

**ASSESSMENT OF ACCESS TO AND UTILISATION OF TREADLE AND HIP  
PUMP TECHNOLOGY BY FARMERS IN MACHAKOS COUNTY, KENYA**

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**C50/CE/24288/12**

**A THESIS SUBMITTED TO THE SCHOOL OF HUMANITIES AND SOCIAL  
SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR  
THE DEGREE OF MASTER OF ARTS (GENDER AND DEVELOPMENT  
STUDIES) OF KENYATTA UNIVERSITY**

**MARCH 2019**

**DECLARATION**

I confirm that this thesis is my original work and has not been presented to any other university or institution for an award of a degree

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**DEDICATION**

I dedicate this work to my family: my dear and beloved grandfather Samwel Njoroge who even though had little formal education introduced me to school and inspired me to be more informed. I also dedicate this work to women farmers in arid and semi arid areas who despite the harsh climatic conditions strive to achieve food security and improve their income through agriculture.

## ACKNOWLEDGEMENT

This research acknowledges some of those who were involved. Their support was instrumental to the success of the study. May God bless you as I acknowledge Him as the Most High who enabled the success of this study.

I am grateful for the invaluable assistance and insight of Dr. Grace Okong'o and Dr. Casper Masiga who are my supervisors, for their immense and meticulous guidance, dedication, professional advice and availability. My gratitude also extends to the lecturers who tirelessly taught me in theory classes of Master of Arts in Gender and Development Studies programme thereby enriching this study with the learnt knowledge and skills.

I owe special gratitude to 132 farmer groups with members composed of women farmers in Machakos County. Special thanks also go to key informants of the study i.e. chiefs, extension officers and KSI/WSU informant who patiently and forthrightly answered the questions for the study. Without their cooperation, this study would not have been possible. My sincere thanks go to the Gender and Development Studies Administrative staff for their care, guidance and concern throughout the study period. My appreciation also goes to my course mates whom we journeyed together, encouraging each other and supporting each other with positive criticism. I appreciate Andrew Wanyonyi, Jenniffer Mueni and Patrick Kirui who were the research enumerators and team in data collection for their dedication and technical support. May God bless you abundantly.

Lastly, I acknowledge my family for their patience and encouragement during the study period. Specifically Mrs. Eunice Njenga who is one of my biggest cheerleader, aunt Alice Kariuki who lengthened my tether whenever I faced obstacles. Special acknowledgment too goes to my dear husband and beloved life partner Joseph Kimani.

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**LIST OF ACRONYMS**

<b>CIDP:</b>	County Integrated Development Plan
<b>CoK:</b>	Constitution of Kenya
<b>FAO:</b>	Food and Agriculture Organization
<b>FGD:</b>	Focus Group Discussion
<b>GoK:</b>	Government of Kenya
<b>GPS:</b>	Geographical Positioning System
<b>KSI:</b>	Kick Start International
<b>NGO:</b>	Non-Governmental Organization
<b>NACOSTI:</b>	National Commission for Science, Technology and Innovation
<b>RDRS:</b>	Rangpur Dinajpur Rural Service
<b>SPSS:</b>	Statistical Package for the Social Sciences
<b>SSI:</b>	Small scale Irrigation
<b>WSU:</b>	Washington State University

**OPERATIONAL DEFINITION OF TERMS**

- Access:** In this study, access means the ability to obtain a treadle or hip pump technology through awareness of its availability and finance options to purchase it
- Adoption:** Take up of the treadle and hip pump technology through fully purchasing the technology using any of the finance options offered by KSI/WSU study.
- Buyer:** A respondent who bought treadle or hip pump in cash, credit or savings option between 2015 and 2016
- Dropbox:** Dropbox is a free cloud storage service for sharing and storing files including photos, documents and videos. To use Dropbox you need to create an account on dropbox.com and allow the service to create folders on all your connected devices such as PCs, laptops or other mobile devices and synchronize any files you store on Dropbox with the connected devices. Files can be shared with others by providing them with a link to your Dropbox folder.
- Earth point:** A Google Earth software that displays coordinate grids on Google Earth
- Google Earth:** Webopedia defines Google earth as a virtual globe, map and geographical information program that was originally called Earth Viewer 3 Dimension (3D), and was created by Keyhole, Inc. It maps the Earth by the superimposition of images obtained from satellite

imagery, aerial photography and Geographical Information System 3D globe.

**Hip pump:** According to Kick start International (KSI) products, a hip pump is a unique pump developed to create a lower cost and lighter weight, portable pump. The pump allows users to use their leg, body weight, and momentum, rather than the small muscles of the upper back and shoulders. This allows the pump to be easily used to irrigate an acre or more.

***Kibarua:*** Swahili word for temporary work, casual labour

***M-Pesa:*** This is a mobile phone-based money transfer, financing and micro financing service, launched in 2007 by Vodafone for Safaricom and Vodacom, the largest mobile network operators in Kenya and Tanzania. M-Pesa allows users to deposit, withdraw, transfer money and easily pay for goods and services with a mobile device.

**Non- buyer:** A respondent who did not buy a treadle or hip pump, has water and was exposed to the small-scale irrigation technology by a salesperson between 2015 and 2016.

**Treadle pump:** KSI products define a treadle pump as a human-powered pump with the look of a modified Stairmaster. It has easy operation and high flow rate of water that allows farmers to irrigate up to 2 acres of land per day. It is a lower cost and more cost effective solution than

motorized irrigation pumps, which are hard to fuel, maintain and repair in rural Africa and have many recurring costs.

**Utilisation:** Appropriateness of the treadle and hip pump technology to be physically used by farmers who had been marketed and distributed the pump by KSI/WSU team

## ABSTRACT

The purpose of this study was to assess the access to and utilization of the treadle and hip pump technology by farmers in Machakos County, Kenya so that gender responsive strategies can be suggested to improve the uptake of the technology among the farmers. This was due to low adoption of the two pumps in Machakos county after previous KSI/WSU study that marketed and distributed the technology among farmers in the county. The specific objectives of the study were: to establish which irrigation technologies used before introduction of hip and treadle pumps; to find out how the farmers were accessing to and utilizing pumps; to examine the challenges facing farmers when accessing to and utilizing the pumps in the county and to suggest gender responsive strategies that would enhance access to and utilisation of pump technology. The study was guided by the social relations framework of analysis by Naila Kabeer. The framework, which gives a political, rather than a technical or informational solution, was complemented by the diffusion of innovations theory. The study used experimental and descriptive research designs for both qualitative and quantitative data. The study had 70 respondents comprising 42 farmers who were pump buyers purposively selected for the study and 28 pump non-buyers identified via snowball sampling method. Data were collected using interview schedules, key informant interview guides and focus group discussion guides. Findings indicate that the majority of respondents used irrigation tools that were powered by human and/or animals. In access, the most preferred type of pump among pump buyers was the hip pump over the treadle pump. Cash and credit payment option was preferred over savings option of pump purchase. In utilization, men used the pump more than women did since men were involved in operation and maintenance as they pedal while women distribute water using pipes. The major challenges to access to and utilization of the pump technology were at family level and market level. The study concluded that the use of the treadle and hip pump technology was still appropriate in relation to the tools they were previously used to. However, the pump technology design in itself hampered use by women since it requires a lot of energy to use. The study recommends putting gender responsiveness in design of pumps, consistent intergenerational marketing and distribution of the pump technology with follow up by the marketer for adoption among women, men and youth. The marketer should also consider marketing and distribution through working with female opinion leaders, establish demonstration plots with women headed households as well as appoint enterprising women such as the group secretary as pump dealers to build supply networks and create linkages with farmers. The marketer can also consider advertising and marketing that does not conform to gender stereotypes and type of media chosen and content of message about the pump to reach women should consider their low mobility level outside their home or village. The study also recommends recruitment of female salespersons by KSI/WSU team as well as train male staff on the importance of seeing women as potential customers and how to interact with them while holding consistent talks with men in the family too. There is also need for KSI/WSU team to have gender relations conceptual awareness building and implementation through writing brief policy statements on gender issues in the context of the organization.

## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background to the study

Globally, farming is perceived as a lucrative venture in regions with sustained fertility and water resources. For arid and semi-arid region, farming has been a difficult and expensive venture as irrigation projects are required to enable food security for both domestic and commercial use. For this reason, the need to develop more approaches that will improve farming in arid and semi-arid areas became a necessity for NGOs and government stakeholders (Ivers & Cullen, 2011). Regardless of this provision, the need to develop small-scale farmers required cheap farming technology that they could use in smallholder farms. This led to embracing of technology in the agriculture sector. One of the technologies is the treadle pump, which was developed in 1979 by a team working with the Rangpur Dinajpur Rural Service (RDRS). RDRS was an NGO working in northwest Bangladesh to meet what they perceived as a large, unsatisfied demand for manual irrigation pumps. The treadle pump extracted larger volumes of water more than the existing hand-operated pumps. The design of the pumps targets the poor and those in remote areas with limited access to diesel and technical support (Purcell, 1997).

According to Bielenberg and Allen (1995) in their book, use of treadle pump technology came in stages as initial ventures did not create a sustainable solution. For instance, the first treadle pump was operated manually. This made it hard for smallholder farmers to irrigate their farms frequently and effectively and led to the

creation of more automatic means of irrigation. Prabhu (1999) observes that global projects funded by NGOs majorly focus on equipping women with the knowledge and equipment to take on farming. This is influenced by the fact that women in arid and semi-arid areas are the worst affected by low food production and low economic status. In an argument by Ivers and Cullen (2011), women in arid areas have a major responsibility as home keepers as well as breadwinners. Equipping them with advanced farming tool, elevate their ability to play their domestic role.

Asia was the birthplace of the treadle pump (Orr et al. 1991), for this reason, the demand for the technology in rural Bangladesh was significant. Its popularity then increased its supply across neighboring nations including India and Pakistan. In these regions, the number of rural farmers was massive as they solely depended on agriculture for their livelihood. Both men and women in the regions were provided with treadle water pumps. NGOs' involved in the programme wanted to increase the buying power of the consumer thus launching a purchasing plan that would fit the financial comfort of the farmers. The NGOs' provided pumps for irrigation projects on credit to farmers prior to agreeing to a payment plan (Prabhu, 1999). Since the creation of the treadle pump in Bangladesh, 1.4 million pumps have been sold to the local farmers by 1991 (Alistair et al. 1991). This depicts the importance of the affordable irrigation option.

Postel (2012) points out that in Europe, the number of small-scale farmers accessing and utilizing the pump was slightly lower than that in Asia or Africa. For this reason, accessing the treadle pumps was not a desired mode for irrigation. He further points

that NGOs' rarely focus on developing food programme in Europe due to the financial comfort of most of its dwellers compared to those in Africa and Asia. Therefore, the use of the treadle pump in the region was not massively embraced. However, small-scale farmers in Hungary and Poland realized the affordable irrigation option offered by the technology. Postel (2012) asserts that rural Hungary was highly populated with small-scale farmers who also supplied their products as well as retain some for domestic use. The use of diesel pumps made their irrigation cost massive thus minimized profits and production. After the introduction of the treadle pump, the demand was huge as both women and men opted for the affordable mode of irrigation.

The hip pump is a KSI innovation of the small-scale irrigation pump in terms of the body parts used to operate it, lighter weight and lower cost than the treadle pump. Kay and Brabben (2000) observe that the use of the treadle and hip pump in Africa is higher as a continent than any other continent as it is one of the greatest consumers of the product. The technology is mostly used in sub-Saharan Africa where there is availability of water for irrigation. In 1998, the International Development Enterprises began the marketing of the treadle pump in Africa citing the advantages of using the technology for small-scale farmers (Sijali & Mwago, 2009). The response was promising as both men and women enrolled in groups to access the pumps. The response was then boosted by the involvement of NGOs to increase food security in rural Africa.

KSI has mostly focused on empowering women groups and increasing their financial security. From these efforts, the treadle and hip pump technology is being used mainly in Kenya, Tanzania, Malawi, Zambia, Mali, Burundi, Sudan, Burkina Faso, Uganda and Rwanda (Sijali & Mwago, 2009). The popularity of the technology in these countries was mainly influenced by Kick Start International (KSI). The organization was born in Kenya, which increased the use of pumps in the country as well in East Africa. In the region, Tanzania and Kenya have embraced the opportunity presented by the technology more than any other country in the region.

Machakos County is one of the 47 counties in Kenya and formerly part of the Eastern province where the pump technology has been adopted, thus of interest to this study. Ngugi et al. (2011) describe Machakos county local climate as semi arid with hilly terrain and an altitude of 1000 to 1600 metres above sea level. Sections of the county also experiences food shortage due to low production of food and low uptake of agriculture technologies.

An introduction of small-scale irrigation technology by KSI in conjunction with Washington State University (WSU) targeting women began in 2014 and ended in 2016. This is the treadle pump and hip pump brought to various lower Eastern Kenya counties including Machakos, Kitui and Makueni. The goal of KSI/WSU was to offer the technology and purchasing plan fit to the financial comfort of women farmers and through comprehensive marketing of the pumps to assure as many sales as possible.

The study engaged farmers eligible to receive pumps using the criterion that required a farmer to have access to appropriate land and water to irrigate crops. The farmers

were to purchase the pumps either in cash, on credit or savings options. The treadle pump cost KES 14,950 while the hip pump cost KES 9,500 which farmers were expected to pay back within six months. Pumps were provided to individuals but on the basis of a group loan and repayment. Once pumps were distributed to the group members, the farmers were further taught how to use and maintain the technology KSI (2015).

This study sought to assess how the women farmers were accessing the KSI/WSU technology as well as utilizing the treadle and hip pump technology in their farms in Machakos County. The researcher engaged with women farmers who took up the KSI/WSU pump technology and those who did not take up the technology yet they had water available to irrigate their crops, i.e., the non-buyers in the study.

## **1.2 STATEMENT OF THE PROBLEM**

The treadle and hip pump technology was introduced by KSI/WSU team through marketing and distribution to solve the problem of farmers' dependency on erratic rain-fed agriculture. Machakos County being a semi arid area, the pump technology was to enable the farmers access water from their available water sources to irrigate crops and practice agriculture throughout the year and seasons. Adoption of the technology would enable the farmers irrigate larger areas of land more than using other manual irrigation modes such as buckets to irrigate their crops. Due to disparities in financial ability among the women farmers, the pumps were offered using different financial options, i.e., cash, credit and savings. However, the problem

to which the pumps were aimed to solve still persists such as lack of private and small-scale irrigation tools that will enable all year round production of crops by farmers through irrigation hence improved income food security among the farmers. The assumption was that the pump price and mode of payment would be an issue thus introducing the different finance options and pump types. However, even with the pump payment flexibility, the technology uptake was still low. Utilization of the pump would imply practicing agriculture throughout the year hence more income for the women and improved food security in their families. This study therefore sought to understand the reason and the dynamics behind the low adoption of the pump technology among the farmers. Non-buyers were also targeted by this study to help unveil reasons why they were not interested in the pump technology yet there seemed to be a need for the pump technology.

### **1.3 OBJECTIVES OF THE STUDY**

The main objective of the study was to assess the access and utilization of the treadle and hip pump technology among farmers due to low adoption of the pumps in previous study so that gender responsive strategies can be suggested to improve the uptake of the pump technology among the farmers. The specific objectives were:

- i. To establish the irrigation technologies used before the introduction of hip and treadle pumps in Machakos County.
- ii. To find out how farmers are accessing to and utilizing the treadle and hip pumps in Machakos County.

- iii. To examine the challenges facing farmers in accessing to and utilizing the treadle and hip pumps in Machakos County.
- iv. To suggest gender responsive strategies that will enhance access to and utilization of treadle and hip pump among farmers in Machakos County.

#### **1.4 RESEARCH QUESTIONS**

- 1.) Which technologies were being used before introduction of hip and treadle pumps among farmers in Machakos County?
- 2.) How are farmers accessing to and utilizing the treadle and hip pumps in Machakos County.?
- 3.) What challenges face farmers when accessing to and utilizing the treadle and hip pumps in Machakos County.?
- 4.) What gender responsive strategies could be used to enhance access to and utilization of treadle and hip pump among farmers in Machakos County?

#### **1.5 STUDY ASSUMPTIONS**

The study assumptions for this study were that:

- i. Irrigation technologies used before were inferior to the treadle and hip pump technology.
- ii. The other assumption was that the financial options, i.e., purchase on cash, credit or savings options that were offered to aid and ease access to the pump technology would enhance the farmers access to and utilization of the pump

technology.

- iii. The study also assumed that the farmers had challenges accessing to and utilizing the treadle and hip pump technology due to the low adoption rate in the KSI/WSU marketing and distribution study results.
- iv. The study too assumed strategies suggested to improve access to and utilization of the pump technology are the best and would enhance access and utilization of the treadle and hip pump technology among farmers in Machakos county.

## **1.6 JUSTIFICATION OF THE STUDY**

In the world today, the impact of technology on peoples' lives cannot be gains said. That is why this study is timely especially in the light of the fact that when it comes to farming, Sachs (2018) points out that men's issues usually take precedence yet over 80% of agriculture worldwide is done by women. Impact of technology in food production cannot be ignored too, so it is, even on how its acquired and utilized. The erratic weather that requires a shift of farmers from dependency on rain fed agriculture to irrigation also justifies the study.

Frameworks hailing from global, regional, national and gender and development frameworks such as Sustainable Development Goal (SDG) 2 which focus on zero hunger by 2030. It also recognizes that doubling agricultural productivity and incomes of small-scale food producers especially women by ensuring sustainable food production systems, and by progressively improving land and soil quality. Agriculture

is the single largest employer in the world, providing livelihoods for 40% of the global population. It is the largest source of income for poor rural households. Women make up about 43% of the agricultural labor force in developing countries, and over 50% in parts of Asia and Africa. However, women own only 20% of the land Griggs et al. (2013). The Kenya vision 2030 economic pillar together with the most recent big four agenda focus on food security and require a look on how women are involved in agriculture and technology related issues for maximum outcomes in food security and improved income (Kenya, 2007).

The study was also in line with recommendations for further research by Njuki et al. (2014) to find out whether market-based approaches on their own can guarantee women access to and ownership of technologies, and the specific measures that need to be taken by businesses to achieve the goal of reaching and benefiting women. KSI/WSU study on low adoption of the technology also required further study of the reasons behind the performance in the uptake, an activity that was beyond the scope of their work.

### **1.7 SIGNIFICANCE OF THE STUDY**

This study is significant to policy makers at both county and national governments to inform their decisions in relation to women in agriculture, their access to and use of technology such as the treadle and hip pump. The study is significant to NGOs', CBOs' and farmer group leaders to guide them in technology adoption related issues among their beneficiaries and group members too. The study is also significant to

donors with projects related to the pump and other technologies to inform their decisions in marketing and distribution of the technologies for maximum sales and utilization by their target beneficiaries and market. In addition, the study is significant to researchers in contributing to knowledge about the treadle and hip pump technology and as adopted by women farmers in Machakos County.

### **1.8 SCOPE AND LIMITATION OF THE STUDY**

The study was based in Machakos County that stretches from latitudes 0° 45' South to 1° 31' South and longitudes 36° 45' East to 37° 45' East. The study took place in the year 2017 in places where the technology was introduced within the county by KSI/WSU marketing team. It was the ideal time as two years had elapsed (2015 to 2016) since the introduction and utilization of treadle and hip pump technology to the farmers by KSI/WSU team. The study targeted 1059 households of both buyers and non-buyers of pumps from 132 farmer groups in Machakos County. The rationale of the researcher's choice of Machakos County was that, relative to other lower Eastern counties where use of irrigation technology is severely hampered by dry climatic conditions, Machakos county had potential to use the pump more due to an expansive land terrain and availability of natural and manmade water sources. It therefore stood a better chance of portraying observable response to adoption of the pump. The technology was also likely to influence the women due to nearness to the towns bordering Machakos county especially Nairobi the Kenya capital which has more ethnic diversity and a probable source of off farm income. The focus of this study was

mainly on women farmers who had purchased the treadle and hip pump technology. Non-buyers were also targeted by this study to help unveil reasons why they were not interested in the pump technology yet there seemed to be a need for the technology.

### **1.9 LIMITATIONS OF THE STUDY**

The researcher faced various limitations during the study. Language barrier was one of the limitations during the study since the researcher did not know the local language; however, this was overcome by seeking translation by enumerators who understood the language. Due to the area residents being used to free food and other household goods donated by government or people especially when drought strikes, some of the respondents expected a portion of reward in form of food or the like during the study. To address this, the researcher emphasized that the study was for academic purpose only and the findings would benefit the entire county residents. The study concentrated on Machakos County where KSI/WSU team had marketed and distributed the pump technology, therefore, most of the research outcome may be very specific to the study area. However, the findings may be cautiously applied to farmers living in similar climatic conditions as those in Machakos County.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter reviews literature related to irrigation technologies used before introduction of hip and treadle pumps among women farmers in semi arid areas of Machakos County, how the women farmers are accessing and utilizing the treadle and hip pumps. The chapter also explores challenges facing women farmers when accessing and utilizing the treadle and hip pumps among women farmers in semi arid areas of the County and other parts of the world and the strategies these other parts of the world used to overcome the challenges. This chapter also discusses the theoretical and conceptual frameworks of the study.

