupawose, W. (2004). *Irrigation in Zimbabwe. A broad overview in Africa*. Routledge.

Mutsvangwa, T., & Doranalli, K. (2006). *Agriculture and Sustainable Development, Netherlands*. Organization of the United Nations.

Mwendera, E., Manyatsi., M., Magwezi, O., & Dlamini, M. (2002). *Water Demand Management programme.*

Narayanamoorthy, A. (2007). Does Groundwater Irrigation Reduce Rural Poverty? Evidence from Indian States. Irrigation and Drainage,

Njuguna, A., & Gathenya, J. (2021). *Education as a Determinant of Livelihood Diversification: A Case Study in ASALs.*

Njuki, J., Kaaria, S., Chamunorwa, A., & Kaaria, S. (2011). Empirical analysis of the role of social capital in rural development: An exploration of the impacts of social capital in enhancing community resilience in ASALs. *Agriculture and Human Values*, 28(2), 215-229.

Odhiambo, J., et al. (2017). Financial Capital and Livelihood Diversification in ASALs: Insights from a Study on Small Business and Non-Agricultural Investments. *African Journal of Agricultural Research*, 12(47), 3365-3377.

Peacock, T. (2005). Financial & Economic Aspects of Smallholder Irrigation in Zimbabwe & Perspective. Reprinted from Journal of International Development, Harare. University of Zimbabwe Press.

Rukuni, M., Mudimu, G., & Jayne, K. (2010). *Food Security Policies in the SADCC Region.*

Ruttan, W. (2006). Productivity, Growth in World Agriculture: Sources and Constraints. Economic Perspectives.

SADC. (1992). Regional Irrigation Development Strategy. Country Report, Zimbabwe. ACK

Saleth, R. (2006). Water Institutions in India. Economics, Law and Policy, New Delhi:

Sayer, J. & B. Campbell. (2003). The science of sustainable development local livelihoods and the global environment. Cambridge University Press

Shama, R., & Shamma T. (2004). Irrigation Engineering. Chad and Company, New Delhi

Shaw, W. (2006). The Geography of United States Poverty. New York: Garland Publishing.

Sithole, M., & Testerink, J. (2003). Irrigation and food security in Swaziland: Current Smallholder Irrigation in Zimbabwe. Weavers Press: Harare.

Synnevåg, G., Kabote, S. J., Nombo, C. I., Mamiro, D., & Mattee, A. Z. (2015). Smallholder adaptation to climate change in semi-arid areas of Tanzania: experiences from Iramba and Meatu districts. *Sustainable intensification to advance food security and enhance climate resilience in Africa,* 467-485.

Taherdoost, H. (2016). Validity and reliability of the research instrument; how to test the validation of a questionnaire/survey in a research. How to test the validation of a questionnaire/survey in a research (August 10, 2016).

Terry, A., & Ryder, M. (2007). Improving food security in Swaziland: The transition from subsistence to communally. United Nations: Rome.

Ulrich, A., Speranza, C. I., Roden, P., Kiteme, B., Wiesmann, U., & Nüsser, M. (2012). Small-scale farming in semi-arid areas: Livelihood dynamics between 1997 and 2010 in Laikipia, Kenya. *Journal of Rural Studies,* 28(3), 241-251.

United Nations Development Programme (UNDP). (2018). Access to Credit and Income-Generating Activities in ASALs: A Report on the Role of Financial Capital in Enhancing Resilience.

United Nations Development Programme (UNDP). (2020). *Importance of Human Capital in ASALs: Adaptive Knowledge and Skills.*

Weber, B., & Jensen, L. (2004). Poverty and Place: A Critical Review of Rural Poverty Literature. Oregon State University. Rural Poverty Research Center.

World Bank. (2008). Agriculture for Development. World Bank Report. World Bank: Washington DC.

World Bank. (2012). World development indicators 2012. The World Bank.

APPENDICES

Appendix I: Introductory Letter

Dear Sir/ Madam/Respondent,

Re: **Research Questionnaire**

I am a student at Moi University undertaking a Master's degree in development. I am conducting a study on: *Small-Scale Irrigation Schemes in Livelihood Diversification in Asal: A Case of Makaror Location, Wajir County*. The study is being conducted purely for academic purposes. It is not meant to evaluate your opinion or demean your institution in any way whatsoever. Your response will be strictly confidential to provide insight into the issues under study and thereby suggest possible solution to them. You identify and responses will be treated with uttermost confidentiality.

In view of this, therefore, I wish to kindly request you to fill the questionnaire attached. Please respond to the items in the questionnaire completely and as truthful as possible.

Thank you.

Yours faithfully

…….

