DETERMINANT OF THE ADOPTION OF INTEGRATED NATURAL RESOURCE MANAGEMENT TECHNOLOGY BY SMALL SCALE FARMERS IN NDHIWA DIVISION, KENYA

BY

ISAIAH KASE OKUTHE

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FACULTY OF ARTS AND SOCIAL SCIENCES

MASENO UNIVERSITY

DECLARATION

I certify that this is my original work and has not been presented elsewhere for an award of a degree, diploma or certificate

By Candidate

ISAIAH KASE OKUTHE: PG/PHD/010/2009

Signature: ______________________________ Date: ______________________

By Supervisors

This Thesis has been submitted for examination with our recommendation as University supervisors.

Signature. ___________________________ Date____________________________

Prof. Felix Kioli (PhD.)
Department of Sociology and Anthropology
South Eastern Kenya University

Signature. ___________________________ Date____________________________

Dr. Paul Abuom (PhD.)
Department of Environmental Sciences
Maseno University

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DEDICATION

To God my creator, from whom I continue to draw my strength to live each day and whose love I delight. To my parents who faithfully instilled in me values that continue to inspire me to this day. To my colleagues and friends whose love, inspiration and company have continued to give my life good reason to aspire for the best. To my wife, brothers and sisters whose constant prayers and hard work has made me to be what I am today. Finally I dedicate this thesis manuscript to small scale farmers of Ndhiwa Division who gave me unrestricted information for this research.

ABSTRACT

Agricultural development lies at the heart of poverty reduction and increased food security in most developing nations. Sub-Saharan Africa is, however, the only region in the world where per capita agricultural productivity has remained stagnant over the past 40 years. Soil fertility depletion and the corresponding declining agricultural productivity in Kenya's Ndhiwa Division have led to attempts to popularize Integrated Natural Resource Management (INRM) technology that could restore soil fertility. However, reports have shown that adoption of INRM technology is low yet the causes of this are not well understood from the existing literature. The main objective of the study was to assess the determinants of the adoption of INRM technology by small scale farmers in the division. The specific objectives of the study were to examine the socio-economic factors that influence the adoption of INRM technology, explore the institutional factors that influence the adoption of INRM technology and asses the socio-cultural factors influencing the adoption of INRM technology by small scale farmers in Ndhiwa Division. The study was based on the diffusion of innovation theory described by Rodgers (1995) that states the process of adoption consists of a series of choices over time through which an individual evaluates a new innovation and then decides whether to adopt or reject. An ex-post-facto survey design utilizing both qualitative and quantitative methods of data collection was used in the study. The study population was 43,231 small scale farmers in the Division. For quantitative data collection, a sample of 220 small scale farmers in the division was obtained using coefficient of variation by Nassiuma (2000) and selected using systematic random sampling approach. For qualitative data, purposive sampling was used to select small scale farmers where 4 Focus Group Discussion (FGD) each consisting of 10 discussants were conducted. Additionally 37 Key Informants were interviewed. Quantitative data was analyzed through descriptive and inferential statistics. Qualitative data was coded and organized into themes and sub-themes for generalization to be made. Chi-square and one way ANOVA was used to test the stated hypotheses. Test of hypotheses were carried out at 5% level of significance. Findings of the study indicated that 47% of the farmers had adopted INRM technology. Further household heads education status, gender, farm size, gender, farming experience and household size had positive association with adoption of INRM technology. Additionally, there was a positive influence of access to credit, participation in extension, participation in cooperative society, membership in social groups, mass media exposure, access to inputs, off farm income and access to market on adoption of INRM technology. Results also revealed that there was a positive relationship between, cultural traditions and beliefs and frequency of visiting outside social system and the adoption of INRM technology. Whereas, the study found no evidence to show that tenancy status influences adoption of INRM technology. The findings of the study underlined the importance of support in the areas of extension, strengthening cooperatives and social groups and improving market and credit condition to enhance adoption of INRM technology.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADP	Area Development Programme
AEP	Agricultural Extension Programs
C-MAD	Community Mobilization Against Desertification
CIMMYT	International Centre for Maize and Wheat Improvement
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
G.O.K	Government of Kenya
GIZ	German Agency For Technical Cooperation
ICMFFS	Integrated Crop Managemnt Farmer Field School
ICRAF	International Centre for Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund For Agricultural Development
IFAP	International Federation of Agricultural Producers
KARI	Kenya Agriculture Research Institute
KCFS	Kenya County Fact Sheet
KEFRI	Kenya Forestry Research Institute
KII	Key Informant Interviews
LM	Lower Midland
MDGs	Millennium Development Goals
MOA	Ministry of Agriculture
MOARD	Ministry of Agriculture and Rural Development
NGOs	Non-Governmental Organizations
NRC	National Research Council
SSA	Sub-Sahara Africa
TSBF	Tropical Soil Biology and Fertility
UM	Upper Midland
UNCTAD	United Nations Conference on Trade and Development

DEFINITON OF TERMS

Adoption **:** It is the mental process through which an individual passes from first learning a new idea to its final use. In this study, adoption means sustained use of integrated natural resource management (INRM) technology.

Cosmopoliteness: This refers to the degree of orientation of the people towards the social system to which they belong. It is measured in terms of frequency of visits to the outside village.

Diffusion **:** This refers to the spread of new information or ideas from source to ultimate users.

Extension Activities: Refers to the information a front-line extension worker gives to farmers regarding the new technology for the purpose of improving productivity on the farm.

Frontline Extension Workers: These are the ground level extension staffs who works directly with the farmers by providing them with extension advice

Household: Comprise a person or group of persons generally bound by ties of kinship who live together under a single roof or within a single compound and who share a community of life in that they are answerable to the same head and share a common source of food.

Integrated natural resources management practices: This is scientific knowledge use in natural resources management. In this study natural resource management practices refers to fertilizer and manure use, agro forestry and Stover lines.

Innovation: Refers to a technology, idea, method or object perceived as new by an individual or members of a social system which may not necessary be the result of recent research but have developed by farmers.

Institutional Factors: These are factors dealing with or pertaining to legal institutes or the elements of a subject. They include government policies and regulations at all level of government in any country. In this study, institutional factors refer to land tenure, access to credit, access to equipment and inputs, contact with extension service institutions, social groups, infrastructure, access to market, research.

Non-Adoption: Non-use of the scientific knowledge for practical purposes. This is the situation when an individual is not using an innovation.

Small Scale Farmers: Smallholders are identified by the size of their farms. In this study a small-scale farmer is a farmer who owns less than five hectares.

Socio-cultural Factors: Culture is all the values, norms and customs that people share with one another. In this study culture refers to traditional beliefs, attitudes and customs.

Socio- economic Characteristics: It is a measure of small holder farmer characteristics indicated by wealth, land, land size, farm enterprise.

Technology Development: This is a process from problem diagnosis, design, complementation and evaluation of the technology.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

There is an increasing concern for ecosystem management, biodiversity conservation, and ecological limits of land use all over the world populations to ensure sustainable food security (Food and Agriculture Organization, 2017). According to a growing consensus, the soil resource base is a key component of agro-ecosystems and must be managed in a sustainable way (FAO, 2017). Various studies in the world have shown the potential of Integrated Natural Resource Management (INRM) as an approach to sustainable agricultural production and soil management especially in the tropics (Young, 1997; Phiri *et al.,* 2003). Campbell et al. (2001) define INRM as "a conscious process of incorporating the multiple aspects of natural resource use (be they bio-physical, socio-political or economic) into a system of sustainable management to meet the production goals of farmers and other direct users (food security, profitability, risk aversion) as well as the goals of the wider community (poverty alleviation, welfare of future generations, environmental conservation)". It focuses on sustainability through greater participation of all possible stakeholders, including users-farmers, from the planning level itself, reducing possible future conflicts (Sayer & Campbell, 2004). What makes INRM unique to other resource management strategies, is the integrated approach, which is interdisciplinary and 'learning cycle'. Apart from intersectoral problem analysis, INRM is also grounded in a learning paradigm, premised upon a social constructivist approach to development and grounded in learning process approaches (Hagmann et al., 2003). That is, as scientists become aware of the complex problems inside the natural resource system, farmers too become aware of their action and of the complex issues that need to be dealt with including their social, economic, and cultural factors influencing natural resource management (Hagmann et al, 2003; German et al., 2012).

