FACTORS INFLUENCING SUSTAINABLE IRRIGATION OF SMALL SCALE DRYLAND FARMING IN KITUI CENTRAL DISTRICT, KITUI COUNTY, KENYA

BY

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DECLARATION

This research project report is my original work and has never been presented for a degree award in any other university.

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

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DEDICATION

This study is dedicated to my wife Halima Francis and children Simion Francis and Perera Francis for their patience and moral support as I conducted this research project.

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ABBREVIATIONS AND ACRONYMS

ASALs	Arid and Semi-Arid Lands
CAP	Chapter in (Kenyan Constitution)
CBS	Central Bureau of Statistics
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agricultural Organization Statistics (FAO Statistics)
GDP	Gross Domestic Product
GOK	Government of Kenya
GTZ	German Technical Corporation
HP	Horse-Power
IFAP	International Food Agricultural Policy
IFPRI	International Food Policy Research Institute
ILECF	International Lake Environment Committee Foundation
IMF	International Monetary Fund
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KShs	Kenya Shillings
LHP	Low Horse-Power
MA	Master of Arts
MoA	Ministry of Agriculture
MWI	Ministry of Water and Irrigation
NEMA	National Environmental Management Authority
NGOs	Non-Government Organization
NIB	National Irrigation Board
PRSP	Poverty Reduction Strategy Paper
SES	Social Ecological System
UON	University of Nairobi
WFP	World Food Programme

ABSTRACT

Purpose of this study was to investigate the factors influencing sustainable irrigation of small scale dryland farming in Kitui Central District, Kitui County, Kenya. The study was guided by the following objectives to: establish how land tenure; identify the extent to which national irrigation policy; establish how irrigation technology; determine the extent to which competitive alternative water uses; and identify how farmer's level of education and training had influenced sustainable irrigation of small scale dryland farming.

A descriptive survey research design was adopted. The target population was all small-scale dryland irrigation farmers in the district. In each cluster, a proportional 10% of the population was sampled. The small-scale farmers were grouped into three clusters Kalundu and Nzeeu river banks and those using shallow wells. From each cluster a sample proportional to 10% of the population was selected using simple random sampling to give 76, 61 and 13 a total of 150 small-scale farmers and 10% was given as the minimum sample size representing the target population by (Mugenda and Mugenda, 2003). A questionnaire and an interview guide were used for data collection. The instrument was pretested by a means of a pilot study.

In the pilot study, the questionnaire was administered on a random sample of ten small scale irrigation agriculture farmers who did not participate in the actual study and reliability was determined using a split-half method. During data collection the questionnaire was personally administered to 103 farmers as well as face-to-face interview with 47 of the selected farmers who were not able to fill in the questionnaire independently. The filled in questionnaire was collected before leaving each of the selected farmer to visit the next farmer.

Data was analyzed using descriptive statistics that utilized the frequency distributions; percentages; averages or mean values for concentrations of responses. Study results were presented in frequency distribution tables preceded by the findings' explanations. The study findings were that land tenure, irrigation policy, irrigation technology, water legal rights with competitive alternative water uses and farmers' level of education and training had significantly influenced sustainable irrigation of small scale dryland farming in Kitui Central District. The study recommendations were that for any state that wishes to maximize the land use, the traditional discriminative land tenure should be controlled by the government as it waives the intense politicization of land tenure.

The irrigation policy and technology should be supportive to the development and growth of small scale dryland farming in its provision for incentives that promotes small scale dryland farming establishments, in market access, credit access, transport and the general provision of the required infrastructural facilities that could help in enhancing sustainable irrigation of small scale dryland farming in most of the arid and semi-arid lands.

On the availability of water for irrigation, water legal rights and competitive alternative water uses the government should provide a level equal opportunity access to sustainable water source and supply in order to support a sustainable irrigation of small scale dryland farming programme that would change most of the arid and semi-arid lands to green with adequate agricultural produce.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Sustainable irrigation is defined pragmatically by (Abrams, 1998) as 'when the irrigation scheme continues to work overtime after the initial donor support has been withdrawn. In this study, sustainable irrigation has been used as the ability of the irrigation dryland farmers of 2-3 hectares of farm-land on intensive crop production to recover from the irrigation scheme's technical equipment breakdown and continued repair and maintenance under the local farmers' management. That is why the scholars Parry- Jones, Reed and Skinner, (2001) defined sustainable small-scale irrigation dryland farming as involving the notions of minimal external support, village-level financing and the continuation of beneficial service overtime, long after the withdrawal of donor support.

Sustainable irrigation of small scale dryland farming in the arid and semi arid lands (ASALs) like the case of Kitui Central District could only be achieved under sustainable irrigation of small scale dryland farming. The World Food Summit of 1996 defined sustainable irrigation of small scale dryland farming as "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Sustainable irrigation of small scale dryland farming pertains to multiple aspects including availability of arable land as influenced by the land tenure systems of a country; adequate water supply and water use legal rights; diseases; lack of peace; farmers' education and training levels which could enhance use of irrigation of dryland farming, irrigation technology and infrastructure for successful agricultural production and transportation (Gabre-Madhin, 2009).

Sustainable irrigation of small scale dryland farming could also be influenceed by the institutional, social, technical, environmental and financial dimensions applied to farming in an area with unreliable rainfall to support rainfed agriculture (Abrams, 1998). The world food insecure population is increasing at an alarming rate (Gabre-Madhin, 2009). In the year 2000, about 830 million people in the world were food insecure, but this has risen to 925 million in 2011 {(Jamah, 2011) as quoted in the Standard News Paper February 27th, 2011)}.

Sub-Saharan Africa alone is the home of nearly 240 million of chronically food insecure population, which makes 25% of the total population living in the developing countries (Jamah, 2011). But, agricultural production is declining significantly in Africa (Gabre-Madhin, 2009). In 1995, over one-third of the African continent grain consumption apparently depended on food imports (Aileen, 2003) and each year some 30 million people require emergency food aid. In the year 2000 food aid in Africa amounted to 2.8 million tonnes (Slater, Peskett, Ludi and Brown, 2007). However, rainfed dryland farming has failed to attain sustainable food production in the sub-Saharan Africa (Gabre-Madhin, 2009). Africa needs a sustainable irrigation technology for agricultural food production in order to improve in its agricultural food production to a level that can sustain the high population growth rate (Slater, et al., 2007).

In Kenya, the agricultural sector supports livelihoods of about 80% of the 41 million people (Government of Kenya (GoK): Population Census, (2009). The sector also accounts for 25% of the Kenya's national gross domestic product (GDP) and it is the second largest after service sector. Small-scale farmers account for over 75% of the total agricultural output and about 50% of the marketed agricultural produce (GoK, 2009).

Initiation and management of irrigation schemes in Kenya is delegated to the National Irrigation Board (NIB) by the Ministry of Water and Irrigation (MWI) which is legally mandated by the government to manage all irrigation related resources on behalf of the Government of the Republic of Kenya (GoK, 2009).

The board was established through the Irrigation Act of 1966 (CAP 347) of the Laws of Kenya, it is also subject to the State Corporations Act (CAP 446) of the Laws of Kenya, which guides the operations and functions of all Public Sector Corporations (Kinyua, 2004). The latest NIB irrigation policy is to normalize the operations and provide infrastructure for the existing irrigation schemes; restart stalled irrigation schemes through farmers' sensitisation and capacity building; initiate long term sustainability of irrigation schemes through self-owned initiated activities as well as to avoid interdependence of individual irrigation schemes; to increase farmers' participation in irrigation management; to expand irrigation development through assessments and to develop new irrigation schemes (GoK, 2009).

Change in freshwater availability is associated with global climate change. Karl, Melillo, and Peterson (2009) argued that agriculture, uses roughly 70% of the total global freshwater supply and so the agricultural sector is adversely influenceed by the global climate change. The global climate change influences the small-scale irrigation dryland farming worldwide due to the increased variability in precipitation and competing demands for fresh water supply challenging the capacity to maintain dryland irrigation agricultural output (Slater, et al., 2007).

Some of the irrigation technology constraints influenceing small-scale farming in ASALs include; high cost of equipments and their repair and maintenance, especially the motorized pumps (Baker, 2005). There is no collateral to safeguard loans either from the government agricultural finance corporation or from commercial banks in small scale irrigation farming (Karl, et al., 2009). However, income gains from small-scale irrigation agriculture are impressive (Omiti, Otieno, Nyanamba and Mccullouch, 2009).

On average a small-scale farmer on 2-3 acre-land of rainfed agriculture makes less than KShs. 60,000 gross income annually, compared to the same annual unit of land of irrigation agricultural gross income margins of KShs. 100,000 for Snow peas and French beans, KShs. 34,000 for Kale and KShs. 45,000 for onions (Omiti et al, 2009). However, only less than 50 000 hectares are used for small-scale irrigation which is very small compared to the estimated small-scale irrigation potential of 300 000 hectares and in total there is about 80 000 hectares of irrigation area in Kenya (Omiti et al, 2009). Kitui Central District is in the central hilly part of Kitui County, one of the driest Counties in Kenya (GoK, (2010) Kitui District Vision 2030).

In Kitui Central District, the main agricultural land use utilizes the unreliable short-rains' crop and livestock husbandry (Christian and Mbuthia, 2008). The rainfall pattern is bimodal but erratic and unreliable within the range of 500 mm to 700 mm annually (Vasudevan and Gichohi, 2008). Rainfed food production is unreliable, except among the farmers who grow crops such as millet, sorghum, green grams and cowpeas. Thus, there is rampant food insufficiency in the district (Vasudevan and Gichohi, 2008). Small scale irrigation of dryland farming is dominantly in the rural regions surrounding the Kitui County headquarters, but along the Kalundu and Nzeeu river banks with isolated cases of farmers who use water from their shallow wells for irrigation (Christian and Mbuthia, 2008). It is against this background that this study investigates factors influencing sustainable irrigation of small scale dryland farming in Kitui Central District, Kitui County, Kenya.

1.2 Statement of the problem

Although, there has been low small scale irrigation in Kenya as revealed in the background to the study, its contribution to the national income, employment, sustainable irrigation of small scale dryland farming and nutrition is recognized worldwide (Jamah, 2011). For example, the increasing demand for staple food and income generated from small scale irrigation agriculture in Africa is currently at KShs. 12,000 billion annually (Jamah, 2011). This shows that there is untapped food production and income generation potential from small scale irrigation farming. Given the policy support it deserves small scale irrigation of dryland farming is capable of solving not only food and income insufficiency, but also create employment opportunities (Christian and Mbuthia, 2008).

However, with this knowledge sustainable irrigation of small scale dryland farming issues have not yet been addressed in Kitui Central District (Vasudevan and Gichohi, 2008). In the Vision 2030 policy paper it was convincingly projected that Kenya would have attained an economically viable agricultural production which would be sustainable and commercially competitive in the global market by the year 2030 (GoK, 2010). however, three years later in 2012, down the line, there was yet no significant impact of implementation of the Vision 2030 agricultural food production initiatives in Kitui Central District that would show some improvement in the food production.

Consequently, rural poverty and food insecurity persists with the decrease of food aid and donor funding from the World Bank and International Monetary Fund (IMF) (Christian and Mbuthia, 2008). Approximately there are 93,000 people in Kitui Central District

(GoK: CBS-Population Census, 2009). This population still depends on relief food aid to meet its rainfed agricultural food deficits and farmers hardly get surplus for sell (Christian and Mbuthia, 2008). Although small scale irrigation of dryland farming can provide sustainable irrigation of small scale dryland farming and surplus for commercial purpose it has not been adequately adopted in the district. This study will investigate factors influencing sustainable irrigation of small scale dryland farming in Kitui Central District, Kitui County, Kenya.

1.3 Purpose of the study

Purpose of this study was to investigate factors influencing sustainable irrigation of small scale dryland farming in Kitui Central District, Kitui County, Kenya.

1.4 Objectives of the study

This study was guided by following the objectives:

i. To establish how land tenure systems influences sustainable irrigation of small scale dryland farming in Kitui Central District.

ii. To identify the extent to which national irrigation policy influences sustainable irrigation of small scale dryland farming in Kitui Central District.

iii. To establish how irrigation technology influences sustainable irrigation of small scale dryland farming in Kitui Central District.

iv. To establish the extent to which competition with other fresh water users influence sustainable irrigation of small scale dryland farming in Kitui Central District.

v. To identify how farmer`s level of education and training influences sustainable irrigation of small scale dryland farming in Kitui Central District.

1.5 Research questions

The following were the research questions that guided the study

i. To what extent do land tenure systems influence sustainable irrigation of small scale dryland farming in Kitui Central District?

ii. To what extent does the irrigation policy influence sustainable irrigation of small scale dryland farming in Kitui Central District?

iii. How does farmers' irrigation technology influence sustainable irrigation of small scale dryland farming in Kitui Central District?

iv. To what extent does competition with other fresh water users influence sustainable irrigation of small scale dryland farming in Kitui Central District?

v. How do farmers' education and training levels influence sustainable irrigation of small scale dryland farming in Kitui Central District?

1.6 Hypothesis of the study

Ho: There is no significant difference between the treated mean values of irrigation dryland 2-acre farm yields and the control mean values of rainfed dryland 2-acre farm yields at 5% significance level.

H_1: There is significant difference between the treated mean values of irrigation dryland 2-acre farm yields and the control mean values of rainfed dryland 2-acre farm yields at 5% significance level.

1.7 Significance of the study

From this study findings conclusions, recommendations and suggestions for further studies were made. The findings may unravel some impeding factors of sustainable irrigation for small scale dryland farming in the ASALs. In addition to visualizing the importance of sustainable management of irrigation for small scale irrigation of dryland farming and correct former farming impedance to enhance food security, income generation and employment opportunities. Development agencies may use these findings in enhancing their financing function and other linkage drivers for sustainable irrigation for improved small scale irrigation of dryland farming. Policy makers may understand that sustainable irrigation of small scale dryland farming can be managed through sustainable irrigation from small scale irrigation dryland agriculture by getting hold of the study area (Kitui Central District) situational analysis on sustainable irrigation for small scale dryland farming, hence helping them in designing new policy approaches for intervention. The Government through the Ministry of Agriculture and allied Ministries may use the study findings to enhance policy designs and formulation of suitable strategies for implementation of sustainable irrigation that would help in promoting small scale irrigation of dryland farming especially in Kitui Central District, Kitui County, Kenya.

1.7 Delimitations of the study

The research focused on a sample of 150 small scale farmers in Kitui Central District who either or not sells a proportion of their produce in the market. Kitui Central District and covered only the factors influencing sustainable irrigation in small scale irrigation of dryland farming. The research also compared between rainfed and irrigation of small scale dryland, 2 acres farm yields (number of 90 kilograms bags produced). The findings may be useful in contributing to the existing additional literature for future studies on sustainable irrigation in small scale irrigation of dryland farming. The study findings may also be useful to other researchers for comparisons.

1.8 Limitations of the study

Study limitations such as time and finance constraints were anticipated while conducting the study: extra funds were sourced with minimisation on costs as well as working for longer hours to hit the threshold time limit. The irrigation characteristics of Kitui Central District may not be homogeneous to those of the other places. Thus, it was advisable that the findings be cautiously generalizable to other regions. Since most of the small scale farmers work throughout the day, thus to give proper attention to filling in the questionnaire was a limitation. However, the farmers were visited several times and ensuring that the questionnaire was reasonably short. Item's interpretation differences were solved using personal counterchecking and triangulation to ascertain uniformity of data.