Halima Ahmed Abdullahi

Appendix II: Questionnaire

Section A: Background Information

i. Questionnaire Number……

Please tick where applicable

i. Age

18 – 30 [ ]

31 – 45 [ ]

46 – 55 [ ]

Over 55 [ ]

ii. Sex

Male [ ]

Female [ ]

iii. How long have you been practicing irrigation farming?

Less than 2 years [ ]

3 – 5 years [ ]

6 – 10 years [ ]

10 years [ ]

Section B: Specific Information

Small-scale Irrigation Has Diversified Household Crop Based Food.

Kindly rate the extent to which you agree with the following statements on small-scale irrigation as an impact on diversified household crop-based food.

SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree

Statement	**SA**	**A**	**UD**	**D**	**SD**
The irrigation has enabled them to plant crops which initially they could not even imagine they could do well in their area					
Small-scale irrigation has reduced incidences of food insecurity					
The residents can grow crops more than once a year					
Irrigation farming increases the crop yields					
Small-scale irrigation has enabled the farmers enjoyed different types of food					
The farmers are able to grow the crops any time					

Small-scale Irrigation Influences Sustainability of Livestock Production

Kindly rate the extent to which you agree with the following statements on small-scale irrigation as an impact on sustainability of livestock production

SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree

Statement	**SA**	**A**	**UD**	**D**	**SD**
Small-scale irrigation has enabled the farmers to grow fodder and pastures					
The farmers have been able to get water for their livestock hence reduced deaths					
The farmers have been able to rear improved breeds					
The cows, camels and goats are able to produce more milk					
The livestock can now produce quality meat					
The improved breeds which require a lot of water can do well in the arid areas as a result of the irrigation					

Small-scale Irrigation has Enhanced Family Income.

Kindly rate the extent to which you agree with the following statements on small-scale irrigation as an impact on enhanced family income.

SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree

Statement	**SA**	**A**	**UD**	**D**	**SD**
Irrigation increases employment					
Small-scale irrigation schemes have resulted in increased production and income					
Food production from irrigated farms is a major source of wealth creation					
The crops and livestock have enabled the farmers to comfortably provide for their families					
The small-scale farmers are able to produce surplus food which they can sell					
The unemployed youths in the area can indulge in farming					

The influence of Irrigation Agriculture on External Livelihood Assistance.

Kindly rate the extent to which you agree with the following statements on small-scale irrigation as an impact on external livelihood assistance.

SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree

Statement	**SA**	**A**	**UD**	**D**	**SD**
NGOs undertake a wide range of water-related functions					
The government plays a critical role in creating an enabling environment for technology development					
The government should develop policies and regulations that influence irrigation equipment manufacture, importation, promotion and servicing					
The NGO's have drilled boreholes to be used for irrigation					
The government and other stakeholders provide training to the farmers					
The government allocates some money to the arid areas to be used for irrigation					

Appendix III: Interview Schedule for Farmers and Food Security Managers

In your own opinion do you think irrigation has played any role in livelihood sustainability in Makaror Locations?

Briefly explain the reason for your answer above

……

……

……

To what extent has small-scale irrigation diversified household crop-based food.

……

……

……

How has small-scale irrigation influenced sustainability of livestock production

……

……

……

How has small-scale irrigation enhanced family income?