There are technology that replenish soil fertility and provide other needs such as fuel wood, hence become integral part of the household subsistence needs (Young, 1997; Phiri *et al.*, 2003). Integrated Natural Resource Management is a sustainable agricultural system with potentials to improve food security, and is being promoted with success in most parts of the USA and other parts of the world (Young, 1997; Phiri *et al*., 2003). Argentina, Brazil, Paraguay and Uruguay have had a six-fold increase in the production of grains since the 1970s (Ekboir & Parellada, 2002). This increase came about as a result of farmers adopting three different technology: soya beans in the late 1960s, improved cereals and oilseeds germplasm since the early 1970s and INRM technology in the 1990s (Ekboir & Parellada, 2002). The adoption was triggered not only by the availability of new technology but also by public policy changes and private firms' commercial strategies (Ekboir & Parellada, 2002). The impact of technology, policies, social, cultural and institutional strategies cannot be separated because without INRM technology, the impact of improved germplasm would have been very small, since INRM technology were necessary to stop soil erosion and improve water management (Ekboir & Parellada, 2002). At the same time, new and improved germplasm increased the profitability of INRM technology, fostering adoption (Ekboir & Parellada, 2002). The adoption of INRM technology only became technically feasible with the development of glyphosate and economically feasible when it became substantially cheaper and culturally acceptable in the early 1990s (Ekboir & Parellada, 2002). Despite the successes in the increased adoption of INRM in North and South America, the adoption among small scale farmers in Eastern and Southern Africa has been very low because of cost issues leading to low agricultural production (Young, 1997; Phiri *et al* ., 2003).

In the Philippines, considerable efforts have been committed to research and extension to facilitate the adoption of INRM technology, yet a report by Young (1997) and Phiri *et al* ., (2003) described adoption of INRM as "sporadic and transient, rarely continuing once external support is withdrawn, hence need for institutional arrangement for continued adoption". Farmers were more interested in a local adaptation of the technology which includes natural vegetation and grass strips (Young , 1997; Phiri *et al* ., 2003). Another challenge to adoption of INRM technology was the high cost, low institutional support and low socio-cultural acceptance which affected the farmer's planning horizons and the confidence with which they expected to benefit from long term investment in INRM technology (Young, 1997; Phiri *et al* ., 2003). This has hampered the adoption of INRM technology and should therefore be addressed to enhance the adoption of these technology.

Food security is one of the main global concerns in many developing countries (FAO, 1995; International Federation of Agricultural Producers, 1995; FAO, 2017). For example, significant proportion of the rural population in sub-Saharan Africa (SSA) is food insecure and malnourished ((FAO, 2017). Declining soil fertility and low nutrient levels is recognized as one of the major biophysical impediment to growth of African agriculture (Nye & Greenland, 1960; Pieri, 1989; Yates & Kiss, 1992; FAO, 1996; Vanlauwe & Giller, 2006). The failure to match food supply to demand is mainly attributed to soil nutrient depletion following intensification of land use without proper land management practices and inadequate external inputs (Sanchez & Jama, 2001). Experience from various researches has revealed low adoption rate of new agricultural technology in the context of smallholder farming in Africa (Perret & Stevens, 2003 ; Gabre-Madhin & Haggblade, 2004); on average 22% in Sub-Saharan Africa (SSA) as opposed to 78% in South Asia and 84% in East Asia (Evenson & Gollin, 2003). For example, the low soil fertility in SSA arises due to low adoption of INRM technology, breakdown of the erstwhile traditional natural fallow system that used to be the means of replenishing the soil fertility and, continuous cultivation of crops without external fertilizer due to the high costs of mineral fertilizers (Vanlauwe & Giller, 2006).

Estimates in Zambia indicate that the ratio between the prices of nitrogen fertilizer and the major crop (maize) increased fourfold after the elimination of price subsidies on nitrogen fertilizer and this led to a 70% decline in fertilizer use by farmers (Howard & Mungoma, 1996). While the government has re-engaged in distributing fertilizer to certain categories of smallholders and encouraged private traders to do the same, only 20% of smallholder farmers in Zambia use fertilizer (Govereh *et al.*, 2002). The INRM technology marketing is further constrained by the geographically landlocked nature of many countries in the region, the poor road infrastructure, poverty and lack of proper institutional arrangements, which hinders access to INRM technology at affordable costs to smallholder farmers. This has lowered the adoption of INRM technology in SSA. Further, Ajayi et al. (2003) presented a synthesis of a number of studies that looked at the factors influencing farmers' decisions to adopt fertilizer tree-based agroforestry in Zambia. Their analysis identified a number of factors positively associated with the planting of fertilizer trees: farmer awareness of the technology, membership of farmers' group, wealth status, size of the land holding, the use of modern farm inputs, possession of oxen and cash crop production. They also identified factors having a negative relationship with the decision to establish fertilizer trees included labour constraints and a short investment horizon of the farmer (Ajayi et al., 2007). Although their study found that gender, education, marital status, age, size of the household, off-farm income and size of the maize field did not have a direct relationship with farmers' decision to initially test fertilizer trees in their fields during the early years of the dissemination of agroforestry in farming communities (Ajayi et al. 2003), there could be variarions from one country to another. At the same time, a review of the impact of institutions and policies to support the adoption of soil fertility technology in Zambia and Zimbabwe revealed that the low producer pricing policies adopted by these governments heavily tax smallholders and thus reduced the financial ability of farmers to invest in soil fertility management technology (Mekuria & Waddington, 2004). However, such policies may also vary from one country to another.

In Ethiopia, Mekoya et al. (2008) found that farmers generally had positive perceptions about multipurpose fodder trees for their feed value and contribution to soil conservation, but that adoption was constrained by agronomic problems, low multipurpose value and land shortage. They recommended that farmers should be involved at all stages of project design and implementation to enhance adoption. On the other hand, in Uganda, research showed that landholding size is an important barrier as poor farmers are able to adopt improved varieties, but their intensity is constrained by land availability. Further, Meijer et al. (2015) in a review of literature about role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa, found out that studies such as Matata et al. (2010) identified the factors which drive the adoption of improved fallows among smallholder farmers in western Tanzania. The results suggest that significant explanatory variables include receiving information on improved farming, farmer participation in improved farming, membership of farm groups and contacts with extension, whereas marital status, formal education and regular off-farm income had no influence on the decision to plant improved fallows. Farmers listed a number of constraints to the adoption of improved fallows, and the main obstacles listed were lack of awareness or poor knowledge of improved fallows, unwillingness to plant trees and the inability to wait two years before getting benefits from the technology (Matata et al. 2010 quoted in Meijer et al., 2015).

In Kenya, due to low soil fertility and productivity, INRM technology was piloted in Kakamenga, Kisii and Ndhiwa in Homa Bay County by Kenya Agricultural Research Institute (KARI) in response to low agricultural productivity (GOK, 2001). However, results of the piloted project of INRM, which is the technical backbone of ISFM, combining use of organic and in-organic sources of plant nutrients, showed that there was high adoption of the technology in Kisii and Kakamenga than in Ndhiwa where adoption was low (Okuthe, *et al.*, 2008). This was also confirmed by Okuthe et al (2013) which found out that only 47.7% of farmers adopted INRM technology. The results of the project evaluation indicated that there could be socio-economic and cultural differences between Kisii, Kakamega and Ndhiwa, though the evaluation did not investigate about them (Okuthe et al., 2008). Similarly, Ministry of Agriculture (2014) found out that yields of staple food crops (such as maize, rice, beans, groundnuts, sorghum and millet) are typically 4-12 bags per hectare in Ndhiwa Division and has been declining over the years (Table 1.2) compared to 20-30 bags per hectare in parts of Kenya, the causes of this are yet to be known.

Table 1.1: Estimated Yields of staple cereals in Ndhiwa division in the last 5 years

Year	Maize	Beans	Ground nuts	Sorghum	Millet
2014	8	4	5	12	4
2013	9	4	6	13	5
2012	10	6	6	13	6
2011	12	8	8	15	6
2010	12	8	9	16	8

Source: Ministry of Agriculture annual report, 2014

Adoption of INRM practices appears to be an appropriate strategy for improving the poor soil fertility in western Kenya yet the level of adoption of INRM components either singularly or in combination has not been established by different studies (Marenya & Barret, 2007). According to Marenya and Barret (2007), much research has focused on technical aspects of INRM technology without consideration of determinants of the adoption of INRM technology. Moreover, much of the adoption studies in soil fertility management that have examined determinants of farmers' decisions to adopt soil fertility enhancing technology have focused on adoption of a single technology. In a few studies that have analyzed more than one technology (for example, Bonabana, *et al.*, 2006; Marenya & Barret, 2007), the analytical methods applied did not permit analysis of integrated analysis of the technology. Such analyses did not provided the big picture on adoption of INRM components (Marenya & Barret, 2007). Therefore, the objectives of this study were to assess adoption levels of INRM components singularly and combined use of organic plus inorganic resources; identify and understand socio-cultural factors that determine their adoption patterns.