1.9 Assumptions of the study

The study assumptions were that small scale irrigation farming had adequate farmers for a representative sample of the study. Small scale dryland farming study may contribute to sustainable food security, create employment and increase small scale farmer's income. Data collection had not influence the farmers' responses to ensure unbiasedness in the study results.

1.10 Definition of significant terms

Dryland farming: refers to the agricultural activities on any sized piece of land in areas with unreliable rainfall that hardly supports rainfed food/crop and livestock production.

Farmer's level of education and training: is defined in this study as the highest level of education and training sector or class completely attained by the farmer.

Food security: all people, at all times able to have physical and economic access to sufficient and nutritious food for active and healthy lives.

Land tenure: is here explained as usually involving the rules that govern the land tenure and the related land owned property with legal property rights for ownership.

Low-cost irrigation technology: as defined in this study refers to irrigation on small plots where farmers have the major controlling influence and using a level of technology which farmers can influenceively operate and maintain.

Policy: refers to guidelines for accomplishing a proposed plan of action on activities aimed at improvement or development of any area of concern, usually designed by politicians.

State imposed land tenure systems: is the state guaranteed individual registered land title deed and land user rights which do not offer greater land use security rights in African countries.

Sustainable small-scale irrigation: is 2-3 hectares of farm-land under irrigation with the farmers' full control over irrigation technology used and its non-biodegradable influence operation and maintenance.

Title deed: is a state guaranteed individualized land titling registration certificate in a registered land tenure systems.

1.11 Organization of the study

This study was organized into five chapters. Chapter one was the introduction of the study and it consisted of the background to the study; statement of the problem, purpose and objectives of the study, research questions; significance, delimitations, limitations and assumptions of the study and operational definition of terms.

Chapter two was the literature review that supports the study and it comprises of introduction of the chapter's content; then the literature review presented according to the objectives of the study and the theoretical and conceptual frameworks are presented at the end of the chapter.

Chapter three was the research methodology and it consists of research design, target population, sampling procedures and sample size, research instruments with their reliability and validity, data collection procedures and analysis, logistical and ethical considerations in the study and Operationalisation of the study variables.

Chapter four presented data analysis, interpretation and presentation. It starts with the analysis of biodata of the irrigation small scale dryland farmers and the rest of the chapter is arranged according to the objectives of the study. Chapter five was the summary, conclusions, discussions and recommendations of the findings and suggestions for further studies on irrigation of dryland farming.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter consists of: introduction; description of the factors influencing sustainable irrigation for small scale dryland farming according to the objectives of the study such as: influence of land tenure; national irrigation policy; irrigation technology; competitive alternative water uses and how farmer's level of education and training influences sustainable irrigation of small scale dryland farming in Kitui Central District

2.2 Influence of land tenure on sustainable irrigation of small scale dryland farming

Land tenure is a complex issue which should be allowed to develop or evolve with changing socio-economic and cultural conditions of a given community (Cifdaloz, Regmi, Anderies and Rodriguez, 2010). Traditional or customary land tenure systems offer as much security as any other system provided that communities have legal ownership and authority over their land and irrigation system. Governments can strengthen this tenure system by supporting and empowering local communities (Cifdaloz et al., 2010). Highly centralized systems of governance, combined with bureaucratic top down decision making, tend to impose decisions on local people at the irrigation project's grassroots level. This is a weak government in terms of its influenceiveness, impact, accountability and transparency because it denies its citizens their creativity as well as self-innovativeness (Cifdaloz et al., 2010).

Governments have to fully understand traditional and indigenous tenure systems before radical attempts are made to alter them for ideological or purely political reasons. These tenure systems have survived a century of neglect, abuse and exploitation by colonial and contemporary governments (World Bank, 2006). Above all, these tenure systems require support to strengthen local institutions and empower local communities in administering tenure and allowing the tenure system to evolve over time. Tenure security in terms of exclusive rights of groups and individuals it has hopefully been argued, are the very basis of political and social power and status (FAO, 2005). When such rights are overly subordinated to the state, it follows that the political rights of rural people are diminished and that democratic processes and institutions are undermined. This diminution of rights and undermining of democracy is a major cause of tenure insecurity, with resultant negative impact on agricultural productivity and the management of natural resources, particularly on communally held land and irrigation systems (FAOSTAT, 2004).

Most modern smallholder irrigation systems are controlled and managed by state organs. Governments have attempted to replace customary land tenure systems with state guaranteed individual rights (Ashley & Maxwell, 2001). In general, state imposed individualized land tenurial systems do not necessarily offer greater security for African land users, because of the weaknesses of the Government Institutions in Africa. Therefore, possession of land title deeds or land-use rights is closely associated with poverty. As a rule very poor farmers either have no land title or partition of their land has led to extremely small-scale farm holdings, and this means that they are not creditworthy. Such farmers are for this reason unable to undertake irrigation measures or make long-term investments initiatives on such piece of land (FAO, 2005).

However, land titling and registration programmes have generally not yielded positive small scale irrigation of dryland farming benefits (Cifdaloz et al., 2010). Moreover, formal land title deed does not necessarily increase the individual's land tenure security

(Baker, 2005). The indigenous land tenure systems are dynamic and evolve with changing social, economic, cultural and political circumstances. As cited in (Moore, 1996), Bruce, Mighot-Adholla and Atherton (1993) provide evidence that customary land tenure user rights evolve towards more alienable individual rights as population pressure increases and as agriculture becomes more commercialized. Close to two thirds of the natural wealth in developing, low-income countries is embodied in crop and pasture land (World Bank, 2006). Although, land tenure in many African countries is characterized by dualism; i.e. the co-existence of large-scale commercial farms, owned by the elite and the powerful, and small-scale customary holdings mainly owned by the poor local peasant who constitute the majority in all the countries, the small-scale farm holdings contribute to the bulk of the domestic food/cash crop and livestock production (Kurwijila, 2004). In this type of orientation, small scale farmers have suffered historical land tenure injustices since the colonial times. This implies that, small scale irrigation of dryland farming has been lagging behind in most African countries and Kenya is not an exemption.

Kurwijila (2004) argue that land reforms are yet to be fully realized in Africa. African states' inadequacy to formulate good and clear land tenure policies has encouraged land fragmentation. For example in Kenya, 47% of households live in 1.5 acre-piece of land and 89% in less than 3 acres-piece of land due to the land fragmentation issue (Kinyua, 2004). Therefore, the inability to enter into formal land transactions and use of land as collateral for credit access has remained a constraint to small-scale irrigation of dryland farming. In addition the family's ability to feed itself and to produce for commercial orientation has been falling (Kinyua, 2004). This has been reflected by decline in per capita food and cash crop production in Africa (FAO, 2005).

Despite the land tenure system's problem. Kurwijila (2004) mentions the elements of land tenure without discussing their implications to the small scale irrigation of dryland farming. He has also omitted land tenure fees and land hire which are common in the small scale irrigation of dryland farming (Carter, 2006). The two economic fallacies that Kurwijila (2004) associated with state imposed individual land tenure reforms are: First the fallacy of economies of scale in agricultural production and the second fallacy is the traditional state view that multiple parcels of land in separate locations are inefficient for agricultural production (Kurwijila, 2004). However, worldwide small-scale farms can be highly economical and efficient just the same way the large-scale farms do. There exists great wisdom in smallholders having multiple parcels of land in separate locations, because of the parcels varying potential and/or suitability for a wide spectrum of crops a variety of these crops are grown (FAOSTAT, 2004).

State imposed land tenure reforms from the traditional communal land tenure to a registered title deed land tenure system in Kenya has experienced problems based on the fundamental interpretation of the tenure rights under customary law (Bruce, et al., 1993). Often, traditional inheritance and succession laws supersede the implied statutory laws of interstate inheritance. Moreover, in most matrilineal African societies, registered title deed land tenure system usually means that only the individual name of the male head of the household appears on the title deed. Since a title deed is a non-negotiable property, women and dependent children are often prejudiced when family owned land property is to be transacted or foreclosed on business transactions in which they are not involved (Bruce, et al., 1993).

In most African customary laws, the male heads the family but land is a property that belongs to the whole family (Christian and Mbuthia, 2008). Wives and dependent children, therefore, should have inalienable rights to sub-division or inheritance. Thus, the immediate family has to be party to or concede to any land transactions or mutations that may influence its immediate and/or future land tenure and user rights or interests (Cifdaloz et al., 2010). The cultural laws and practices of family rather than individual rights are the basis of Africa's celebrated social security system in the traditional communal land tenure. The traditional communal land tenure system is still relatively cost-influenceive, compared to the state imposed land tenure system and its cost-influenceiveness is unlikely to be replaced by the state social security registered title deed land tenure system into the future of the African cultural laws, beliefs and practices (Cifdaloz et al., 2010).

State land is often used by the public sector but, more importantly, most land under indigenous customary tenure, is usually designated as state land (Meinzen-Dick, 2007). This poses the most serious land tenure insecurity and lack of exclusivity and insecure land use rights. In all land tenure systems, the rule of law and how it is applied, importantly determines the security of the land use rights. Therefore there is no land tenure system that is good or bad, right or wrong; rather, it has to be secure, appropriate and to facilitate indiscriminative land use needs in the society (Meinzen-Dick, 2007).

2.3 Influence of irrigation policy on sustainable irrigation of small scale dryland farming

African governments have paid a lip service to its rural poor population in smallholder irrigation dryland agriculture, through unclear policy framework and institutional inefficiencies (McIntyre et al., 2009). In general these governments continue to tax the small-scale irrigation agricultural sector as well as treating it equally to its superior service sector counterpart. The states also offer cheap food protection interests of the urban minority, who are more politically powerful than the rural majority (Janssen and Anderies, 2007). Although, economic growth is ultimately the solution to poverty and hunger, it must be supported a sustainable agricultural production policy whose ultimate goal is to increase food/cash crop and livestock production among small scale irrigation dryland rural poor farmers in Africa (Janssen and Anderies, 2007).

However, such a policy framework is difficult to come by under the present political circumstances where the ruling political parties and the economically powerful private sector are urban biased. Small-scale irrigation dryland agriculture is indeed pro-poor, pro-rural and pro-women and therefore, the African governments should invest more in this sector (North, 1994). While the ASALs lack water, their soils are, in part, highly fertile (North, 1994). It is entirely possible to achieve high and sustainable agricultural yields in the ASALs fertile pockets, if they are irrigation. Development of irrigation agriculture in these regions would thus be a good option for a poverty-oriented approach with availability of water resources (GoK: Poverty Reduction Strategy Paper (PRSP), 2000). Structural adjustment programmes inadvertently contributed to the weakening of African state institutions through blanket policies of budgetary austerity (North, 1994). Through an understanding of the agricultural policy which does not empower smallholders to have a voice in the search for opportunities and solutions to their problems adds to the short-comings of sustainable irrigation (North, 1994). If agricultural institutions are not guided by the needs of the rural majority, then it follows that individual agricultural institutions must have increased incentives to be creative and responsive and to interact and function as a system (Janssen and Anderies, 2007).

Agricultural service organizations have the challenge to examine their operational inter-institutional relationships (Fujiie, Hayami and Kikuchi, 2005). Farmer organizations representing smallholders as well as water users' associations are generally unable to institutionalize collective action on a special interest basis. The balkanization of smallholders, with limited capacity for collective action has created a political and institutional vacuum in rural areas of Africa. The successful political and economic systems are those which seem to have evolved flexible institutional structures that can survive the shocks and changes that are a necessary part of successful evolution (Fujiie, et al., 2005).

Elements of a sustainable irrigation policy framework that need to be given consideration are: participation of all relevant stakeholder groups in both policy formulation and implementation of the individual measures adopted; ecological sustainability, that is the water consumed on a water-body must not be allowed to exceed the safe yield; a poverty orientation mindful of the need to equitably allocate water both within and outside irrigation schemes (Fujiie, et al., 2005). Adequate consideration of other water uses that may be in competition with irrigation schemes (drinking water, water for cattle and wildlife, water for ecosystems; equal consideration for water-quality issues; equal consideration for land-use issues, land-rights issues, and the land-management issues bound up with a countrywide introduction of good agricultural practices (Barker and Molle, 2004).

2.4 Influence of technology on sustainable irrigation of small scale dryland farming

Kenya is already utilizing, the low-cost technology for small-scale irrigation defined in this study as irrigation on small plots where farmers have the major control influence and use of any level of technology which the farmers can influenceively operate and maintain (Meinzen-Dick, 2007). Many different technologies and techniques are used for water collection and distribution for small-scale irrigation in Kenya, including rainwater harvesting, bucket irrigation, gravity fed sprinkler and drip, treadle and pedal pumps, rope and washer, motorized pumps, wind-power and construction of small earthen dams (Meinzen-Dick, 2007).

Inexpensive simple gravity and pump sprinkler systems for horticultural crops have been extremely profitable investments. Their numbers are growing fast in high-potential areas such as on the slopes of Mt. Kenya where commercialization of horticultural crops for domestic and international markets is in full swing. However, the spread of this technology to cover most of the estimated potential irrigation area is limited by physical conditions and increasing competition for water. Field practices are techniques focused on keeping water in the field, distributing it more efficiently, achieving better soil moisture retention (Verhallen, et al., 2003).

Techniques focused on keeping water in the field, distributing it more efficiently, achieving better soil moisture retention are typically less expensive than management strategies or system modifications (Evans, 1998). When traditional field practices fall short of expectations and the management strategies and systems modifications discussed below are out of reach, the field practices of dry-land farming are another avenue to explore. Examples of Dry-land farming field practices include: The chiseling of extremely compacted soils; Furrow diking to prevent runoff; Land leveling for more even water distribution (Verhallen, et al., 2003).

In order for dry-land farming to be feasible for farmers, it often must be accompanied by financial incentives like conservation easements, which involves the transfer of development and/or land use rights to a government agency or non-profit providing tax benefits or direct payment for retirement of the land (Kromm and White, 1990). Management strategies allow the irrigator to monitor soil and water conditions to ensure water is delivered in the most efficient manner possible (Evans, 1998). By collecting this information, farmers can make informed decisions about scheduling, the appropriate amount of water for a particular crop, and any system upgrades that may be needed (Anderson and Heimlich, 2000).

The methods include: measuring rainfall; determining soil moisture; checking pumping plant efficiency; and scheduling irrigation (Evans, 1998). Farmers have to rely on a number of factors to monitor soil moisture, including temperature and humidity, solar radiation, crop growth stage, mulch, soil texture, percentage of organic matter, and rooting depth. The government of Queensland (2002) in Australia has done an influenceive job of compiling a fact sheet on a variety of irrigation scheduling tools, including the associated pros, cons, and costs of each (Anderson and Heimlich, 2000).

To ensure that pumping plants are running at their most efficient guarantees that water is being delivered to the plant and not wasted (Evans, 1998). A pump in need of repair or adjustment cannot only waste water but also cost money (Anderson and Heimlich, 2000). The management strategies described above allow for the correct amount of moisture to be delivered to the plant. When combined with system upgrades, farmers can maximize the amount of water savings and the efficiency of their land (Verhallen, et al., 2003). While this is not an automatic replacement for a dam, there could be an opportunity for removal or the ability to delay construction a new barrier, depending on the size of the diversion (Kromm and White, 1990).