#### **2.2 Irrigation technologies used by women farmers before introduction of hip and treadle pumps**

Various studies have been on small-scale irrigation across the world. In developed countries, irrigation technologies are more advanced, mechanized and require heavy initial and operating costs. A study by Zou et al. (2013) study in China on irrigation technologies explored an economic perspective through a cost-effectiveness analysis of four water-saving irrigation techniques. The study compared the techniques widely implemented in China to address the impacts of climate change which were sprinkler irrigation, micro-irrigation, low-pressure pipe irrigation and channel lining. The results of this study showed that micro-irrigation has the highest incremental cost for

adaptation followed by sprinkler irrigation and low-pressure pipe irrigation, but when considering the revenues from improved adaptation, all of the measures assessed were economically feasible. The study was done in a developed country and compared different irrigation technologies that had already been acquired.

In their study in South Asia and sub Saharan Africa, Fraiture & Giordano (2014) found that small-scale private irrigation as a venture is thriving but also is an overlooked sector. The study although on irrigation and small-holder farmers using their resources, it describes and analyzes the private versus the underperforming public irrigation sector with emphasis on the thriving but overlooked private sector drawing from examples from five countries in sub-Saharan Africa and two states in India.

A study in Ethiopia on water lifting technologies for irrigation by Nigussie et al. (2017) explored the intra-household gender dynamics in of water lifting technologies such as rope and washer pump, tractor and drip and solar pumps. The findings showed evident disparities on domains of productive and reproductive uses, labor, access to resource, and benefits including income. Some of the water lifting technologies such as solar pumps are expensive and may not be affordable to the women and poor farmers.

Ragasa (2014), in her analysis of extension system reforms, she examined the experience of programme and projects that aim to increase women's access to extension services adds that the use of digital devices is also widely utilized by women as a source of information and education on farming practices. The study

analysed extension system reforms in India, Uganda, Venezuela and Ethiopia. The analysis found out that use of radio and television channels broadcast farming programme was done guided by professionals in the field. The information was then to be accessed and applied during farming. For most women, they cited the use of radio and television had increased the knowledge of farming as they can ask question that specifically affect their farming projects. She further explains that apart from the use of radio and television, small-scale women farmers use mobile short messages subscription services as a source of information. In this approach, NGOs and government farming programme create a mobile platform from which women can be informed on available technology. In addition, women can send messages to ask farming queries and receive immediate answers on their questions.

Sreelata and Naomi (2012) define the traditional methods of farming as drudgery. The authors further point out that the methods are highly tasking for women but the yields are not enough for both household and economic use (Sreelata & Naomi, 2012). The increased preference of traditional farming methods in rural areas has increased the levels of food insecurity and poverty. With weather patterns becoming less dependable, technological farming provide success opportunities for farmers in semi-arid areas (Sreelata & Naomi, 2012). However, the ability of people to embrace technological farming is too limited. Many farmers are unwilling to increase their knowledge in their fields due to high costs of technological farming as well as the lack of information on the required approaches. This study sought to find out how access and utilization of the treadle and hip pump technology unfolded, bearing in

mind the farmers had been educated about the technology and given financial options and payment plans for the technology by KSI/WSU marketers of the pumps between year 2015 and 2016.

Various studies related to agriculture in Machakos county and other Eastern Kenya counties have been done. However, there is scarcity in studies on irrigation and tools used to irrigate crops by farmers on their farms. Different studies done have concentrated on separate aspects of agriculture technologies that lead to full potential of performance of crops with irrigation tools not being mentioned in the aspects. These inspired study on this objective with regard to the study purpose. Some of the studies slightly related to irrigation done by Recha et al. (2016) involved a study on soil and water management technologies in changing rainfall patterns and farmers' adaptation through soil water management practices in semi-arid in Machakos and Makueni county. The study found that farmers in these semi-arid counties practice fifteen diverse soil and water management interventions on their farms with the most popular practices being cut-off drains, retention ditches, terracing, run-off harvesting and agro forestry. The study concentrated on harnessing and utilizing green, i.e., rainfall stored in soil and blue, i.e., rainfall collected into storage tanks water technologies but not the tools used to utilize the stored water.

In their study on factors related to the low uptake of technologies and innovations in semi-arid areas of lower Eastern Kenya, Kavoi et al. (2014) found that among the technologies promoted were drought tolerant crops as well as rearing of local breeds of goats and poultry in the three Counties. These include a focus on dairy goat

production, cassava commercialization, soil fertility and water conservation and farmer-led innovations. Again, in this study no irrigation technologies have been mentioned.

### **2.3 Women farmers access and utilization of the treadle and hip pumps technology**

According to Shah et al. (2000), the treadle pump was developed in 1979 by a team working with the Rangpur Dinajpur Rural Service (RDRS), an NGO working in Northwest Bangladesh. It ensured access of the pump through providing a 50% subsidy to farmers on the purchase price. However, further increases were limited by production capacity, the lack of a nationwide sales network, and the fact that a short supply chain from the manufacturer to the customer did not use the promotion potential of retailers.

Farrington and Lewis (2014) observe that in Asia, NGOs have pioneered many of the treadle pump distribution initiatives subsequently incorporated in public sector extension services. NGOs continue to play a lead role in ensuring that women farmers and women on the farm receive training, information, and improved technologies. Their services often are increasing in scope and scale, either as complementary support to government efforts or to fill the gaps created as government expenditures and capabilities decline.

Prabhu (1999) in her study on marketing treadle pumps to women in India with the International Development Enterprise (IDE) organization discusses from a gender

perspective how the organisation has tried to define and integrate gender awareness into its thinking and internal practices as well as its programme of technology dissemination. Prabhu agrees that for a long time, advocates of the use of appropriate technology for development tended to overlook or misrepresent women's circumstances and needs, even though a key aspect of developing appropriate technology is to answer the question to who is 'appropriate' technology for. It is now widely recognised by development theorists and policy-makers that not only should technology be gender-neutral but can also be a tool to change gender relations.

She further argues that through using technology, women can gain a chance of empowerment with their daily lives made easier and they can challenge the stereotypical gender roles, through gaining time, skills, and knowledge to participate in other kinds of work. Prabhu (1999) cites two basic means of promoting appropriate technology; the first is by using trained extension workers. She explains that the major advantage of this is that it provides a free service to the poorest farmers. Yet its disadvantage is that government and non-government organizations can never fund enough extension agents at least in India to reach the scores of people who need, and will benefit from, using the technology. A further disadvantage for women farmers and those who aim to improve gender power relations is that extension agents in India are mostly men who for cultural reasons tend to restrict their interactions to male farmers, assuming that no woman would be interested in irrigation technology. The second way to promote technology is through the private sector. The advantages of this route are that it harnesses the efficiencies of the private sector to promote and

supply technologies on a large scale. IDE believes that its success stems from its treatment of poor people as customers and not recipients of charity, and the fact that it disseminates products that are affordable and appropriate for their needs.

In India, IDE promotes treadle pumps in selected districts of Uttar Pradesh, Bihar, West Bengal, Assam, Meghalaya, and Orissa. Since IDE started working in the region in the late 1980s, small and marginal farmers in south Asia purchased over 1.4 million treadle pumps to irrigate their land, through over 3,000 small enterprises such as local hardware and agriculture input shops (Prabhu, 1999). These pumps are mostly bought by male farmers, but used both by male and female farmers. Treadle pumps are used extensively by women, particularly in areas where male migration rates are high.

In building the supply network for appropriate technologies, Prabhu (1999) describes how IDE works with and through others, creating linkages between and building on the strengths of the private sector and NGOs. IDE works in partnership with the local private sector through identifying and motivating suitable manufacturers to make, market treadle pumps to women farmers in India therefore linking farmers with appropriate distributors and dealers who will stock and supply the product at the grassroots level and training local mechanics to provide after-sales service .

In terms of marketing, IDE uses innovative methods of rural marketing to promote technology among farmers. These include highly interactive farmers' meetings; product demonstrations, for example at village bazaars and fairs; and video shows of a hugely entertaining commercial film with the necessary ingredient of melodrama whose action is centred around the treadle pump. All these promotional techniques are

employed to varying degree in each area, depending on the level of awareness about the product (Prabhu,1999).

Though the treadle pump is not a community product, i.e., one which lends itself to community ownership and management, IDE therefore works directly with individual farm families. However, community-level promotion efforts such as farmers' meetings enable IDE to understand the needs and aspirations of marginalised farmers as a social grouping. Ideas for new products come out of these meetings and other forms of direct contact. IDE staff follow up farmers' meetings with visits to existing users of treadle pumps in order to check on the quality of installations, to train them in regular maintenance of the pumps, and to ensure that they have access to a mechanic for repairs, should the need arise. These one-on-one meetings are also used to gauge the farmers' satisfaction with the product. All this feedback is channeled back into IDE (Prabhu, 1999).

From a gender perspective and in their gender, technology, and marketing strategy since 1997, Prabhu (1999) informs that IDE external evaluators and funders advised for empowerment of rural women through targeting them as purchasers and users of their products, and by training them to maintain and repair them. However, for an organisation such as IDE, it immensely posed a challenge to acknowledge women as users of technology, and to adapt its working practices according to their needs. This is because it meant ridding IDE's work of predominantly masculine values, which was hard because most of IDE's marketing staff were young men. Considering the machismo associated with achieving sales targets or well-defined quantitative

indicators, one would realize that little space was left for 'gender' concerns and the development of 'softer', more qualitative indicators of success.

Prabhu (1999) further describes how advertising and marketing requires adopting a commercial route to promote technologies through various means of advertising, and these usually conform to gender stereotypes. Like extension agents, advertising managers and sales representatives in the commercial sector are mostly men. Many brought marketing treadle pumps to women farmers in India 'traditional' perspectives about 'men's' and 'women's' worlds to their work. In the area of agriculture, advertising and sales activities almost exclusively target men, as it is often seen, falsely, as a male-only domain. Prabhu advises that advertising or promotional campaigns that do aim to reach both men and women purchasers to promote different kinds of products can be a powerful means of breaking some gender stereotypes. Incorporating a gender perspective into promotional campaigns has implications for the type of media chosen, and the contents of the message. A major obstacle she described faced by advertisers in rural India is the relatively low mobility level of women outside their homes or their villages.

Prabhu (1999) further describes a solution that took time for IDE to persuade women to participate in 'mixed' promotional events. The greatest challenge for their male staff was how to talk to women without such a gesture being misinterpreted. Seeking out and working with female opinion-leaders greatly helped to overcome this. Another strategy was to work with local NGOs, including one which had established a network of active women's self-help groups. IDE also conducted pump demonstrations among

women, encouraging them to try the demonstrated technology; and established demonstration plots with women-headed households. It also appointed an enterprising woman mostly the secretary of the self-help group in the area as a dealer for treadle pumps, who would be able to earn a steady income from commissions earned off pump sales. Finally, they provided training for local IDE male staff on gender issues, the importance of women farmers as customers and, most importantly, on how to interact with women. Throughout this whole process, they ensured consistent talks with the men in the family as well. As a result of these efforts, over 18 months 75 pumps were sold to marginal women farmers with credit support from their groups.

Prabhu (1999) noted that once other, poorer, farmers in the village observed the product work and seen its impact on the other farmers' output over at least one or two crop cycles, they invested in it as well. The reason being that poorer farmers cannot take risks and invest in a product whose returns they are not sure about. In order to reduce the time-lag between the poorest farmers first seeing the product and their eventual purchase, IDE worked with local NGOs and the supply chain to provide credit, which absorbs some of the risk. Thus, adopting a more commercial route to promoting technologies does not limit one's ability to reach the poorest. It does, however, mean taking into account from the start the time it will take to reach the poorest farmers. Having said that, if one has products that are cheap, they can reach the poorest farmers at the outset.

Prabhu concludes that there is a long learning curve on integrating gender concerns

with technology development and dissemination. It is therefore critical to move slowly and strategically, and be prepared to take small steps. Recognizing that each geographical area has its own peculiarities, which must be explored and understood before steps are made in accordance with local conditions is important. She reports that IDE learned that products must be developed with an understanding of gender roles and relations, because the nature of the technology itself will determine the degree to which it is adopted by women.

In marketing terms, Prabhu states lessons on sales that selling the pumps to women is not in itself a sufficient indicator of the level of involvement of women in the use of the technologies they were promoting. While women may not actually go to shops to buy the technologies, they may significantly influence the decision to purchase, and therefore information about the product should be made available to them. She recommended the importance of including other indicators of women involvement in monitoring and evaluation, such as women's attendance at training sessions and promotional events.

To staff, Prabhu (1999) recommends the importance of staff to be trained to see the potential of both men and women as users of technologies, and the potential of using technologies to challenge unequal gender relations. It is important that in the trainings, there be a combination of conceptual awareness-building and practical tips for implementation. Another early step that IDE found useful is to put in writing a brief, lucid policy statement on gender issues in the context of their organisation's work. Integrating gender into the development and marketing of appropriate

technologies by then was a relatively new area, and therefore there had few models to emulate. A big challenge for IDE was to develop good qualitative indicators to measure the impact over time of integrating gender issues into their activities.

In West Africa the treadle pump was promoted by Enterprise Works as an alternative to the traditional rope and bucket irrigation. The objective of the study was to improve output and incomes and reduce poverty among farm households. The study by Adeoti et al. (2007) reported an assessment of the dynamics of its adoption and impacts, with a special focus on poverty reduction among adopters and non-adopters of treadle pumps in two regions of Ghana. The results of the study reveal that time and labor savings for irrigation were the major attractive features of the treadle pump for those who adopted it. The difference in net income between adopters and non-adopters was about US\$393 per hectare, with an increase in land and labor productivities. About 21% of pump adopters stopped the use of the treadle pump because it broke down, while about 10% shifted to motorized pumping. The study showed that adoption of treadle pumps reduces poverty. The study recommended that increased collaboration with local institutions, such as extension services, would improve the transfer of treadle pump technology to farmers. After-sales service and training of farmers on repairs could also reduce treadle pump abandonment.

Mangisoni (2008) did a study on impact of treadle pump irrigation technology on smallholder poverty and food security in Blantyre and Mchinji, Malawi among pump adopters and non-adopters. Study results found that adopters of the technology had higher net farm incomes than non-adopters per year. Likewise, under rain-fed

conditions, adopters had higher net farm incomes than non-adopters. Furthermore, the well-being measurements and analyses of poverty revealed a higher poverty level among non-adopters compared with adopters. The former also had a greater relative risk of falling into deeper poverty than the latter. Transition matrices depicting movement in and out of poverty showed that from 2004 to 2005, some poor adopters moved out of poverty while some non-adopters dropped from being non-poor to poor. No adopter moved from non-poor to poor. The study again although on treadle pump technology did not look at how the farmers acquired the pumps.

A similar study in Malawi by Kamwamba-Mtethiwa (2012) on their irrigation strategy, found that the government and non-governmental organizations (NGOs) actively promoted the use of treadle pumps in smallholder irrigation. Analysis of the adoption dynamics and dissemination approaches of treadle pumps indicated differences between male and female adopters. Female adopters were more likely to pay for subsidized treadle pumps in cash, while male adopters mostly acquired their pumps through a loan. The results also indicated that relatively well-off farmers had a significantly higher probability of adopting the treadle pumps than poor farmers.

In Kenya and Tanzania, a study by Njuki et al. (2014) on access and utilization of treadle and hip pump focused on whether market based approaches to technology development and dissemination can benefit smallholder women farmers. Findings from the study concluded that the approaches on their own cannot guarantee access and ownership of the technologies and businesses need measures toward the goal of reaching and benefitting women. Data from the study showed less than 10 per cent of

pumps were purchased by women and men make most of the major decisions on crop choice and use of income from irrigated crops.

During utilization, men are responsible for the procurement, operation and maintenance of the pumps. They pedal while women assist with water distribution.

Kamara et al. (2004) observe that the difficulty for women to operate the pumps has cultural dimensions. Pedaling the pump with an up-and-down leg motion while being elevated above the ground makes women feel uncomfortable and undignified, particularly in the presence of men. In Orissa India, however, utilisation of the treadle pump was done by all family members but the head of the family did more. Most users did not feel any serious physical fatigue. Women were quite comfortable operating the pump but on stop-gap basis. Children also operated the pumps but for lesser duration and hired labour was utilized in a few cases Srinivas (2004). This, however, contrasts with the situation in Kenya where pumps are purchased by men but are mostly managed by women who hire young men to operate them (Brabben & Kay, 2000).

#### **2.4 Challenges faced when acquiring and using treadle and hip pump among poor women farmers in semi arid areas**

Burney et al. (2013), in their study on small scale irrigation technology in Sub Saharan Africa, found three technology components of small-scale irrigation as access, distribution, and use of the technology that are necessary for a successful smallholder irrigation system. The authors also cited challenges in technologies for

accessing water as posing an especially acute problem without financing. This was because, unfortunately, microfinance institutions (MFIs) in SSA often do not extend into rural areas as this raises operating costs, nor do they offer agriculture-related loans as coordinated risks are high or loans of a reasonable size for this type of investment, i.e., hundreds of dollars as opposed to tens of dollars. Although MFIs are beginning to pursue interesting combinations of credit and insurance to agricultural borrowers, access to credit has lagged far behind demand for productivity-enhancing technologies like distributed irrigation systems. McComb et al. (2014) also found out that finance was also a key constraint: a motorised pump of \$250 may be relatively 'low cost' but is still unaffordable to many farmers. Microfinance services are either unavailable in rural areas or have been unwilling to provide agricultural loans, though some are now more supportive.

Despite the above pitfalls, Burney et al. (2013) found that new solutions were emerging for smallholders in SSA. In a welcome development, in 2012, the direct lending site Kiva.org partnered with the One Acre Fund, a smallholder agricultural extension programme in Kenya, Uganda, Rwanda, and Burundi, to begin extending agricultural loans to farmer groups. In several cases, farmers have organized into groups to overcome physical and economic water access issues. Although the limited literature on farmer groups is mixed, success stories tend to be found where distributed systems are used in a cooperative setting, permitting the sharing of knowledge, risk, credit, and marketing. In Sri Lanka Aheeyar et al. (2005) in their study on land and water use established that manual irrigation methods such as the

canal methods were used when farms are in close proximity to rivers. The main disadvantages of these approaches, is that they depended heavily on farms proximity to water sources.

Adelman (2009) posits that rural poverty is complex, and there is no single solution to the problems farmers face that is why One Acre Fund takes a holistic, long-term approach. They offer a complete bundle of services, using a market-based model that helps their organization remain financially sustainable and expand to reach more and more farmers every year. The one Acre model comprises 4 components which are flexible repayment asset-based loans throughout the loan term, delivery of inputs to locations within walking distance of every farmer served, training farmers throughout the season on modern agricultural techniques and market facilitation such as crop storage solutions and teach farmers about market fluctuations, so that they can time crop sales to maximize profits.

In an argument by Valdivia and Gilles (2001) when technological innovations do address women's tasks and make them more profitable, men often take them over. This was exactly what happened when pump irrigation was introduced for rice production in West Africa. For sustainable improvements, not only must benefits be targeted to rural women, but mechanisms must also be put into place to ensure that these benefits can be retained by the intended beneficiaries.

Poverty in semi-arid areas in Kenya can be attributed to the overreliance on rain fed agriculture for financial income. Bukania et al. (2013) are of the assumption that dealing with poverty levels in Kenya would require changing the perception and

mentality of people living in rural, arid and semi-arid areas. The authors further assert that regardless of the fact that farming would be the most reasonable solution to poverty, it incentives in structural and financial support which are not provided in rural areas. Olielo (2013) argues that the implementation of new farming techniques is costly especially for women in no income.

Fisher (2006), among many ideas, suggests exploring bundling the pumps with products and services such as fertilizer, seeds, and farming and marketing advice to increase the chances of the farmers' success and loan repayments. Lewis et al. (2015) also profile another challenge that would hinder access to and utilization of treadle and hip pump technology as the lack of detailed hydro-geological mapping for Africa as a whole. Treadle pumps can only reach a certain depth – around 7 metres, depending on the type of pump so it would not be useful if water resources are deeper. Successful rainwater harvesting in on-farm ponds can also depend on soil type and rainfall patterns, and works best on moderately sloping land.

The illiteracy level in women in rural Sub-Saharan region is high which minimizes their ability to be able to seek finance from banks. Ivers and Cullen (2011) assert that women tend to be less attracted to credit and finance due to poor education in the field as well as their overreliance on the traditional approaches to farming. The authors further assert that this has limited the entrepreneurial abilities for women in rural areas (Ivers & Cullen, 2011). With proper education, the tendency by women to access finance and credit would increase significantly. The education strategy should

include giving women education on the benefits of increasing their investment in farming.