Previously, attempts have been carried out by the World Agroforestry Centre (ICRAF) and the Tropical Soil Fertility and Biology programme (TSBF) in collaboration with KARI, Kenya Forestry Research Institute (KEFRI), the Ministry of Agriculture (MOA) and other agencies (Rao *et al.*, 1998). Much emphasis was been devoted to integrated soil fertility management (ISFM) approach. ISFM refers to making best use of inherent soil nutrient stocks, locally available soil amendments, and inorganic fertilizers to increase land productivity, whilst maintaining or enhancing soil fertility and improving efficiency of nutrient and water use, but recorded little success (Vanlauwe, *et al*,. 2002; Maatman *et al.*, 2007). Else where in Kenya, low adoption rates have been attributed to be correlated to various factors such as: marginal farming conditions, social and cultural factors (Stoop, 2002), low economic returns to the farmer (Hatibu *et al*., 2002), low ratio of benefit to costs brought about by inadequate development or complete lack of food trade among the rural areas (Hatibu & Rockstrom, 2005); or agro-ecologic factors (Gabre-Madhin & Haggblade, 2004). However a study on the socio-economic determinants of the adopton of INRM technology in most parts of Kenya is minimal and with mixed results. For example, according to Smaling et al., (1993), small holder farm farms of about 2 hectares or less are usually cultivated continuously without adequate investment in INRM technology resulting in removal of nutrients from soils mainly through crop harvests (Odera *et al*., 2000). For instance in Western Kenya, which has population densities exceeding 300 per km^2, farms are characterized by widespread failure to make sufficient investments in INRM technology, resulting in declining soil fertility, low returns to agricultural investment, decreased food security and general high food prices consequently threatening food security in this region (Odera *et al*., 2000).

A few authors have looked at technology adoption, for example, Monyo, *et al*., (2002) in a study on adoption of sorghum and pearl millet varieties in Western Kenya, Mafuru, *et al*., (2007) in their study on adoption of improved sorghum varieties in the Lake Zone of Nyanza and Okuthe, *et al.,* (2008) who looked at household level determinants of adoption of improved sorghum varieties in Homabay. These studies have looked at and emphasized on varietal attributes of crops but much has not been studied and documented on the economic factors influencing adoption of INRM technology. These studies have further demonstrated that varietal attributes have a positive influence on the adoption of improved technology. However, there is scanty and inadequate information on the institutional determinants of the adoption of INRM technology in an integrated manner. Smallholder agriculture in Kenya is nonetheless characterized by widespread failure to make sufficient soil fertility replenishment and soil conservation investment in order to sustain the quality of farmland (Sanchez *et al*., 2001; Reardon *et al*., 2001; Barret *et al*., 2002; World Bank, 2003). The current study has therefore assessed the institutional determinants of adoption of INRM technology and how they influence the decision to adopt INRM technology.

Further, literature based on cross-sectional analysis has explored the adoption of INRM methods in order to understand the failure to make these critical investments (Sheikh *et al*., 2003; Phiri *et al.*, 2003; Franzel *et al.*, 2001; Pfister *et al.*, 2005). However, most studies have focused on economic analysis, for example Sheikh *et al.*, (2003) in a study on logit models for identifying the factors that influence the uptake of new "no tillage" technology by farmers in the rice-wheat and cotton-wheat farming, while Phiri *et al.*, (2003) who looked at the association of wealth status and gender with the planting of improved tree fallows in Eastern Province of Kenya. Additionally Franzel *et al.*, (2001) in a study on assessing the adoption of agroforestry practices in western Kenya and Pfister *et al.*, (2005) in their study on the dynamic modeling of resource management for farming system emphasized on the characteristics of technology in central Kenya. These studies have focused on farmers' preferences and evaluation criteria on adoption of INRM technology giving no attention to other socio-economic factors such as farm size, income, labor, age, gender and level of formal education.

Different studies focusing on influence of farm size on adoption of INRM have come up with mixed results. For example, according to Amudavi (1993) farmers with large size farms adopt more advanced farm practices than small size holders (Amudavi, 1993). However, other studies such as Rolling (1990), Kibede *et al.*, (1990), Lionberger (1996), Wasula (2000), found that farm size did not have any significant influence on the adoption of INRM technology. Yaron, Dinar and Voet (1992) and Harper *et al.*, (1990) also argued that small farm size may provide an incentive to adopt a technology especially in the case of an input-intensive innovation such as a labor-intensive or land-saving technology such as greenhouse technology among others as an alternative to increased agricultural production. It is not known whether it could explain why in Kakamega and Kisii counties which have high population pressure with limited farm sizes adopted INRM technology as compared to Ndhiwa sub-county, with less population pressure and large land size. With huge tracks of land, farmers can adopt shifting cultivation rather than use new technology with high cost such as use of fertilizers and labour intensive. At the same time, there is high poverty level in Ndhiwa sub-county as compared to those in Kakamega and Kisii, yet it is not clear whether it could explain the variation in the adoption of INRM technology. Ndhiwa division has an absolute poverty level of 77.49%, low agricultural production at an average of less than 4 bags per hectare of most cereals, land degradation, monthly mean income of Kshs. 3,852 and a 20.28% unemployment rate (KCFS, 2011). On the basis of this background, it is not clear whether poor farmers may afford to higher labourers, buy fertilizers or seedlings of trees to intercrop for soil nutrient replenishment.

In Ndhiwa, the inhabitants are predominantly Luo ethnic community and there could be socio-cultural factors which hamper adoption of INRM technology. For example, Okuthe et al (2013) found out that younger farmers (aged 40 years and below) were better adopters of INRM than older farmers. However, percentage of non-adopters were higher than adopters in the same age category at 75.7% and 65.7% respectively. However, if farm size would be considered as a determinant of adoption, then it would be tricky for most young farmers who probably do not own any land. Among the Luo, men inherit land from their fathers, which often occurs whenthey want to put up a home of their own separate from their fathers. This in most cases occurs when the sons have had children and become of certain age, mostly 40 years and above. Before then, it is not clear whether the young farmers would rely on decision made by their fathers who own the land. Similarly, Okuthe et al., (2013) showed that out of 220 farmers interviewed in Ndhiwa division 124 farmers (56%) were female compared to 96 farmers (44%) who were female, but more male farmers (61.9%) were more likely to adopt INRM technology than female farmers (38.1%). However, the study maily focused on female farmers seeking consent from husbands to plant improved fallow trees due to lack of land ownership yet other factors such as their ability to buy fertilizers or decision to use animal manure were never considered. In the Homa Bay County Integrated Development Plan of 2013-2017, women and the youth are the majority of the poor (Homa Bay County, 2013). Additionally, according to Khadiagala (2001), cultural practices may not only restrict implementation of development programs but can restrict participation as well. Diamond (1992) assert that in Luo community, it is a taboo for a woman to plant or cut finger euphorbia due to a belief that it would make them barren. It is thus not known whether they would not be allowed to plant some other improved trees that add soild nutrients. Further, land tenure and ownership rights have been based on male patrilineage (Cohen & Atieno-Adhiambo, 1989). Being that the Constitution of Kenya 2010 gives women the right to inherit land from parents and co-own land with their spouses, it is not clear whether the past traditional land tenure system still has an influence on how women utilize land including improving soil fertility and productivity.

In Kenya, agricuotural extension services have been available for a long time. Different reports have shown that extension services, if properly designed and implemented, improve agricultural productivity and conserve the soil (Birkhaeuser et al 1991; Bindlish and Evenson 1993; Evenson and Mwabu 1998; Romani 2003). Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seed varieties, crop management, and marketing (Birkhaeuser et al 1991; Bindlish and Evenson 1993; Evenson and Mwabu 1998; Romani 2003). Exposure to such activities is intended to increase farmers' ability to optimize the use of their resources. However, at times even when technology are available, smallholder farmers have no access to them (Fliegel, 1993). More importantly, private extension provision, which would save most farmers is generally skewed towards high agricultural potential regions and high-value crops. Remote areas and poor producers, especially those growing low-value crops with little marketable surplus, are poorly served (Muyanga & Jayne,).

Institutional factors have also been identified as determinants of adoption of INRM technology. For example, access to credit has been reported to stimulate technology adoption (Simtowe & Zeller, 2006; Mohamed & Temu, 2008). It is believed that access to credit promotes the adoption of risky technology through relaxation of the liquidity constraint as well as through the boosting of household's-risk bearing ability (Simtowe & Zeller, 2006). When farmers borrow, they are able to buy farm inputs and increase farm productivity (Simtowe & Zeller, 2006). However, it is widely acknowledged that inadequate financial resources are a key constraint to farmers' investments, the key to enhancing agricultural productivity (Townsend, 2008). At the same time, access to credit has been found to be gender biased in some countries where female-headed households are discriminated by credit institutions, and as such they are unable to finance yield-raising technology, leading to low adoption rates (Muzari *et al*., 2013). Thus, in as much as the government has launched Uwezo funds and Women Enterprise Funds (Government of Kenya, 2006), it is not clear whether the youth and women may take advantage of the opportunities to access credit facilities to boost their desire to adopt new technology that improve their productivity and soil conservation.

Therefore, this study aimed at determining the level of adoption and assessing the socio-economic, institutional and socio-cultural factors that influence farmers' decision to adopt or reject INRM technology that will restore the soil fertility and improve agricultural productivity in Ndhiwa division leading to food security.