Monitoring the water needs of crops in the most efficient manner possible requires technological upgrades that require an initial outlay of capital (Evans, 1998). In addition to the cost of implementing these system upgrades, there may be training required to integrate new computer systems and others (Verhallen, et al., 2003). System modifications, often the most expensive of the three categories, require making changes to an existing irrigation system or replacing an existing system with a new one (Evans, 1998).

Typical system modifications that allow for the most efficient delivery of water are: Add drop tubes to a centre pivot system and retrofitting a well with a smaller pump (Evans, 1998). Replacement irrigation systems include: installing drip irrigation, micro sprinklers, or solid set systems; or constructing a tail water recovery system (Kromm and White, 1990). Many farms still use inefficient irrigation techniques like travelling gun, and centre pivot, which apply more water than crops require (Bureau of Reclamation, 1996).

Modern irrigation technology, such as drip irrigation, micro sprinklers and solid set systems can deliver water much closer to the actual plant and achieve much greater water efficiency (Evans, 1998). These irrigation tools are the most efficient in terms of delivering water to crops. They use the latest technologies to determine the exact amount of water a crop needs in order to grow and delivers the water directly to the plant.

However, they often prove most efficient when used with vegetable and fruit tree crops and less so with dense grain crops (Verhallen, et al., 2003).

Low horsepower (LHP), diesel pumps are also very popular among farmers who can afford them, the pumps are not inexpensive -typically selling for KShs. 50,000- KShs. 70,000 for 3-5 HP pumps (Meinzen-Dick, 2007). There has been no revolution in pump technology in small-scale irrigation in Kenya due to the equipment's costs, especially motorized pumps costs, are still high. Pump breakdowns are major problems; farmers are not trained to maintain pumps and do not know the spare parts for these pumps (Meinzen-Dick, 2007). Irrigation small scale dryland farmers do not have collateral to safeguard loans either from the government agricultural finance corporation or from commercial banks (McIntyre et al., 2009). Overall, the government has put a lot of effort into crop and livestock research; but much less effort has gone into support for agricultural engineering towards improvement in sustainable small-scale irrigation. Thus, knowledge and capacity for technology development and application is lacking. Overall, there remains little national awareness of innovative, lower-cost technologies (Baker, 2005).

2.5 Influence of water legal rights on sustainable irrigation of small scale dryland farming

Climate change will influence where, when, and how much water is available for all uses (Karl et al. 2009). Barker and Molle (2004) have argued that irrigation agriculture, which consumes an estimated 70% of developed water supplies and produces 40% of global agricultural commodities from 17% of the global cropped area, is likely to experience significant impacts from climate change. The 90% of farms worldwide are less than 2 hectares in size which support majority of the world's poorest people (McIntyre et al. 2009). Understanding the impact of climate change on small-scale irrigation systems is of critical importance (Baker, 2005).

Although there are many points in a linked Social–Ecological System (SES) in which water users and irrigation departments may intervene to ensure influenceive and efficient use of water in response to these challenges (Meinzen-Dick, 2007), experience suggests that interventions that are narrowly focused are unlikely to improve performance (Hall, 1999). For example, massive investment by states throughout the world carried out from 1950 to 1980 to expand irrigation infrastructure have been unsustainable (World Bank, 2006). Examples of failures, due to a variety of factors including poor system management and service provision and poor understanding of farmer priorities as quoted by (Ostrom, 2002), include the Jamuna project in India (Anderson and Heimlich 2000), the Mahaweli in Sri Lanka (Jayawardene 1986), the Dez Pilot in Iran (Levine, 1980) and many major projects across Asia (Bromley, 1982).

Experiences with high costs and underperformance of large-scale irrigation systems have resulted in reduced investment in these schemes (Jones, 1995). This places significant pressure on existing small-scale irrigation systems (Baker, 2005) to maintain the livelihoods of millions of people around the world. It also raises important questions related to identifying the productive limits of the small-scale irrigation systems in determining how they may become vulnerable as their limits are reached, and assessing their capacity to cope with global climate change (Ostrom, 2002). The associated policy challenge is to identify points of intervention to strengthen community-managed, small-scale irrigation systems and to organize large-scale systems to capture the strengths of the small-scale ones (Ostrom, 2002).

Irrigation systems are comprised of human agents along with physical infrastructure, social infrastructure like (trust, reciprocity and structured relationships), institutional infrastructure like (water legal rights and rules, labour allocation rules and collective choice rules) and biophysical processes that interact in complex ways (Baker, 2005). For example, engineers and policy analysts have frequently not understood why farmers employ diverse rules across irrigation systems and switch between multiple rules depending on conditions (Lansing, 1991).

There are still numerous small-scale, community managed irrigation systems including in the Zanjera societies of the Philippines and indigenous systems of Northern Thailand, China, Laos, Japan, India, and Nepal serve a third or more of the total irrigation area in Asia (Barker and Molle 2004). This proportion stands at 75% in Nepal (Regmi, 2008). Not only have these systems proven sustainable, they distribute water more equitably, maintain their infrastructure better, and produce higher yields than larger state funded irrigation systems with better infrastructure (Regmi, 2008).

Detailed analysis of the relationship between irrigation system's performance and robustness–vulnerability trade-offs contributes to the ongoing development of tools to help tailor policies to the local social and biophysical context and to move beyond policy panaceas (Ostrom et al. 2007). Water management for sustainable dryland irrigation should be looked at in connection with the influences of climate change. Kenya should be prepared to come to terms with major and growing uncertainties regarding precipitation regimes (GoK, 2010). Irrigation agriculture influences both the quantity and the quality of available water resources. One precondition of sustainable water resources management is a reliable database on available and utilizable water resources (GoK, 2010).

Constantly growing degradation of water catchment areas and increasing erosion, poses a fundamental challenge to the environmental sustainability of irrigation in Kenya (Nissen-Petersen, 1982). Challenges facing sustainable irrigation for small-scale dryland farming are with scarce water resources, environmental influences on deforestation, soil degradation, crop diversity, migration and withdrawal of public funding (Slater et al., 2007). It is against the backdrop of these challenges that this study will investigate factors influencing sustainable irrigation for small-scale dryland farming with the increased variability in precipitation and freshwater availability related to climate change (GoK, 2009)..

Generally it is still possible to expand irrigation in Kenya; even though the country has scarce water resources, experts are of the opinion that no more than 20 percent of the safe yield of the country's water resources has been tapped (World Bank, 2006). One difficulty involved in selecting suitable locations to expand irrigation in Kenya, is that the places where the greatest water-resource development potentials have been identified are often sparsely populated; one needs to think here only of the land along the Tana River (GoK, 2009).

However, it is recommendable to expand irrigation only in places with higher population density for sustainable and viable irrigation (GoK, 2010). Small-Scale Irrigation structures should be given precedence over Large-Scale Irrigation structures, because the former are much easier for farmers to manage (GoK, 2009). As provided under current legislation, it is important always to have the National Environmental Management Authority (NEMA) conduct an environmental assessment before any concrete plans are drawn up to expand irrigation. Smallholder irrigation farming generally enjoys water rights via a third party, usually a State Bureaucrat holding such water rights in trust for the local irrigation community (Rukuni, 1994).

This situation exacerbates the already insecure land tenure situation and smallholder irrigators' rights are often susceptible to State and Political Interference (Rukuni, 1994). Water is the most essential development commodity in this area; the major sources in Kitui County are the ephemeral rivers. Water scarcity forces women and girls to walk up to 20 kilometres in dry periods to water sources such as springs and scoop holes (FAO, 2005). The development of boreholes in Kitui County like the rest of Kenyan Counties is primarily the business of donors, the government and the churches (De Bruijn and Rhebergen, 2006).

The costs involved in the drilling and equipping of a borehole 100m deep are high and it was worked out in the early 1990s at some Ksh 2 million. However, the sponsoring agency providing the rural water project service should ensure community participation for sustainability of the projects once they leave (De Bruijn and Rhebergen, 2006). The main economic activity in Kitui Central District is charcoal burning, basket weaving and subsistence rain-fed dryland farming which hardly produce any excess farm outputs above the household's domestic consumption. This means that most of the households in the district are income-poor not unless some members of the households are in salaried job employment (Vasudevan and Gichohi, 2008).

2.6 Influence of education and training on sustainable irrigation of small scale dryland farming

Farmers with little education and training are often insufficiently prepared for either irrigation tasks or land management (Anderson and Heimlich 2000). They often lack knowledge about sustainable land management and integrated plant protection. Targeted training for farmers in both issues is thus an urgent need. In particular in cases involving the introduction of farming to nomads or people who live from fishing; the target groups as a rule lack traditional preliminary farming know-how (Rukuni, 1994). There is need for greater empowerment of communities through education and training over the conservation of their environment. Knowledge is power, with education and training greater empowerment of the rural communities could be attained (GoK, 2010).

At the provincial level, coordination between irrigation authorities and agricultural authorities is essential as a means of harmonizing training measures and combining them in reasonable ways (Blank, Mutero & Murray-Rust, 2002). After training the farmers, delegation of responsibility and authority and creating administrative and institutional mechanisms that are legitimate, influenceive and accountable in the control of land use and natural resource utilization was possible (German Technical Corporation (GTZ) (Carter, 2006).

Communities, can utilize common property resources influenceively and sustainably, provided they clearly benefit from the resources and they are empowered through local level institutions and training (Blank, et al., 2002). This concept needs to be extended to the use and management of water resources by the small scale irrigation agricultural communities (Carter, 2006). Irrigation can be used to sharply improve food security, in both quantitative and qualitative terms (Blank, et al., 2002).

However, the incomes generated in this connection play less of a role due to marketing problems, expected in the areas where these vulnerable people live (International Lake Environment Committee Foundation (ILECF) (Carter, 2006). Nomads can benefit from an irrigation approach that creates sustainable irrigation of small scale dryland farming in addition to making a good economic sense, as in the comparison of sustainable irrigation of small scale dryland farming gained with the costs that would have otherwise been required to provide food aid for them (Carter, 2006). In developing countries, rural household farmers have limited resources to support a large proportion of the population, who do not dominate the agricultural production sector.

Thus, the availability of education and training on the agricultural research and technologies to these household farmers is crucial towards ensuring sustainable food supply (IFAD, 2006). Education and training has been supported in research as one of the ways that ensures stable food production and supplies as well as alleviation of poverty due to its ability to enhance the farmers' adoption of innovative modern methods of farming (Ahmed and Carlo, 2006). While lack of education and training endangers a state of poverty, poverty itself hinders the advancement of education and training. Poverty forces families to employ children at home and in the fields to provide income for their households (Ahmed and Carlo, 2006).

Impoverished households, in many cases, cannot pay school fees for their children, and the necessity of earning income for survival of the household discourages them from educating their children (Ahmed and Carlo, 2006). Goklany (2007) asserts that education and training closely relates to increased food production and food access, a relationship that also intersects with the relationship between good health and greater wealth. Both of these relationships promote progress, economic growth and technological change.

If people get education and training that allows them to gain sufficient income and obtain food for survival, the state of poverty and hunger is reduced. Thus, educating the youth can be useful in addressing the current and future food insecurity, through adoption of irrigation of small scale dryland farming with the application of appropriate irrigation technology (Goklany, 2007).

Small-scale farmers in Kenya account for 75% of total agricultural production, allowing them to dominate the sector because they produce over 70% of maize, 65% of coffee, 50% of tea, 90% of sugar, 80% of milk, 85% of fish, and 70% of beef and related products on small land holdings of two to three hectares (Hazell, 2006).

Ensuring that the small-scale irrigation dryland farmers are educated means that they have the knowledge to increase farm production which is the first part of the farm produce marketing chain. With knowledge to increase farm production, the other factors like to ensure that they have access to arable land, markets and ability to export products would be organized by use of this education and training to enhance increase in agricultural productivity.

Hazell (2006) states that although farmers need access to land, appropriate technology and key inputs like seed, fertilizer and access to credit, this might not be the end by itself. Farmers' limited access to land, infrastructure, technology and poverty-related factors are not the only barriers to improving food security, but the key barrier would be lower levels of education and training which acts as the organizer of the other factors of agricultural production.

2.7 Theoretical framework

This study is based on the Janssen and Anderies (2007), after Irrigation Management Transfer (IMT) viability theoretical framework for a sustainable dryland farming irrigation scheme. The broad objective of IMT is to increase irrigation performance while reducing constraints on public budget. It is a strategy to improve economic conditions by reducing the role of the state or its agents through privatization and empowerment of local communities.

The underlying principle is to encourage farmers and local communities to take responsibility for the management of local resources, and thereby limit external interventions to the provision of information and institutional support services that enhance efficient resource allocation (Janssen and Anderies, 2007).

Janssen and Anderies (2007) defines viability as the ability of the irrigation scheme to generate sufficient income to satisfy the household income expectations of the irrigators and to cover basic operational and maintenance costs of the irrigation infrastructure, while not mining the natural resources (soil and water).

Janssen and Anderies (2007) also postulates that although income expectation may differ widely across cultures and among individuals, it is much related to the relative role irrigation plays in the income functions of individual irrigators. Janssen and Anderies (2007) have developed their Irrigation Scheme's Viability Theoretical Framework from International Water Management Institute's global studies on sustainable dryland farming irrigation schemes such as (Svendsen, 1994; Brewer et al., 1999).

However, these studies have stressed on getting the right sustainable dryland irrigation process along with the favourable technical, legal and institutional conditions' viability, while, Janssen and Anderies (2007) have emphasized on the fact that dryland irrigation scheme's viability after IMT will further depend on the costs of sustainable self-management and reliance of the farmers on their sustainable irrigation.

2.8 Conceptual framework

Conceptual framework is a graphical/narrative of relationships of the study variables-network where the independent variables network with moderating/intervening and the outcome also called dependent variable is the output (Orodho, 2005). This is shown in Figure 2.1 below.