The ability to use to access technology in farming is enabled by how well the women are able to use the available technology. To address this problem, women across Africa take part in education projects that include both theory and practical. Women farmers have quantitatively and qualitatively less access to information, technology, land, inputs and credit. Policy-makers, managers, agents and participants in agricultural support services are generally males, who are not always sufficiently aware of the specific problems and needs of women farmers. As a result, information and extension services are typically geared towards male farmers, on the assumption that the message will trickle across to women (FAO, 2007).

### **Summary of literature review**

The above review with regard to irrigation technologies used before introduction of treadle and hip pump in Machakos county shows that one of the previous studies was based on developed countries and with irrigation technologies that had been already acquired. A comparison of private vs. public irrigation sector in another study is made with a conclusion being that the private irrigation sector is overlooked. More of the irrigation technologies study done was on gender dynamics in water lifting technologies such rope and washer, tractor and solar pumps than on treadle and hip pump technologies. Some of these technologies are also likely to be expensive and may not be affordable to women farmers in Machakos County. Other studies related

to irrigation technology in Machakos county have concentrated on separate aspects of crop performance such as rainfall stored in soil and water collected into tanks but not the tools used utilize the stored water . The other aspect concentrated in studies on agriculture in Machakos county is on drought resistant crops and livestock.

On access to and utilization of treadle and hip pump, other studies done show that some of the farmers were given the pumps on subsidy in purchase price which is not the case in this study. Some also show that NGO's pioneered in the pump distribution initiative and were subsequently incorporated in public sector extension services to complement or fill gaps created as government expenditures and capabilities declines. This is not the case in this study too. One of the studies in India defines and integrates gender awareness to thinking and organization internal practices as well as technology dissemination for the treadle pump. The study is likely to be part of the basis of this study due to commonality in the purpose to reach women farmers with the pump technology.

Other studies done in Africa with regard to the treadle and hip pump technology concentrated on improved output and incomes to reduce poverty among farm households, poverty and food security as well as market based approaches to technology development and dissemination. Other studies on utilization showed disparities in use of the pump among family members with men using it more than women and children. This study thereby filled the gap created by other pump studies done before in areas that are not arid or semi arid and without the financial options directed to women farmers. This study also sought to narrow the gap by specifically

focusing on assessment of how women farmers who are in arid and semi arid area of Machakos County were accessing and utilizing the treadle and hip pump technology.

Other studies are also exclusively rural or urban related, this study brought in a synergy of urban and rural income due to the study site proximity to town i.e. Nairobi.

In addition the study sought to understand access and utilization of treadle and hip pump among women farmers from a gender lens with interplay of various levels of institutions that are related as key determinants of successful access and utilization of the technology.

The results of KSI/WSU study in 2015 to 2016 also offered insight for more investigation into selected reasons for the low uptake of the treadle and pumps uptake, an issue that was beyond the scope of the KSI/WSU study which ended in 2016.

## **2.5 Theoretical framework**

The study was guided by two theories, namely, social relations framework by Naila Kabeer (1994) and diffusion of innovations theory by Rogers (1983). The second theory was important since it complemented the social relations framework which gives a political rather than a technical or informational solution.

### **2.5.1 Social relations framework**

This study was guided the by social relations framework by Naila Kabeer (1994). The key tenets of the framework include an analysis of how existing gender discriminations and inequalities are created, maintained and reproduced in institutions

(i.e., the state, the market, the community and family/kinship) with the aim of involving women in their own development solutions. The third objective in this study anchors the challenges faced by women farmers while accessing to and utilizing the pump technology based on the four institutions. In this case the state is represented by the national government level and county government level which have arms mandated to create policies. The market refers to the pump designer, marketer and distributor who in this case is the KSI/WSU team. The community refers to the community at large with its various organization such as farmer groups. The family/kinship refers to the basic unit of the society and together with kinship created by the extended family.

The framework also uses five concepts to analyse gender inequality, these are, development as increasing human well being, social relations, institutional analysis, institutional gender policies, and immediate, underlying and structural causes. In this study, the framework analysed the 5 concepts in the light of treadle and hip pump technology access and utilization within the 4 institutions that create, maintain and reproduce inequalities in the access to and utilization of treadle and hip pump technology among women farmers in Machakos County.

### **2.5.2 Diffusion of innovations theory**

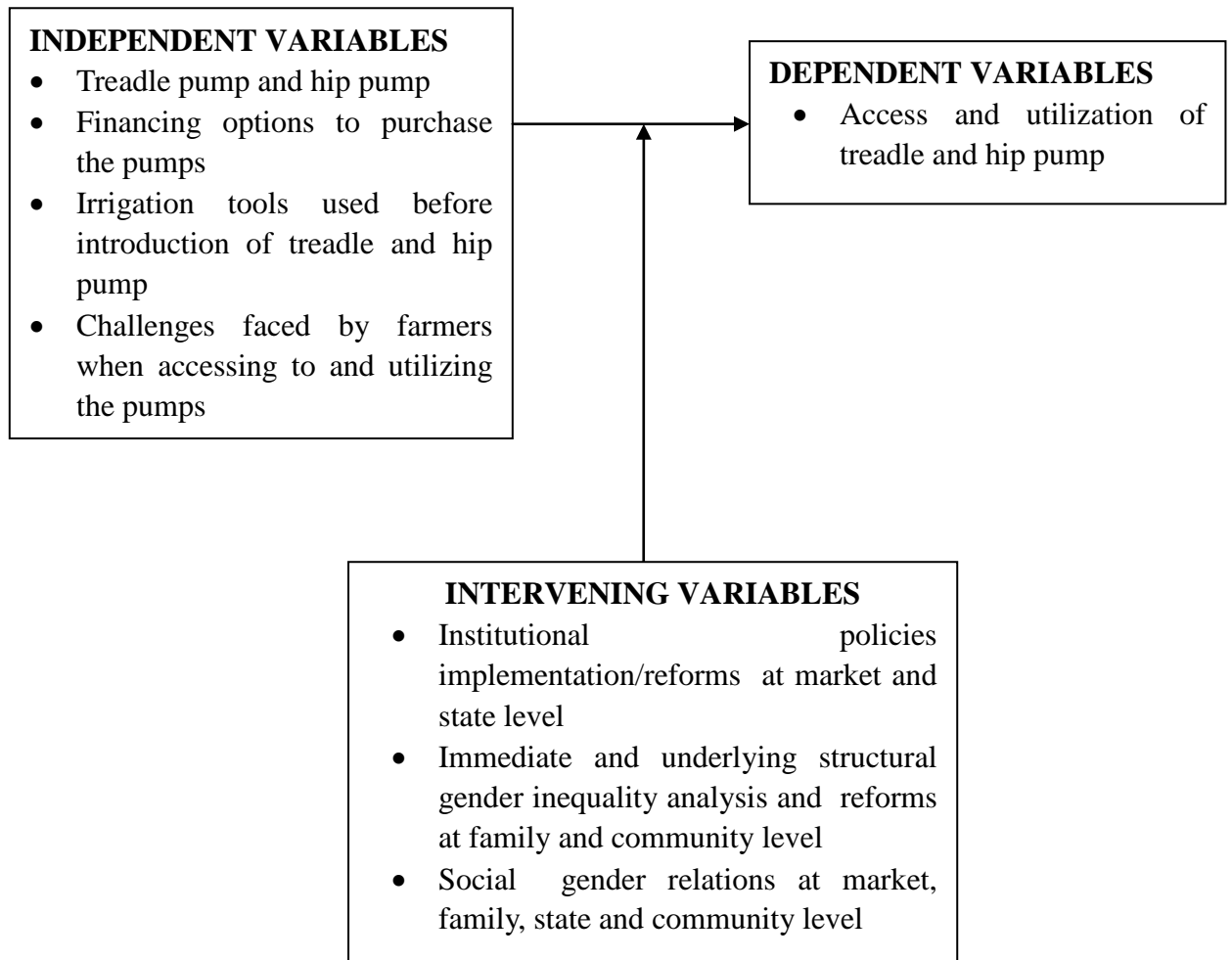
The study also employed the diffusion of innovations theory by Rogers (1983). The key tenets of the theory are on the five stages of an innovation life cycle that a product undergoes upon introduction to a new market. The theory explains how, why, and at

what rate in the 5 stages a product spreads in the influence of four main elements, i.e., the innovation itself, communication channels, time and social system. It is in this four elements that this study anchored the strategies to improve access to and utilization of treadle and hip pump technology among women farmers in Machakos county.

In his theory Rodgers distinguishes the five stages of an innovation life cycle in which the product might find itself with five different user groups, i.e., innovators, early adopters, early majority, late majority or laggards that accept the product or idea. Depending on the stage of the product, several adjustments take place, e.g., much or little promotion or a high or low sales price.

In this study the treadle and hip pump technologies and the financial options of payment were innovations to be adopted and was used by KSI/WSU to market their product to women farmers in Machakos county between 2015 and 2016. Rogers argues that diffusion is the process by which an innovation is communicated over time among the participants in a social system. In this study, the innovation was implemented among women farmers in Machakos over a period of 18 months through KSI/WSU sales persons. This study sought to explain how, why, and at what rate the pump technology innovation was adopted with regard to the stage of the innovation itself, communication channels, time and social system among farmers in Machakos county.

## 2.6 Conceptual framework



**Figure 2.1 Conceptual Framework**

Figure 2.1 shows the interaction of variables in the access and utilization of treadle and hip pump small-scale irrigation pumps by farmers in Machakos County. The independent variables are the treadle pump and hip pump, financing options to purchase the pumps, irrigation tools used before introduction of treadle and hip pump and challenges faced by farmers when accessing to and utilizing the pumps. For a successful adoption of the technology consideration to intervening variables, a cross-

examination and reforms is required at institutional policies and analysis of the policies at market and state level, immediate and underlying structural reforms at family and community level and social relations at market, family, state and community level.

## **CHAPTER THREE**

### **METHODOLOGY OF THE STUDY**

#### **3.1 Introduction**

This chapter describes the methodology used in the study on assessment of access to and utilization of treadle and hip pump small-scale irrigation (SSI) technology among women farmers in Machakos County. The chapter describes the research design, research site, target population, sampling techniques, sample size, research instruments, validity and reliability, data collection, data analysis procedure and finally the ethical issues observed during the study period.

#### **3.2 Research Design**

The study used descriptive and experimental research designs to generate quantitative and qualitative data. Bickman et al. (1998) suggest that descriptive research can answer questions such as ‘what is’ or ‘what was’. On the one hand, the purpose of using descriptive research for this study was to enable the researcher to depict the participants in an accurate and objective way using interviews and discussions about their experience during access and utilization of treadle and hip pump technologies. On the other hand, experimental research design was incorporated in the study to find out the difference between pump buyers and pump non-buyers. This would also determine the efficacy and efficiency of the previous financial options provided by KSI/WSU in 2015-2016, i.e., purchase of pump using cash, credit or savings options to enhance access of the pumps.

The indicators and measurements for access to the pump were done through assessing the type of pump purchase, the finance option used to purchase the pump and the number of pump buyers against the number of people that the pump was marketed to in groups. Utilization of the pump was measured by asking pump buyers whether they had used the pump and who used it since they bought their pump.

### **3.3 Research site**

The study took place among the rural smallholder farmer households in Machakos County that lies in the lower Eastern counties of Kenya as shown in Appendix 1. It also shows the earth points of various groups on google earth maps for the farmer groups that the study respondents came from together with the finance options they were exposed to by KSI/WSU team. KNBS (2010) describes Machakos County as one of the 47 counties in Kenya and one of the eight counties in the Eastern region and three counties in the lower Eastern counties. The county borders Embu, Murang'a and Kiambu counties to the North, to the west Nairobi and Kajiado counties, to the south Makueni county, and to the East Kitui county. The county has a total area of 6208.2 km<sup>2</sup> most of which is semi-arid. It is also divided into eight sub-counties namely, Masinga, Yatta, Kangundo, Matungulu, Kathiani, Mavoko, Machakos Town and Mwala. The County has a total of 40 wards and 75 locations. It lies between latitudes 0°45'South and 1°31'South and longitudes 36°45'East and 37°45'East.

The KNBS (2010) statistics further show that the county has a population of 1,098,584. The county has an average population of 177 per square kilometer. The County receives a bimodal rainfall with short rains coming in October to December and long rains in March to May. The annual average rainfall ranges between 500 mm and 1300 mm, and is unevenly distributed and unreliable. Total annual rainfall ranges from 1000mm in highland areas to 500mm in the low lying areas. Temperature varies between 18°C and 29°C throughout the year. The coldest month is July and the warmest months are October and March prior to the onset of the rains. Dry periods are experienced in February to March and August to September. Agriculture contributes 70% of household income, rural self-employment contributes 10%, and wage employment contributes 11 % while urban self-employment contributes 5%. The most dominant vegetation in the County is dry bush in the higher areas, savanna with scattered trees. Most farmers rely heavily on rain fed agriculture although some parts practice irrigation. Subsistence agriculture is mostly practised with maize and drought resistant crops.

The rationale of the researcher's choice for Machakos County was that, relative to other lower Eastern counties where use of irrigation technology is severely hampered by dry climatic conditions, Machakos county had the potential to use the pump due to its expansive land terrain and availability of natural water sources. It therefore stood a better chance of portraying observable response to adoption of the pump. The technology was also likely to influence the farmers due to nearness to the towns

bordering Machakos county especially Nairobi the Kenya capital which has more ethnic diversity and a probable source of off farm income.

### **3.4 Study population**

The study targeted farmers from 1059 households of both buyers and non-buyers of pumps from 132 farmer groups in Machakos County. These farmers had participated in the KSI/WSU marketing and distribution study on savings (mobile layaway) and credit (rent-to-own) as innovative solutions to enable poor farmers to access small-scale irrigation pumps conducted by KSI/WSU on in Lower Eastern Counties, i.e., Machakos , Kitui and Makueni in 2015-2016. The farmers comprised of two categories: those were pump non-buyers who were unknown and those who bought pump in the previous KSI/WSU study period. This study identified all pump buyers that had participated in the KSI/WSU study in Machakos county. The pump non-buyers were to be identified through the pump buyers since they knew group members who had water and did not purchase the pump technology. These buyers and non-buyers informed the researcher about access to and utilization of treadle and hip pump technology among the women farmers. The access to and utilization aspect was beyond the scope of KSI/WSU study and therefore the researcher build on the KSI/WSU study by assessing how the women were accessing to and utilizing the technology.

### **3.5 Sampling techniques and sample size**

The sampling frame used in this study followed the KSI/WSU procedure that recruited pump buyers from 132 registered farmer groups in Machakos County as given by the county department of social services. In 2014, the groups through their leaders had gone through a baseline study and screening for groups that were likely to adopt the pumps in terms of group composition, i.e., more women than men and availability of water to irrigate crops was done using the information given by their leaders. The groups were then exposed to marketing and distribution of hip and treadle pump using the three financial options by KSI/WSU for a period of nine months. The end line study by KSI/WSU buyers of the pump in Machakos county informed the basis for this study's' pump buyer respondents. The non-buyers were to be recruited through asking buyers to lead the enumerators to group members who had water to irrigate crops in their land but did not purchase any of the pumps.

### 3.5.1 Recruitment of treadle and hip pump buyers

Table 3.1: Sampling procedure and sample size for treadle and hip pump buyers and non-buyers per sub county in Machakos county.

<b>Sub county</b>	<b>Buyers</b>	<b>Female</b>	<b>Male</b>	<b>Non buyers</b>	<b>Female</b>	<b>Male</b>	<b>Total</b>	<b>%</b>
<b>Yatta</b>	18	12	6	14	11	3	32	45.7
<b>Mwala</b>	7	4	3	6	5	1	13	18.6
<b>Matungulu</b>	6	3	3	3	3	0	9	12.9
<b>Masinga</b>	0	0	0	0	0	0	0	0
<b>Machakos</b>	5	3	2	2	1	1	7	10
<b>Kathiani</b>	2	2	0	1	0	0	3	4.3
<b>Kangundo</b>	1	1	0	0	0	0	1	1.4
<b>Mavoko</b>	3	2	1	3	2	1	6	8.6
<b>No.</b>	42	27	15	28	22	6	42	100

The study used purposive sampling technique to recruit pump all the 42 pump buyers from the KSI/WSU study in Machakos county. This gave a response rate of 100%. The study recruited KSI/WSU study research enumerators to collect data. The enumerators had already familiarized themselves with the respondents from the previous study and it was easy to re- introduce themselves and explain the purpose of their visit as a follow up to their previous contact. The enumerators also used Earth Points, an app they had previously utilized for tagging GPS points on Google Earth during the KSI/WSU marketing and distribution study in 2015-2016 for ease and to

purposively locate the participants. According to the enumerators, it emerged that most pump buyers were dispersed in 7 out of 8 sub counties of the study area. The dispersion was influenced by sources of water for use with pumps which include shallow wells, rivers/streams, earthen reservoirs, community well, sand dam or stream diversion. The sub counties informed and guided the study sampling blocks and locations as indicated in table 3.1 above.

The study used pump buyers as entry point to the study locale and sampling process. The enumerators relied on contacts they had established in the previous study to recruit a total of 42 pump buyers who participated in the KSI/WSU study in between 2015 to 2016.

### ***3.5.2 Recruitment of treadle and hip pump non-buyers***

Though the number of pump non- buyers was unknown, the enumerators were able to recruit 28 pump non-buyers using snowball sampling technique across the selected sub counties. This involved asking for reference from pump buyers who knew group members that had water to irrigate their crops but did not purchase treadle or hip pump. This is illustrated in table 3.1. The technique was appropriate since the non-buyers were difficult to reach through any other sampling method.

### ***3.5.3 Recruitment of key informants***

Other study participants included in the study were key informants such community leaders represented by chiefs, county government workers represented by agriculture

extension officers and KSI/WSU representative too. The key informants were purposively recruited based on their positions and possession of professional and social in-depth knowledge, skills and roles in the community and the study. They were to provide vital information about the pump buyers and non-buyers as well as qualitative summaries and documentation.

### **3.6 Data collection instruments**

The study used both primary and secondary data. Primary data was collected using interview schedules and focus group discussions administered to farmers who were buyers and non-buyers of the pump technology. Primary data was also collected using key informant interview guides administered to key informants. Secondary data from sources such as other related literature on the subject in the university and online-based libraries, e-books, journals, reports and the media to supplement primary data.

#### **3.6.1 Interview schedules for pump buyers and non-buyers**

Interview schedules were administered to both buyers and non-buyers of the pump technology. This was convenient because not all respondents were able to read and write. Interviews were also able to capture qualitative data at first hand from participants. It was also appropriate to use interviews because the researcher was able to observe non-verbal cues from the participants as well as reword the questions where participants seemed not to understand questions.

### **3.6.2 Focus group discussions guides for pump buyers and non buyers**

The researcher conducted 6 FGDs in this study. Four of them were pump buyers FGDs at Makutano, Kithimani, Mwala and Kyanganga areas. Pump non-buyer FGDs were conducted at Kyumvi and Masinga area. To meet the groups, the group leaders were contacted and asked the date and time they meet in their meeting points. The researcher and enumerators adjusted their schedule to coincide with the groups' convenient time and meet with the group members where they converge. The inclusion criteria for buyers FGD involved holding discussions with people who bought pumps using the different finance options offered during the KSI/WSU study while the non-buyer FGDs inclusion criteria was to involve people who had been marketed to by KSI/WSU team, they had water on their farms but did not buy the pumps. The focus group discussions composed of (6-8) women and were conducted using a focus group discussion guide. The groups discussed for one hour thirty minutes. The moderator introduced the topic of discussion and helped the farmers to participate in a lively and natural discussion amongst them. There was also one enumerator to take notes as the discussions went on. The FGDs also allowed the participants to agree or disagree with each other so that it provided an insight into how a group thought about an issue presented. Krueger and Casey (1988) say that this is ideal in collecting the data because it allows the participants to reveal a wealth of detailed information and deep insight. It creates an accepting environment that puts participants at ease allowing them to thoughtfully answer questions in their own

words and add meaning to their answers. Themes relating to the FGDs were both pre-determined as well as others emerged during the discussion.

### **3.6.3 Key informant interview guides for key informants**

The key informant interview guides were administered to key informants mainly chiefs from the selected villages, agriculture extension officers from the selected sub counties and KSI/WSU representative. The enumerators went through the questions with the key informants to ensure clarity of the questions. The key informants were easy to locate and hence the return rate was 100% though some questions had no responses. The interview guides allowed the individuals to respond in their own words and expressed their opinion freely. Similarity of questions also ensured data acquired is identical, correct and standard.

### **3.7 Validity and reliability**

Validity refers to how well a test measures what it is purported to measure while reliability is the degree to which an assessment tool produces stable and consistent results. The researcher aligned the questions in the study with the study objectives. The data collection instruments were also pre-tested before the main study was conducted. Based on the pre-test, the instruments were reviewed by re-phrasing the questions that were ambiguous and not well understood and the irrelevant ones removed. Data entered was also reviewed for any outliers to ensure validity.