1.2 Statement of the Problem

Soil fertility depletion and the attendant declining agricultural productivity in Kenya have led to many attempts to develop and popularize INRM technology that could restore soil fertility. For example, in Kisii, Kakamega and Ndhiwa Division. However the adoption of these technology remained low in Ndhiwa compared to the other areas, yet the causes of this low adoption are not very well understood. Most studies have focused on farmers' preferences and varietal attributes in adoption of INRM technology, yet socio-cultural and economic as well as institutional factors also have the potential of inlfuencing adoption of such technology. Anecdotal results from studies on socio-economic, institutional and socio-cultural determinants of adoption of INRM technology have shown mixed results. Whereas some studies have found a positive relationship between these determinants and the adoption of INRM technology, others have indicated that there is no significant relationship between the socio-economic, institutional and socio-cultural factors and the adoption of INRM technology.

This study therefore attempts to determine the level of adoption of INRM technology in Ndhiwa division which has been low in order to concretize the existing data which is inadequate and scanty. The study also provides an empirical explanation on the role of income, gender, level of education and family size on the adoption of INRM technology in Ndhiwa Division where such information is not clear, scanty and has mixed results in order to improve on their adoption. Additionally access to credit, access to inputs, contact with extension, participation in social groups, and access to market which are an impediment to adoption have also been studied to enhance the inadequate information on adoption of INRM technology. Further the norms, rules and traditions that hamper farmer's decision to adopt newly introduced INRM technology consisting of use of manure, fertilizer, use of stover lines and agro forestry in Kenya's Ndhiwa division have been assessed to add to and enhance and augment the existing literature.

1.3 Research questions

(i) What is the level of adoption of INRM technology among small scale farmers in Ndhiwa division, Kenya?

(ii) How do socio-economic factors influence the adoption INRM technology by small-scale farmers in Ndhiwa division, Kenya?

(iii) How do socio-cultural factors influence the adoption of INRM technology by small-scale farmers in Ndhiwa division, Kenya?

(iv) How do institutional factors influence the adoption INRM technology by small-scale farmers in Ndhiwa division, Kenya?

1.4 Broad Objectives

The broad objective of the study was to assess the determinants of small scale farmers' decision to adopt INRM technology in Ndhiwa Sub County, Kenya.

1.4.1 Specific Objectives are:

(i) To determine the level of adoption of INRM technology by small-scale farmers in Ndhiwa division.

(ii) To examine the influence of socio-economic factors on the adoption of INRM by small-scale farmers in Ndhiwa division.

(iii) To assess the influence of socio-cultural factors on the adoption of INRM by small-scale farmers in Ndhwa division.

(iv) To explore the influence of institutional factors on the adoption of INRM by small-scale farmers in Ndhiwa division.

1.5 Hypotheses

1. **Ho_1**: Socio-economic factors do not significantly influence the adoption INRM technology by small-scale farmers in Ndhiwa division, Kenya
2. **Ho_2**: Socio-cultural factors do not significantly influence the adoption of INRM technology by small-scale farmers in Ndhiwa division, Kenya
3. **Ho_3**: Institutional factors do not significantly influence the adoption INRM technology by small-scale farmers in Ndhiwa division, Kenya

1.6 Significance of the Study

The continued threat to world's natural resources is exacerbated by the need to reduce poverty and unsustainable farming practices all over the world. A significant proportion of the rural population in sub-Saharan Africa (SSA) is food insecure and malnourished ((Food and Agriculture Organization, 1995). Food security is one of the main global concerns in many developing countries (Food and Agriculture Organization, 1995; International Federation of Agricultural Producers, 1995). Food insecurity is most acute in sub -Saharan Africa, where the attainment of food security is intrinsically linked with reversing stagnation and safeguarding the natural resource base (IFAP, 1995). Declining soil fertility and low nutrient levels is recognized as one of the major biophysical impediment to growth of African agriculture (Nye & Greenland, 1960; Pieri, 1989; Yates & Kiss, 1992; FAO, 1996; Vanlauwe & Giller, 2006).

This study attempts to provide data that will unearth the determinants of small scale farmers' decision to adopt or not to adopt newly introduced INRM technology consisting of manure and fertilizer use, agro forestry and use of stover lines in Kenya's' Ndhiwa division. This may be used in making critical decisions that would enable farmers to adopt these technology. Beside this study will lead to policy recommendations to policy makers to help enhance transfer of INRM concepts and practices. Farmer's access to these technology could foster economic development through increased agricultural production and food security for people in the rural areas. This is through making recommendations on agricultural technology transfer strategies so that the present and future generations of small-scale farmers apply scientific knowledge and improved agricultural technology and skills in their farm work. This will enable Kenya achieve vision 2030 based on the economic pillar.

This study also provides a useful input for the strategy for revitalizing agriculture in Kenya and development of training materials for extension staff that are critical in the transfer of agricultural technology. Besides, the study provides insight into how socio-economic, institutional and socio-cultural factors can enable smallholder households secure their basic needs, promote self-reliance and adopt sustainable INRM technology as a means of breaking the cycle of natural resource degradation to ensure agricultural/environmental sustainability and eradicate extreme poverty and hunger (Sustainable Development Goals) in this households.

Understanding the factors that influence or hinder adoption of INRM technology is essential in planning and executing technology related programmes for meeting the challenges of food production in developing countries. Therefore to enhance technology adoption by farmers, it's important for policy makers and developers of new technology to understand farmers need as well as their ability to adopt technology in order to come up with technology that will suit them.

The findings from the study may also be used by researchers, planners, policy analysts; activists and practitioners to build the case for more focused planning for interventions on INRM within the development sector and also contribute to knowledge in the area of natural resource management.

Further, the study intended to fill the gaps established from past studies in order to enhance faster and sustainable adoption of INRM technology in Kenya and other developing countries as well, to accelerate gains in productivity and achieve the poverty targets of the SDGs. The findings of this study would help various policy responses to encourage use of INRM and other improved technology to reverse the slide in agriculture and help boost production and enhance food security. Also the findings would provide some opportunities and challenges in galvanizing the government in considering partnership between private and public sectors as visible options in poverty reduction and sustainable development.

1.7 Scope of the Study

The study was conducted in Ndhiwa division, Homabay County, Kenya. It mainly focused on the influence of socio-economic, socio-cultural and institutional factors on the adoption of improved natural resource management practices. The socio-economic factors studied were farm size, age, income, labor, gender and level of formal education. The institutional factors studied included land tenure, access to credit, access to inputs, contact with extension, participation in social groups, and access to market. The socio-cultural factors studied were traditions, customs and beliefs and cosmo politeness Also studied was the level of adoption of improved natural resource management practices. Only small scale farmers were included in the study.

1.8 Limitation of the Study

The adoption of new technology is influenced by many factors. A factor which is found to enhance adoption in a particular technology in one locality at one time might be found to hinder or be irrelevant for adoption of the same technology in another locality at the same or different time for the same or different technology. Therefore, it is difficult to identify universally defined factors either impeding or enhancing adoption of technology. This study was restricted to identification of factors influencing and assessing level of adoption of INRM technology in Ndhiwa Division. In addition due to the spatial-temporal issue, the results of the study will have practical validity mainly to areas having similar features with the selected area. Additionally majority of farmers who were the main respondents were semi illiterate. The researcher overcame this limitation by explaining to farmers the questions in the questionnaires. Another limitation of the study was lack of guarantee of participation of households included in the study. The researcher overcame this by explaining the importance of the study to household members.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter highlights the major concepts of literature reviewed which are significant to the study. It covers work on adoption of INRM technology, determinants of agricultural technology adoption, socio-economic factors influencing technology adoption, institutional factors affecting technology adoption and socio-cultural factors affecting technology adoption. It also presents the theoretical framework on diffusion and adoption of technology, a conceptual framework that illustrate the relationship between the dependent and independent variables and how the study will be used to determine the influence of the independent variables on the dependent variable.

2.2 Adoption of INRM Technology

Concern about the negative impacts of modern agriculture on human health, the natural environment and resources has prompted development and diffusion of an alternative called INRM technology. INRM technology is the approach that not only makes better use of natural goods and services for human needs without damaging the environment, but also minimizes the use of external inputs. Besides, it enables farmers to more effectively use their knowledge and skills (Duesterhaus, 1990; Shiri *et al*., 2012). INRM technology are considered to be based on dimensions of economics, society and environment (Von Wiren-Lehr, 2001; Zhen *et al*., 2005). Hence, sustainability of the farming production system is achieved if it is economically viable, socially acceptable and environmentally sounds (Shiri *et al*., 2012). However, to convince farmers to adopt INRM technology promoted by governmental institutions, they first need to believe that these technology are vital, provide safety for the rural environment and create stable and long-term income (Tatlıdil *et al*., 2009). Moreover, the perceived importance of agricultural sustainability differs from farmer to farmer and it is influenced by their socioeconomic characteristics and information-seeking behavior. Hence, determining the level of adoption and studying the factors influencing the adoption of INRM technology is crucial to design extension programs for sustainable agriculture development (Tatlıdil *et al*., 2009).