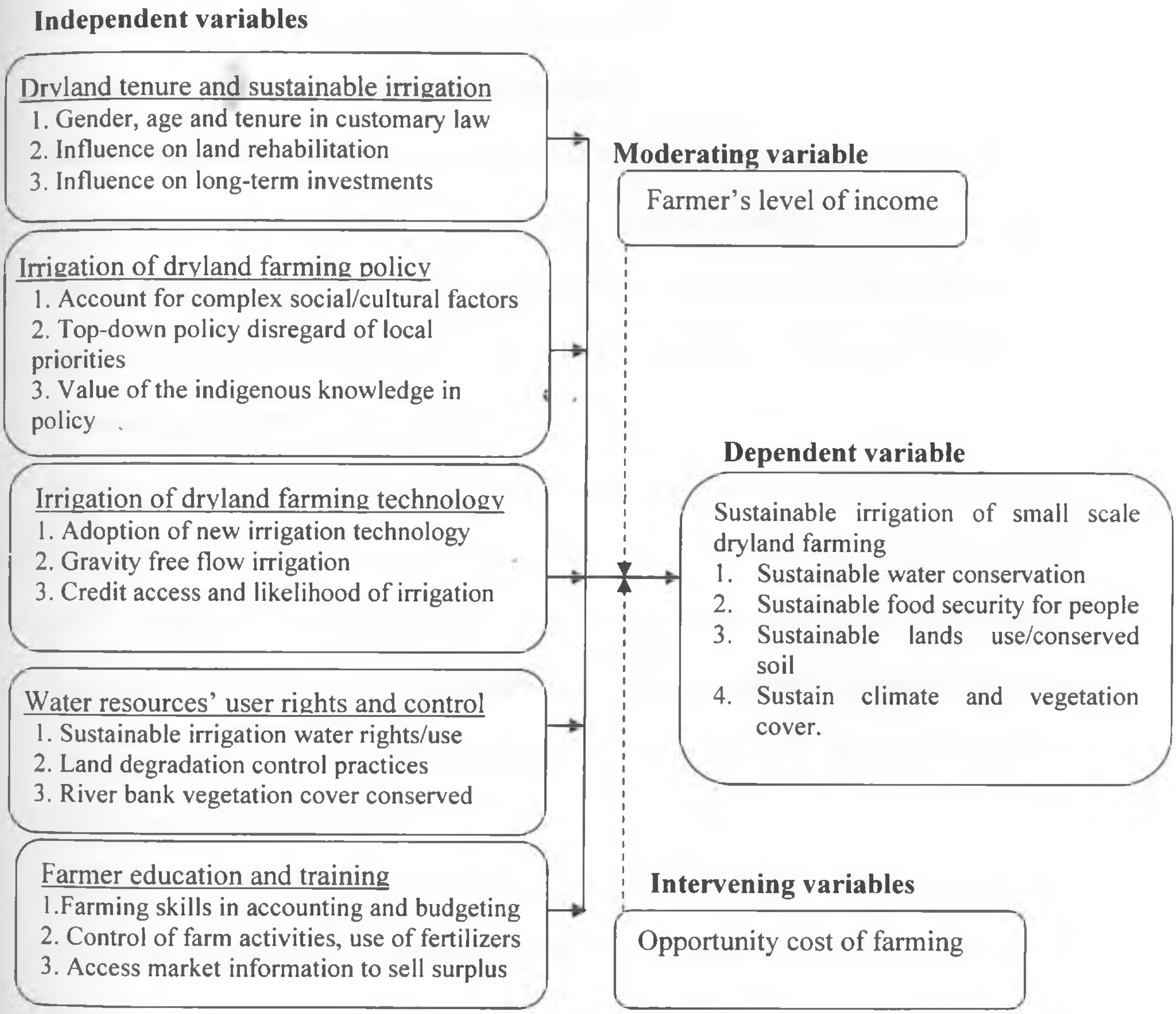


Figure 1: Conceptual framework for sustainable irrigation of small scale dryland farming

Insecure land tenure reduces people's incentives to make long-term investments in rehabilitation of land and maintain soil quality because they have no long-term or permanent rights to the land. Customary land tenure practices and laws may guarantee people's land tenure rights over legislated registration title deed. In the design of dryland management projects, government policy does not appreciate the complex social and cultural factors and often coupled with disregard for the priorities of the resource users, at the grassroots, who are the targets of the programs.

Recognition of the weaknesses of such a top-down approach may help in turning policy on dryland farming to be intensive participatory. Intensive participatory policy on dryland farming would result to local land use management arrangements that increase rural people's authority over resources are promoted, indigenous knowledge is valued and special attention is paid to local priorities.

Access to irrigation technological support services like (extension services and inputs) is often restricted in dryland agricultural management. However, rural communities have proven capable of tackling extreme livelihood conditions deriving from dryland degradation, including through reforestation and irrigation activities. Providing Credit is one of the best ways of encouraging rural population to take an interest in environmentally sound activities.

Smallholder dryland farmers using irrigation, often face difficulties in obtaining credit due to lack of collateral. Awareness raising and education and training can lead to changes in attitudes and longer term social change in the rural communities' investments, land rehabilitation and management of small scale dryland irrigation agriculture.

In fact, understanding the value of protecting one resource (tree species, water source, fodder crop or skill), encourages rural population to see the value of sustaining and protecting the environment in general. Education and training provides management and organizational skills to the rural small scale dryland farmers in the irrigation agriculture sector, thus helping them to influenceively participate in decision-making processes and project activities.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This is the research methodology that was used to carry out the study. The chapter consists of the research design, target population, sampling procedures and sample size, research instruments, reliability and validity of the instruments, data collection procedures, data analysis, logistical and ethical considerations and Operationalisation of the study variables.

3.2 Research design

This study will adopt a descriptive survey research design. In this design data for the study was collected using a questionnaire and interview guides from purposively selected small-scale farmers who were using irrigation in their farming activities to study the factors influencing sustainable irrigation for small scale dryland farming in Kitui Central District, Kenya (Orodho, 2005). Kitui Central District is selected for this study because water is scarce in the district and it is this water that should be used for irrigation to improve food production that helps in reducing food shortages in the area hence ensuring sustainable food security. Study participants were selected equally across all zones in the study area currently on irrigation small scale farming using non-randomized sampling system, because randomized sampling may lead to inclusion of some farmers who are not on small scale or not utilizing irrigation in their farming.

3.3 Target population

This study targets all small-scale dryland irrigation farmers on Kalundu and Nzeeu river banks and shallow well users. Preliminary headcount gave 1503 irrigation small scale dryland farmers in the district, on Kalundu river banks=761, Nzeeu river banks=613 and shallow well users=129. Therefore the study target population was1503 small scale irrigation dryland farmers.

3.4 Sampling procedures and sample size

Small scale irrigation farming in Kitui Central District was carried out along the Kalundu and Nzeeu River basins with a few farmers using shallow wells. Estimate farmers per zone from a preliminary headcount are 761, 613 and 129 as presented in table 3.1. Purposive sampling was used to select farmers with maximum of 2-3 hectares of land to qualify as small-scale farmers, where preliminary headcount gave 1503 small scale farmers in this category in irrigation farming.

Table 3.1, Sampling frame, sampling procedure and sample size

Irrigation Zones	Population (N)	Proportion Percentage	Sample Size (n)
Kalundu River Basin	761	10	76
Nzeeu River Basin	613	10	61
Individual Shallow Well-Users	129	10	13
Total	**1503**	**10**	**150**

In each cluster, a proportional 10% of the population was sampled. Thus, from each cluster a sample of 76, 61 and 13 was selected using simple random sampling to give a total of 150 small-scale farmers on irrigation farming as presented in table 3.1; and 10% is given as the minimum sample size representing the target population by (Mugenda and Mugenda, 2003).

3.5 Research instruments

Questionnaire and interview guide was used to collect data. The questionnaire was structured with closed-ended items and the interview guide had similar questions and was used on the farmers who attested to not being able to fill in the questionnaire to allow for consistency in the data collected in both methods. The questionnaire had two sections; section I the biodata of the respondents and section II was the questions in groups of the factors influencing sustainable irrigation for small scale dryland farming.

3.5.1 Validity of the research Instrument

A research instrument is valid depending on how the data collected is related in terms of influence the items had sampled significant aspects of the purpose of the study (Orodho, 2005). Content validity of the instruments was used to measure the degree to which the items represent specific areas covered by the study. Therefore, content validity of the instrument was determined by experts in research methodology in the University of Nairobi who will look at the measuring technique and coverage of specific areas (objectives) covered by the study. The experts advised the researcher on the items to be corrected. Lecturers from the University of Nairobi ascertained the validity of the research instruments. The corrections identified on the questions were incorporated in the instruments so as to increase its validity.

3.5.2 Reliability of the research instrument

To establish the reliability of instruments, a split-half method was used by a means of a pilot study (Kasomo, 2006). During the pretest the questionnaire was administered on a random sample of ten small scale irrigation agriculture farmers. The participants in the pilot study were not included in the actual study sample. The data values were operationalized and split into two halves using the old-even item numbers divide, and then correlated using Pearson Product-Moment Correlation Coefficient and resubmitted to Spearman rank correlation coefficient. The correlation coefficient results were 0.87 which was greater than 0.75 and sufficient for the questionnaire to have high reliability (Kasomo, 2006).

3.6 Data collection procedures

A research authorization permit was obtained from the District Education and training Officer, in Kitui Central District in order to be allowed to collect data. A copy of the permit was submitted to the District Agricultural Officer in Kitui Central District. The small scale farmers under irrigation agriculture were pre-visited by the researcher to establish rapport before the actual data collection for familiarization. The questionnaire was personally administered by the researcher as he interviewed the selected farmers who were not be able to fill in the questionnaire and he collected the filled in questionnaire before leaving each of the selected farmer.

3.7 Data analysis

Data was analyzed using descriptive statistics in which frequency distributions; percentages; averages values and standard deviations in each questionnaire item was calculated. Statistical tally system was used to generate frequency counts from the 5-point rating likert scale responses comprising of the ratings Strongly Agree [1], Agree [2], Neutral [3], Disagree [4], Strongly Disagree [5], so as to prepare frequency distributions tables.

Percentages in the 5-point rating likert scale responses out of the total study sample responses per item were also calculated. Since the questionnaire items were of the 5-point likert rating scale a theoretical mean value of 3.0 was determined as a criterion to judge the average = □ values of the 5-point rated items, using the formula with □ $= (Y1 + Y2 + Y3 + Y4 + Y5)/5 = \sum_{i=1}^{n=5} Yi/5$; for the 5-points like (1+2 +3+ 4+ 5)/5 = 15/5= 3.0. Therefore, any mean equal to or greater than (□ ≥ 3.0) indicated that the responses disagree with the given statement on irrigation of dryland farming, while any mean equal to or less than (□ ≤ 3.0), but between 2.5 and 2.99 as (2.5 ≤ □ ≤ 2.99) indicated that the responses are neutral with no inclination to either side of the 5-point likert rater scale of the given statement on irrigation of dryland farming.

However, any item with a mean less than (□ < 2.5) was regarded as the responses agreed with the statement on irrigation of small scale dryland farming. Therefore, the direction of inclination of the calculated mean value within the 5-point scale from the theoretical mean value of 3.0 was used to describe the level of influence of each variable on sustainable irrigation of small scale dryland farming. A one-way Analysis of Variance (ANOVA) was used for comparing between the five 30 member group of selected farmers response mean difference such as the means of the 2-acre 90 kg annual yields from the control rainfed small scale dryland maize farming with the mean of the 2-acre 90 kg annual yields from the treated irrigation small scale dryland maize farming.

Two sets out of 300 responses (treated irrigation = 150 responses on yields in 90kg bags) of treated irrigation small scale dryland maize farming 2-acre 90 kg annual yields' means for each of the 30 group of farmers to get 5 groups of farmers with the other set of responses (rainfed = 150 responses on yields in 90kg bags) of the control rainfed small scale dryland maize farming five of the 2-acre 90 kg annual yields' means for each of the five-30 member group of selected farmers were calculated.

After the interpretation and analysis of the data obtained from the interviewed selected farmers who were not able to fill in the questionnaire and the filled in questionnaire the study findings obtained were presented in frequency distribution tables with explanations in between the study frequency distribution tables.

3.8 Ethical and logistical considerations of the study

A research authorization permit was obtained from the District Education and training Officer, in Kitui Central District in order to be allowed to collect data. A copy of the permit was submitted to the District Agricultural Officer in Kitui Central District. The small scale farmers under irrigation agriculture were pre-visited by the researcher to establish rapport before the actual data collection date, for him to be familiar with the respondents.

The participants were asked not to write down their names on the questionnaire. They were also assured that their identity would remain anonymous in order to uphold their privacy. The personal right of choice of participation in this study was emphasized, thus permission to participate was sought before interviewing or administering the questionnaire to the selected small scale irrigation agriculture farmers.

3.9 Operationalization of the study variables

To achieve the objectives of the study on the investigation of factors influencing sustainable irrigation of small scale dryland farming in Kitui Central District, Kenya which were:- the influence of land tenure; national irrigation policy; irrigation technology; competitive alternative water uses and farmer's level of education and training on sustainable irrigation of small scale dryland farming in Kitui Central District, Kenya. Data was collected using a questionnaire and an interview guide shown in

Appendices II and III. Operationalization of the study variables has been illustrated as table 3.2.

Table 3.2, Operationalisation of the study variables

Objectives	Variables		Indicator(s)	Measurement	Level of scale	Tools of analysis
	Independent	Dependent				
To establish Land tenure influence on sustainable irrigation of small scale dryland farming	Land Tenure	Sustainable irrigation of small scale dryland farming	Gender, age -customary law - Influence on land rehabilitation - long-term land investments	Gender, age -customary law - Influence on land rehabilitation - long-term land investments	-Nominal -Ordinal -Interval	**Descriptive statistics** -Frequency distributions -Percentages -Mean value
To identify influence of policy on sustainable irrigation of small scale dryland farming	Irrigation Policy	Sustainable irrigation of small scale dryland farming	-Tenure policy - Account local socio-cultural - Top-down -Bottom-up -Participatory	-Tenure policy - Account local socio-cultural - Top-down -Bottom-up -Participatory	-Nominal -Nominal -Ordinal	**Descriptive statistics** -Frequency distributions -Percentages -Mean value
To establish influence of technology on sustainable irrigation of small scale dryland farming	Irrigation Technology	Sustainable irrigation of small scale dryland farming	New technology -Gravity free flow irrigation -Credit access - Information Technology	New technology -Gravity free flow irrigation -Credit access - Information Technology	-Interval -Nominal -Ordinal	**Descriptive statistics** -Frequency distributions -Percentages -Mean value
To determine influence of water legal rights on sustainable irrigation of small scale dryland farming	Water Legal Rights For Users	Sustainable irrigation of small scale dryland farming	- Sustainable water use - degradation control practices - vegetation cover conserved	- Sustainable water use - degradation control practices - vegetation cover conserved	-Interval -Nominal -Ordinal	**Descriptive statistics** -Frequency distributions -Percentages -Mean value
To identify influence of education and training on sustainable irrigation of small scale dryland farming	Education and training Levels of Farmers	Sustainable irrigation of small scale dryland farming	-Highest education and training -Farming experience -Farming skills knowledge	-Level of education and training -level of experience knowledge technology	-Interval -Nominal -Ordinal	**Descriptive statistics** -Frequency distributions -Percentages -Mean value -Parametric one-way ANOVA

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

Content in chapter four is data analysis, presentation and interpretation of the study findings. The subtitles in this chapter are arranged according to the objectives of the study. The findings were presented in frequency distribution tables, mean values, percentages and explanations of the findings in between the tables for further elaboration as well as interpretation of the study results.

4.2 Questionnaire return rate

All of the issued questionnaires were 103 and 47 farmers were interviewed. The expected questionnaires were received from 103 sampled irrigation dryland farmers and the 47 farmers were personally interviewed using face-to-face question answer method. All the 150 sampled irrigation dryland farmers had provided data for this study. Therefore, the questionnaire return rate was 100 per cent, which represented an excellent response rate. This participation rate implied that the data obtained was adequate and the study results were to give the researcher a valid and reliable conclusion and recommendations for the study.

4.3 Demographic characteristics of the respondents

In part I of the questionnaire and the interview guide were three items in question numbers 1, 2 and 3. The sampled irrigation small scale dryland farmers were asked to indicate their gender, age and their highest level of education and training.