### **3.8 Pre-test**

A pretest study was done using the designed data collection tools for the study. The researcher did this through a random pre-test sample included 6 farmers, 3 who had purchased and used the treadle or hip pump in Kiambu sub-county and 3 of their neighbours who had water to irrigate but had not purchased a treadle or hip pump. The farmers were not part of the actual survey. Others included in the pretest were a pump dealer and a pump salesperson. The purpose of the pre-test was to ensure that items in the data collection tools were stated clearly and give the same meaning to all respondents. This provided a trial run for the data collection and ensured reliability and validity of the study. The pre-test also enabled the researcher to familiarize with administration of the instruments, and revealed whether the anticipated analytical techniques were appropriate. In addition, the researcher also sought assistance from the academic supervisors. The pretest helped to highlight any errors of inclusion or omission in the study tools. Necessary alteration and modification were effected before the actual data gathering exercise.

### **3.9 Data collection procedures**

Data collection was systematic and sequential, after obtaining approvals and permits from Kenyatta University, National Commission for Science, Technology and innovation (NACOSTI) and line county ministries, the study embarked to recruit research assistants. The research assistants were first trained on how to go about with the research tools. The researcher and the assistants assigned themselves the various

sub counties with pump buyers as indicated in table 3.1. They called the selected respondents on phone for introduction and sought permission for an agreed date of interview and focus group discussions with them. Before beginning of each interview, the research assistants sought individual informed formal consent from the respondent. The study purposively targeted and interviewed pump buyers. Through snowballing, the study included pump non buyers. The study administered key informant guides to key informants. Data that was extracted was captured on the interview schedules, key informant guides and focus discussion group guides. The interviews were conducted at the farmers 'place of residence'. The researcher asked questions that were on the interview schedule. Each response was noted down on the interview schedule systematically according to the objectives of the study. In order to avoid loss of key informant interview guides by the respondents, they were filled with the aid of a research assistant in a sitting.

Focus group discussions were done with the farmers at a central place where the group normally meets. Each group consisted of 6-8 members majorly with more women than men. The researcher moderated the discussion while the research assistants took notes of the proceedings in a notebook during the discussion. Data collected was both qualitative and quantitative.

### **3.10 Data analysis and presentation**

The results of the study were both qualitative and quantitative and were analyzed as follows, quantitative data were analyzed using SPSS version 21 software to give

descriptive statistics, and presented as percentage, frequencies, averages tabulations and histograms and pie-charts. Qualitative data were analyzed according to themes and patterns formed. They were presented in a narrative form and verbatim quotations.

### **3.11 Ethical issues management and considerations**

Even though there were no distinctive risks for taking part in this study, the right to collect data was sought from supervisors, Kenyatta University graduate school and research permit from National Council of Science and Technology NACOSTI. An introduction letter from Kenyatta University graduate school was sought. This assisted the researcher to seek for a research permit from (NACOSTI). After being authorized by NACOSTI, the researcher contacted and visited Machakos County commissioner office, ministry of education and the ministry of agriculture.

These letters revealed the nature of the researchers study and proved to the researchers' institutional affiliation. Participants through reading, understanding and signing a consent guide gave the authority to participate in the study. A couple of cautions were also kept in mind when engaging with the respondents such as the right to privacy and to participate. Efforts were made to ensure the respondents sampled participated. However, each respondent was allowed to withdraw at will and for whatever reason they deemed fit. Precautions were also observed to ascertain that all respondents felt secure and at ease to answer questions. Where the household head was present, consent was sought from them before starting the process of interview

and in case the respondent needed to attend to sensitive responsibilities they were excused from time to time by the research assistants.

Collected data was treated with confidentiality and an assurance was given that no real names would be used in the report findings. Information collected and entered was stored in cloud using Dropbox and access to the collected information was available and restricted to the intended purpose and persons with sharing rights only.

The data was also used for academic purposes only.

## **CHAPTER FOUR**

### **FINDINGS AND DISCUSSION**

#### **4.1 Introduction**

This chapter presents the research findings. The chapter is organized into five sections. The first section presents demographic data of the women and men who took part in the study. The other four sections are based on the following study objectives: to establish what irrigation technologies were used before introduction of hip and treadle pumps among farmers in Machakos County; how the farmers were accessing and utilizing the treadle and hip pumps; the challenges faced when accessing and utilizing the treadle and hip pumps among women farmers in Machakos County; as well as suggested gender responsive strategies that can enhance access to and utilization of treadle and hip pump technology.

#### **4.2 Socio demographic information**

The demographic information of the participating treadle and hip pump buyer and non-buyer women farmers was analysed on the basis of age, education, marital status, sex, occupation, area of residence, type of household and level of income per month. The analyses were necessary because they were found to affect the access to and utilization of treadle and hip pump technology.

##### **4.2.1 Age of Respondents**

One of the socio demographic information sought out was to find out the age of respondents in this study. Table 4.1 shows the respondent's age bracket.

**Table 4.1: Buyer and non-buyer respondent age**

Age in years	Buyers frequencies		Non buyers frequencies		Total	%
	Female	Male	Female	Male		
<b>21-25</b>	1	0	2	1	2	2.9
<b>26-30</b>	4	2	5	2	13	18.6
<b>31-35</b>	5	2	2	4	13	18.6
<b>36-40</b>	3	1	0	0	15	21.4
<b>41-45</b>	3	1	2	0	6	8.6
<b>46-50</b>	2	2	6	0	10	14.3
<b>51+</b>	10	3	7	2	11	15.7
<b>No.</b>	30	12	19	9	70	100

From the above table, majority of the respondents were in the age brackets 36-40(21.4%)(**15**), followed by respondents in age brackets 26-30 (18.6%)(**13**), 31-35 (18.6%)(**13**), 51+ (15.7%)(**11**), 46-50 (14.3%)(**10**), 41-45 (8.6%)(**6**) and 21-25 (2.9%)(**2**). From other pump studies, by the majority age range that can use the human powered pump is between 21-49 years. This study also established that 84.3%(**59**) of the participants were aged 21-49 years, meaning that they could effectively work and utilize the pump technology.

Diffusion of innovations theory also requires that for innovations adoption to succeed, young people in a population should be targeted since they easily adopt new technologies. Evidence on age as a barrier to adoption of the technology was captured

verbatim from some the remaining 15.7 %( **11**) respondents who were elderly in the study site as follows;

‘I bought the pump to keep for use by my grandchildren when I stop selling from this shop’ (Interview with a pump buyer in Tala who had purchased the pump but was not using it on 5/04/2017)

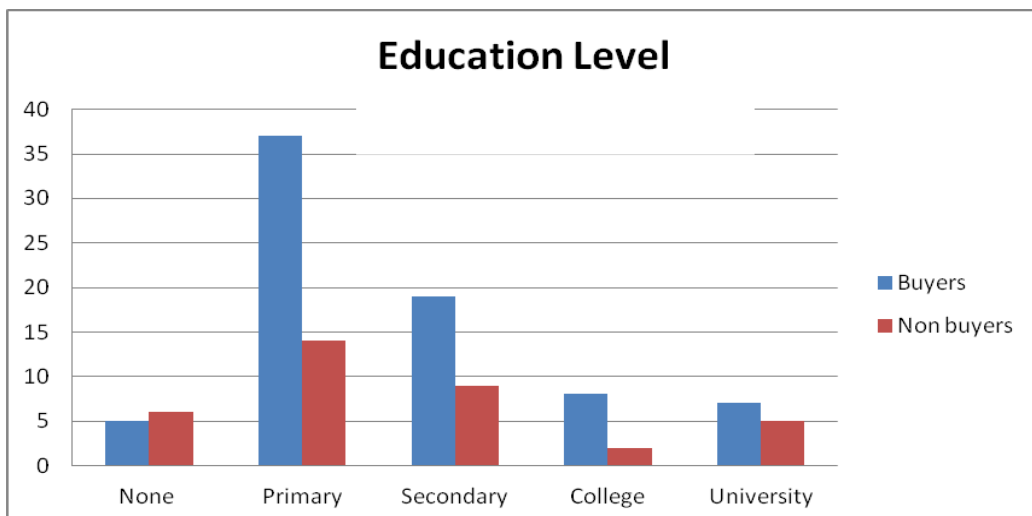
Another elderly woman associated her hip problem to use of the pump since it occurred after her use of the pump to water her vegetables.

‘ My hip bone started having problems when I used the hip pump I decided to hire someone who will be pumping the water for me at a cost from the river as I irrigate my crops’ (Interview with a hip pump buyer from Kabaa on 8/02/2017).

This study therefore generally found that the pump was marketed to the right people in terms of age. This is an important factor in relation to availability of labour for the purpose of effective access to and utilization of the treadle and hip pump technology.

#### 4.2.2 Respondents’ level of formal education

Socio demographic information sought to find out the respondents’ level of formal education too. Figure 4.1 below shows the outcome.

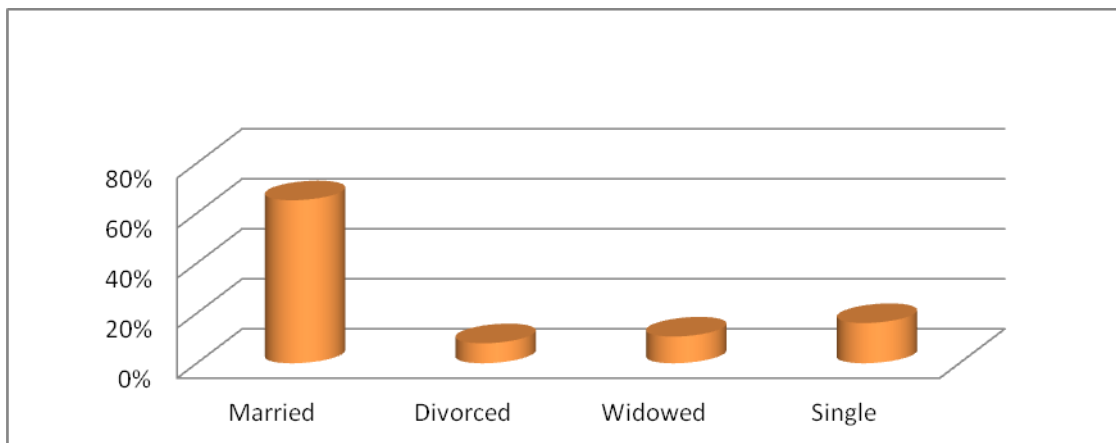


**Figure 4.1: Education level**

The farmers had diverse levels of education: None 7(**10%**), primary level 32(**45.7%**), secondary level 18(**25.7%**), college level 6(**8.6%**), and university level 7(**10%**). It can therefore be observed that most farmers had basic education level and could understand how to operate and take care of the treadle and hip pump. Literature from other countries reveals that certain variables have a consistent positive effect on access to and utilization of agricultural technology. These include higher education, exposure to extension programs which teach farmers how to use the new technologies, and adoption of other financial options. In this study, it was noted that higher education did not necessarily matter for respondents to adopt the pumps since the pump was owned across all levels of education.

#### 4.2.3 Marital status

Marital status of respondents in the study is as shown in the Figure 4.2 below.



**Figure 4.2: Respondents' marital status**

From the figure above, 44(**62.8%**) most of the respondents were married. It was further established that 7(**10%**) of the respondents were divorced, 9(**12.9%**) had lost their loved ones and only 10(**14.3%**) of the respondents were single. Married couples on a per centage basis, were more likely to be treadle and/or hip pump purchasers as they were highly represented among respondents. This concurs with the diffusion of innovations theory that proposes that the social system is an element that influences adoption of an innovation. In this case, the social system is the family that gives occupants of the institution a status and role of taking care of their offspring.

#### **4.2.4 Respondents' sex**

The study had mainly targeted women farmers as purchasers and users of the pump technology. Table 4.2 below shows frequencies and per centage in terms of sex of the 70 respondents who participated in the study.

**Table 4.2 Sex of the respondents**

<b>Sex of respondents</b>	<b>Buyers</b>	<b>Non Buyers</b>	<b>Buyers (%)</b>	<b>Non Buyers (%)</b>
<b>Female</b>	30	19	69.8	67.8
<b>Male</b>	12	9	30.2	32.2
<b>No.</b>	42	28	100	32.2

It was important to establish the sex of the respondents since it affects and contributes to gender disparities in innovations adoption if and when one sex dominates any of

the four institutions described in Naila Kabeer's framework, i.e., the state, market, community and family. As evidenced from the above table, women were more heavily represented than men were. In this study, there was an approximate 69.8/30.2 split between female and male respondents for buyers to 67.8/32.2 split for non-buyers of the treadle and hip pump. The gender distribution in Machakos county is relatively the same (KNBS 2009), however, a major deviation in this study was because in most cases men move to the adjacent Nairobi city which offers seasonal employment, i.e., away from their farms. This also concurs with Prabhu (1999) study that women, particularly in areas where male migration rates are high, use treadle pumps extensively. Responses from the women farmers below confirm the same.

‘Most men are employed and work in industries in Nairobi’ agreed members of Wiyumisye group (FGD session at Makutano, Yatta 12/3/2017)

A woman from Maavuni also confirmed the same:

“I met with my husband in Nairobi, he was then a casual worker at GM, he retired while still working there. I had to come over here before him” (Alice a pump buyer respondent from Maavuni 17/4/2017)

Having more women than men also heavily affected the adoption of the pump since some mentioned their inability to use the pumps considering the energy required to operate them.

### **Table 4.3: Key informants**

The study also had key informants represented as shown in Table 4.3 below.

**Table 4.3: Categories and sex of key informants**

<b>Title</b>	<b>Male</b>	<b>Female</b>	<b>N(%)</b>
Extension officers	3	1	<b>4(30.8)</b>
Chiefs	4	4	<b>8(61.5)</b>
KSI/WSU	1	0	<b>1(7.7)</b>
<b>Total</b>	<b>8</b>	<b>5</b>	<b>13(100)</b>

Key informants were represented as follows; 4 (**30.8%**) extension officers, 8 chiefs (**61.5%**) and 1(**7.7%**) KSI/WSU representative. Gender disparities were visible among key informants save for chiefs' population only that was almost equally represented due to Government of Kenya (GoK) specification in the constitution of Kenya (2010) that no more than 2/3 of the same gender should occupy public position. Other key informant representation disparities could also be due to the positions they hold which are traditionally public and are held by men. Asked about the disparities in representation, a female extension officer from Machakos town Sub County had this to say'

'We have previously experienced situations where male officers were chased from homes by some male home owners especially when they appeared alone. Although this was partly solved by meeting the farmers in groups, some women in groups may not express themselves well in these groups which are also male dominated' said Mueni. (Key informant interview with Machakos sub county extension officer 15/2/2017)

The same question answered by KSI representative,

"We have good sales people, during the KSI/WSU study, for the first time we had one female

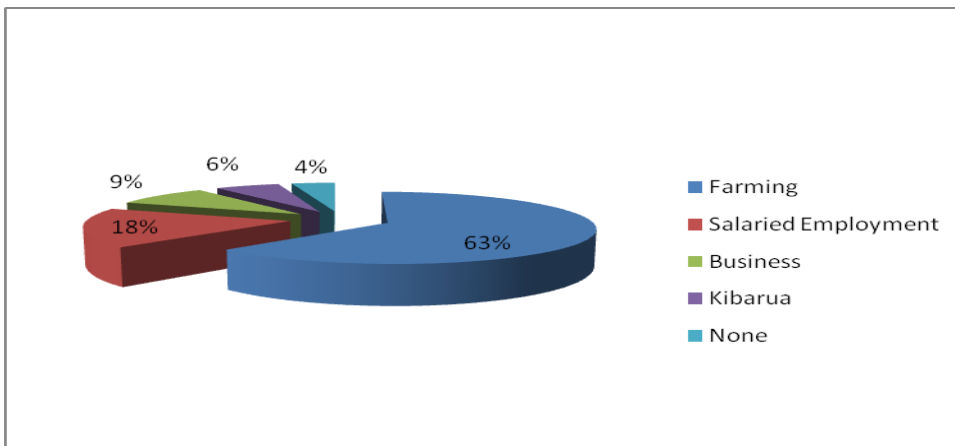
representative posted in Kyanganga area. She did better than any other sales person during the study. Her sales were higher than any other among the salespersons in Machakos” (Key informant interview with KSI/WSU representative 20/4/2017)

The above disparities concur with Prabhu (1999) study in India where she explains that although one way of promoting appropriate technology is by using trained extension workers, one of its disadvantage for women farmers and those who aim to improve gender power relations is that extension agents in India are mostly men who for cultural reasons tend to restrict their interactions to male farmers, assuming that no woman would be interested in irrigation technology.

According to Naila Kabeer’s social relations framework, the above representation by sex of female and male in institutions such as the community, market and state are the ones that propagate gender disparities even in policymaking. There is therefore need to see both men and women as users of technology and to be able to challenge unequal gender relations and therefore use both male and female marketers and distributors of the pump technology for effective adoption of technology among them.

#### **4.2.5 Occupation**

Figure 4.3 shows the respondent occupation:



**Figure 4.3: Respondents occupation**

It was noted that most of the respondents reported that their household had a large number of economically productive members as represented by the largest population which had their occupation as farming 44(**62.8 %**), salaried employment 13(**18.6%**), business 6( **8.6%**), *kibarua* 4(**5.7%**) and none 3(**4.3%**).

#### 4.2.6 Type of household

**Table 4.4: Household status**

Household Status	Buyers	Non Buyers	%
Male and Female Adults	8	7	21.4
Female adult only	3	1	5.7
Male adult only	3	0	4.3
Male adult and children < 14 yrs old in the household	3	3	8.6
Female adult and children < 14 yrs old in the household	6	11	24.3
Male and female adults and children < 14 yrs old in the household	19	12	44.3
<b>N</b>	42	28	100

Table 4.4 above shows that there were few families with no male and female members of their household as represented by female adult only 4(5.7%) and male adult only 3(4.3%). Some female or male single parent households appeared to be interested in the treadle and hip pump technologies, i.e., male adult and children 6(8.6%) and female adult and children 17(24.3%). The results above indicate that households with two or more adults and younger children 31(44.3 %) were more likely to buy the treadle and hip pump technology. This is because such households have greater responsibilities such as education and health for the children apart from basic needs responsibilities than households without children. KSI/WSU representative confirmed the same:

“Our database generally shows that over 70% of pumps are registered under male names, however, interestingly, the household statuses majorly compose of families with children. This has always been influenced by responsibilities that come with having children e.g. paying school fees, medical expenses etc” (Key informant interview with by KSI/WSU representative 20/4/17)

#### 4.2.7 Respondents estimated income per month

Table 4.5 shows the respondent's approximate income per month in terms of brackets.

**Table 4.5: Respondents estimated income per month**

Income range in Kshs.	Buyers			Non buyers			Total %
		Female	Male		Female	Male	
<5000	22	20	2	13	12	1	50
5000-10000	12	7	5	7	5	2	27.1
10000-15000	4	2	2	5	1	4	12.9
>15000	4	1	3	3	1	2	10
<b>Total</b>	42	30	12	28	19	9	100

From Table 4.5 above the study found out that majority of respondents 35(**50%**) both buyers and non-buyers of the pump earned less than 5000 per month. The income per month was estimated according to the respondent's weekly expenses and savings. More than half of the respondents reported to have no monthly income when asked this question at first. Some reported to be dependent on their husbands or other members of family. On further probing, it was clear that the low earnings they got were used to run day-to-day activities of the household. This outcome affirms the social relations framework by Naila Kabeer in that, how relationship between people, distribution of resources and activities are shared and reworked through institutions affects the overall goal of development. In this study, half of the study respondents earned lower than Kenya shillings 5000 per month.

### 4.3 Technologies used before introduction of hip and treadle pumps among women farmers in Machakos County.

This section covers the first objective of the study that sought to find out the current irrigation technologies used by farmers in Machakos County before introduction of treadle and hip pumps.

#### 4.3.1 Irrigation tools used by farmers in their farms before introduction of the treadle and hip pump technologies.

Irrigation technologies used before introduction of hip and treadle pumps among farmers in Machakos County are as shown in Table 4.6 below.

**Table 4.6: Irrigation tools used by farmers on their farms**

<b>Technology</b>	<b>Buyers Female</b>	<b>Buyers Male</b>	<b>Non buyers female</b>	<b>Non buyers Male</b>
	N(%)	N(%)	N(%)	N(%)
Bucket/ bottle	24 (80)	10(83.3)	8(42.1)	6(66.7)
Gas pump	9 (30)	2 (16.7)	10(52.6)	6(66.7)
Electric / solar pump	5(16.7)	1(8.3)	1(5.3)	3(33.3)
Human powered pump	9(30)	6(50)	6(31.6)	5(55.6)
Other				

Irrigation tools used by farmers were as represented Table 4.6 above, results show that use of bucket or bottle to irrigate among both buyers and non-buyers was most popular method of irrigation. This is simply because it is readily available and most households irrigate crops for family use and not for economic purposes. The findings also concur with Fraiture & Giordano (2014) study that found small-scale private irrigation as a venture that is thriving but also is an overlooked sector. Lack of appropriate tools to irrigate crops could be one of the reasons. A key informant reported that the other tools such as gas pump and solar pump were unpopular among the farmers since the tools required high initial cost and maintenance.