Various authors define technology in different ways. Loevinsohn *et al*., (2013) define technology as the means and methods of producing goods and services, including methods of organization as well as physical technique. According to these authors new technology is new to a particular place or group of farmers, or represents a new use of technology that is already in use within a particular place or amongst a group of farmers. Technology is the knowledge/information that permits some tasks to be accomplished more easily, some service to be rendered or the manufacture of a product (Lavison, 2013).

Technology itself is aimed at improving a given situation or changing the status quo to a more desirable level. It assists the applicant to do work easier than he would have in the absence of the technology hence it helps save time and labor (Bonabana-Wabbi, 2002) Adoption on the other hand is also defined in different ways by various authors. Loevinsohn *et al*., (2013) defines adoption as the integration of a new technology into existing practice and is usually proceeded by a period of 'trying' and some degree of adaptation. Citing the work of Feder, Just & Zilberman (1985), Bonabana-Wabbi defines adoption as a mental process an individual passes from first hearing about an innovation to final utilization of it.

Adoption and diffusion are two interrelated concepts depicting the decision to use or not to use and the spread of a given technology among economic units over a period of time. Adoption can have several definitions and in this study, to adopt is to bring a given technology like INRM under use in order improve soil fertility and contribute to agricultural productivity. The adoption of the new technology, particularly in subsistence farming is governed by a complex set of factors such as household specific, farm, institutional and technological.

The dynamic nature of adoption decisions involves a change as information is progressively collected. Adoption is conceptualized as a multi-stage decision process involving information acquisition and learning by doing by growers who vary in their risk preferences and their perceptions of riskiness of an innovation (Feder *et al*., 1985).

Adoption is in two categories; rate of adoption and intensity of adoption. The former is the relative speed with which farmers adopt an innovation, has as one of its pillars, the element of 'time'. On the other hand, intensity of adoption refers to the level of use of a given technology in any time period (Bonabana- Wabbi, 2002). Defining technology adoption is a complicated task since it varies with the technology being adopted. For instance the study by Doss (2003) showed that adoption of improved seed in a survey done by CIMMYT classified farmers as adopters if they were using seeds that had been recycled for several generations from hybrid ancestors. In other studies adoption was identified with following the extension service recommendations of using only new certified seed (Doss, 2003; Bisanda, 1998; Ouma, 2002).

Therefore in defining agricultural technology adoption by the farmers, the first thing to consider is whether adoption is a discrete state with binary response variables or not (Doss, 2003). That means definition depends on the fact that the farmer is an adopter of the technology or non-adopter taking values zero and one or the response is continuous variable (Challa, 2013). The appropriateness of each approach depends on the particular context (Doss, 2003). Many researchers use a simple dichotomous variable approach in the farmers' decisions of new technology adoption. This approach according to Jain *et al.,* (2009) is necessary but not sufficient because the dichotomous response reflects the status of awareness of improved technology rather than the actual adoption.

2.3 Determinants of the Adoption of INRM Technology

There is, indeed, a consensus that low and declining soil fertility is the fundamental problem limiting smallholder agricultural productivity in SSA (Sanchez *et al.,* 2002). This means that little progress can be made without first addressing this key problem. Reversing this situation is particularly important in SSA where an estimated 300 million farmers live and work in marginal lands (United Nations Conference on Trade and Development (UNCTAD, 2010). Limited use of INRM technology is a key factor contributing to the problem especially under conditions of continuous farming in Africa where only a small proportion of farmers use INRM technology (Morris *et al.,* 1999). This is certainly inadequate to raise crops significantly. The current state of fertilizer use per hectare in Africa is about 10% of the world's average, indeed untenable compare to Europe and Asia where fertilizer use stands at 80% and 60% respectively. National fertilizer recommendations for a good crop of maize, 3-4 tons per hectare, is typically 10 times the current used rates (Jama *et al.,* 1997).

The need to improve soil management in the continent has become a very important issue in the development policy agenda because of the strong linkage between soil fertility and food insecurity on one hand and the implications on the economic wellbeing of the population on the other hand (Ajayi *et al*., 2003). At the core of the Integrated Natural Resource Management

(INRM) paradigm is the recognition that no single component of soil fertility management can stand on its own in meeting the requirements of sustainable soil fertility management (Vanlauwe, 2004; Place *et al.,* 2003).

There has been a large range of factors that influence adoption of INRM technology. Hence it is essential to establish a theoretical base to model the relationship between explanatory variables and adoption of INRM technology. Some factors commonly found in previous studies related to adoption of INRM technology can be grouped into three categories: (1) socioeconomic characteristics of farmers including farm size, household income, age, gender, farming experience and level of formal education; (2) institutional factors such as land tenure, access to credit, access to inputs, contact with extension, participation in social groups, and access to market and (3) socio-cultural factors which includes attitude, customs and beliefs, Cosmo politeness and farmers perception about technology (Nguyen & Chinawat, 2015).

There exist vast literatures on factors that determine agricultural technology adoption. According to Loevinsohn *et al.,* (2013), farmers' decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between characteristics of the technology itself and the array of conditions and circumstances. Diffusion itself results from a series of individual decisions to begin using the new technology, decisions which are often the result of a comparison of the uncertain benefits of the new invention with the uncertain costs of adopting it (Hall & Khan, 2002). An understanding of the factors influencing this choice is essential both for economists studying the determinants of growth and for the generators and disseminators of such technology (Hall & Khan, 2002).

Traditionally, economic analysis of technology adoption has sought to explain adoption behavior in relation to personal characteristics and endowments, imperfect information, risk, uncertainty, institutional constraints, input availability, and infrastructure (Feder et *al.*, 1985; Koppel 1994; Foster & Rosenzweig, 1996; Kohli & Singh, 1997; Rogers, 2003 and Uaiene, 2009). A more recent strand of literature has included social networks and learning in the categories of factors determining adoption of technology (Uaiene, 2009). Some studies classify these factors into different categories. For example, Akudugu *et al.*, (2012) grouped the determinants of agricultural technology adoption into three categories namely; economic, social and institutional factors. Lavison (2013) broadly categorized the factors that influence adoption of technology into Social, Economic and physical categories, McNamara, Wetzstein & Douce (1991) categorized the factors into, farmer characteristics, farm structure, institutional characteristics and managerial structure, and Nowak (1987) grouped them into informational, economic and ecological, while Wu & Babcock (1998) classified them under human capital, production, policy and natural resource characteristics.

Chi & Yamada (2002) carried out a study in Japan on the adoption of technology in INRM technology. These researchers used Focused Group Discussions (FGDs) and established the following reasons for low adoption: farmers did not believe because it was new to them; they had not seen the demonstration Fields; they worried of low yield, low education, old age farmers who did not believe new technology and only believe their own experience, old behavior of cultivation practices embedded in farmers for long period: were not persuaded to use new technology. They only practiced by their own practices such as using high rate of seeds by directly broadcasting and spraying pesticide for prevention of insect occurrence.

In Nigeria a number of agroforestry adoption studies were undertaken by researchers from corporate and private organizations because of the benefits of agroforestry practices. Cobbina & Atta-krah (1989), conducted research on agroforestry practices. The study was conducted in Oyo State of Nigeria and the villages used for the study were Owu-Ile and Iwo –Ale. The sample for the study was twenty from a population of one hundred and eighty. The data were collected by the use of questionnaire. The analysis was done using mean and standard deviation .The findings of the study found that planting of two leguminous trees *glirricida sepieum* and *lucaena* which are leguminous trees increased foliage, increased soil fertility and the crops yielded double. The nitrogen-rich foliage from the recommended trees of *leucaena* and *gliricida* can be applied as green manure for the maintenance of soil fertility or can be fed to livestock as a high protein feed supplement.

In another study conducted by National Research council (NRC,1984), on agroforestry technology, the council found out that, Agroforestry adoption is likely to sustain economic productivity, without causing severe degradation of the environment. NRC (1993), further, noted that because of the low fertility of most upland tropical soils, some degradation is inevitable with any cultivation systems. Lai (1989), stated that soil organic matter, Ph, soil structure, infiltration rate, cation exchange capacity, and the base saturation percentages are maintained at more favorable levels in agroforestry systems due to reduced losses to run-off, and soil erosion, efficient nutrient recycling, biological nitrogen fixation by leguminous trees, favourable soil temperature caused by drying, and improved drainage because of roots and other biomass.

Although there are many categories for grouping determinants of technology adoption, there is no clear distinguishing feature between variables in each category. Categorization is done to suit the current technology being investigated, the location, and the researcher's preference, or even to suit client needs (Bonabana- Wabbi 2002). For instance the level of education of a farmer has been classified as human capitals by some researchers, while others have classified it as a household specific factor. This study will review the factors determining adoption of INRM technology by categorizing them into socio-economic factors, socio-cultural factors, and institutional factors. This will enable a depth review of how each factor influences adoption.