Data on personal details of the farmers was analysed and presented using frequency distribution tables to find out how these personal details of the farmers had influenced sustainable irrigation for small scale irrigation of dryland farming in Kitui Central District of Kitui County, Kenya. The analysed data that was obtained from the returned questionnaires' item number one was tabulated as in Table 4.1.

Table 4.1, Distribution of irrigation of dryland farmers by Gender

Farmers by Gender	Number of farmers	Percentage
Male	27	18.0
Female	123	82.0
Total	**150**	**100.0**

As presented in table 4.1, while 82% of the 150 interviewed farmers were females only 18% of the farmers were males. This showed that mostly the irrigation farming activities within Kitui Central District were dominated by females. In a nut shell most men had left the farming activities to their wives and went looking for other sources of income either from salaried employment or from other business enterprises.

In the reviewed literature, it was noted that due to the absence of male majority who have more physical body energy required for influence irrigation of dryland farming there could be low irrigation farm outputs as noted by (Degefa, 2001). The analyzed responses on ages of irrigation dryland farmers are as presented in table 4.2,

Table 4.2, Distribution of irrigation dryland farmers by Ages

Age	Number of farmers	Percentage
Aged less than 20 years	86	57.3
Aged ranging 21-30 years	37	24.7
Aged ranging 31-40 years	15	10.0
Aged ranging 41-50 years	9	6.0
Aged greater than 51 years	3	2.0
Total	**150**	**100.0**

As presented in table 4.2, mainly more 57.3% of the sampled irrigation dryland farmers in the study were aged less than 20 years old, The 24.7% of sampled irrigation dryland farmers were aged between 21-30 years, to get 82% of the farmers in the study area who were aged less than 30 years old. With only less than 10% of the sampled irrigation dryland farmers aged above 40 years, meant that mostly the energetic youths were engaged in irrigation of dryland farming in Kitui Central District

4.4 Influence of land tenure on sustainable irrigation of small scale dryland farming

The research question (i) sought for the answer of how land tenure had influenced the sustainable irrigation for small scale irrigation of dryland farming in Kitui Central District, Kenya as indicated by influence of land tenure on land use practices' gender/age discrimination in the customary law, land tenure influences on farmers' land rehabilitation/soil conservation practices and influences of land tenure on farmers' long-term investments. The irrigation of small scale dryland farmers were asked to use a 5-point likert rating scale given as **(SA)** Strongly Agree = 1; **(A) Agree** = 2; **(N)** Neutral = 3; **(D)** Disagree = 4 and **(SD)** Strongly Disagree = 5. The analysed data was presented as presented in table 4.3.

Table 4.3, Distribution of farmers by influence of land tenure on irrigation small scale dryland farming

Land tenure indicators of dryland Irrigation	Frequency distributions by 5-point rating scale values					
	SA	A	N	D	SD	Total
Land tenure's gender and age discrimination in law	96	47	4	1	2	**150**
Land tenure's influence on land rehabilitation practices	117	31	0	1	1	**150**
Land tenure's influence on land use investments pattern	103	41	5	0	1	**150**
Cumulative Sum of the 3-indicators' Frequency	**316**	**119**	**9**	**2**	**4**	**450**

As presented in table 4.3, by the cumulative sum of the 3-indicators' frequency, most 435 of the total 450 of the selected irrigation small scale dryland farmers agreed that land tenure issues influenced the sustainable irrigation of small scale dryland farming in Kitui Central District. The interpretation was that land tenure negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District

The cumulative summary of the 3-indicators' frequency for land tenure in the 5-point scale rater was presented below, where, **(*x*)** = Scale Values in 5-point numerical values of likert scale ranked as $x = (1,2,3,4,5)$, and **(*fx*)** = Sum of product of Cumulative Sum of Frequency and the 5- Scale Values **(*x*)** = (1,2,3,4,5). The tabulated summary is presented in Table 4.4.

Table 4.4, Distribution of farmers by cumulative 3-land tenure indicators on influence of sustainable irrigation of small scale dryland farming.

	Number of farmers	(*x*)	(*fx*)	Percentage
Strongly agree	316	1	316	**70.2**
Agree	119	2	238	**26.5**
Neutral	9	3	27	**2.0**
Disagree	2	4	8	**0.4**
Strongly disagree	4	5	20	**0.9**
Total	**450**		**609**	**100.0**

The study results in Table 4.4, majority 96.7 percent of the total 450 cumulative sum of the 3-indicators of land tenure frequencies of the sampled irrigation small scale dryland farmers strongly agreed that land tenure issues influenced the sustainable irrigation of small scale dryland farming in Kitui Central District

The mean of scale value of x was calculated using the formulae $\sum fx/\sum f = 609/450 = 1.35$. This mean was between the 5-point likert scales' 1-to-2, which represented to Strongly Agree. The study findings were therefore interpreted as almost all selected dryland farmers were strongly in agreement that land tenure had significant negative influence on sustainable irrigation of small scale dryland farming in Kitui Central District.

The study findings were not different from the previous reviewed literature in most modern smallholder irrigation systems are controlled and managed by state organs. Governments have attempted to replace customary land tenure systems with state guaranteed individual rights (Ashley and Maxwell, 2001). In general, state imposed individualized land tenurial systems do not necessarily offer greater security for African land users, because of the weaknesses of the Government Institutions in Africa.

Therefore, possession of land title deeds or land-use rights is closely associated with poverty. As a rule very poor farmers either have no land title or partition of their land has led to extremely small-scale farm holdings, and this means that they are not creditworthy. Such farmers are for this reason unable to undertake irrigation measures or make long-term investments initiatives on such piece of land (FAO, 2005).

However, land titling and registration programmes have generally not yielded positive small scale irrigation of dryland farming benefits (Cifdaloz et al., 2010). Moreover, formal land title deed does not necessarily increase the individual's land tenure security

(Baker, 2005). The indigenous land tenure systems are dynamic and evolve with changing social, economic, cultural and political circumstances.

As cited in (Moore, 1996), Bruce, Mighot-Adholla and Atherton (1993) provide evidence that customary land tenure user rights evolve towards more alienable individual rights as population pressure increases and as agriculture becomes more commercialized. Close to two thirds of the natural wealth in developing, low-income countries is embodied in crop and pasture land (World Bank, 2006).

4.5 Influence of irrigation policy on sustainable irrigation of small scale dryland farming

The research question (ii) sought for the answer of the irrigation policy problem and how the policy influenced the sustainable irrigation for small scale irrigation of dryland farming. The selected irrigation small scale dryland farmers were asked to rate the irrigation policy indicators as: Irrigation policy on complex social/cultural factors, Top-down irrigation policy with disregard of locals and Irrigation policy values indigenous farmers' knowledge.

They used a 5-point likert rating scale ranked from 1-to-5 as **(SA)** Strongly Agree = 1; **(A)** Agree = 2; **(N)** Neutral = 3; **(D)** Disagree = 4 and **(SD)** Strongly Disagree = 5. The responses were grouped together then coded and analysed. After data analysis, the results were presented as presented inTable 4.5.

Table 4.5, Distribution of farmers by irrigation policy influence on irrigation of small scale dryland farming

	Frequency distributions by 5-point rating scale values					
Irrigation policy indicators for dryland farming	**SA**	**A**	**N**	**D**	**SD**	**Total**
Irrigation policy on complex social/cultural factors	93	49	0	5	3	**150**
Top-down irrigation policy with disregard of locals	132	15	1	2	0	**150**
Irrigation policy values indigenous farmers' skills	141	7	1	0	1	**150**
Cumulative sum of the 3-indicators' frequency	**366**	**71**	**2**	**7**	**4**	**450**

As presented in table 4.5, by the cumulative sum of the 3-irrigation policy indicators' frequency, most 435 of the total 450 of the selected irrigation small scale dryland farmers agreed that irrigation policy issues influenced the sustainable irrigation of small scale dryland farming in Kitui Central District

The study interpretation was that national irrigation policy had a significant negative influence on the sustainable irrigation of small scale dryland farming in the District as illustrated in Table 4.5. A summary of the study results in Table 4.5, in the cumulative irrigation policy indicators of sustainable irrigation of dryland farming with the 5-point scale rater x = 1,2,3,4,5 was also tabulated, **(x)** = Scale Values in 5-point numerical values of likert scale ranked as x = (1,2,3,4,5), and **(fx)** = Sum of product of Cumulative Sum of Frequency and the 5- Scale Values **(x)** = (1,2,3,4,5). The summary of the study results in Table 4.5, were as presented inTable 4.6.

Table 4.6, Distribution of farmers by cumulative 3- irrigation policy indicators of influence on irrigation of small scale dryland farming.

	Number of farmers	(x)	(fx)	Percentage
Strongly agree	366	1	366	**81.3**
Agree	71	2	142	**15.8**
Neutral	2	3	6	**0.4**
Disagree	7	4	28	**1.6**
Strongly disagree	4	5	20	**0.9**
Total	**450**		**562**	**100.0**

As presented in table 4.6, there were 97.1 per cent of the farmers who strongly agreed (strongly agree and agree) that the national irrigation policy was not in favour of irrigation of small scale dryland farming, because it negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District.

Only 2.5% of the farmers disagreed with the fact that the national irrigation policy was not in favour of irrigation of small scale dryland farming, because it negatively influenced sustainable irrigation of small scale dryland farming. The others 0.4% of the farmers were undecided on the influence of national irrigation policy on sustainable irrigation of small scale dryland farming. The mean calculated was $\sum fx/\sum f = 562/450 =$ 1.25. This mean was between 1-to-2 in the likert rating scale which represented Strongly Agree in this study. The study findings were interpreted as almost all respondents were strongly in agreement that the national irrigation policy had a significant influence on sustainable irrigation for small scale dryland farming in the District. The study findings were not different from the previous reviewed literature African governments have paid a lip service to its rural poor population in smallholder irrigation dryland agriculture, through unclear policy framework and institutional inefficiencies (McIntyre et al., 2009).

In general these governments continue to tax the small-scale irrigation agricultural sector as well as treating it equally to its superior service sector counterpart. The states also offer cheap food protection interests of the urban minority, who are more politically powerful than the rural majority (Janssen and Anderies, 2007).

Although, economic growth is ultimately the solution to poverty and hunger, it must be supported a sustainable agricultural production policy whose ultimate goal is to increase food/cash crop and livestock production among small scale irrigation dryland rural poor farmers in Africa (Janssen and Anderies, 2007).

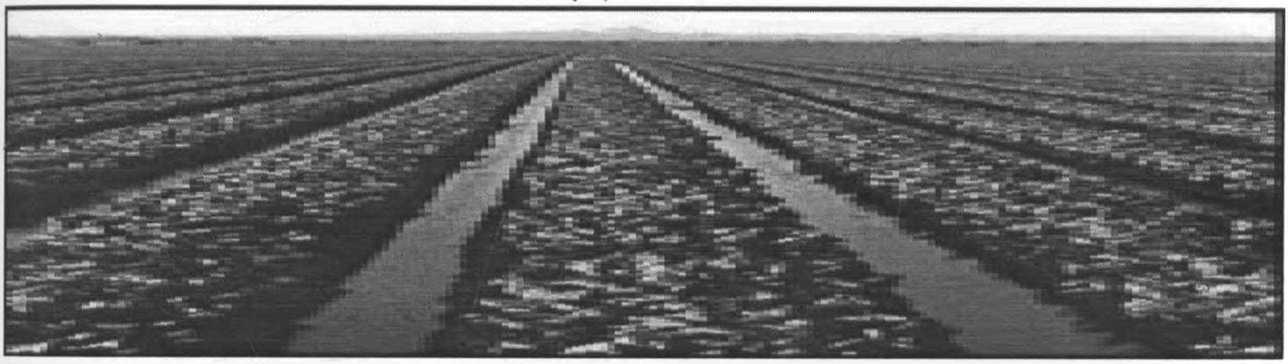
However, such a policy framework is difficult to come by under the present political circumstances where the ruling political parties and the economically powerful private sector are urban biased. Small-scale irrigation dryland agriculture is indeed pro-poor, pro-rural and pro-women and therefore, the African governments should invest more in this sector (North, 1994). While the ASALs lack water, their soils are, in part, highly fertile (North, 1994).

It is entirely possible to achieve high and sustainable agricultural yields in the ASALs fertile pockets, if they are irrigation. Development of irrigation agriculture in these regions would thus be a good option for a poverty-oriented approach with availability of water resources (GoK: Poverty Reduction Strategy Paper (PRSP), 2000).

4.6 Influence of irrigation technology on sustainable small scale dryland farming

The research question (iii) of the study sought for the answer of the problem on the extent to which irrigation technology had influenced sustainable irrigation for small scale dryland farming in Kitui Central District, Kenya. The selected small scale irrigation dryland farmers were asked to rate the following indicators of the level of influence of the farmers' irrigation technology on sustainable small scale dryland farming adoption of sustainably efficient irrigation technology, gravitational free water flow irrigation for reliable, convenient and sustainable irrigation and access to credit to secure sustainable irrigation technology equipments were indicators of the influence of irrigation technology on sustainable irrigation for small scale dryland farming.

As was revealed in literature, inexpensive simple gravity and pump sprinkler systems for horticultural crops are extremely profitable investments. However, its spread of this technology to cover most of the estimated potential irrigation area is limited by physical conditions and increasing competition for water. Field practices are techniques focused on keeping water in the field, distributing it more efficiently, achieving better soil moisture retention, as presented inFigure 4.1(Verhallen, et al., 2003).



Source: Copyright © Verhallen, Fisher, and Shortt (2003) Irrigation Conservation Practices.

Figure 2: Land that has been levelled and furrow irrigation for feasible dryland farming When traditional field practices fall short of expectations and the management strategies and systems modifications discussed below are out of reach, the field practices of dry-land farming are another avenue to explore. Examples of Dry-land farming field practices include: The chiselling of extremely compacted soils; Furrow diking to prevent runoff; Land levelling for more even water distribution (Verhallen, et al., 2003). The

adoption of planned use of technologies can also help people exchange experiences, find common ground for decisions and actively participate in and guide development activities(Ado, 2009).

The irrigation small scale dryland farmers were asked to use a 5-point likert rating scale ranked from 1-to-5 as **(SA)** Strongly Agree = 1; **(A)** Agree = 2; **(N)** Neutral = 3; **(D)** Disagree = 4 and **(SD)** Strongly Disagree = 5. The responses were grouped together then coded and analysed. After data analysis, the results were presented in tabular form. The distribution of farmers by influence of irrigation technology on irrigation of small scale dryland farming was given as presented in table 4.7

Table 4.7, Distribution of farmers by irrigation technology influence on sustainable irrigation of small scale dryland farming.

	Frequency distributions by 5-point rating scale values					
Irrigation technology indicators for dryland farming	**SA**	**A**	**N**	**D**	**SD**	**Total**
Adoption of sustainably efficient irrigation technology	110	18	8	12	2	**150**
Gravitational free water flow for sustainable irrigation	111	32	3	3	1	**150**
Credit access for sustainable irrigation technology tools	79	51	7	13	0	**150**
Cumulative sum of the 3-indicators' frequency	**300**	**101**	**18**	**28**	**3**	**450**

As presented in Table 4.7 above, a majority 401 of the cumulative sum of the total 450 of the 3-indicators' frequency responses from the selected irrigation small scale dryland farmers agreed that irrigation technology influenced the sustainable irrigation of small scale dryland farming in Kitui Central District

The interpretation was that irrigation technology negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District. The summary of the study results in Table 4.7, were used with the 5-point scale rater and tabulated as presented in Table 4.8, where **(*x*)** = Scale Values in 5-point numerical values of likert scale ranked as

x = (1,2,3,4,5), and **(fx)** = Sum of product of Cumulative Sum of Frequency and the 5-Scale Values **(x)** = (1,2,3,4,5) as presented in table 4.8.