‘Most farmers cannot afford gas pumps due to the initial cost and maintenance as it uses petrol that is why we encourage them to purchase a treadle or a hip pump which only requires human energy and they are environmentally friendly as they save towards owning a gas pump. (Key informant interview with KSI/WSU representative 20/4/2017).

However, while the study findings were contrary to Sreelata and Naomi (2012) results that agricultural production in Kenya’s arid and semi-arid regions has been slowed by the lack of appropriate technologies. In this study, the treadle and hip pump technology offered by KSI/WSU study team complemented the abundant supply of labor and counter the scarcity of water, and lack of off-farm jobs to build cash reserve to purchase technology. The study however, concurred with the authors in that some of methods used by farmers to irrigate are highly tasking for women but the yields are not enough for both household and economic use (Sreelata & Naomi, 2012). The study also concurs with the authors findings that the increased preference of

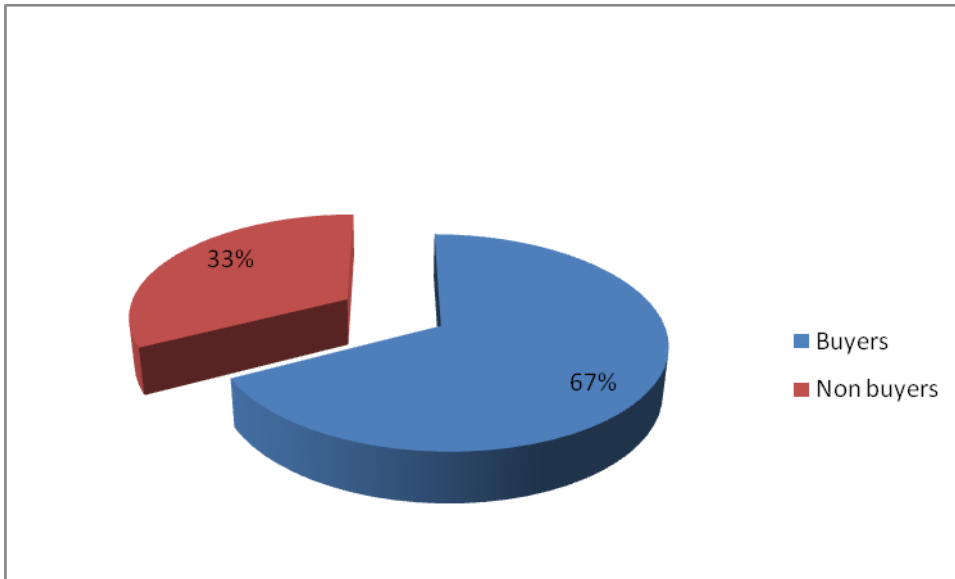
traditional farming methods in rural areas has increased the levels of food insecurity and poverty. This is a case evident from socio demographic information on income levels of respondents in this study. Being mainly a women study and whose occupation was highly dominated by farming, their lack of finances to purchase mechanized tools for irrigation leaves them using human or animal powered tools that are readily available even though they are tiresome too.

#### **4.4 Access and utilization of treadle and hip pump technology**

This section covers the second objective of the study that sought to find how farmers in Machakos County are accessing to and utilizing the treadle and hip pump technology. Study participants were asked to give responses in relation to systems required to enable access and utilization of the treadle and hip pump technology. These systems are; buyers of pump, type of pump, mode of payment, access to M-Pesa and other financial services, adoption rate and source of information of the treadle and hip pump, average distance to where the farmer can get the pump, water and labour availability.

##### **4.4.1 Buyers and non-buyers of the treadle and hip pump by farmers**

Appendix 2 show the two different pumps that women farmers were to adopt using the three financial options offered by KSI/WSU team during the marketing and distribution phase. The number of buyers and non-buyers of the treadle and hip pump in the study were as illustrated in Figure 4.4 below:



**Figure 4.4: Pump buyers vs non buyers**

It was established that most participants were buyers represented by 42(60%) response level while 28(40%) were non-buyers of the pumps. The results for some of the non-buyers were influenced and explained by the following interview responses;

“Our type of soil is poor and does not retain water for long. This year it was worse since there was hardly enough rain” (Interview with a pump non-buyer in Kabaa area. 8/02/2017)

“We were told that the pump cannot draw water more than 7 metres deep and mine is always lower than that”(Interview with a pump non-buyer in Mwala area. 8/04/2017)

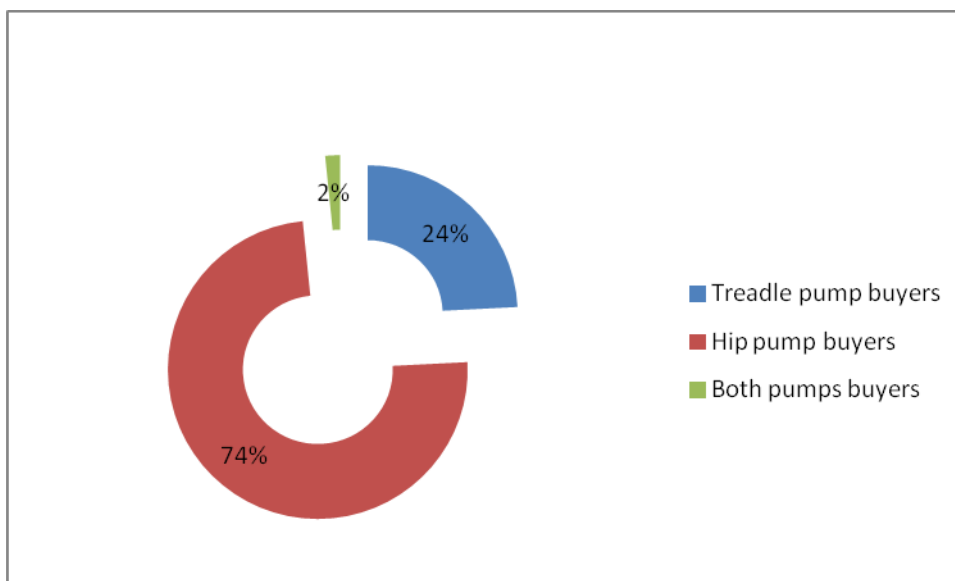
“I have a gas pump and did not see the need to buy a manual pump” (Interview with a pump non-buyer in Kabaa area. 8/02/2017]

Some of the reasons for not buying also concurred with Lewis et al. (2015) study that treadle pumps can only reach a depth of around 7 metres, depending on the type of pump so it would not be useful if water resources are deeper. Successful rainwater

harvesting in on-farm ponds also depend on soil type and rainfall patterns and works best on moderately sloping land.

#### 4.4.2 Type of pump preference

The type of pump preferred between the treadle and hip pump among the pump buyers is as shown in Figure 4.5 below.



**Figure 4.5: Type of pump preference**

From Figure 4.5 above, 31(74%) of respondents bought the hip pump whereby the pump was cheaper than the treadle pump. 10(24%) chose a treadle pump and only 1(2%) had both pumps. More women bought a hip pump than men among the pump buyers. The results are in line with diffusion of innovations theory where an innovation is required to be easily affordable for it to be adopted. The pump marketer should therefore consider affordable but effective pumps.

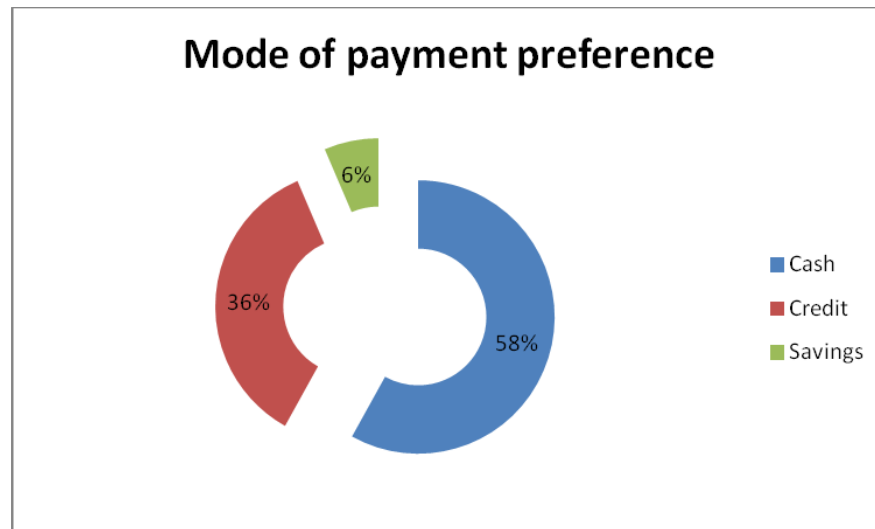
‘We preferred the hip pump since it was cheaper than the treadle one’ (FGD discussion response with pump buyers at Kithimani 15/4/2017)

Prabhu (1999) study in India observed that although in marketing terms also, selling the pumps to women is not in itself a sufficient indicator of the level of involvement of women in the use of the technologies they were promoting. The pumps were mostly bought by male farmers, but used both by male and female farmers. While women may not actually go to shops to buy the technologies, they may significantly influence the decision to purchase, and therefore information about the product should be made available to them.

Women being the target purchasers and users in this study and generally the highest number participating in agriculture worldwide may have the desire to access tools that improve their work, however lack of finance as a resource to acquire tools that support their work deters their effort and willingness to access and utilize the tools. Their financial status and affinity to purchase the hip pump which was cheaper than the treadle pump is evident here.

#### 4.4.3 Mode of pump payment preference

Access to and utilization of treadle and hip pump technology sought to find out the mode of pump payment preferred by the pump buyers in the study. The three finance options of cash credit and savings were offered to the farmers to enable them purchase the pumps within their financial comfort. The findings are as illustrated in Figure 4.6 below.



**Figure 4.6: Pump payment plan**

On the mode of payment for the pump technology, 24(58%) of the respondents purchased their pump through cash payment, while credit and savings mode of payment were at 15(36%) and 3(6%) as shown in the response rate. The above trend could be attributed to the immediate benefits of acquiring the pump. On one hand, purchasing the pump on cash and on credit ensured the farmer had the pump at hand hence the motivation to use it. On the other hand, opting to purchase the pump through saving towards owning it made the benefit of having the pump not being

immediate and visible which lead to some farmers who had registered to purchase the pump using saving option to pull out at some point. The farmers pull out from the pump purchase process is contrary to Prabhu (1999) study that use of NGOs to avail the pump technology on credit as a strategy to enable poorer farmers to take risks and invest in a pump. This was not the case in this study.

However, the majority purchase of the pump in cash concurs with a study in Malawi by Kamwamba-Mtethiwa (2012) where female adopters were more likely to pay for subsidized treadle pumps in cash and male adopters mostly acquire their pumps through a loan.

Reasons for some of the non-buyers to opt out of the pump purchase plan were'

“I opted out since it was taking too long to get the pump and I had problems with money. I decide to be refunded what I had contributed and wait until I get enough money to buy a pump” (Interview with a pump non-buyer at Masinga 18/3/2017)

“There were no rains and those who enrolled resorted to hunger first resolution” (Key informant interview with KSI/WSU representative 20/4/2017).

The pump payment plan was in itself an innovation, diffusion of innovations theory recommends that an innovation should give options to its access. In this study, the respondents preferred cash option compared to savings and credit options in acquiring the pump. Women being majority of players in agriculture saw the pump as a relief to their work and were willing to have the tool almost immediately to help them in their day-to-day work in the farm. Social relations framework is also reflected in the choice in mode of payment, those with available cash were able to pay and have the pump

while those without even pulled out of the pump ownership process. This was also heightened by the period of lack of rains as reported by KSI/WSU key informant above.

#### 4.4.4 Access to M-Pesa and other financial services opportunities

The study sought to find out the access to M-Pesa and other financial services opportunities that would enable farmers to buy pumps. The responses are as illustrated in Table 4.7 below.

**Table 4.7: Access to and utilization of MPESA and other financial services**

##### Response

	<u>Yes (%)</u>	<u>No (%)</u>
M-Pesa used to purchase your pump	28( <b>66.7</b> )	14( <b>33.3</b> )
Member of “Merry-Go-Round” savings club	62( <b>88.6</b> )	8( <b>11.4</b> )

From the above table, mode of payment and source of funds for pump purchase was key to this study. However, even though most women farmers were members of merry-go-round savings club 62 (**88.6%**), low number of the farmers used M-Pesa to repay their pumps. The farmers were expected to use M-Pesa to make payments towards their pump purchase for installments in the credit and savings pump purchase options. This was contrary to the study expectation that each household had at least a mobile phone and would be able to use the mobile platform to repay for their pump.

This could be attributed to Ivers and Cullen (2011) study that in sub-Saharan Africa, farming for economic income is determined by the ease at which credit and finance is made available for farmers. The same problem could be said to be affecting poor women in rural semi-arid areas of Machakos County. In semi arid regions, the access to banking services in rural areas is limited thus the poor financial and credit access for women. Financial structures in rural regions are weak thus banks neglect the areas due to the high risks involved. McComb et al. (2014) also found this in their study that finance was also a key constraint: a motorized pump of \$250 may be relatively 'low cost' but is still unaffordable to many farmers. Microfinance services are either unavailable in rural areas or have been unwilling to provide agricultural loans.

However, commenting on the illiteracy level in women in rural Sub-Saharan region is high which minimizes their ability to be able to seek finance from banks. The study differed with Ivers and Cullen (2011) assertion that with an education strategy giving women education on the benefits of increasing their investment in farming would increase their access and utilization of technology. Participants in this study had undergone intense education about the pump technology. However, there were other challenges in their access to and utilization of the technology other than education about it. The major one being source of funds to purchase considering their income level and knowledge on how to finance a loan.

“The reason why I have never taken a loan is because I fear debts and my property to be auctioned, I have seen this happen with KWFT” (Interview with Kyalo a pump non-buyer from Mwala 8/4/2017).

Respondent's ability to use M-pesa services and access to financial services reflect on the social relations framework aspect where inequalities in access to resources at family level are reflected in institutions such as the market. In this case, access to financial services was a platform that seemed to lack. Uses of merry-go-round group only means one gets the same amount of cash they have contributed to the kitty over a period of time. Moreover, mental models had already been created in some respondents after having experiences on what happened to those who have taken loans before and were unable to repay. The women's uncertainty about their income from their full time job of practicing agriculture calls for multi-stakeholder structural revamping that will support the women from conception to consumption of products across the agriculture value chain.

#### **4.4.5 Adoption rate and source of information about the treadle and hip pump.**

A question on the access to and utilization of treadle and hip pump technology sought to determine the adoption rate and source of information of the treadle and hip pump among the respondents.

Ninety six percent 67 (**96%**) of farmers reported that they would want to be the first to use a technology as compared to 3(**4%**) who would want to wait until they see another person use it first so that they can use it. The above results are contrary to Prabhu (1999) study in India where adoption rate of treadle pumps among poor farmers trend is low due to their inability to take risks on a product they are not sure of its success. She argues that bottom of the pyramid farmers are likely to wait and

see at least two successful crop seasons from other farmers so that they can be convinced to take up the technology. She mentioned that IDE as an organization overcome the situation through working with NGOs to avail the pumps to farmers on credit. In this study however, the credit option was given and the framers reported that they would want to be the first to use a technology yet the pump technology uptake was low.

Diffusion of innovations theory proposes that four main elements influence the spread of a new idea; the innovation itself, communication channels, time and social system. In this study, the treadle and hip pump irrigation tools, by far the most important source of information for both buyers and non-buyers of the pump was the vendor at 50 (72%) response rate. This result identified a major challenge to acceptance of credit and savings mode of payment for the pumps. Cash sales are made directly from a vendor but this is not the case for credit or savings sales that are the result of interaction between a marketer and the potential buyer. The 50 (72%) pump owners rely on the vendor as their most useful information source but neither credit nor savings buyers have a direct seller/buyer relationship with a vendor at purchase. It was therefore difficult for the latter to access important information on product improvement, operation and maintenance. New technology information which could improve utilization of the pump may therefore not be available to the credit and savings buyer if there is no formal link with the vendor until a challenge arises. Prabhu (1999) states that the success of IDE as an organization in pump marketing and distribution can be attributed by their approach through building supply networks

of the pump by creating linkage between the strength on private sector and NGOs. Through private sector, IDE motivate suitable manufacturer to make pumps to farmers and linking them to appropriate distributors and dealers to stock and supply at local level as well as training local mechanics to provide after sale service. Another gender responsive approach IDE use and that can be adopted by KSI/WSU team is use working with female opinion leaders in the community, establishing demonstration plots with women headed households as well as appointing enterprising women in groups such as the secretary to be a pump dealer and earn steady income from commission of pump sales.

#### **4.4.6 Average distance from home to pump access location**

Access to and utilization of treadle and hip pump technology was also sought by asking respondents to determine the average distance from their home to locations where they could get treadle and hip pump in terms of distance from the local market, town market and distance from a pump owner or vendor. Table 4.8 shows the responses.

**Table 4.8: Average distance in kilometers from respondents' home to pump access location**

	<b>Buyer</b>
To town market	65.8 Km
To local market	56.7 Km
To pump owner	39 Km
To pump vendor	92 Km
Total average distance	87.6 Km

The average distance from farmers' location to the town and local market, pump vendor and owner was 87.6 km. The above average shows that the distribution of pumps is not even. The above information also confirms Naila Kabeer's Framework on how the market community and state synergy can bring disparities for women to access and utilize the technology. Distance from one pump owner to the other also showed how hard it was for a farmer to access a pump in the community even if they decided to share. This was further aggravated by the experimental part of the research where KSI/WSU ensured that there was a 15 km distance between the 3 different treatments of cash, credit or savings mode of pump purchase. Part of this problem could be solved by Prabhu (1999) IDE approach of building supply networks through creating linkage between private sector and NGOs. Through private sector, IDE motivate suitable manufacturer to make pumps to farmers and linking them to appropriate distributors and dealers to stock and supply at local level as well as training local mechanics to provide after sale service. Together with gender

responsive approach through working with female opinion leaders in the community, establishing demonstration plots with women headed households as well as appointing enterprising women in groups to be pump dealers and earn steady income from commission of pump sales, this would be a win situation in terms of the challenge in distance to access to the pumps.

#### **4.4.7 Access to water for utilization with treadle and hip pump**

Accessibility to water for use with the treadle and hip pump among the respondents was sought and found as presented in Table 4.9.

**Table 4.9: Rainfall status in 2015 to 2016**

<b>Rainfall</b>	<b>2015 % of Respondents</b>	<b>2016 % of Respondents</b>
Normal	17(24.3)	30(42.9)
Above Normal	2(2.9)	25(35.7)
Below Normal	51(72.9)	15(21.4)
N	70	70

During the period of the KSI/WSU study, buyers and non-buyers were experiencing difficult rainfall conditions with majority, 51(72.9%) of participants responding that rainfall was below normal until the short rains of 2016 when normal or above normal rainfall patterns predominated. Access to water is part of infrastructure required to

determine whether a farmer could utilize the pump since use of the pump goes hand in hand with availability of water. The following were some of interview responses about access to water for use with the pumps:

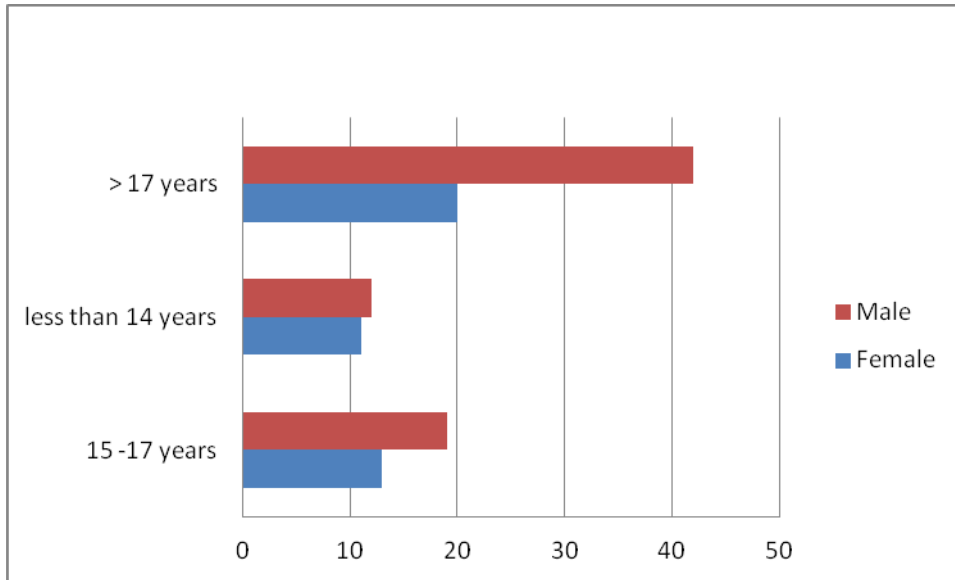
“My dam lasts for only 3 days and dries up, do you offer tanks/dam liners using the financial options we had been given for pumps?” (Interview with a pump buyer at Masii. 13/2/2017).