Technology adoption remains one of the most researched areas in agricultural and rural development. However very few studies have looked at the adoption of more than one improved technology e.g Monyo, *et al*., (2002) in a study on adoption of sorghum and pearl millet varieties in Tanzanai and Nega (2003) in a study on farm level adoption of new sorghum technology in Tigray region, Ethiopia. Additionally Mafuru, *et al*., (2007) in their study on adoption of improved sorghurm varieties in the Lake Zone of Tanzania and Okuthe, *et al.*, (2008) who looked determinants of adoption of improved sorghum varieties, have given some insight at the adoption of improved technology with conflicting results. Further, the existing studies have focused on the level of adoption of one technology which is based on varietal attributes. This study distinguishes itself by providing a greater insight into the level of adoption of INRM technology in an integrated manner.

The studies above have also provided vital evidence on the adoption of improved technology where Monyo *et al.,* (2002) reported low adoption of pearl millet varieties in Tanzania while Nega (2003) reported very low adoption of sorghurm technology in Tigray region, Ethiopia.

However, most of these studies have concentrated mainly on one improved technology with emphasis on the varietal attributes. These studies therefore provide conflicting results. Besides, majority of the studies were conducted in the case of improved seed varieties. In addition, while majority of the studies were actually conducted in the field, some studies used only one survey methodology. Use of one survey method alone might pose difficulty in ascertaining that the data is thorough and convincing since conditions could have changed by the time the research was conducted.

INRM technology adoption study conducted in Kenya by Scherr (1995), was designed to test several INRM interventions, aimed at reversing the constraints that have appeared in the semi-arid lands of Kenya, as a result of population pressure. Three hundred farmers were sampled from one thousand nine hundred farmers. The data for the study was collected by the use of questionnaire and analysed using percentages, means and standard deviation .The finding of the study which was in line with design methodology of diagnosis and design methodology of the International council for Research in Agroforestry (ICRAF), identified research needs of the semi-arid areas of Kenya to include: Low productivity of crops, as a result of low soil fertility (low organic matter and nitrogen levels) high rate of soil erosion and runoff shortage of animal fodder, especially during the dry season shortage of fuel wood and building poles and shortage of cash (no cash crops).

The findings of the study was in line with the above research needs suggested developing INRM technology that will take adequate care of the above mentioned problems. The project objectives of International council for research in Agroforestry (ICRAF) were to develop INRM technology for the semi-arid areas of Kenya, and other East African countries, with a view to improving the quality of lives of the inhabitants. Following the identification of the constraints, the following objectives were stated: to examine the possibilities of maintaining or increasing productivity by establishing alley cropping to examine the possibilities of improving the quality, quantity and seasonal distribution of forage crops on the farm by planting fodder trees or such species in the grazing areas and by developing cut-and-carry forage systems to examine the possibilities of reducing the labour requirements of free-grazing systems to examine the possibilities of increasing the cash income of the farmers by the introduction of trees.

Result from trials in Machakos districts gave green matter yields for leucaena about 1.5kg/tree per season at average intra row spacing of 0.62m and between row spacing of 3.5m. The relative yield of maize per unit or crop area increased by 22%. Due to the high population density of Kenya, the intervention technology designed to counteract the constraints as a result of the issues of over-population is agroforestry which is a one of the modern INRM technology.

Studies on agroforestry adoption in Western Kenya by Scherr (1995), on the economic factors in farmer adoption of agroforestry in western Kenya revealed that agroforestry practices in western Kenya evolved historically, along with land-use intensification, to meet new needs for tree products and services. The choice of agroforestry practices on particular farms varied considerably, reflecting resource constraints and differing livelihood strategies. Farmers consistently adopted agroforestry technology to reduce associated risks

2.4 Socio-economic Factors Influencing Technology Adoption

Most adoption studies have attempted to measure economic analysis of human capital through the farmer's Education, age, Gender, and household size (Fernandez-Cornejo & Daberkow, 1994; Fernandez-Cornejo *et al.*, 2007; Mignouna *et al.*, 2011; Keelan *et al.*, 2014). The influence of socio-economic factors on adoption of INRM technology have been studied with varied results. Socio-economic factors include age, household income, gender, farm size, farm income, family size, household size, and level of education among others.

2.4.1 Farm Size

Farm size is hypothesized to positively relate to the adoption of new practices. Many technological advances require large farm size. Farmers with large size farms adopt more advanced farm practices than small size holders (Amudavi, 1993). According to Lionberger (1996), what is good for a large scale farmer may not be good for a small scale farmer. Shiferaw & Holder (1998), found that peasants decision to retain conservation structures were positively related to the per capita availability of cultivatable land and land parcel in Ethiopian highlands. This concurred with the findings by Rolling (1990), and Kibede *et al.*, (1990) and Wasula (2000), who found farm size not significant in the adoption of INRM technology. Farm size may not have a significant effect on the adoption of technology in cases where farmers have sufficient land for the implementation of the technology and thus land size is not a constraint to production.

Farm size plays a critical role in adoption process of a new technology. Many authors have analyzed farm size as one of important determinant of technology adoption. Farm size can affect and in turn be affected by the other factors influencing adoption (Lavison, 2013). Some technology are termed as scale-dependent because of the great importance of farm size in their adoption (Bonabana- Wabbi, 2002). Many studies have reported a positive relation between farm size and adoption of agricultural technology (Kasenge, 1998; Gabre-Madhin & Haggblade, 2001 Ahmed, 2004; Uaiene *et al*., 2009; Mignouna *et al*, 2011). Farmers with large farm size can use this to acquire credit hence better adoption of technology of improved technology.

Farmers with large farm size are likely to adopt a new technology as they can afford to devote part of their land to try new technology unlike those with less farm size (Uaiene *et al*., 2009). In addition, lumpy technology such as mechanized equipment or animal traction require economies of size to ensure profitability (Feder, Just and Zilberman, 1985). Some studies have shown a negative association between farm size on adoption of new agricultural technology. For example small farm size may provide an incentive to adopt a technology especially in the case of an input-intensive innovation such as a labor-intensive or land-saving technology. Farmers with small land may adopt land-saving technology such as greenhouse technology, zero grazing among others as an alternative to increased agricultural production (Yaron, Dinar and Voet, 1992; Harper *et al.,* 1990). Other studies have reported insignificant or neutral relationship with adoption. For instance a study by Grieshop *et al*., (1988), Ridgley and Brush (1992) Waller *et al.*, (1998) Mugisa-Mutetikka *et al.,* (2000), Bonabana- Wabbi (2002) and Samiee *et al.,* (2009) concluded that size of farm did not affect Integrated Pest Management (IPM) adoption implying that IPM dissemination may take place regardless of farmers' scale of operation. Kariyasa & Dewi (2011) also found that extensive of land holdings had no significant effect on the degree of Integrated Crop Management Farmer Field School (ICMFFS) adoption probability.

The above mentioned studies consider total farm size and not crop acreage on which the new technology is practiced. Since total farm size has an effect on overall adoption, considering the crop acreage with the new technology may be a superior measure to predict the rate and extent of adoption of technology (Lowenberg, 2000). Therefore in regard to farm size, technology adoption may best be explained by measuring the proportion of total land area suitable to the new technology (Bonabana- Wabbi, 2002). Besides, property size is often, but not usually associated with the INRM technology adoption (Ghadim *et al.,* 2005). For example, De Souza *et al.,* (1999) & Adeola (2010) ascertained that farm size had a significant influence on adoption of soil conservation practices but Wollni & Andersson (2014) did not find its influence on the adoption of INRM technology. Although farm size may not directly influence the adoption of improved technology, large size for farming may be an incentive for farmers to adopt INRM technology that will restore soil fertility and improve productivity. This therefore calls for a study to establish the role farm size on the adoption of INRM technology.

2.4.2 Household Income

Household income is assumed to be associated to the adoption in some studies. Caviglia (2003) found that farm income of farmers had positive influence on adoption of INRM technology while (Ngombe *et al.,* 2014) stated that off-farm income had negative influence on the adoption of INRM technology. Arellanes & Lee (2003) revealed that household income was not significantly influenced the adoption of INRM technology. According to the World Bank (2000), poverty is the main cause of environmental degradation. Total household income can be used as a proxy to working capital because it determines the available capital for the investment in the adoption of INRM technology. One way of measuring the household's poverty is through income.

Household income has bearing on the socio economic status of farmers. Farmers from higher economic status have access to resources and institutions controlling resources necessary for the effective adoption of INRM technology (World Bank, 1983). This is consistent with the findings of Blankie (1989), Gaft (1993) and Tiffer *et al* (1994), who found social status to be a significant factor affecting the adoption of INRM technology. In most cases, the adoption of information is largely by an opinion leader who tends to occupy high socio economic status, which is positively related to the adoption (Adams, 1984 & World Bank, 1993). Wasula (2000) found farm income significant to the adoption of soil conservation measures. In addition, Aboud (1992) also found income as an important variable in his study of environmental degradation and farmers adoptive strategies in Nakuru District. On the other hand, Wasula (2000) found that firm income had no effect on the adoption of selected INRM technology in Nakuru District. Income by a household can be used to acquire raw materials and labor. This is very important for enhancing the adoption of INRM technology hence need for a study to confirm or reject this.