……

……

……

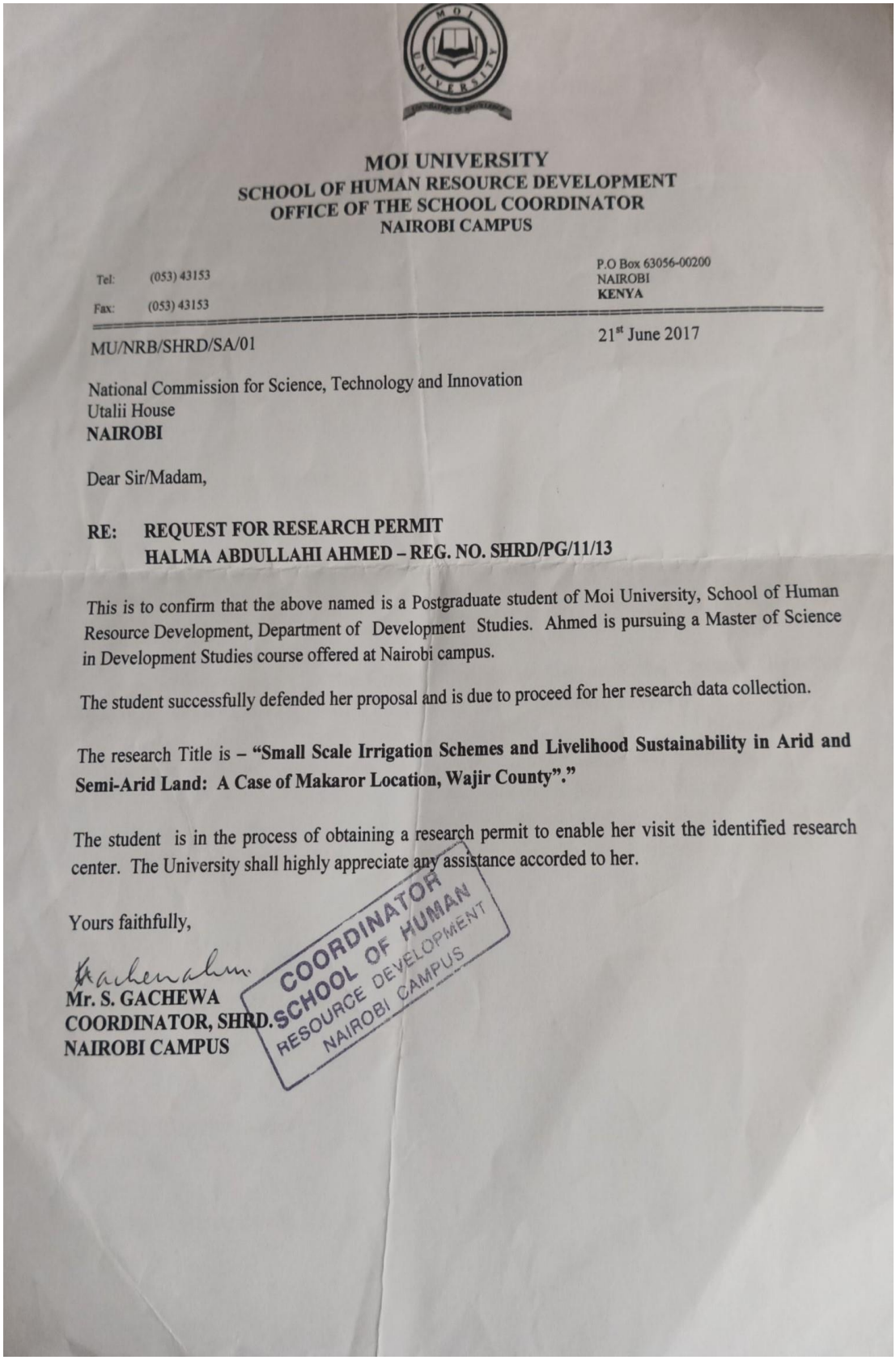
What are the influence of irrigation agriculture on external livelihood assistance?

……

……

……

Appendix IV: Moi University Introductory letter



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OFFICE OF THE SCHOOL COORDINATOR
NAIROBI CAMPUS

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P.O Box 63056-00200
NAIROBI
KENYA

MU/NRB/SHRD/SA/01

21st June 2017

National Commission for Science, Technology and Innovation
Utalii House
NAIROBI

Dear Sir/Madam,

RE: REQUEST FOR RESEARCH PERMIT
HALMA ABDULLAHI AHMED – REG. NO. SHRD/PG/11/13

This is to confirm that the above named is a Postgraduate student of Moi University, School of Human Resource Development, Department of Development Studies. Ahmed is pursuing a Master of Science in Development Studies course offered at Nairobi campus.

The student successfully defended her proposal and is due to proceed for her research data collection.

The research Title is – **"Small Scale Irrigation Schemes and Livelihood Sustainability in Arid and Semi-Arid Land: A Case of Makaror Location, Wajir County"."**