The findings concur with study on micro irrigation in Sri Lanka by Aheeyar et al. (2005) which established that manual irrigation methods such as the canal methods were used when farms are in close proximity to rivers. The main disadvantages of these approaches, is that they depended heavily on farms proximity to water sources. In this case the researcher and as suggested by Fisher (2006) on bundling the pump with other inputs, the researcher suggests bundling of the pump package with a water harvesting and storage system for small scale irrigation farmers where soils do not favour storage of water.

The burden of water always falls on women in almost all households. Lack of water for use with the pumps coincided with lack of water for household use. The same women being depended on to use the pump are also the ones expected to ensure there is water in their homes. There is need for sensitization to families on the benefits of all members sharing the work of getting water home as everyone’s responsibility in order to get more out of the resources they have such as land.

#### 4.4.8 Utilization of the pumps and availability of labour

The question on availability of labour to operate the treadle and hip pump among the respondents cannot be ignored. Figure 4.7 demonstrates the outcome in percentage of time used physically by gender as given by respondent's.



**Figure 4.7: Physical users of pumps**

All pump buyers reported to have used their pump for at least one time. Although both women and men might have used the pump at once, it was reported that men used the pump more than women did since men are involved in operation and maintenance as they pedal while women distribute water using pipes. It is evident from the above graph that more males than females were involved physically when utilising the pump.

This also implies that the innovation itself, i.e. the treadle and hip pump is likely to be suitable where there are men with physical energy to operate it than women.

“It is tough using the pump”. (Interview with Ann a buyer from Maavuni17/4/17).

The above report was common among women respondents citing that the work of pedaling the treadle pump and pulling the hip pump for them they got tired quickly and often preferred to participate in direct irrigation of crops using the pipe as men pedaled the pump.

Although during a study by Kamara et al. (2004) in Malawi on pump utilization saw men responsible for the procurement, operation and maintenance of the pumps, there was no cultural dimensions in use of the pump in Machakos county. Srinivas (2004) study in Orraso India, saw utilisation of the treadle pump done by all family members but the head of the family did more. Most users did not feel any serious physical fatigue. Women were quite comfortable operating the pump but on stopgap basis. Children also operated the pumps but for lesser duration and hired labour was utilized in a few cases.

Despite having economically productive persons from the demographic characteristics of study respondents, 45(64.3%) also reported to have no enough labour in their homes for use of the pump and had to hire a person to help thereby adding cost of using the pump while 25(36%) reported they had enough labour. This however concurred with (Brabben and Kay 2000) study in Kenya where pumps are purchased by men but are mostly managed by women who hire young men to operate them.

It also posed an inequality in distribution of labour as in the social relations framework where people and their responsibilities in the activity of use of pump technology was not only unequal at family level but also in the market in form of pump innovation.

“KSI needs to come up with a high performance gender neutral pump that can be used without maintenance irrespective of intensity of use and terrain it is operated”(Key informant interview with an extension officer at Mathingau 15/3/2017)

A gender responsive pump is therefore important to be considered by pump marketers such as KSI/WSU team in order to improve the access to and utilization of pumps across all gender.

#### **4.5 Challenges faced by farmers when accessing and utilizing the treadle and hip pump**

This section covers the third objective of the study that sought to find out the challenges that women farmers faced while accessing and utilizing the treadle and hip pump irrigation technologies. In the study 62(88.6%) stated that they had challenges while 8(11.4%) did not face challenges in the process of acquiring their pump. The researcher categorized the list of challenges given from individual responses and FGD discussions into themes under institutions in Naila Kabeer’s social relations framework on how access to and utilization of the treadle and hip pump challenges were reworked in the four institutions categories of the family, community, market and state.

**Table 4.10 Challenges as perceived by study respondents**

Levels of challenges	Buyers				Non buyers				KSI representative		Chiefs		Extension officers	
	Female		Male		Female		Male							
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Family	20	67	5	42	11	58	5	56	1	100	4	50	2	50
Community	21	70	3	25	6	32	7	78	1	100	6	75	1	25
Market	16	53	10	83	4	21	5	56	1	100	2	25	3	75
State	25	83	7	58	8	42	7	78	1	100	4	50	2	50
<b>Average</b>														
Family	23( <b>54.5%</b> )				14( <b>50%</b> )				1( <b>100%</b> )		4( <b>50%</b> )		2( <b>50%</b> )	
Community	14( <b>47.5%</b> )				15( <b>55%</b> )				1( <b>100%</b> )		6( <b>75%</b> )		1( <b>25%</b> )	
State	15( <b>50%</b> )				14( <b>50%</b> )				1( <b>100%</b> )		2( <b>25%</b> )		3( <b>75%</b> )	
Market	20( <b>68%</b> )				11( <b>38.5%</b> )				1( <b>100%</b> )		4( <b>50%</b> )		2( <b>50%</b> )	

#### 4.5.1 Family level challenges

The first category of challenge sought to determine the family institution challenges faced by farmers when accessing and utilizing the treadle and hip pump technology.

Table 4.10 shows that challenges in access and utilization of the treadle and hip pump technology were majorly rooted in the family institution. From the table above, 23(**54.5%**) of pump buyers, 14(**50%**) of pump non buyers, 1(**100%**) of KSI/WSU

representative, 4(50%) of chiefs and 2(50%) of agriculture extension officers reported that family as an institution posed a challenge in access to and utilization of the treadle pump and hip pump technology.

The family is the basic and fundamental unit in the society. Its operations are basically based on social constructs that determine gender roles and gender relations too. These roles and relations are passed to younger ones through socialization. For example in this study, there were individual responses based on family unit situations that reinforced male dominance situation such as'

“I personally saw the importance of the pump but my husband refused that we buy the pump. If I had my own money I would have bought it though” (Interview with woman non-buyer respondent from Masii13/2/2017).

The above situation calls for not only the current engagement with women as customers to buy the pump technology but also for consistent talks with men in the family as well.

Family challenges were not confined to the nuclear family but also the extended one.

A woman buyer reported she was unable to continue using the pump due to an extended family conflict:

“My daughter in law left with the treadles after a quarrel with her husband’. (Interview with a pump buyer respondent from Kabaa 8/02/2017).

More participants reported at a personal level the reason for not accessing and utilising the pump:

“I got sick and was unable to continue using the pump” reported another one female pump buyer at Kyumvi 15/2/17.

“I lost the number to pay the pump to” said one savings option pump buyer who had stopped paying for her pump 2 months after she enrolled ,

“The pump is tiresome to use” responded a pump buyer who had a pump that she did not use, and  
 “The pump did not allow me to do other activities”  
 (Interviews at Kabaa with pump buyers 8/02/2017) .

The above statements versus access to and utilization of the treadle and hip pump technology cannot be ignored for example with regard to the women’s’ financial ability and their willingness to acquire the pumps. Despite one reporting that she got sick, generally, women’s physical ability to use the pumps hinders their usage of the pump due to their body and muscle structure being weaker compared to that of men. Moreover, private dichotomy household chores such as cooking, washing and preparing children to school among others are left to be done solely by women. There is need for gender aware training which allows for opportunities to share workloads rather than expecting the women to do all the work at family level. The last statement established that having the pump adds more workload especially to some of Machakos women farmers whom most of their spouses work off farm jobs.

The study deduced some of the challenges from pump non-buyers when accessing the pump technology were:

“I had other priorities, I have school fees and medical bill to pay first” said one pump non-buyer in Mwala 8/4/2017.

The other challenge was commitment to other loans as a reason by a non-buyer to purchase the pump,  
 “I had another loan with KWFT’.”

Another pump non-buyer reported that,  
 “I preferred purchasing the pump via credit.” This was a response resulting from an effect of clustering of pump marketing areas into cash, credit and savings options clusters from the previous KSI/WSU study.

“I wanted to dig my earth dam deeper first before I purchase the pump” responded another one. This

confirms that some did not want to purchase the pumps until they were assured of source water.

A chief key informant reported that

“People in my area fear loans especially after they saw how some institutions come and take family property when one is unable to repay”(Key informant interview with Kivuva, a chief from Maiuni 15/4/2017.)

From the above responses and according to the social relations framework, the researcher found that there were inequalities in the family as an institution. There were also immediate and underlying structural causes that brought challenges when accessing and utilizing the pump technology as one chief reported that village residents had seen their neighbours lose property out of taking loans and this made other become credit averse. Some respondents also had no reliable sources of water storage for use with pumps after rains stopped.

#### **4.5.2 Community challenges**

The community as an institution among farmers posed a challenge when accessing and utilizing the treadle and hip pump technology. Table 4.10 shows 14(**47.5%**) of pump buyers, 15(**55%**) of pump non-buyers, 1(**100%**) of KSI/WSU representative, 6(**75%**) of chiefs and 1(**25%**) of agriculture extension officers responded that community as an institution posed a challenge in access to and utilization of the treadle and hip pump technology. The following individual and FGD discussion responses reported that:

“Our group disintegrated and we could no longer continue the process of acquiring pumps. The chair person was the one leading and giving us information

and now the group is no longer there.”(FGD response by pump non-buyers at a group in Kyanganga 13/2/2017)

The above response calls for education among the self-help groups on group dynamics. One woman buyer who had stopped paying her pump on savings arrangement also reported that:

“A group member was conned and I feared to continue paying and be conned also”. (Interview response at Kyanganga 13/2/2017)

Upon further probing, it was confirmed that the group member had sent her payment to KSI/WSU salesperson that had since left working with them. This made other group members in the area to stop paying for their pumps.

‘My pump was stolen’. (Interview response by a pump buyer at Kola 14/2/2017).

This confirmed social morals of people around utilization of the pump also needs to be considered as a challenge when the effects are negative. It was also perceived that men were more suitable to use the pump since they were the ones involved in pedaling while women use the hose to irrigate. Women were of the opinion that the pump requires energy since men have enough to use. This challenge is linked to the family and market level challenges too.

“The pump is tiresome and requires two people when using especially the pedaling part requires a lot of energy which we women lack. Personally I am involved in directing the hose to the crops or tank while my husband or son pedals the pump” (Interview with a woman pump buyer at Kithimani 15/4/2017)

The above response shows a need to develop technology with understanding of gender roles and relations because the nature of technology determines the degree of adoption by women. The study also established that some participants requested to be

given the pump free as reported by some enumerators and KSI/WSU representative. This could be partly due to the culture of receiving relief food in the study area when rains do not come through.

“Farmers would get highly interested during the marketing phase and put in a deposit only for them to start losing interest with time. Some would think that since KickStart is an NGO, the pump will eventually be given out for free” (Key informant interview with KSI/WSU key informant 20/4/2017)

This may not only be a challenge for KSI/WSU team but also other NGOs there is need to sensitize communities that for any meaningful development to happen they have to own and be part of it. It also encourages Bukania et al. (2013) assumption that dealing with poverty levels in Kenya would require changing the perception and mentality of people living in rural, arid and semi-arid areas. The author further asserts that regardless of the fact that farming would be the most reasonable solution to poverty; the venture requires incentives in structural and financial support which are not provided in rural areas. Therefore efforts should be made to change perception and mentality of Machakos county women farmers that for any development to happen, they have to invest in it too.

From the above findings, the community itself had challenges to adoption of the pump technology. The researcher observed social relations framework immediate and underlying structural causes of the members not adopting the pump too coming into play. This was evident from responses in that the utilization required more use of men in pedaling the pump since it is tiresome to women. The pump design in itself also hampered its utilization hence at the design level question on what gender dimensions

to consider may not have been considered and as Prabhu (1999) put it, in case of appropriate technology, “appropriateness” for who should be considered. There were cases of pump theft that made the owners stop using their pump. Others reported of the community groups they had disintegrated and therefore cutting their source of information about the pump. The structure of payment via M-Pesa had also not been understood as some pump buyers preferred paying through salespersons themselves and one was “conned” through this. The incidence led to some farmers pull out from the pump payment plan leading to low adoption of the pump in the area. Therefore, community challenges in themselves were linked to the family and market level challenges.

#### **4.5.3 State challenges**

The third challenge that faced farmers when accessing to and utilizing the treadle and hip pump technology was the state level challenges. The state as an institution in this study represented both the national and county government in Kenya. Table 4.10 shows 15(**50%**) of pump buyers, 14(**50%**) of pump non-buyers, 1(**100%**) of KSI/WSU representative, 2(**25%**) of chiefs and (**75%**) of agriculture extension officers responses that the state as an institution posed a challenge to access and utilization of the treadle and hip pump technology

Some of state and county policies were available but not in action for example a statement by KSI/WSU representative that;

“Machakos County Integrated Development Plan (CIDP) states that there should be compulsory roof harvesting for each household while in the real sense over most of the households interviewed had no water harvesting system. The constitution of Kenya gives freedom for county governments to designate a ministry that will deal with irrigation; there was no definite ministry for the same by the time of our study in Machakos county” (Key informant interview with KSI/WSU representative 20/4/2017).

The above statement shows a gap that if dealt with is likely to strengthen the family level and community challenges in access to and utilization of the treadle and hip pump especially among women farmers. This is because a fully-fledged and defined responsibility to irrigation would mean more emphasis and focus on the assigned role.

An extension officers interview reported that not only the ratio of officers to farmers overwhelms them but also that there were more male than female officers in Machakos county. They also cited infrastructure and financial constraints in their job rendering them unable to reach the large numbers of farm households.

“Our budget does not allow to move adequately as we would want the budget allocation in agriculture for Machakos county was only 5.1% (2014/2015) as shown Intergovernmental Annual report yet agriculture is the backbone of this county’s economy” (Key informant interview with an extension officer in Mwala 8/4/2017)

A cursory look at the above statement and percentage tells that agriculture as a venture in the county is not a priority in investment yet it is the leading occupation of Machakos county residents and like any other part of the world is done by women. More budget with a gender lens in it is required for this case. KSI/WSU may also consider engaging extension workers more since they are involved in giving services

to farmers. The government may also consider enforcing gender balance among the extension workers as Prabhu (1999) saw male extension workers restricted their interactions to male farmers only assuming that women did not need the information about the treadle pump technology.

The national government was also on spotlight with the following response from an FGD

“They promise us fertilizer and seeds but we queue for long until we decide to use our own resources which are inadequate since we fear that the rains might end before we plant”. (FGD response by pump buyers group at Mwala 8/4/2017)

The extension officer from Mwala added that;

“The Kenya national government has irrigation projects in Machakos county under the National Irrigation Board (NIB). However, the projects are large scale. Smallholder women farmers are left out yet they account for 70% of income in Machakos county. ” said an extension officer from Mwala 8/4/2017)

“I am also aware of a national irrigation policy which is still underway and a draft as of now recognizing small holder farmers’ since the current irrigation Act (cap 347) is archaic, concentrates on public schemes and does not address issues related small holder farmers and the private sector”, added the extension officer

From the above feedback, a fast track on policies is required as small-scale farmers are mostly women and this is likely to improve their output in agriculture. The state level challenges in access to and utilization of the treadle and hip pump technology among women farmers although not a major challenge if strengthened would improve the adoption rate of the treadle and hip pump technology.

#### 4.5.4 Market challenges

The market institution had its share in posing challenge to access and utilization of the treadle and hip pump technology from individual interviews and FGD discussion responses. Table 4.10 shows 20(68%) of pump buyers, 11(38.5%) of pump non buyers, 1(100%) of KSI/WSU representative, 4(50%) of chiefs and 2(25%) of agriculture extension officers responded that pump marketers as an institution posed a challenge to access and utilization of the treadle and hip pump technology. One of the respondents stated that:

“There was no follow up by KSI/WSU people”  
(Interview with a credit pump buyer from Matuu on 13/2/2017).

Another participant who thought the cost of sending payment via phone was high said:

“I prefer cash being picked from home since sending charges are high”(Interview with a credit pump buyer from Matuu on 13/2/2017).

One farmer who also needed to irrigate a large area responded as follows;

“The pump cannot irrigate a large area” (Interviews with a non-buyer from Matuu on 13/2/2017)

“The pump can only draw water 7m deep” (Interviews with a non-buyer from Matuu on 13/2/2017)

The technology itself was also reported to have its limitations in terms of labour;

“The pump requires more than one person to operate”  
(Interviews with a credit buyer from Machakos 14/2/2017)

“The pump is tiresome and relatively not easy for use by women” (Interviews with a buyer from Kisukioni on 11/2/2017)

Challenges were also reported on the time given to pay for the pump, one participant

gave the following response:

“The time limit for repayment was too short”  
(Interviews with a savings buyer from Machakos on  
13/2/2017)

Group members from Kyangala also thought the distance to where they get the pumps was too far:

“The distance to the market especially to vendors is far  
and I am unable to replace my rubber caps”. (FGD with  
a group from Kyangala on 14/2/2017)

Contrary to Valdivia and Gilles (2001) argument that technological innovations do address women’s tasks and make them more profitable, men often take over them. In this study, the technology itself had its limitation, i.e., women reported the pump to be more of a technology for men since it required a lot of energy to operate which women lack compared to men. Other underlying challenges were environmental challenges evident from the following interview responses:

“There was poor rainfall”. (Interviews with a pump  
buyer from Machakos 14/2/2017)

“My earth dam water dried 3 days after the rains  
stopped”. (Interviews from Mwala 11/2/2017)

According to FGD response;

“Payment time for the pump to some farmers was too  
short , again KSI/WSU did not follow up, they came,  
left and never came back”. (FGD participants response  
at Kyumvi 15/2/2017)

The above confirmed that communication channel partly contributed to low adoption of the pump technology. It also deduced that contrary to Ragasa (2014) in her study that examined the experience of programme and projects that aim to increase women’s access to extension services through use of digital devices as a source of

information and education on farming practices. In her study technology such as radio and television channels broadcast farming programs that are guided by professionals in the field were used, however, farmers in Machakos county were expected to use mobile phones to pay towards their pump purchase. The mode of communication platform was not interactive as described a respondent below.

“Lack of real time interaction between the payment channel and the pump purchase did not give a personal feel to the buyers. Pump marketers should therefore consider blending various media channels such as radio and television together with an interactive short message platform”. (Interview with a communication student and pump buyer in Mwala 8/4/2017).

The above findings call for revamping in communication channels about the pump as tool from the marketer to the farmer. Use of platforms that are interactive and gender inclusive for all is necessary to aid in reaching the farmers for access and utilization of the treadle and hip pump technology. This is an aspect the diffusion of innovation theory encourages for a stage at which the pump technology was, i.e., introduction in the early stages which requires high levels of marketing and contact time with innovation recipients for maximum sales and use. In addition, use of strategies that would ensure innovation supply and innovation such as one described by Prabhu (1999) in her study on sale of treadle pumps to women in India. These include building the supply network for appropriate technologies through working with others, creating linkages between and building on the strengths of the private sector and NGOs. It involved identifying and motivating suitable manufacturers to make, market treadle pumps to women farmers in India therefore linking farmers with

appropriate distributors and dealers who will stock and supply the product at the grassroots level and training local mechanics to provide after-sales service .

In terms of marketing, she reported the use innovative methods of rural marketing to promote technology among farmers. These include highly interactive farmers' meetings; product demonstrations, for example at village bazaars and fairs; and video shows of a hugely entertaining commercial film with the necessary ingredient of melodrama whose action is centered around the treadle pump. Other strategies include seeking out and working with female opinion-leaders greatly helped to overcome this. Market level challenges just like family level challenges were one of the major challenge in access to and utilization of the treadle and hip pump technology. Marketers of the pump need to work on the above challenges through improving the infrastructure such as flexible and consistent payment platform discussed between them and buyer. The marketer should also ensure the necessary bundling of the pumps is available especially with water. Of importance is to also consider gender responsive aspects in the pump design for use by women since they are the major players in agriculture.

#### **4.6 Strategies to enhance access and utilization of the treadle and hip pump technology**

This section covers the fourth objective of the study that sought to establish gender responsive strategies to enhance access to and utilization of the treadle and hip pump technology among women farmers in Machakos county. The responses are discussed

in line with elements that influence spread of a new idea in the diffusion of innovations theory. These elements are; the innovation itself, communication channels, time and social system. Depending on the stage of the product among the five stages a product undergoes upon introduction to a new market, several adjustments take place e.g. much or little promotion or a high or low sales price.