2.4.3 Level of Education

Formal education of farmers is expected to associate with the adoption of INRM technology. Numerous studies found that education of farmers tends to positively influence their decision to adopt INRM technology (Ngombe *et al.,* 2014; Teklewold *et al.,* 2013) while study of Clay *et al.,* (1998) did not find influence of education levels on the adoption of these INRM technology. Chitere and Dourve (1985), Amudavi (1993), and Ndiema (2002) in their respective studies found that education is a significant factor in facilitating awareness and adoption of INRM technology in Njoro and Rongai Divisions, Kenya. This is so because education enables one to access information needed to make a decision to use an innovation and practice a new technology. Formal education is an important element for knowledge about the existing technology. Education through training increases managerial competence and therefore enhances ability to diagnose, assess, comprehend and respond to financial and production problems.

Education enables one to access information needed to make a decision to use an innovation and practice a new technology. High level of education enhances the understanding of instruction given and also improves the farmers' level of participation in agricultural activities. The implication is that extension systems and agricultural development projects should seek not only to provide technical options to small scale farmers, but also to attempt to make up for low levels of educational attainment, perhaps through emphasis on management training and skill building. This is in agreement with the studies conducted by Taha (2007) who reported significant positive relationship of education with the adoption of improved onion production package. Similarly Addis (2007) and Mahadi (2005) reported positive and significant relationship of education with adoption of technology. Education enables the farmer acquire knowledge and skills; analyze INRM technology in terms of its advantages hence improve on the adoption.

Education of the farmer has a positive influence on decision to adopt new technology. Education level of a farmer increases his ability to obtain; process and use information relevant to adoption of a new technology (*Mignouna et al*., 2011; Lavison 2013; Namara *et al*., 2013). For instance a study by Okunlola *et al.* (2011) on adoption of new technology by fish farmers and Ajewole (2010) on adoption of organic fertilizers found that the level of education had a positive and significant influence on adoption of the technology. This is because higher education influences respondents' attitudes and thoughts making them more open, rational and able to analyze the benefits of the new technology (Waller *et al*., 1998). Education therefore enables a farmer to acquire new knowledge and apply this knowledge leading to better adoption of INRM technology.

This eases the introduction of a new innovation which ultimately affects the adoption process (Adebiyi & Okunlola, 2010). Other studies that have reported a positive relationship between education and adoption include; Goodwin and Schroeder (1994) on forward pricing methods, Huffman and Mercier (1991); Putler and Zilberman (1988) on adoption of microcomputers in agriculture, Mishra and Park (2005); Mishra et al. (2009) on use of internet on use of internet, Rahm and Huffman (1984) on reduced tillage, Roberts et al. (2004) on precision farming and Traore, *et al*. (1998) on on-farm adoption of conservation tillage. On the other hand, some authors have reported insignificant or negative effect of education on the rate of technology adoption (Grieshop *et al*., 1988; Khanna, 2001; Banerjee, *et al*., 2008; Samiee *et al*., 2009; Ishak & Afrizon, 2011). Studying the effect of education on technology adoption, Uematsu and Mishra (2010) reported a negative influence of formal education towards adopting genetically modified crops. Since the above empirical evidence have shown mixed results on the influence of education on the adoption of new technology, more studies need to be undertaken in order to come up with a more consistent result.

2.4.4 Age

Age of farmers is often hypothesized to have an impact upon adoption of INRM technology. Some studies found that farmers' age had a significant influence on the adoption of INRM technology (Kassie *et al.*, 2013; Zdenka and Michal *et al*., 2013). Rogers (1983) argued that younger and educated farmers are more inclined to adopt new practices. This was supported by Wasula (2000), who found that the age of a household head significantly influenced the adoption of INRM technology in Rongai and Njoro Divisions, Kenya. However studies by Ndiema (2002), found no relationship between ages and the adoption of INRM technology in Njoro Division, Kenya. Although age is assumed to be a determinant of adoption of new technology, it is not clear whether this is the case for INRM technology hence need for a study to understand this.

Older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate technology information than younger farmers (Mignouna et al, 2011; Kariyasa and Dewi 2011). On contrary age has been found to have a negative relationship with adoption of technology. This relationship is explained by Mauceri et al. (2005) and Adesina &Zinnah (1993) that as farmers grow older, there is an increase in risk aversion and a decreased interest in long term investment in the farm. On the other hand younger farmers are typically less risk-averse and are more willing to try new technology. For instance, Alexander and Van Mellor (2005) found that adoption of genetically modified maize increased with age for younger farmers as they gain experience and increase their stock of human capital but declines with age for those farmers closer to retirement. This clearly indicates that there is varied information on the role of age on the adoption of INRM technology and there is a dire need to establish the correct information.

2.4.5 Gender

Gender is likely to influence characteristics that are specific to various gender groups. Studies by Kamuru (1998), observed that gender is not a factor in the adoption of INRM technology but a factor in the adoption of specific technology. According to Wasula (2000), gender had no influence on the adoption of INRM technology in Nakuru district. This concurred with the findings of Ndiema (2002) where gender did not affect the adoption of improved wheat varieties in Nakuru District.

In Sub Saharan Africa, conventional methods of agricultural extension have traditionally tended to be geared towards men while ignoring women (Saito *et al.,* 1994). These authors noted that the bias against women is manifested in the delivery of the extension message itself. The message is mainly provided by male extension agents to mainly men with implicit assumption that it will "trickle down" to women. Extension messages tend to focus on activities of male farmers while ignoring the wide range of agricultural activities, responsibilities and constraints facing women farmers (Saito *et al.,* 1994). According to Saito *et al.,* (1994) discrimination against women in agricultural technology generation and dissemination inevitably affected women negatively, leads to inefficient use of resources (as women fail to adopt improved technology) and lower levels of agricultural production.

Previous research in Africa has documented women's lesser access and control to critical resources (land, cash and labor) often undermining their ability to mobilize labor needed to carry out labor-intensive INRM technology (Quisumbing *et al.,* 1995). These inequalities are caused by cultural conditions in many African societies which traditionally did not grant women secure entitlements to land and other property (Quisumbing *et al.,* 1995).

Gender issues in agricultural technology adoption have been investigated for a long time and most studies have reported mixed evidence regarding the different roles men and women play in technology adoption (Bonabana- Wabbi 2002). In analyzing the impact of gender on technology adoption, Morris and Doss (1999) found no significant association between gender and probability to adopt improved maize in Ghana. They concluded that technology adoption decisions depend primarily on access to resources, rather than on gender

Gender may affect technology adoption since the head of the household is the primary decision maker and men have more access to and control over vital production resources than women due to socio-cultural values and norms (Tesfaye *et al.*, 2001; Mesfin, 2005; Omonona *et al.*, 2006; Mignouna *et al*., 2011). For instance, a study by Obisesan (2014) on adoption of technology found that, gender had a significant and positive influence on adoption of improved cassava production in Nigeria. His result concurred with that of Lavison (2013) which indicated male farmers were more likely to adopt organic fertilizer unlike their female counterparts. Many previous studies reported that household's gender has positive effect on adoption in favor of males. For example, Techane (2002), in his studies on determinants of fertilizer adoption in Ethiopia found that male headed households were more likely to adopt fertilizer use than female headed households. Similarly, Wasula (2000) reported that gender differences among the farm households positively influenced adoption and intensity of adoption of fertilizer use at 5% significant level. They also further mentioned that being a male headed household increases probability of adoption by 5.9%. Gender is an important factor that influences technology adoption in SSA. This is because ownership and access to most resources and INRM technology in most cases favor men hence most women have no incentive to invest in INRM technology leading to low adoption. This builds a case for a study to establish the relationship between gender and adoption of INRM technology.

2.4.6 Farming Experience

Experience of the farmer is likely to have a range of influences on adoption of INRM technology. Experience will improve the farmers' skills in production operations. Higher skill increases the opportunity of not undertaking the traditional enterprise. Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of technology (Chilot, 1994). Farm experience was revealed to have significant and positive influence on the adoption of INRM technology by studies conducted by Adeola (2010) and Tosakana et al. (2010) but it was not found significant influence on the adoption of INRM technology in the studies of Rezvanfar et al. (2009) and Arellanes and Lee (2003) in Ethiopia. It is therefore important to establish the influence farming experience on the adoption of INRM technology.

2.4.7 Household Size

Household size is simply used as a measure of labor availability. It determines adoption process in that, a larger household have the capacity to relax the labor constraints required during introduction of new technology (Mignouna et al, 2011; Bonabana- Wabbi 2002). Besides, Ngombe et al. (2014) and De Souza Filho et al. (1999) revealed that farm labor was associated with the adoption of INRM technology.

The studies above have demonstrated that a majority of socio-economic factors have a positive influence on the adoption of INRM technology. However, some studies have contrary opinion and argue that some socio-economic factors have no relationship with the adoption of INRM technology. The studies therefore provide mixed results. Since the above empirical evidence have shown mixed results on the influence of socio-economic factors on the adoption of new technology, more study need to be done in order to come up with a more consistent result. The study therefore aimed at conducting an in-depth assessment into the influence of socio-economic factors on the adoption of INRM technology for concrete results.