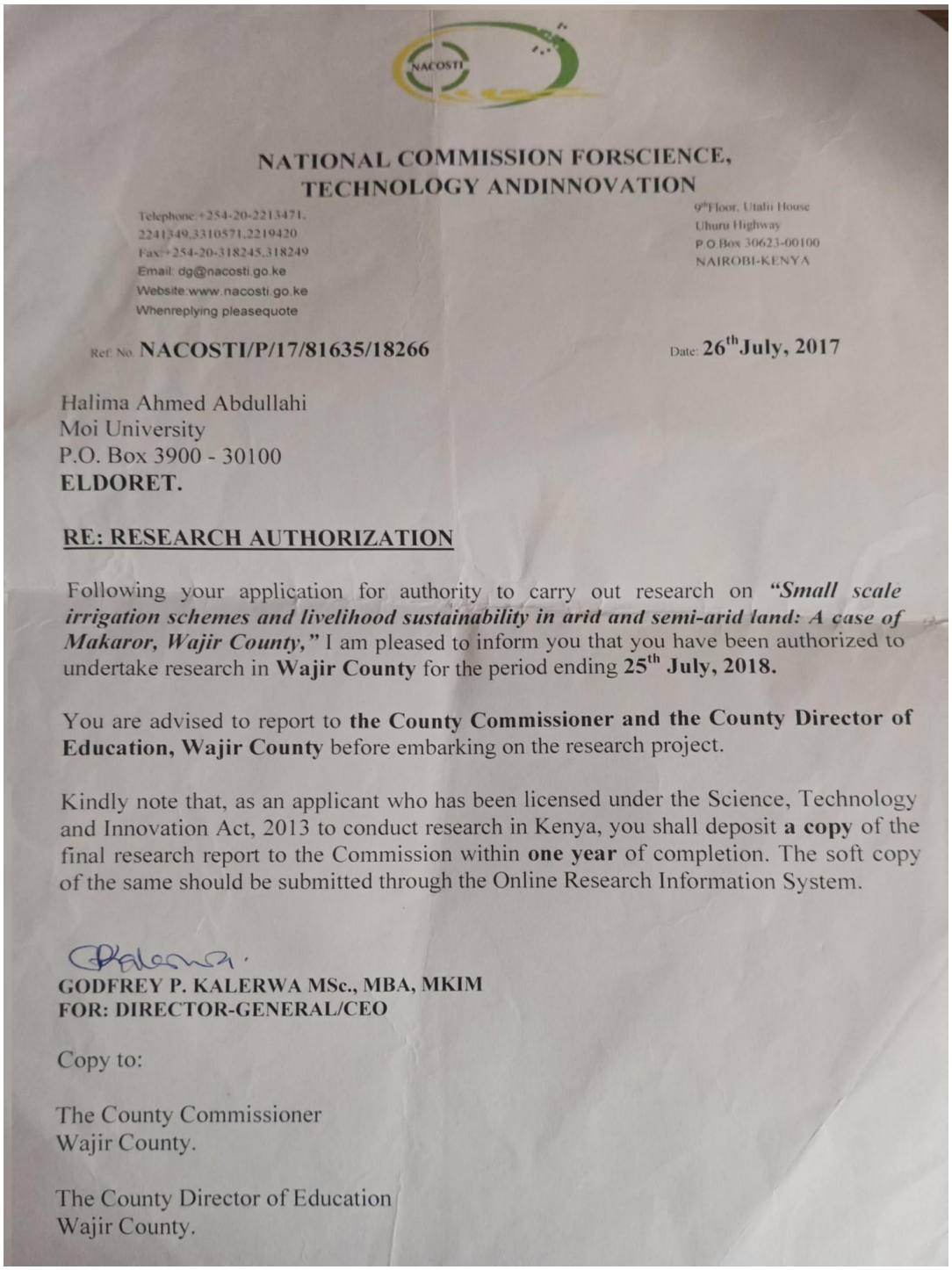
The student is in the process of obtaining a research permit to enable her visit the identified research center. The University shall highly appreciate any assistance accorded to her.

Yours faithfully,

Mr. S. GACHEWA
COORDINATOR, SHRD.
NAIROBI CAMPUS

COORDINATOR
SCHOOL OF HUMAN
RESOURCE DEVELOPMENT
NAIROBI CAMPUS

Appendix V: NACOSTI Authorisation Letter



NATIONAL COMMISSION FORSCIENCE,
TECHNOLOGY ANDINNOVATION

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NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/81635/18266**

Date: **26th July, 2017**

Halima Ahmed Abdullahi
Moi University
P.O. Box 3900 - 30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Small scale irrigation schemes and livelihood sustainability in arid and semi-arid land: A case of Makaror, Wajir County,"*** I am pleased to inform you that you have been authorized to undertake research in **Wajir County** for the period ending **25th July, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Wajir County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Wajir County.

The County Director of Education
Wajir County.

Appendix VI: Plagiarism Certificate

SR283

ISO 9001:2019 Certified Institution

EDU 999 THESIS WRITING COURSE

PLAGIARISM AWARENESS CERTIFICATE

This certificate is awarded to

HALIMA ABDULLAHI AHMED.

SHRD/PGD/11/13

In recognition for passing the University's plagiarism

Awareness test for Thesis: **SMALL-SCALE IRRIGATION SCHEMES AND LIVELIHOOD SUSTAINABILITY IN ARID AND SEMI-ARID LAND: A CASE OF MAKAROR LOCATION, WAJIR COUNTY**
With a similarity index of 18% and striving to maintain academic integrity.

Awarded by:

Prof. Anne Syomwene Kisilu
CERM-ESA Project Leader Date: 14/09/2023