**Table 4.11 Strategies to enhance access and utilization of treadle and hip pump as suggested by the respondents**

Strategies to enhance access and utilization of treadle and hip pumps	Buyers				Non buyers				KSI representative		Chiefs		Extension officers	
	Female		Male		Female		Male							
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Innovation	23	77	11	92	16	84	8	89	1	100	6	75	3	75
Communication channel	21	70	2	17	13	69	7	78	1	100	4	50	2	50
Time	19	63	4	33	5	26	9	100	1	100	2	25	4	100
Social system	27	90	7	58	18	95	6	67	1	100	8	100	2	50
<b>Average</b>														
Innovation	35(83.3%)				24(85.7%)				1(100%)		6(75%)		3(75%)	
Communication channel	18(42.9%)				21(75%)				1(100%)		4(50%)		2(50%)	
Time	20(47.6%)				8(28.6%)				1(100%)		2(25%)		4(100%)	
Social system	31(73.8%)				23(82.1%)				1(100%)		8(100%)		2(50%)	

#### 4.6.1 Innovation strategies

The following responses with regard to innovation strategies were given as on Table 4.11 by 35(83.3%) of pump buyers, 24(86.5%) of pump non-buyers, 1(100%) of KSI/WSU representative, 6(75%) of chiefs and 3(75%) of agriculture extension officers. Some responded in terms of labour that;

“The pump should be modified for use by one person because it requires one person to pedal as the other one irrigates. This hinders use of the pump when there is no other person to help during its use”. (Interview response by a woman pump buyer in Masinga 15/2/2017)

The above statement goes back to the pump market level challenge where the design reported to be unresponsive to gender and in this case requiring use by more than one person. Pump purchase payment innovations too were thought to be costly for others and they suggested;

“KSI/WSU should waiver sending charges when farmers are paying for the pump via cell phone. The transaction fees are relatively high”. (Interview response by a woman buyer in Makutano 11/2/2017)

Although KSI/WSU team financial options may have been thought to enable the women farmers access the pump technology at their financial comfort, some still felt that the sending charges via phone were still high and requested for a waiver. A request that can be easily related to the low-income level of the respondents from the socio demographic information. Pump marketers were of the suggestion that;

“More engagement with the local partners who are already working with the farmers to enhance deeper penetration and more learning. There is need for more education on the need to see irrigation as a great input in enhancing agriculture production and regularizing

farm incomes”. (Key informant interview with KSI/WSU representative 20/4/2017)

The above as a strategy is encouraged since innovations and their adoption require a multi-stakeholder approach and not a one fits all approach. An extension officer also suggested that:

“I would recommend rainwater harvesting and storage strategies and encouraging young people to embrace farm work through creation of an enabling environment and socialization to value addition in agriculture as opposed to off farm work”. (Extension officer in Machakos Town 15/2/2017)

“I would recommend our farmers to be taken to other areas that people have used the pumps successfully so that they learn better about the benefits of utilizing such technology”. (Key informant interview with chief from Kiatini village 10/3/2017).

The above suggestions from key informants are supported by diffusion of innovation theory where at early stages; an innovation requires the adopters to be shown how it has worked in other places in order to enhance its access and utilization. With all the necessary conditions shown, the adopters are able to come up with homegrown solutions with resources that are available to them.

#### **4.6.2 Communication channels strategies**

The second strategy to improve access to and utilisation of treadle and hip pump on Table 4.11 is on communication channels as suggested by 18(**42.9%**) of pump buyers, 21(**75%**) of pump non- buyers, 1(**100%**) of KSI/WSU representative, 4(**50%**) of chiefs and 2(**50%**) of agriculture extension officers. KSI/WSU representative suggested:

“Education on the available avenues where the farmer groups can access support, how they can take advantage of opportunities available for groups such as Women Enterprise Fund and Youth Enterprise Fund among other avenues as stated in the Kenya constitution”. (Key informant interview with a KSI/WSU key informant 20/4/2017)

The above strategy may especially work among women since they tend to form self help groups both formal and informal at village level. The market can also take advantage of this and create a synergy to reach these women with the information on available avenues for finance to their projects and that would enhance access to and utilization of the pump technology too. It also concurs with Prabhu (1999) strategy that IDE organization work with women self help groups to encourage to use treadle pumps.

Some farmers preferred use of media like radio while one chief suggested frequent visits by KSI/WSU during chief barazas to demonstrate on pump use.

“Apart from our farmers to be taken to other areas that people have used the pumps successfully so that they learn I would also recommend bringing the demonstrations of pump use during chief barazas”. (Key informant interview with chief from Kiatini village 10/3/2017).

Ideally chief barazas are likely to be attended by men, engaging them with introduction to the treadle and hip pump technology would also enhance access to and utilization of the pump technology among them. Prabhu (1999) also encouraged seeking to work with mixed promotional events instead of men only or women only settings to avoid male staff being misinterpreted in their interactions with women.

One pump buyer also recommended the following;

“I would recommend pump sellers to maintain a consistent point of reference to payment either to avoid theft and confusing farmers during payment”. (Interview at Kyanganga with pump buyer 13/2/17).

Another respondent and a communications student recommended;

“The mobile platform should also be interactive and not one way communication. This is because the current platform does not allow a farmer to ask questions in case of any, it only relays information on payment towards pump purchase”. (Interview with pump buyer in Mwala 8/4/2017).

Prabhu (1999) also encourages in terms of communication, frequent engagement and follow-ups are important since it is in these forums that they learnt what to improve in their products with feedback from the farmers. Another aspect of communication that IDE as organization used to beat gender stereotypes about the pump was incorporating gender perspective in promotional campaign where the type of media chosen and content of message used served the low mobility level of women who rarely and almost always is not outside their homes or village. These include promoting different kinds of products for men and women too. Sources of information should therefore be accessible to men and women and youth and packaged in a gender inclusive language is also important.

These findings indicate that communication channels had hiccups with some occasioning respondents to lose trust and stop paying for their pump. This could be improved through frequent follow-ups and updates on pump use and payment. Diffusion of innovations states that communication of innovation influences the sales level of an innovation. For the pump technology, more and frequent communication is required from the marketers to the farmers in order to increase sales volume.

### 4.6.3 Time strategies

The time given for the farmers to do pump purchase was 6 payment installments spread in six months. Table 4.11 shows 20(47.6%) of pump buyers, 8(28.6%) of pump non-buyers, 1(100%) of KSI/WSU representative, 2(25%) of chiefs and 4(100%) of agriculture extension officers thought the time was enough while some thought it was limited.

“We should have been given one and a half years to pay for the pump”. (Interview with woman non-buyer who pulled out in Kyumvi 15/2/2017).

Extension officer’s take on time was that;

“Innovations might take time depending on the population and their environment. Our farmers might have been affected by poor rains hence the low adoption rates”. (Key informant interview with extension officer at Mwala 8/4/2017).

KSI/WSU representative thought time limit was not much of an issue but it needed to be extended a little bit considering the unfavorable weather conditions that prevailed the KSI/WSU study.

“Regarding time, we thought the timing was adequate since we have used the same timeline for other parts of our projects. KSI/WSU project in Machakos too had its timeline which we were supposed to implement and report”. (Key informant interview with KSI/WSU representative 20/4/2017).

Prabhu (1999) says that use of credit and NGOs to market and distribute the pump technology is likely to fast track the process of the technology adoption among poor farmers, however, in this study; the approach did not work as expected, as there was generally low adoption of the pumps despite using the same strategy. Diffusion of innovations theory recognizes that for an innovation take up; there are different types

of people and their speed of uptake to innovations. These include the innovators, early and late majority and laggards. Introduction of the financial innovations in Machakos county was its first ever through the pump technology. Those who took up can be considered as the innovators in the financial options innovations. With this study results, improvement on the package of the pump can be done to attract the early and late majority of the pump technology using the financial options.

Time was indeed not enough for the farmers considering the weather patterns with delayed rainfall that was below normal. However, the researcher suggests the issue of time to be consultative among sellers and buyers in a way that it is not too short or too long to repay for a pump.

#### **4.6.4 Social system strategies**

Social systems such as the family, community, state and market strategies to enhance the access and utilization of pumps among women farmers in Machakos county were also suggested. Table 4.11 shows 31(**73.8%**) of pump buyers, 23(**82.1%**) of pump non-buyers, 1(**100%**) of KSI/WSU representative, 8(**100%**) of chiefs and 2(**50%**) of agriculture extension officers strongly believed that the entire social system required coordination so as to enhance access and utilization of the treadle and hip pump technology.

FGD participations requested that:

“KSI/WSU should give a package with water harvesting and storage system with the 3 payment options and do follow up on the same”. (FGD

participants at Masinga 8/4/2017).

KSI/WSU representative proposed the following;

“I propose for support and collaboration with stakeholders such as county government and micro finances which can give subsidies or low interest rates loans to farmers and aid in their access to the pumps”. (Key informant interview with KSI/WSU representative 20/4/2017).

An extension officer suggested;

“Improvement in extension officer’s ratio to farm households as well as providence of enough budget in agriculture would make a real difference since it is the back bone of Machakos County economy”. (Key informant interview with Matungulu Extension officer 17/4/2017).

Olielo (2013) affirms the need to invest in education; training and adoption of new technologies by women in order to accrue maximum benefit in food production. In this study, education and training about the technology was concentrated on more than what must accompany the technology and how to deal with it i.e. unavailability of water and time of pump repayment. Prabhu (1999) also observed some in house gender responsive strategies that improved IDE sales of the treadle pump in India. These include training male staff on issues of gender and the importance of seeing both women and men as potential customers and users of the pump to challenge unequal gender relations. She also suggest writing of brief policy statement on gender issues in the context of organization work in addition to qualitative indicators of integrating gender issues into organization activities.

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Introduction**

This chapter highlights the summary of findings, conclusion, recommendations and suggestions for further research.

#### **5.2 Summary of the findings**

This section summarizes key findings of the study based on the objectives of the study. The objectives were; to establish the technologies used before introduction of hip and treadle pumps among women farmers in Machakos County; to find out how the women are accessing to and utilizing the treadle and hip pumps; to examine the challenges facing women farmers when accessing and utilizing the treadle and hip pumps and to suggest gender responsive strategies that might enhance access and utilisation of treadle and hip pump technology among women farmers in Machakos County.

The first objective found that irrigation technologies used before introduction of hip and treadle pumps among women farmers in Machakos County were manual and mostly powered by human and or animals. Use of bucket or bottle to irrigate among both buyers and non-buyers was most popular method of irrigation simply because it is readily available and most households irrigate crops for family use and not for economic purposes. The finding was backed by evidence from socio demographic information on income levels of respondents in this study. Being mainly a women

study and whose occupation was highly dominated by farming, their lack of finances to purchase mechanized tools for irrigation leaves them using human or animal powered tools that are readily available even though they are tiresome too.

The second objective found that among the study respondents, the most preferred type of pump was the hip pump, simply because it was cheaper than the treadle pump. This concurred with diffusion of innovations theory that advocates for an innovation to be easily affordable for it to be adopted. Among the pump purchase financing options, the farmers preferred buying pumps on cash and credit over savings options. This is because the immediate benefits of the pump could be seen in cash and credit options as compared to savings options that required the farmer to pay towards a pump and possess it when they finish paying towards it. Although use of M-pesa to pay towards pump repayment installments was expected to be high, the respondents in the study preferred use of cash to pay for towards their pump purchase. Women also being major players in agriculture saw the pump come as a relief to their day-to-day work and were willing to have it almost immediately; hence, the high rates of purchase in cash by the pump buyers. Financial services as a platform lacked among the respondents and most reported to be credit averse due to previous experiences in consequences of inability to pay for goods taken on credit. Access to information about pumps was mainly gotten from pump vendors because of interaction between a marketer and the potential buyer. Neither credit nor savings buyers had a direct seller to buyer relationship with a vendor at purchase which made it difficult for the latter to access important information on product improvement, operation and maintenance.

Distribution of pumps among the farmers was not even, making access to a pump difficult in the community even if the farmers decided to share pumps. Access to water as part of infrastructure required to determine whether a farmer could utilize the pump was a challenge since they experienced difficult rainfall conditions that was below normal during the study period. Although both women and men might have used the pump at once, it was reported that men used the pump more than women did since men are involved in operation and maintenance as they pedal while women distribute water using pipes.

The third objective on challenges of access to and utilization of the pump had the challenges categorized into themes under institutions in Naila Kabeer's social relations framework on how pump access and utilization challenges were reworked in the four institutions, i.e., the family, community, market and state. Major challenges to access to and utilization of the pump technology were at family level and market level. At family level, the women willingness to acquire the pumps was met by the inability to do so due to lack of finances while at market level, the pump design itself required some gender responsive considerations as some women said it was tiresome for them to use. Community level and state challenges were reported too, however, solution to their contribution to the challenges would act as accessories to strengthen solutions at family and market level.

The fourth objective on strategies that would enhance access to and utilization of pump technology had the strategies put in themes based on elements that influence spread of an idea as stated in the diffusion of innovations theory. These elements are;

the innovation itself, communication channels, time and social system. The pump innovation design was reported to be unresponsive to gender as some women said it was tiresome for them to use and they sometimes had to hire someone to do it for them. The payment options to use mobile phone was also not taken up as expected since most buyers preferred to pay for their pump purchase in cash or submit the payment to the pump marketer in cash. Use of mobile phone to communicate in access to and utilization of the treadle and hip pump technology was not favorite and use of available avenues such as chiefs *barazas* and women groups to consistently talk with men in the family and interact with women throughout respectively was suggested. The mobile phone platform was seen as less interactive since the farmers could not interact back and forth with it. Diffusion of innovations states that communication of innovation influences the sales level of an innovation. For the pump technology, more and frequent communication through mixed gender promotional events is required from the marketers to the farmers in order to increase sales volume. On one hand, respondents in the study thought the timeline given by the pump marketer to pay towards the pump was limited while on the other hand, the marketer stated the time was adequate since the project also had its scope in terms of time. Diffusion of innovations theory recognizes that for an innovation to be adopted; there are different types of people and their speed of uptake to innovations. These include the innovators, early and late majority adopters and laggards. In this study results, improvement on the package of the pump can be done to attract the early and late majority of the pump technology using the financial options. Time as a factor was

also unfavorable to the farmers in terms of weather as the time when the pumps were introduced to them there was low rainfall too.

Social systems such as the family, community, state and market strategies to enhance the access and utilization of pumps among farmers in Machakos county were also suggested. These include a need for a multi-stakeholder approach through gender aware training which allows for opportunities to share workloads rather than expecting the women to do all the work and ensuring sources of information about the pumps need to be accessible to men, women and youth and packaged in a gender inclusive language.

### **5.3 Conclusion**

From the findings above, this study concludes the following on access to and utilization of the treadle and hip pump technology. In the first objective, the farmers use irrigation technologies that are manual and powered by human or animal and therefore the use the treadle and hip pump technology was still appropriate in relation to the tools they were previously used to. However, the pump technology design in itself hampered use by women since it requires a lot of energy to use.

In the second objective, although the pump marketer and distributor availed as much information as possible about the pump technology and finance options to purchase it, a myriad of hiccups abound access to and utilization of the pump among the targeted women farmers. These include availability of finances, water, labor to use the pump as well as the distance to get the pump information and vendors. Other hiccups

include lack of consistent follow up by the pump marketer and distributor.

The third objective on challenges in access to and utilization of the treadle and hip pump among farmers had family level and market level challenges lead while community and state level challenges followed. Lack of water, finances, labour, time of pump repayment, priorities in a family, source of information about the pumps and distance to point of purchase of the pump were also critical. The challenges faced by the farmers were both internal and external, i.e., from buyers and marketers to the environment in which they operated.

#### **5.4 Recommendations**

From the foregoing conclusions above, this study recommends the following to support farmers in Machakos County to access and utilize treadle and hip pump technology;

The first objective on irrigation technologies used before introduction of treadle and hip pump technology recommends consistent intergenerational marketing and distribution of the pump technology with follow up by the marketer for adoption among women, men and youth.

On the second objective, the researcher recommends the pump marketer to adjust pumps to a high performance gender-responsive pumps that can be easily used by women since they are the main players in agriculture. A consultative analysis by both buyers and sellers of the pump innovation to consider all aspects that come with the pump for it to work effectively is important too. This include water harvesting and

storage points, avenues of accessing loans, information source about the pump and labour to operate for it to be successfully adopted. Pump marketers together with other players in agriculture can also find a solution through lobbying for implementation of existing policies or introduction of new ones on small-scale irrigation at county level that would enhance the access and utilization of treadle and hip pump technology.

On the third objective, the researcher recommends that family level challenges to be addressed through education on importance of support of farm chores by everyone in the family regardless of their gender. Market level challenges to also be addressed by the marketer through design of pumps that are gender responsive to allow participation in utilization by all members of the family. Another gender aspect the marketer can utilize in marketing and distribution is through working with female opinion leaders, establish demonstration plots with women headed households as well as appointing enterprising women such as the group secretary as pump dealers to build supply networks and create linkages with farmers. This secretary can earn steady income from commissions of pump sales. The marketer can also consider advertising and marketing that does not conform to gender stereotypes during promotional campaigns through promoting different kinds of products for women and men. The type of media chosen and content of message about the pump to reach women should consider their low mobility level outside their home or village. Community level challenges can be adjusted through tapping on solutions at family level while state level challenges to be addressed by in a bottom up manner by

marketers together with other key players in agriculture such as CBO's, NGOs, self help group and faith based organizations through lobbying for support at county level. On the fourth objective, the researcher recommends recruitment of female salespersons by KSI/WSU team as well as train males staff on the importance of seeing women as potential customers and how to interact with them while holding consistent talks with men in the family too. There is also need to for KSI/WSU team to have gender relations conceptual awareness building and implementation through writing brief policy statements on gender issues in the context of the organization. Qualitative indicators of integrating gender issues in to their activities are also key. A change in the perception and mentality of people living in rural, arid and semi-arid areas of Machakos through education on financial services and a multi-stakeholder approach to agriculture technology innovations is key.

### **5.5 Suggestions for further research**

The researcher recommends further study to be done with linkages between financial service providers and women groups with prior training on financial literacy. The study can also include bundling of the pump technology with water harvesting and storage system where water storage is a problem and finally the study can expose all pump repayment options to the target purchasers.

## REFERENCES

- Adelman, C. (2009). Global philanthropy and remittances: Reinventing foreign aid. *The Brown Journal of World Affairs*, 15(2): 23-33.
- Adeoti, A., Barry, B., Namara, R., Kamara, A. and Titiati, A. (2007). *Treadle pump irrigation and poverty in Ghana*, Vol. 117. International Water Management Institute.
- Aheeyar, M. M. M., Kumara, S. K., & Samarasinghe, G. D. L. (2005). The application of micro irrigation technologies in the small farming sector in Sri Lanka. *HARTI, Colombo*.
- Alistair, O., Islam, A. & Gunnar, B. (1991). *The Treadle Pump: Manual Irrigation for Small Farmers in Bangladesh*. R.D.R.D. Pdf.
- Bickman, L., Rog, D. J. and Hedrick, T. E. (1998). *Applied research design: A practical approach. Handbook of applied social research methods*, 19,19.
- Bielenberg, C. N., & Allen, H. (1995). *How to make and use the treadle irrigation pump*. Intermediate Technology.
- Bukania, Z. N., Mwangi, M., Karanja, R. M., Mutisya, R., Kombe, Y., Kaduka, L. U., & Johns, T. (2014). Food insecurity and not dietary diversity is a predictor of nutrition status in children within semiarid agro-ecological zones in eastern Kenya. *Journal of nutrition and metabolism*, 2014.
- Burney, J. A., Naylor, R. L. and Postel, S. L. (2013). The case for distributed irrigation as a development priority in sub-Saharan Africa. *Proceedings of the National Academy of Sciences*, 110(31), 12513-12517.

- Farrington, J., & Lewis, D. J. (Eds.). (2014). *Non-governmental organizations and the state in Asia: Rethinking roles in sustainable agricultural development*. Routledge.
- Fisher, M. (2006). Income is development: Kickstart's pumps help Kenyan farmers transition to a cash economy. *Innovations*, 1(1), 9-30.
- Food and Agriculture Organization, (2007). *Education for rural people and food security: A cross country analysis*. Rome: FAO.
- Fraiture, C., & Giordano, M. (2014). Small private irrigation: A thriving but overlooked sector. *Agricultural Water Management*, 131, 167-174.
- Griggs, David, Mark Stafford-Smith, Owen Gaffney, Johan Rockström, Marcus C. Öhman, Priya Shyamsundar, Will Steffen, Gisbert Glaser, Norichika Kanie, and Ian Noble. "Policy: Sustainable development goals for people and planet." *Nature* 495, no. 7441 (2013): 305.
- GOK (Government of Kenya). (2010). *Agricultural Sector Development Strategy 2010–2020*.
- Ivers, L. and Cullen, K. (2011). "Food insecurity: special considerations for women. *The American Journal of Clinical Nutrition*, 94, (6): 1740–1744.
- Kabeer, Naila (1994). *Reversed realities: gender hierarchies in development thought*. London New York: Verso Books.
- Kamwamba-Mtethiwa, J., Namara, R., De Fraiture, C., Mangisoni, J. and Owusu, E. (2012). Treadle pump irrigation in Malawi: Adoption, gender and benefits. *Irrigation and Drainage*, 61(5): 583-595.