Table 4.8, Distribution of farmers by cumulative 3-indicators of irrigation technology of influence on irrigation of small scale dryland farming.

5 point ratings	Number of farmers	(x)	(fx)	Percentage
Strongly agree	300	1	300	**66.7**
Agree	101	2	202	**22.4**
Neutral	18	3	54	**4.0**
Disagree	28	4	112	**6.3**
Strongly disagree	3	5	15	**0.6**
Total	**450**		**683**	**100.0**

As presented in table 4.8, most 89.1 per cent of the farmers (respondents) had strongly agreed that irrigation technology had influence on sustainable irrigation of small scale dryland farming in Kitui Central District, Kenya. Only 6.9 per cent of the 150 farmers (respondents) had strongly disagreed, including all those who had (strongly disagreed and disagreed) that the gender stereotyped roles had influence on sustainable irrigation of small scale dryland farming and 4% of the respondents were undecided.

The mean calculated was $\sum fx/\sum f$ = 683/450 = 1.52. Therefore the calculated mean was in between likert scale point values of 1 and 2, where 1 – represented strongly agreed and 2 represented agreed which when combined for purposes of this study stood for strongly agreed. Thus the study findings were interpreted to have indicated that majority of the selected dryland irrigation farmers were in agreement that the farmers' inadequacy in adoption of the irrigation technology negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District

The study findings were similar to reviewed literature, sustainable agricultural development is based less on material inputs (seeds and fertilizers) than on the people involved in their use (Okoro and Amaechi, 2008). Investments in scientific and material inputs for agricultural production bear little fruit without parallel investments in people. To this end, communication technologies are powerful tools for informing people and providing them with the knowledge and skills they need to put agricultural science and production inputs to best use (Mbah, 2008).

4.7 Influence of water legal rights on sustainable irrigation of small scale dryland farming

The research question (iv) sought for the answer of the extent to which national water legal rights had influenced sustainable irrigation for small scale dryland farming in Kitui Central District. The selected irrigation small scale dryland farmers were asked to rate the following indicators: Sustainable irrigation water rights used and followed by farmers are as allowed by law, Land degradation control practices are practiced as required by all farmers in your area and River bank vegetation cover is conserved as required by all farmers in your area which represented the influencing attributes of the influence of national water legal rights on sustainable irrigation for small scale irrigation of dryland farming.

The irrigation small scale dryland farmers had been requested to use a 5-point likert rating scale that was numerically ranked from 1-to-5, with the key: **(SA)** Strongly Agree = 1; **(A)** Agree = 2; **(N)** Neutral = 3; **(D)** Disagree = 4 and **(SD)** Strongly Disagree = 5. The responses obtained from the selected irrigation small scale dryland farmers were grouped together then coded and analysed. After data analysis, the results were presented in Tabular form as presented in table 4.9.

Table 4.9, Distribution of farmers by water legal rights influence on sustainable irrigation of small scale dryland farming

	Frequency distributions by 5-point rating scale values					
Water legal rights indicators for irrigation farming	**SA**	**A**	**N**	**D**	**SD**	**Totals**
Sustainable irrigation water rights by law used	123	21	5	1	0	**150**
Land degradation control practices are practiced	112	35	0	2	1	**150**
River bank vegetation cover conserved by farmers	110	37	2	1	0	**150**
Cumulative sum of the 3-indicators' frequency	**345**	**93**	**7**	**4**	**1**	**450**

As presented in table 4.9, a majority 438 of the cumulative sum of the total 450 of the 3-indicators' frequency responses from the small scale farmers agreed that water legal rights issues influenced the sustainable irrigation dryland farming. The summary of these results were tabulated as presented in table 4.10, where **(x)** = Scale Values in 5-point numerical values of likert scale ranked as x = (1,2,3,4,5), and **(fx)** = Sum of product of Cumulative Sum of Frequency and the 5- Scale Values **(x)** = (1,2,3,4,5) as presented in table 4.10.

Table 4.10, Distribution of farmers by cumulative 3-indicators of water legal rights influence on irrigation of small scale dryland farming

5-point scale ratings	**Number of farmers**	**(x)**	**(fx)**	**Percentage**
Strongly agree	345	1	345	**76.7**
Agree	93	2	186	**20.7**
Neutral	7	3	21	**1.5**
Disagree	4	4	16	**0.9**
Strongly disagree	1	5	5	**0.2**
Total	**450**		**573**	**100.0**

As presented in table 4.6, the study findings revealed that majority 97.4 per cent of the farmers had strongly agreed that water legal rights negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District

The mean calculated was $\sum fx/\sum f = 573/450 = 1.27$. Therefore the calculated mean score was closer to likert scale point value of (1) which is equivalent to respondents strongly agreed to the statement that water legal rights negatively influenced sustainable irrigation small scale irrigation of dryland farming. The study findings were no different from the earlier reviewed literature. Irrigation systems are comprised of human agents along with physical infrastructure, social infrastructure like (trust, reciprocity and structured relationships), institutional infrastructure like (water legal rights and rules, labour allocation rules and collective choice rules) and biophysical processes that interact in complex ways (Baker, 2005).

Constantly growing degradation of water catchment areas and increasing erosion, poses a fundamental challenge to the environmental sustainability of irrigation in Kenya (Nissen-Petersen, 1982). Challenges facing sustainable irrigation for small-scale dryland farming are with scarce water resources, environmental influences on deforestation, soil degradation, crop diversity, migration and withdrawal of public funding (Slater et al., 2007). It is against the backdrop of these challenges that this study will investigate factors influencing sustainable irrigation for small-scale dryland farming with the increased variability in precipitation and freshwater availability related to climate change (GoK, 2009).

Generally it is still possible to expand irrigation in Kenya; even though the country has scarce water resources, experts are of the opinion that no more than 20 percent of the safe yield of the country's water resources has been tapped (World Bank, 2006). One difficulty involved in selecting suitable locations to expand irrigation in Kenya, is that the places where the greatest water-resource development potentials have been identified are often sparsely populated; one needs to think here only of the land along the Tana River (GoK, 2009). However, it is recommendable to expand irrigation only in places with higher population density for sustainable and viable irrigation (GoK, 2010). Small-Scale Irrigation structures should be given precedence over Large-Scale Irrigation structures, because the former are much easier for farmers to manage (GoK, 2009). Smallholder irrigation farming generally enjoys water rights via a third party, usually a State Bureaucrat holding such water rights in trust for the local irrigation community (Rukuni, 1994).

4.8 Influence of education and training on irrigation of small scale dryland farming

The research question (v) in this study sought for the answer of the extent to which farmers' education and training influenced sustainable irrigation for small scale dryland farming. They were asked to indicate their highest levels of education and training. The results of farmers' highest levels of education and training were tabulated as presented in table 4.11, where **Frequency** = Frequency and **Percentage** =Percentage.

Table 4.11, Distribution of irrigation dryland farmers by highest level of education and training

Highest level of education and training	Number of farmers	Percentage
None	17	11.3
Primary school education and training	99	66.0
Secondary school education and training	34	22.7
Certificate	0	0.0
Diploma	0	0.0
Degree	0	0.0
Total	**150**	**100.0**

As presented in table 4.11, the study findings had revealed that 77.3% of the sampled irrigation dryland farmers had attended primary level of education and training or no schooling, with 11.3% having not attended any level of education and training and 66% had attained upto primary school level of education and training. Only a few 22.7% of the farmers had attained secondary school level of education and training, while none of the farmers interviewed had attained any other level of education and training above secondary school level. The number of years in formal education and training for the farmers ranged from null = 0, 8 and 12. There were 17 farmers 11.3% who had null = 0 years of schooling. The others 66%, the 99 farmers out of 150 had 8 years of schooling and 22.7%, the 34 of 150 farmers had 12 years.

On average these 8 years of schooling revealed that the farmers in the study had attained upto primary school level of education and training. However, there was no past research evidence linking the mean years of schooling in formal education and training with sustainable irrigation of small scale dryland farming. The selected irrigation small scale dryland farmers were asked to rate the influence of education and training on sustainable irrigation for small scale irrigation of dryland farming using the following indicators ranked as **(SA)** Strongly Agree = 1; **(A)** Agree = 2; **(N)** Neutral = 3; **(D)** Disagree = 4 and **(SD)** Strongly Disagree = 5. After data analysis, the results are presented in Table 4.12.

Table 4.12, Distribution of farmers by education and training influence on sustainable irrigation of small scale dryland farming

	Frequency distributions by 5-point rating scale values					
Education and training indicators for irrigation farming	**SA**	**A**	**N**	**D**	**SD**	**Totals**
Education and training new farming technology	103	41	1	3	2	**150**
Education and training application of manure	121	27	1	0	1	**150**
Education and training practicing farm irrigation	116	27	4	2	1	**150**
Cumulative Sum of Frequency-3 indicators	**340**	**95**	**6**	**5**	**4**	**450**

As presented in table 4.12 a majority 438 of the cumulative sum of the total 450 of the 3-indicators' frequency responses from the selected irrigation small scale dryland farmers agreed that water legal rights issues influenced the sustainable irrigation of small scale dryland farming in Kitui Central District. The interpretation was that water legal rights negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District

To calculate the mean value in the 5-point scale rater the summary of the study results in Table 4.12, was tabulated as presented in table 4.13 where, **(x)** = Scale Values in 5-point numerical values of likert scale ranked as x = (1,2,3,4,5), **(fx)** = Sum of product of Cumulative Sum of Frequency and the 5- Scale Values **(x)** = (1,2,3,4,5).

The direction of inclination in the mean value within the 5-point scale was used to describe the level of influence of education and training on sustainable irrigation of small scale dryland farming. The summary of the cumulative 3-indicators of farmers' education and training are as in Table 4.13.

Table 4.13, Distribution of farmers by education and training indicators on irrigation of dryland farming

Ratings	Number of farmers	(*x*)	(*fx*)	Percentage
Strongly agree	340	1	340	**75.6**
Agree	95	2	190	**21.1**
Neutral	6	3	18	**1.3**
Disagree	5	4	20	**1.1**
Strongly disagree	4	5	20	**0.9**
Total	**450**		**588**	**100.0**

As presented in Table 4.13, there were 96.7 per cent of the farmers who strongly agreed (strongly agree and agree) that farmers level of education and training influenced sustainable irrigation for irrigation small scale dryland farming in Kitui Central District as presented in table 4.9. Only 2% of the farmers disagreed with the fact that farmers' level of education and training had influence on the application of new farming techniques, manure and practicing farm irrigation. The others 1.3% were undecided on the influence of education and training towards improvements in farming techniques to enhance sustainable irrigation of small scale dryland farming.

The Mean Score was calculated using the formulae $\sum fx/\sum f = 588/450 = 1.3067$. The fact that the mean score was in between scales points of 1 and 2, with 1 – representing strongly agree and 2 representing to agree. The interpretation of these study findings indicated that most of the farmers were in agreement that levels of education and training had influence on the sustainable irrigation of small scale dryland farming. This was because education and training levels influenceed the farmers in the ways they were applying new farming technology, manure and practicing farm irrigation.

The enhancement of farming techniques due to higher levels of education and training concurred with the reviewed literature (Psacharopoulos, 1994), where in taking as a proxy of rural development the variation of productivity in the agricultural sector, it has been concluded that completing the first four years of formal schooling results to an increase of 7.4% of farming outputs thus maximizing agricultural production, but marginal impact of additional year schooling after the first four years is decreasing. Therefore, any higher levels of education and training, at least above the secondary school education and training of the farmers might have no significant influence on sustainable irrigation for small scale dryland farming (Psacharopoulos, 1994).

This showed that low level of education and training influenced sustainable irrigation of small scale dryland farming in the area. Education and training could influence sustainable irrigation of small scale dryland farming if farmers have inadequate knowledge of farming technology, have not been employed thus leading to low income levels inadequate to sustain adequate market food supply in their households and inadequate finance for investing in improved modern technological methods of farming which increases high farm output.

In the reviewed literature, education and training has also been supported in research as one of the ways that ensures stable food production due to its ability to enhance farmers' adoption of innovative modern methods of farming (Ahmed and Carlo, 2006). As witnessed from the literature review, Goklany (2007) had asserted that the level of education and training of farmers has been closely related to increased agricultural farm outputs.

Therefore, if people get adequate education and training that allows them to obtain sufficient income and to keep phase with the rapid technological changes required for application in the irrigation of small scale dryland farming, they gain sufficient food to ensure food security and their poverty index would be spontaneously reduced. Thus, educating the youth can be useful in addressing the current and future adoption of irrigation of small scale dryland farming within the context of the application of appropriate irrigation technology (Goklany, 2007).

To test the study hypothesis, the sampled farmers' responses of the questionnaire and the interview guide item number 19 were interpreted, analyzed and presented as presented in table 14, which presents the two sets of 2-acre farm annual yields one:-from the irrigation and the other one was that of rainfed small scale dryland maize farming. Therefore the two levels of ANOVA were treated-irrigation small scale dryland farm 90 kg annual outputs of dry maize and the control was the rainfed small scale dryland farm 90 kg annual outputs of maize.

The treated case was assumed to be the mean values of the 2-acre 90 kg annual yield from the 5 class intervals of 30 farmers each from the total sample size of the 150 farmers who were grouped according to responses on the yields from the irrigation small scale dryland maize farm outputs. The control case was assumed to be the mean values of the 2-acre 90 kg annual yield from the 5 class intervals of 30 farmers each from the total sample size of the 150 farmers who were grouped according to responses obtained from the rainfed small scale dryland farm 90 kg annual outputs of maize.

The mean values of the 2-acre 90 kg annual yield from the 5 classes of 30 farmers each from the 150 farmers grouped into class intervals of 30 farmers on the two sets of yield of

150-150 responses (treated irrigation = 150 responses of 90kg bag yields) and the (control rainfed = 150 responses of 90kg bag yields).

Of both the treated-irrigation and control- rainfed small scale dryland maize farming five 2-acre 90 kg annual yield mean values for each of the five-30 member class interval of 10 classes of the selected irrigation small scale dryland maize farmers were calculated and presented as in Table 4.14.

Table 4.14, Distribution of farmers by the five-30 member group mean values from the 150

Irrigation 2-acre yields per 30 farmers	Rainfed 2-acre yields per 30 farmers
11	9
10	7
12	8
14	11
13	10
Total = 60	**Total = 45**
Grand Total = 105	

The Correction Factor CF= (Grand total)^2 /N = $105^2/10$ = 1102.5; The total sum of squares = sum (X^2i) - Correction Factor = $11^2+10^2+12^2+14^2+13^2+9^2+7^2+8^2+11^2+10^2$ - Correction Factor = 1145-1102.5 = 42.5; The treatment sum of squares = {[(Irrigation total)^2/n +(Rainfed total)^2/n)]- Correction Factor} = {[$60^2/5 + 45^2/5$] - 1102.5} = 1125-1102.5 = 22.5.