- Kavoi, J. M., Mwangi, J. G., & Kamau, G. M. (2014). Factors Related to the Low Uptake of Technologies and Innovations in Semi-Arid Areas of Lower Eastern Kenya. *Agriculture and Soil Sciences*, 1(2), 12-21.
- Kay, M., & Brabben, T. E. (2000). *Treadle pumps for irrigation in Africa* (No. 1). Food & Agriculture Org.
- Kenya National Bureau of Statistics (KNBS). (2010). The 2009 Kenya population and housing census. *Volume IC, population distribution by age, sex and administrative units*.
- KickStart International. *Empowering women with technology*. February 2015.  
<http://www.kickstart.org/about-us/Women's%20Empowerment%20Report%20-%20KickStart%20International%20-%20February%202015.pdf>
- Krueger, R. A., & Casey, M. A. (1988). *Focus groups: A practical guide for applied research*. Beverly Hills.
- Lewis, P. K., Mattson, C. A., & Wood, C. D. (2015). Modular product optimisation to alleviate poverty: an irrigation pump case study. *International Journal of Product Development*, 20(1), 49-73.
- Mangisoni, J. H. (2008). Impact of treadle pump irrigation technology on smallholder poverty and food security in Malawi: a case study of Blantyre and Mchinji districts. *International Journal of Agricultural Sustainability*, 6(4), 248-266.
- McComb, C., Santaefemia, P. S., Johnson, N. G. and Shimada, K. (2014). Identifying technical and economic improvements to the MoneyMaker Hip pump

- through multi-objective optimization. In *Global Humanitarian Technology Conference (GHTC), 2014 Institute of Electrical and Electronic Engineers*, pp. 338-344.
- Ngugi, R. K., Mureithi, S. M., & Kamande, P. N. (2011). Climate forecast information: the status, needs and expectations among smallholder agro-pastoralists in Machakos District, Kenya. *International Journal of Current Research*, 3(11), 6-12.
- Nigussie, L., Lefore, N., Schmitter, P. S., & Nicol, A. (2017). Gender and water technologies: Water lifting for irrigation and multiple purposes in Ethiopia.
- Njuki, J., Waithanji, E., Sakwa, B., Kariuki, J., Mukewa, E., & Ngige, J. (2014). A qualitative assessment of gender and irrigation technology in Kenya and Tanzania. *Gender, Technology and Development*, 18(3), 303-340.
- Olielo, T. (2013). Food security problems in various income groups of Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 13 (4): 1-13.
- Orr, A., Islam, A. N., & Barnes, G. (1991). *The treadle pump: manual irrigation for small farmers in Bangladesh*. Dhaka: Rangpur Dinajpur Rural Service.
- Postel, S. (2012). *The Power of Radically Affordable Irrigation Pumps*. <http://voices.nationalgeographic.com/2012/04/18/the-power-of-a-radically-affordable-irrigation-pump/>
- Prabhu, M. (1999). Marketing treadle pumps to women farmers in India. *Gender & Development*, 7(2), 25-33.

- Purcell, E. (1997). Potential for small-scale irrigation in sub-Saharan Africa: The Kenyan example. *In Irrigation technology transfer in support of food security*, pp....Edited by New York:United Nations.
- Ragasa, C. (2014). Improving gender responsiveness of agricultural extension. *In Gender in Agriculture* (pp. 411-430). Springer, Dordrecht.
- Recha, J. W., Mati, B. M., Nyasimi, M., Kimeli, P. K., Kinyangi, J. M., & Radeny, M. (2016). Changing rainfall patterns and farmers' adaptation through soil water management practices in semi-arid eastern Kenya. *Arid Land Research and Management*, 30(3), 229-238.
- Rogers, E. (1983). *Diffusion of innovations*, 3<sup>rd</sup> ed. New York: Free Press of Glencoe.
- Sachs, C. E. (2018). *Gendered fields: Rural women, agriculture, and environment*. Routledge.
- Shah, T., Alam, M., Kumar, M. D., Nagar, R. K., & Singh, M. (2000). *Pedaling out of poverty: Social impact of a manual irrigation technology in South Asia* (Vol. 45). International Water Management Institute.
- Sijali, V. & Mwago.M. (2009). *Money Maker Pumps: Creating Wealth in Sub-Saharan Africa*.  
[http://siteresources.worldbank.org/AFRICAEXT/Resources/258643-1271798012256/YAC\\_chpt\\_18.pdf](http://siteresources.worldbank.org/AFRICAEXT/Resources/258643-1271798012256/YAC_chpt_18.pdf)
- Sreelata, M., & Antony, N. (2012). Can technology rescue women farm workers from drudgery?. *Appropriate Technology*, 39(2), 57.
- Srinivas, S. N., & Jalajakshi, C. K. (2004). Alternatives to micro-irrigation:

Evaluation of the treadle pump. *Economic and Political Weekly*, 4271-4275

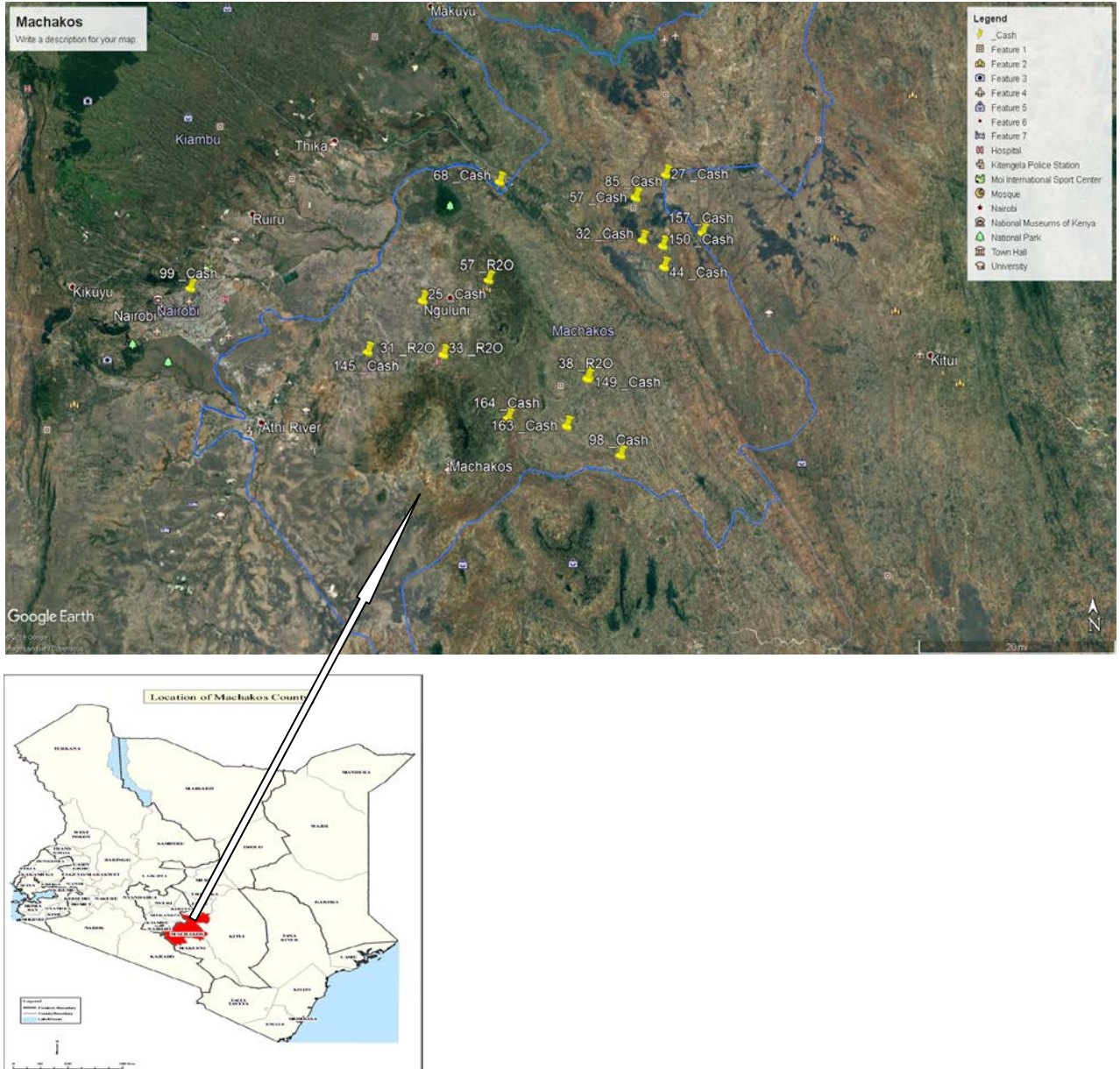
Valdivia, C. and Gilles, J. (2001). Gender and resource management: Household and group strategies and transitions. *Agric Human Values*, 18 (1):5-9.

Vision, K. 2030© Government of the Republic of Kenya 2007. *Ministry of Planning and National Development and the National Economic and Social Council (NESC), Office of the President.*

Zou, X., Li, Y. E., Cremades, R., Gao, Q., Wan, Y., & Qin, X. (2013). Cost-effectiveness analysis of water-saving irrigation technologies based on climate change response: A case study of China. *Agricultural water management*, 129, 9-20.

### APPENDICES

#### Appendix 1: Geographical location of Machakos County in Kenya.



**Appendix 2: Treadle and hip pump**



**Treadle pump**



**Hip pump**

**Appendix 3: Formal consent guide****A2: Formal consent guide**

My name is..... (Interviewers name) I am a student at Kenyatta University studying Gender and Development Studies. I am carrying out a research on 'Assessment of access and utilization of treadle and hip pump technology in Machakos county Kenya'. I need your feedback to help in completion of my course work as well as build on knowledge on how to improve livelihoods in this county and possibly the entire Kenya. Please answer all the questions openly. I would like to assure you that your individual responses will not be shared with anyone. If you have any questions about this interview, please ask and I will do my best to answer your questions. Thank you for your cooperation.

Are you willing to participate in this study? Please tick. 1. YES 0. NO

## Appendix 4: Interview schedules for treadle and hip pump buyers and non-buyers

### BUYERS INTERVIEW

#### A. Farmer bio data

1. Gender: Male .....Female.....
2. Residence (Sub county).....
3. Marital status: Married = 1, Unmarried = 2, Divorced/Separated = 3, Widowed = 4
4. Age.....
5. Occupation.....
6. Education level: None = 0, Primary = 1, Secondary = 2, College = 3, University = 4
7. Type of household? *1*=Male and female adults, *2*=Female adult only, *3*=Male adult only, *4*=Male adult and children < 14 yrs. in the household, *5*=Female adult and children < 14 yrs in the household), *6*=Male and female adults and children <14 yrs. in the household
8. Estimated monthly family income

#### B. Current technologies used before introduction of treadle and hip pump

9. What type of irrigation technologies/tools do you use in your farm?

#### C. Access & utilization of pumps

10. Are you a member of ‘Merry go round’ savings group? 1=YES 2=NO
11. Did you purchase a treadle or hip pump? 1. YES 2. NO
12. Did you use your cell phone to pay for your pump? 1. YES 2. NO
13. What type of pump did you buy? (Tick appropriately)
  - i. Hip pump ii. Treadle pump
14. How did you purchase the pump?
  - 1.Cash 2.Credit 3.Saving
15. How far is the location of the nearest market from your residence? (*Give distance in kilometers*).
  1. Local market.....2. Town market.....
16. How far is the location of the nearest pump owner from your residence? (*Give distance in kilometers*).....
17. How far is the location of the nearest pump vendor from your residence? (*Give distance in kilometers*).....
18. How was rainfall in 2015? 1. Normal 2. Below average 3. above average
19. How was rainfall in 2016? 1. Normal 2. Below average 3. above average
20. Does your household have a reliable water resource that can be accessed for use with the pump? 1=YES 0=NO
21. Have you used your pumps since you purchased it? YES NO
22. During these periods what percent of the time, physically operating the pump, was undertaken by:

Gender	Age	% of All Irrigation Time	Av. Hours/day	No. of Days per Year
11.1 Female	15to 17 years			
11.2 Female	14 years or younger			
11.3 Female	> 17 years			
11.4 Male	15to 17 years			
11.5 Male	14 years or younger			
11.6 Male	> 17 years			

23. In your opinion do you have enough people in your household who are physically able and/or willing to operate a treadle or hip pump? 1=YES 0=NO

**D. Challenges faced when acquiring pumps**

24. Did you have any challenges when accessing and utilizing the pump? Please list the challenges:


25. How did you overcome them if you did.....

26. Are there any strategies that have been put to enhance access and utilization of treadle and hip pump at;

i. Family level? YES NO  
Explain .....

ii. Community level? YES NO  
Explain .....

iii. Market level? YES NO  
Explain .....

iv. County and national government? YES NO  
Explain.....

27. What suggestions would you give to enhance access and utilization of treadle and hip pump technology

## Appendix 5: Non- buyers interview schedule

### A. Farmer bio data

1. Gender: Male .....Female.....
2. Residence (Sub county).....
3. Marital status: Married = 1, Unmarried = 2, Divorced/Separated = 3, Widowed = 4
4. Age.....
5. Occupation.....
6. Education level: None = 0, Primary = 1, Secondary = 2, College = 3, University = 4
7. Type of household? *1*=Male and female adults, *2*=Female adult only, *3*=Male adult only, *4*=Male adult and children < 14 yrs. in the household, *5*=Female adult and children < 14 yrs in the household), *6*=Male and female adults and children <14 yrs. in the household
8. Estimated monthly family income

### B. Current technologies used before introduction of treadle and hip pump

9. What type of irrigation technologies/tools do you use in your farm?

### C. Access & utilization of pumps

10. Are you a member of ‘Merry go round’ savings group? 1=YES 2=NO
11. Did you purchase a treadle or hip pump? 1. YES 2. NO
12. Did you use your cell phone to pay for your pump? 1. YES 2. NO
13. What type of pump did you buy? (Tick appropriately)
  - i. Hip pump ii. Treadle pump
14. How did you purchase the pump?
  - 1.Cash 2.Credit 3.Saving
15. How far is the location of the nearest market from your residence? (*Give distance in kilometers*).
  2. Local market.....2. Town market.....
16. How far is the location of the nearest pump owner from your residence? (*Give distance in kilometers*).....
17. How far is the location of the nearest pump vendor from your residence? (*Give distance in kilometers*).....
18. How was rainfall in 2015? 1. Normal 2. Below average 3. above average
19. How was rainfall in 2016? 1. Normal 2. Below average 3. above average
20. Does your household have a reliable water resource that can be accessed for use with the pump? 1=YES 0=NO
21. Have you used your pumps since you purchased it? YES NO
22. During these periods what percent of the time, physically operating the pump, was undertaken by:

Gender	Age	% of All Irrigation Time	Av. Hours/day	No. of Days per Year
11.2 Female	15to 17 years			
11.2 Female	15 years or younger			
11.3 Female	> 17 years			
11.7 Male	15to 17 years			
11.8 Male	14 years or younger			
11.9 Male	> 17 years			

23. In your opinion do you have enough people in your household who are physically able and/or willing to operate a treadle or hip pump? 1=YES  
0=NO

**D. Challenges faced when acquiring pumps**

24. Did you have any challenges when accessing and utilizing the pump? Please list the challenges:


25. How did you overcome them if you did.....  
.....

26. Are there any strategies that have been put to enhance access and utilization of treadle and hip pump at;
- i. Family level? YES NO  
Explain .....
  - ii. Community level? YES NO  
Explain .....
  - iii. Market level? YES NO  
Explain .....
  - iv. County and national government? YES NO  
Explain .....

27. Why did you choose **NOT** to purchase a treadle pump or a hip pump using the savings/cash/cash method when the opportunity was introduced? (Check all that apply)  
Please list the top four reasons:  
1) \_\_\_\_\_ 2) \_\_\_\_\_  
3) \_\_\_\_\_ 4) \_\_\_\_\_

28. What suggestions would you give to enhance access and utilization of treadle and hip pump technology

**Appendix 6: FGD guide for adopters of treadle and hip pump****Introduction**

Every member to introduce herself stating the name, group she is a member and their view on small scale irrigation using treadle and hip pump

**Engagement questions**

1. Which are the current technologies used before introduction of hip and treadle pumps among farmers in Machakos County?

**Exploratory questions**

2. How are farmers accessing and utilizing the treadle and hip pumps in Machakos County.?
3. What are the challenges facing farmers when accessing and utilizing the treadle and hip pumps among women farmers in Machakos County.?

**Exit question**

4. Are there any strategies that have been put to enhance access and utilization of treadle and hip pump at;
  - i. Family level,
  - ii. Community level,
  - iii. Market level,
  - iv. County and national government
5. Are there any solutions that can enhance access and utilization of treadle and hip pump among women farmers in Machakos County?

**Appendix 7: FGD guide for non-adopters of treadle and hip pump**

**Introduction**

Every member to introduce herself stating the name, group she is a member and their view on smallscale irrigation using treadle and hip pump

**Engagement questions**

1. Which are the current technologies used before introduction of hip and treadle pumps among farmers in Machakos County?

**Exploratory questions**

2. Was your group offered an option to purchase treadle and hip pump technology through different programs?
3. How are farmers accessing and utilizing the treadle and hip pumps in Machakos County.?
4. What are the challenges facing farmers when accessing and utilizing the treadle and hip pumps among women farmers in Machakos County.?

**Exit question**

5. Are there any strategies that have been put to enhance access and utilization of treadle and hip pump at;
  - i. Family level,
  - ii. Community level,
  - iii. Market level,
  - iv. County and national government
6. Why did you not choose to purchase a treadle and hip pump technology even after the different financial methods were introduced?
7. What suggestions would you give to enhance access and utilization of treadle and hip pump technology

.....  
.....

**Appendix 8: Key informant interview guides for chiefs**

**Bio data**

- a. Gender:.....Male .....Female.....
- b. Sub county.....
- c. How long have you been a chief in your area?.....years.
- d. What do you think about agriculture technology adoption in your area?  
.....

Are there any strategies that have been put to enhance access and utilization of treadle and hip pump at;

- i. Family level,
- ii. Community level,
- iii. Market level,
- iv. County and national government
  - e. What suggestions would you give to enhance access and utilization of treadle and hip pump technology  
.....  
.....
  - g. Is there anything important you think I missed?  
.....

**Appendix 9: KSI/WSU representative Key informant interview guide**

**Bio data**

- i. Gender: Male .....Female.....
- ii. Did the uptake of the pumps using the financial options go as expected? YES  
NO

Briefly

explain.....

- iii. In general how was the process of enabling access and utilization of the treadle and hip pump through the financing options you had offered to farmers in Machakos County?

.....

Please explain how it has worked in other areas?

.....

Are there any strategies that have been put to enhance access and utilization of treadle and hip pump at;

- a. Family level,
- b. Community level,
- c. Market level,
- d. County and national government

- iv. What suggestions would you give to enhance access and utilization of treadle and hip pump

.....

.....

- v. Is there anything important you think I missed?

.....

**Appendix 10: Extension officers Key informant interview guide**


**Bio data**

1. Gender:.....Male .....Female.....
2. Sub county.....
3. How was rainfall in 2015? 1. Normal 2. below average 3. above average
4. How was rainfall in 2016? 1. Normal 2. below average 3. above average
5. What type of services do you offer to farmers in your area of work?  
.....  
.....
6. What mode of communication do you use to exchange with the farmers?  
.....  
Who attends the trainings more between men and women?  
.....
7. What are the challenges you face in your work?  
.....
8. Are there any strategies that have been put to enhance access and utilization of treadle and hip pump at;
  - i. Family level,
  - ii. Community level,
  - iii. Market level,
  - iv. County and national government
9. What suggestions would you give to enhance access and utilization of treadle and hip pump technology  
.....  
.....
10. Is there anything important you think I missed?  
.....

Appendix 11: Research permit

**THIS IS TO CERTIFY THAT:**  
**MISS. TERESIAH WAIHERA GITAU**  
**of KENYATTA UNIVERSITY MAIN**  
**CAMPUS, 3653-20100 Nakuru, has been**  
**permitted to conduct research in**  
**Machakos County**  
**on the topic: ASSESSMENT OF ACCESS**  
**AND UTILISATION OF TREADLE AND HIP**  
**PUMP TECHNOLOGY IN MACHAKOS**  
**COUNTY KENYA**  
**for the period ending:**  
**10th February, 2018**


**Permit No : NACOSTI/P/17/69489/15535**  
**Date Of Issue : 13th February, 2017**  
**Fee Received :Ksh 1000**



*[Handwritten Signature]*  
**Director General**  
**National Commission for Science,**  
**Technology & Innovation**

**CONDITIONS**

- 1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.**
- 2. Government Officer will not be interviewed without prior appointment.**
- 3. No questionnaire will be used unless it has been approved.**
- 4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.**
- 5. You are required to submit at least two(2) hard copies and one (1) soft copy of your final report.**
- 6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice**

  
**REPUBLIC OF KENYA**

  
**NACOSTI**  
**National Commission for Science,**  
**Technology and Innovation**

**RESEACH CLEARANCE**  
**PERMIT**

**Serial No.A12770**  
**CONDITIONS: see back page**