The results are set out in the ANOVA Table 4.15 in which there are three sources of variation, as the Treatment, Error and Total. Since there are two treatments, T, there is T-1 = 1 DF (degrees of freedom) for treatments and as there were T = 10 observations total there were 10-1 = 9 total DF. The error DF is obtained by subtraction 9-1 = 8. The SS calculated above are then put in the Table 4.15, and the error SSE is obtained by subtraction of the treatment sum of squares = 22.5 from the total sum of squares = 42.5 as [(42.5-22.5)] = 20.0. The MS is calculated as the SS/DF = 22.5/1 = 22.5 and the error MSE is calculated as the SSE/error DF = 20.0/8 = 2.5.

The F is calculated as the MS/MSE = 22.5/2.5 = 9.0. Using the Critical Significance Level ($\alpha = 0.05$) and the between treatment F (df_1= 2-1 =1) and within treatment (df_2=10 – 1 = 9) degrees of freedom calculated to find the Critical Value of ($F_{(1,9)critical}$) using a Critical Value Table as presented in(Appendix V p.76) if $\alpha = 0.05$, $df_1 = 1$ and $df_2 = 9$ then $F_{(1,9)critical} = 7.209$ compared to calculated F value = 9.000, as presented in table 4.15.

Table 4.15, Analysis of variance table for comparison of rainfed and irrigation yields

Source	**DF**	**SS**	**MS**	**F value**	**$F_{(1,9)critical}$ at ($\alpha = 0.05$)**
Treatment	1	22.5	22.5	9.000	7.209
Error	8	20.0	2.5		
Total	9	42.5			

On condition that the Null Hypothesis is rejected if the calculated F value is greater than or equal to the $F_{(1,9)critical}$ where the critical value is at (1,9) degrees of freedom in which (df_1=1) is the between treatment degrees of freedom and (df_2= 9) is the within treatment degrees of freedom. Therefore if $F \geq F_{(1,9)critical}$ there is a significant difference and the calculated F value = 9.000, is a significant result.

The Null Hypothesis is accepted if the calculated F value is less than the critical value; $F < F_{(1,9)critical}$ there is no significant difference and the calculated F value is a non-significant result. According to the Critical $F_{(1,9)}$ Table Value = $F_{(1,9)critical} = 7.209$

compared to the calculated F value = 9.000, it was concluded that the null hypothesis that there is no significant difference between the treated mean values of irrigation dryland 2-acre farm yields and the control mean values of rainfed dryland 2-acre farm yields was rejected at 5% significance level since the $F_{(1,9)critical}$ = 7.209 is less than the calculated F value = 9.000 at $\alpha = 0.05$.

The interpretation of the study findings above, it was concluded that irrigation of small scale dryland farming yields statistically significant higher farm outputs from a 2-acre dryland farm on intensive small scale farming than the natural rainfed small scale dryland farm outputs from the similar 2-acre dryland intensive farming would do at 95% confidence interval.

The findings of this study proofs that in general we can be 95% confident that irrigation of small scale dryland farming yields statistically significant higher 2-acre farm outputs than the natural rainfed small scale dryland farming from the same size of 2-acre farm would do. This is in part explained by the fact that rainfed small scale dryland farming utilizes the natural unreliable and poorly distributed rainfall in Kitui County where Kitui Central District is located.

In a nutshell to ensure that the irrigation small scale dryland farmers are educated would mean that they have the knowledge to increase farm production. This concurred with (Hazell, 2006) in the reviewed literature in which he terms the educated farmers' knowledge to increase farm outputs as the first part of the farm produce marketing chain. The educated farmers' knowledge would not only increase farm production, but also access to arable land, markets and ability to export farm products would be organized by use of the knowledge they would have already acquired from their education and training to enhance increased agricultural productivity (Goklany, 2007). Thus, the educated farmers would seek for utilization of the more reliable irrigation dryland farming than the utilization of the unreliable natural rainfed dryland farming (Goklany, 2007).

Hazell (2006) had noted that although small scale dryland farmers needed enhanced access to arable land, appropriate technology and key farm inputs like seed, fertilizer and access to credit, these key farm inputs might not be the end of the road map to attaining the influenceive, efficient and reliable improved irrigation dryland agricultural productivity.

Therefore, the farmers' limited access to land, infrastructure, technology and other poverty-related factors are not the only barriers to improving agricultural productivity, but the key barrier to the agricultural productivity improvements would be either the attainment of no schooling or the attainment of the lower levels education and training inadequate to improve the farmers' further income earning methods. In this study higher education and training levels among the farmers were supported because education and training acts as the organizer of the other factors of agricultural production.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter comprises of and is organized into the following subheadings: summary of the study, discussions of the study findings, conclusions of the study, recommendations of the study and suggestions for further studies.

5.2 Summary of the findings

The Purpose of this study was to investigate the factors influencing sustainable irrigation of small scale dryland farming in Kitui Central District, Kitui County, Kenya. The study was guided by the following objectives to: establish how land tenure; identify the extent to which national irrigation policy; establish how irrigation technology; determine the extent to which competitive alternative water uses; and identify how farmer's level of education and training had influenced sustainable irrigation of small scale dryland farming.

The findings of this study proofs that in general we can be 95% confident that irrigation of small scale dryland farming yields statistically significant higher 2-acre farm outputs than the natural rainfed small scale dryland farming from the same size of 2-acre farm would do. This is in part explained by the fact that rainfed small scale dryland farming utilizes the natural unreliable and poorly distributed rainfall in Kitui County where Kitui Central District is located.

In a nutshell to ensure that the irrigation small scale dryland farmers are educated would mean that they have the knowledge to increase farm production. This concurred with

(Hazell, 2006) in the reviewed literature in which he terms the educated farmers' knowledge to increase farm outputs as the first part of the farm produce marketing chain. The educated farmers' knowledge would not only increase farm production, but also access to arable land, markets and ability to export farm products would be organized by use of the knowledge they would have already acquired from their education and training to enhance increased agricultural productivity (Goklany, 2007). Thus, the educated farmers would seek for utilization of the more reliable irrigation dryland farming than the utilization of the unreliable natural rainfed dryland farming (Goklany, 2007).

Hazell (2006) had noted that although small scale dryland farmers needed enhanced access to arable land, appropriate technology and key farm inputs like seed, fertilizer and access to credit, these key farm inputs might not be the end of the road map to attaining the influenceive, efficient and reliable improved irrigation dryland agricultural productivity.

Therefore, the other factors influencing irrigation of small scale dryland farming such as the farmers' limited access to land, infrastructure, technology and other poverty-related factors are not the only barriers to improving agricultural productivity, but the key barrier to the agricultural productivity improvements would be either the attainment of no schooling or the attainment of the lower levels education and training inadequate to improve the farmers' further income earning methods. In this study higher education and training levels among the farmers were supported because education and training acts as the organizer of the other factors of agricultural production.

The study findings were that land tenure, irrigation policy, irrigation technology, water legal rights with competitive alternative water uses and farmers' level of education and training had significantly influenced sustainable irrigation of small scale dryland farming in Kitui Central District.

The study conclusion was that for any state that wishes to maximize the land use, the traditional discriminative land tenure should be controlled by the government as it waives the intense politicization of land tenure.

5.3 Discussion of the findings

A majority 96.7 percent of the selected irrigation small scale dryland farmers had strongly agreed that land tenure issues influenced the sustainable irrigation of small scale dryland farming in Kitui Central District. In literature, some state governments have attempted to replace customary land tenure systems with state guaranteed individual rights (Ashley and Maxwell, 2001). In general, state imposed individualized land tenurial systems do not necessarily offer greater security for African land users, because of the weaknesses of the Government Institutions in Africa. Therefore, possession of land title deeds or land-use rights is closely associated with poverty. As a rule very poor farmers either have no land title or partition of their land has led to extremely small-scale farm holdings, and this means that they are not creditworthy. Such farmers are for this reason unable to undertake irrigation measures or make long-term investments initiatives on such piece of land (FAO, 2005).

There was 97.1 per cent of the selected irrigation small scale dryland farmers had strongly agreed that the national irrigation policy was not in favour of irrigation of small scale dryland farming, because it negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District. In literature, it was noticed that although, economic growth is ultimately the solution to poverty and hunger, it must be supported a sustainable agricultural production policy whose ultimate goal is to increase food/cash crop and livestock production among small scale irrigation dryland rural poor farmers in Africa (Janssen and Anderies, 2007).

However, such a policy framework is difficult to come by under the present political circumstances where the ruling political parties and the economically powerful private sector are urban biased. Small-scale irrigation dryland agriculture is indeed pro-poor, pro-rural and pro-women and therefore, the African governments should invest more in this sector (North, 1994). While the ASALs lack water, their soils are, in part, highly fertile (North, 1994).

Most 89.1 per cent of the selected irrigation small scale dryland farmers had strongly agreed that irrigation technology had influence on sustainable irrigation of small scale dryland farming in Kitui Central District. However, from the literature review, sustainable agricultural development is not only based on material inputs than on the people involved in their use (Okoro and Amaechi, 2008). Investments in scientific and material inputs for agricultural production bears little fruit without parallel investments in people (Mbah, 2008).

In the study findings a majority 97.4 per cent of the selected irrigation small scale dryland farmers had strongly agreed that water legal rights negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District From the reviewed literature, institutional infrastructure like (water legal rights and rules, labour allocation rules and collective choice rules) and biophysical processes that interact with irrigation farming in complex ways needed to be aligned with the land and irrigation policy for successful irrigation of small scale dryland farming to be attained (Baker, 2005). The constantly growing degradation of water catchment areas and increasing erosion, poses a fundamental challenge to the environmental sustainability of irrigation in Kenya (Nissen-Petersen, 1982). Challenges facing sustainable irrigation for small-scale dryland farming are with scarce water resources, environmental influences on deforestation, soil degradation, crop diversity, migration and withdrawal of public funding (Slater et al., 2007).

There was 96.7 per cent of the selected irrigation small scale dryland farmers strongly agreed that farmers' level of education and training negatively influenced sustainable irrigation of small scale dryland farming in Kitui Central District. From the reviewed literature, it was noted that sustainable agricultural development is based less on material inputs (water, irrigation, improved seeds and fertilizers) than on the people involved in their use (Okoro and Amaechi, 2008). The investments in scientific and material inputs for agricultural production were found to bear little fruit without parallel investments in people, the knowledge embodied in the human resource. To this end, education and training is a powerful tool for informing people and providing them with the knowledge and skills they need to put agricultural science and production inputs to best use (Mbah, 2008).

5.4 Conclusions of the study

The researcher concluded that sustainable irrigation of small scale dryland farming could be obtained by enhancing properly well thought out land tenure policy which is free of any sort of discrimination and prejudice against any member who has the opportunity to practice in the irrigation of small scale dryland farming.

Sustainable irrigation of small scale dryland farming could be obtained by enhancing own irrigation technology through adoption of improved, affordable and regional appropriate farming technologies. The new farming methods could be achieved through improved access to irrigation technologies.

This has indirectly been exerting higher influence on the sustainable irrigation of small scale dryland farming in the dryland region in the Kitui Central District, Kenya. The study findings revealed that access to farm inputs would enhance higher amounts of farm outputs.

Availability of water for irrigation, water legal rights and competitive alternative water uses were noticed as factors to consider in enhancing supportive and sustainable irrigation of small scale dryland farming programme that would change most of the arid and semi-arid lands to green with adequate agricultural produce.

The researcher concluded that sustainable irrigation of small scale dryland farming cannot be sustainably achieved without a certain level of farmers' education and training upto four years of basic level or primary level of education and training.

5.5 Recommendations of the study

The researcher recommendations were guided by the study findings there was need for a well thought land policy, irrigation policy and agricultural food and gender policy if all households in dryland areas were to attain sustainable irrigation of small scale dryland farming throughout the year in both off-peak and on-peak harvest seasons.

Concerning gender and age on the land tenure discrimination in the customary laws, there was need for these laws to be subdued by the government to enhance adequate land rehabilitation and conservation in enhancing sustainable irrigation of small scale dryland farming. For those in married family life and farming, this study recommends to the policy makers a gender sensitive land tenure policy that allows equal opportunity in the households land use.

It may be possible to improve sustainable irrigation of small scale dryland farming if agricultural food policies are developed which target women's emancipation to have more income and improve their agricultural productivity so as to fill the gender related sustainable irrigation of small scale dryland farming gap which has been and is still experienced in most of the Kenyan communities.

The researcher recommended to the ministry of agriculture and policy makers for the formulation of the irrigation policy and technology that should be supportive to the development and growth of small scale dryland farming in its provision of incentives that promotes small scale dryland farming establishments. These would include market access, credit access, transport and the general provision of the required infrastructural facilities that could help in enhancing sustainable irrigation of small scale dryland farming in most of the arid and semi-arid lands.

On the appropriate use of irrigation technology, the researcher recommended to the agricultural extension officers to have irrigation small scale dryland farmers sensitization on appropriate irrigation technology and economical irrigation farming practices for sustainable water supply in the irrigation of small scale dryland farming. This is because the educated farmers would have broad range of options for adoption of appropriate irrigation technology and irrigation farming practices.

On the availability of water for irrigation, water legal rights and competitive alternative water uses the government should provide a level equal opportunity access to sustainable water source and supply in order to support a sustainable irrigation of small scale dryland farming programme that would change most of the arid and semi-arid lands to green with adequate agricultural produce.

The researcher also recommended to the ministry of agriculture creation of awareness about the role of education and training in attaining sustainable irrigation of small scale dryland farming and making education and training more affordable to the entire population without discrimination. Education and training level enhances farming skills involving accounting and budgeting.

The researcher recommended sustainable irrigation of small scale dryland farming in the arid and semi-arid regions with economic viability in consideration in order to optimize the irrigation of small scale dryland farming. It was against the backdrop of the challenges of scarcity of water that this study recommended the government to operationalize the factors influencing sustainable irrigation for small-scale dryland farming with the increased variability in precipitation and freshwater availability related to climate change (GoK, 2009).

To this end farmers' education and training level has been recommended as a farm tool that utilizes, the organization of other farm inputs cautiously to ensure farm outputs exceeds the farm inputs. The farmers' education and training also enhances the knowledge of the need for and of the application of manure, fertilizers, improved seeds and irrigation technologies for use in coordination.

However, in agricultural economic terms, there must be adequate research to support the fact that the measurement of profit supersedes the measurements of cost in the application of the irrigation program in the arid and semi-arid regions. Otherwise on one hand a farmer might boast of high yields before ascertaining the economic viability of the irrigation program just to notice on the other hand the cost of small scale dryland farming was higher than the yields.

5.6 Suggestion for further studies

The researcher is suggesting further studies on a sustainable agricultural policy in arid and semi-arid (ASALs) as well as technologically improved and sustainable irrigation of small scale dryland farming situation that would lead to improvement in agricultural production.

Further studies on the role of relief food aid among the poor families in the ASALs combined with a study on reliable, efficient, convenient and sustainable irrigation of small scale dryland farming, would help in chatting the way forward on how to stop dependence on relief food aid and improve food security in the arid and semi-arid lands like Kitui Central District

A further study on the role of basic education and training in enhancing all other factors of agricultural productivity would help in leading to sustainable irrigation of small scale dryland farming as the source of a successful artificial agricultural productivity from the ASALs in absence of adequate rainfall. Similarly, the study on the relationships between the sustainable irrigation of small scale dryland farming and households' food security situations in the arid and semi-arid regions would go along way in helping the state in ensuring food sufficiency for its citizens

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APPENDICES

APPENDIX I: Transmittal letter

P.O Box 260-90200,Kitui.

The Respondents

Kitui Central District

Kitui

Dear Sir/Madam,

Ref: Transmittal Letter

I am congratulating you for having been selected to participate in this study. I am a Post graduate student at the University of Nairobi pursuing a Masters of Arts Degree in Project Planning and Management. As part of the requirements for the award of this degree I am conducting a study on factors influencing sustainable irrigation for small scale dryland farming in Kitui Central District, Kenya. Therefore I am requesting you to co-operate and assist me by filling in this questionnaire. The information you will give will be strictly used for the purpose of this study and your identity will be kept confidential. I will be very grateful for your co-operation.

Thank you in advance.

Yours faithfully,

Francis Venzi Simion.

APPENDIX II: Questionnaire for small scale irrigation dryland farmers

This questionnaire is designed to gather information on factors influencing sustainable irrigation of small scale dryland farming in Kitui Central District, Kenya. I kindly request you to respond to all items by putting a tick (√) where applicable.

PART I: Farmers' Personal Details

1. Please indicate your gender: a. Male ( ) b. Female ( )

2. Age in years

a. Less than 20 ( ) b. 20 – 30 ( ) c. 30-40 ( ) d. 40-50 ( ) e. above 50 ( )

3. Indicate your highest level of education and training:

a. None ( ) b. Primary ( ) c. Secondary ( ) d. Diploma ( ) e. Degree ( )

PART II: Factors that influence sustainable irrigation of small scale dryland farming

On the statements given below use a tick (√) to make your rating choice, using a 5-point likert rating scale that ranges from: (1-2-3-4-5) given as: Strongly Agree-1; Somewhat Agree-2; Neutral-3; Somewhat Disagree-4; Strongly Disagree-5, so as to indicate your level of agreement and/or disagreement with the statements given.

Sustainable irrigation, land tenure and small scale dryland farming

4. Gender and age tenure discrimination in customary law influence farmers' land use practices

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

5. Land tenure influence farmers land rehabilitation like soil conservation practices in the area

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

6. Land tenure influences irrigation dryland farmers' long-term investments in the land used

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

Sustainable irrigation policy for small scale dryland farming

7. Irrigation policy accounts for complex social/cultural factors of irrigation of dryland farming

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

8. Top-down irrigation policy with disregard of local priorities is practiced in your area

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

9. Irrigation policy values the indigenous knowledge of local farmers participation

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

Irrigation technology, sustainable irrigation and small scale dryland farming

10. You adopted new irrigation technology that is sustainably efficient in your area

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

11. Gravity free flow irrigation is more sustainable, reliant and efficient in your area

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

12. You have credit access to secure irrigation technology equipments for sustainable irrigation

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

Sustainable irrigation for dryland farming and water legal rights

13. Sustainable irrigation water rights used and followed by farmers are as allowed by law

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

14. Land degradation control practices are practiced as required by all farmers in your area

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

15. River bank vegetation cover is conserved as required by all farmers in your area

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

Farmers training and education, sustainable irrigation and small scale farming

16. Farming skills in accounting and budgeting for sustainable small scale irrigation farming

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

17. Control of farm activities, use of fertilizers for sustainable small scale irrigation farming

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

18. Access to market information to sell surplus for sustainability of irrigation farming

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]

Strongly Disagree [5]

19. Please give on average the number of 90 kilogram bags of maize from two acre irrigation farming _________ and the number of 90 kilogram bags of maize from two acre rainfed dryland farming ________________

The end of the questionnaire

Signature________________________________

Thank you for your cooperation

APPENDIX III: Interview guide with Kikamba interpretation by the researcher

I am requesting you to assist me in answering a few questions about irrigation in your farming process.

PART I: Farmers' Personal Information

1. Gender: a. Male ( ) b. Female ( )

2. Age in years:

a. Less than 20 ( ) b. 20 – 30 ( ) c. 30-40 ( ) d. 40-50 ( ) e. above 50 ( )

3. Highest level of education and training:

a. None ( ) b. Primary ( ) c. Secondary ( ) d. Diploma ( ) e. Degree ( )

PART II: Factors that influence sustainable irrigation of small scale dryland farming

On the statements given below use a tick (√) to make your rating choice using a 5-point likert rating scale as from: (1-2-3-4-5) given as: Strongly Agree-1 Somewhat Agree-2 Neutral-3 Somewhat Disagree-4 Strongly Disagree-5 to indicate your level of agreement and/or disagreement with the statements below.

Influence of land tenure on sustainable irrigation of small scale dryland farming

4. Gender and age tenure discrimination in customary law

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

5. Land tenure influences farmers land rehabilitation (soil erosion)

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

6. Land tenure influences farmers long-term investments on land

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

Influence of irrigation policy on Sustainable irrigation of small scale dryland farming

7. Irrigation policy accounts for complex social/cultural factors

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4] Strongly Disagree [5]

8. Top-down irrigation policy regard of local priorities

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

9. Irrigation policy values the indigenous knowledge of locals

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

Influence of technology on sustainable irrigation of small scale dryland farming

10. Adoption of new irrigation technology is sustainably efficient

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

11. Gravity free flow irrigation is sustainable, reliant and efficient

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

12. You can access credit to secure the equipments for irrigation technology

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

Influence of water legal rights on sustainable irrigation of dryland farming

13. Sustainable irrigation water rights/use by farmers are allowed

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

14. Land degradation control practices are practiced as required

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

15. River bank vegetation cover is conserved by all farmers

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

Influence of education and training on sustainable irrigation of small scale dryland farming

16. You have farming skills in accounting and budgeting for sustainable irrigation

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

17. You control farm activities, use of fertilizers for sustainable irrigation

Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

18. You can access to market information to sell surplus for sustainable irrigation

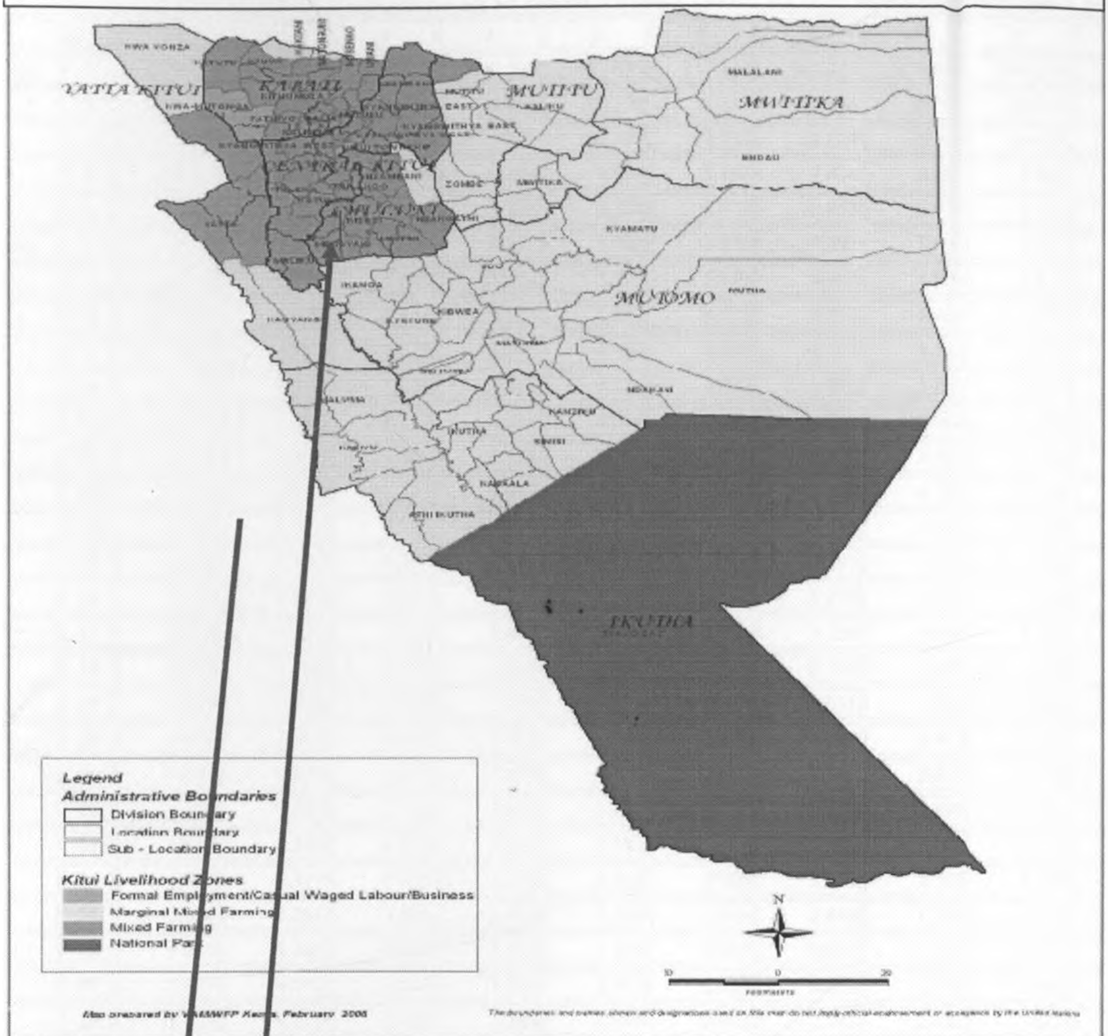
Strongly Agree [1] Somewhat Agree [2] Neutral [3] Somewhat Disagree [4]
Strongly Disagree [5]

19. Please tell me the number of 90 kilogram bags of maize from two acre irrigation farming _________ and the number of 90 kilogram bags of maize from two acre rainfed dryland farming ________________

Thank you very for your cooperation

APPENDIX IV: Map of Kitui District: arrow point is Kitui Central District study area

MAP OF FORMER KITUI DISTRICT: ARROW POINTED IS THE STUDY AREA: KITUI CENTRAL DISTRICT



LEGEND
A MAP OF THE FORMER KITUI DISTRICT WHICH IS CURRENTLY SOUTHERN PART-KITUI COUNTY NOTE: ARROW POINTED IS THE KITUI CENTRAL DISTRICT – ALSO IT IS THE AREA OF STUDY

Source: Adapted from GOK, Ministry of Planning and National Development, (2009)

APPENDIX V: *F*-statistic for $F_{|(df1,df2)\ critical|}$ Values Table at ($\alpha = 0.05$) Level of Significance

F statistic where df_1 is the degrees of freedom (DF) between treatments (number of treatments - 1) and df_2 is the DF within treatments (total sample size – number of treatments) for one-way ANOVA.

Table 6.1, *F*-statistic = $F_{(df1,df2critical)}$ critical values table at $\alpha = 0.05$ significance level

	df_1	1	2	3	4	5	6	7	8	9	10
df_2	1	647.793	799.482	864.151	899.599	921.835	937.114	948.203	956.643	963.279	968.634
	2	38.506	39.000	39.166	39.248	39.298	39.331	39.356	39.373	39.387	39.398
	3	17.443	16.044	15.439	15.101	14.885	14.735	14.624	14.540	14.473	14.419
	4	12.218	10.649	9.979	9.604	9.364	9.197	9.074	8.980	8.905	8.844
	5	10.007	8.434	7.764	7.388	7.146	6.978	6.853	6.757	6.681	6.619
	6	8.813	7.260	6.599	6.227	5.988	5.820	5.695	5.600	5.523	5.461
	7	8.073	6.542	5.890	5.523	5.285	5.119	4.995	4.899	4.823	4.761
	8	7.571	6.059	5.416	5.053	4.817	4.652	4.529	4.433	4.357	4.295
	9	7.209	5.715	5.078	4.718	4.484	4.320	4.197	4.102	4.026	3.964
	10	6.937	5.456	4.826	4.468	4.236	4.072	3.950	3.855	3.779	3.717
	11	6.724	5.256	4.630	4.275	4.044	3.881	3.759	3.664	3.588	3.526
	12	6.554	5.096	4.474	4.121	3.891	3.728	3.607	3.512	3.436	3.374
	13	6.414	4.965	4.347	3.996	3.767	3.604	3.483	3.388	3.312	3.250
	14	6.298	4.857	4.242	3.892	3.663	3.501	3.380	3.285	3.209	3.147
	15	6.200	4.765	4.153	3.804	3.576	3.415	3.293	3.199	3.123	3.060
	16	6.115	4.687	4.077	3.729	3.502	3.341	3.219	3.125	3.049	2.986
	17	6.042	4.619	4.011	3.665	3.438	3.277	3.156	3.061	2.985	2.922
	18	5.978	4.560	3.954	3.608	3.382	3.221	3.100	3.005	2.929	2.866
	19	5.922	4.508	3.903	3.559	3.333	3.172	3.051	2.956	2.880	2.817
	20	5.871	4.461	3.859	3.515	3.289	3.128	3.007	2.913	2.837	2.774
	21	5.827	4.420	3.819	3.475	3.250	3.090	2.969	2.874	2.798	2.735
	22	5.786	4.383	3.783	3.440	3.215	3.055	2.934	2.839	2.763	2.700
	23	5.750	4.349	3.750	3.408	3.183	3.023	2.902	2.808	2.731	2.668
	24	5.717	4.319	3.721	3.379	3.155	2.995	2.874	2.779	2.703	2.640
	25	5.686	4.291	3.694	3.353	3.129	2.969	2.848	2.753	2.677	2.613
	26	5.659	4.265	3.670	3.329	3.105	2.945	2.824	2.729	2.653	2.590
	27	5.633	4.242	3.647	3.307	3.083	2.923	2.802	2.707	2.631	2.568
	28	5.610	4.221	3.626	3.286	3.063	2.903	2.782	2.687	2.611	2.547
	29	5.588	4.201	3.607	3.267	3.044	2.884	2.763	2.669	2.592	2.529
	30	5.568	4.182	3.589	3.250	3.026	2.867	2.746	2.651	2.575	2.511
	31	5.549	4.165	3.573	3.234	3.010	2.851	2.730	2.635	2.558	2.495
	32	5.531	4.149	3.557	3.218	2.995	2.836	2.715	2.620	2.543	2.480
	33	5.515	4.134	3.543	3.204	2.981	2.822	2.701	2.606	2.529	2.466
	34	5.499	4.120	3.529	3.191	2.968	2.808	2.688	2.593	2.516	2.453
	35	5.485	4.106	3.517	3.179	2.956	2.796	2.676	2.581	2.504	2.440
	36	5.471	4.094	3.505	3.167	2.944	2.785	2.664	2.569	2.492	2.429
	37	5.458	4.082	3.493	3.156	2.933	2.774	2.653	2.558	2.481	2.418
	38	5.446	4.071	3.483	3.145	2.923	2.763	2.643	2.548	2.471	2.407
	39	5.435	4.061	3.473	3.135	2.913	2.754	2.633	2.538	2.461	2.397
	40	5.424	4.051	3.463	3.126	2.904	2.744	2.624	2.529	2.452	2.388