2.5 Institutional Factors Affecting Technology Adoption

The effects of institutional factors on technology adoption INRM technology have been studied with different and varied results. Institutional factors in this study include land tenure, farm size, farm income, family size, access to extension services, and farmers' perception of the technology among others (Adams, 1982).

2.5.1 Land Tenure

Regarding land ownership, several studies did not find its influence on the adoption of INRM technology (Adeola, 2010; Arellanes and Lee, 2003; Ngombe *et al.*, 2014) while it was found to have significant and positive influence on the use of INRM technology in the study of Wasula (2000) in Njoro, Nakuru county. This is an indication that findings on the influence of land tenure on the adoption of INRM technology is varied hence there is a need for a study to establish the fact.

2.5.2 Access to Extension

Access to extension services has also been found to be a key aspect in technology adoption. Farmers are usually informed about the existence as well as the effective use and benefit of new technology through extension agents. Extension agent acts as a link between the innovators of the technology and users of that technology. This helps to reduce transaction cost incurred when passing the information on the new technology to a large heterogeneous population of farmers (Genius *et al*., 2010). Extension agents usually target specific farmers who are recognized as peers exerting a direct or indirect influence on the whole population of farmers in their respective areas (Genius *et al*., 2010).

Many authors have reported a positive relationship between extension services and technology adoption. A good example include; Adoption of Imazapyr-Resistant Maize Technology (IRM) by Mignouna *et al*. (2011); Factors determining technology adoption among Nepalese Karki and Siegfried (2004); Uaiene *et al*., 2009; Adoption of improved maize and land management in Uganda by Sserunkuuma (2005); adoption of modern agricultural technology in Ghana Akudugu *et al.* (2012) just to mention a few. This is because exposing farmers to information based upon innovation-diffusion theory is expected to stimulate adoption (Uaiene *et al*., 2009). In fact, the influence of extension agents can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technology (Yaron, Dinar & Voet, 1992); Bonabana- Wabbi 2002). This shows that there is a significant relationship between access to extension and adoption of INRM technology which calls for a study to confirm this.

Farmers who have frequent contact with the extension agents usually have higher adoption rates than those farmers who have less contact with extension staff. Thus the extent to which farmers make contacts with members of extension staff determines the adoption of recommended practices (Wilson & Gallup, 1955). INRM technology extension services are important for the adoption of INRM technology. Farmers require technical advice on the measures suitable for their farms. Herribera (1985) found out that the level of expertise manifested by farmers with intensive extension contact was consistently higher than that of other farmers in Ethiopia. However, this is in contrast with the findings of Wasula (2000), who found that the frequency of extension contact with farmers was not significant to the adoption of INRM technology in Njoro Division, Kenya. This implies that there is a variance in findings on the influence of access to extension and the adoption of INRM technology hence need for more studies to ascertain this.

In a study by Chitere (1985) and Rolling (1988) to establish the extent to which farmers adopt recommended practices, it was found that nearly all farmers in an area previously occupied by European settlers were knowledgeable about improved farming practices. It was also observed that farmers adopt improved farming practices largely because of early exposure to intensive extension education. Some studies indicated a positive relationship between contact with agricultural information sources and adoption of INRM technology (World Bank, 1993). This means that farmers who have been exposed to an intensive extension education may adopt INRM technology in contrast to farmers who are not exposed to extension campaigns.

Several studies revealed contact with extension, participation in training courses are effective factors on adoption of INRM technology (Kassie *et al.*, 2013; Okuthe, 2008; Timprasert *et al.*, 2014). Gecho and Punjabi (2011) found that adoption of improved maize technology was associated to farmers' participation in demonstration while Zegeye and Haileye (2001) ascertained that attendance of training contributed positively to farmers' decision to adopt INRM technology. Contact with extension is an input to improve farmers' performance (Asfaw *et al.*, 1997; Kedir, 1998) Asfaw *et al.*, 1997; Kedir, 1998). It equips farmers with new knowledge and skills, which help them to perform new practices properly. If a farmer has no skill and technical know-how about certain technology, he/she may have less probability of its adoption (Rahmeto, 2007).

The skills acquired through extension helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation. The major sources of agricultural information for farmers in SSA are extension agents. The frequency of visits or availability of extension services is a very important variable in the adoption of INRM technology and it is important to establish this.

2.5.3 Mass Media

Acquisition of information about a new technology is another factor that determines adoption of technology. It enables farmers to learn the existence as well as the effective use of technology and this facilitates its adoption. Farmers will only adopt the technology they are aware of or have heard about it. Access to information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell et al., 2001; Bonabana- Wabbi 2002). However access to information about a technology does not necessarily mean it will be adopted by all farmers. This simply implies that farmers may perceive the technology and subjectively evaluate it differently than scientists (Uaiene *et al*., 2009). Access to information may also result to dis-adoption of the technology. For instance, where experience within the general population about a specific technology is limited, more information induces negative attitudes towards its adoption, probably because more information exposes an even bigger information vacuum hence increasing the risk associated with it (Bonabana- Wabbi 2002). It is therefore important to ensure the information is reliable, consistent and accurate. Farmers need to know the existence of technology through mass media, its beneficial, and its usage for them to adopt it.

The adoption process of agricultural technology depends on access to information and on the willingness and ability of farmers to use information channels available to them (Tadesse, 2008). The role of information in decision-making process is to reduce risk and uncertainties to enable farmers to make the right decision on adoption of improved agricultural technology. Mass media play the greatest role in provision of information in the shortest possible time over large area of coverage (Rahmeto, 2007). Mass media therefore is expected to have a positive impact on the adoption of INRM technology. There is need to confirm or reject this.

2.5.4 Access to Credit

Access to credit has been reported to stimulate technology adoption (Mohamed & Temu, 2008). It is believed that access to credit promotes the adoption of risky technology through relaxation of the liquidity constraint as well as through the boosting of household's-risk bearing ability (Simtowe & Zeller, 2006). This is because with an option of borrowing, a household can do away with risk reducing but inefficient income diversification strategies and concentrate on more risky but efficient investments (Simtowe & Zeller, 2006). However access to credit has been found to be gender biased in some countries where female-headed households are discriminated by credit institutions, and as such they are unable to finance yield-raising technology, leading to low adoption rates (Muzari *et al*., 2013).

There is therefore need for policy makers to improve current smallholder credit systems to ensure that a wider spectrum of smallholders are able to have access to credit, more especially female-headed households (Mkandawire, 1993; Simtowe & Zeller, 2006). This may, in certain cases, necessitate designing credit packages that are tailored to meet the needs of specific target groups (Muzari *et al*., 2013). For instance in Kenya, the government has started a program that offer free interest loans to youths and women (UWEZO fund). This will help empower women and enable them to adopt agricultural technology hence enhancing economic growth.

Credit is important for the purchase of inputs that are vital for agricultural production. Because most small-scale farmers lack security, they usually have little access to credit and have to rely on other relatively expensive sources of capital (FAO, 2002). Alternative types of collateral for loans need to be identified (FAO, 1995a). Ascroft (1973) and Rolling (1988) found that 95% of the most progressive farmers had obtained loans as against 5% of the less progressive farmers. This showed that the market disadvantaged small, less educated and less influential farmers and therefore credit conditions suppressed the capacity to adopt INRM technology.

A survey in Mbeya on adoption of improved wheat technology established that fertilizer use was influenced by credit availability, farm size, extension, and hired labour (CIMMYT, 1999). Smallholders are always faced with problems of obtaining credit to improve their land because of lack of security that in most cases is placed on land (Islam, 1997). Whilst there is growing experience with micro-credit schemes, the majority of rural people do not have access to any such schemes. This proves that lack of credit facilities leads to low adoption of INRM technology hence need for further studies on the relationship between access to credit and adoption of INRM technology.

2.5.5 Access to Equipment and Inputs

Agricultural equipment and inputs are required to optimize yields and overcome labour shortages (FAO, 1986). However, farmers often do not have access to capital, equipment and inputs.

Studies have shown that disparity in access to inputs lead to differences in productivity to the detriment of small-scale farmers (Saito, Mekonnen & Spurling, 1994; FAO, 2002). Most INRM and productivity enhancing technology developed by agricultural research community assumes the type of farming system that purchases its inputs from off the farm and sells its outputs to commercial marketing channels. However most of the small scale farming systems, particularly in Africa, produce their inputs, and consume their own outputs (Rivera, 1987).

As observed by Ndiema (2002) poor input sources may also be another reason that suppresses the capacity to adopt an innovation. Although inputs from reputable source may appear quite rational to a farmer, social forces outside his control dictate his propensity to adopt the technology. The optimal effective INRM technology require inputs from reputable sources (Ndiema, 2002). Inputs therefore are a strong facilitator in enhancing effective access to INRM technology.

The cost of adopting agricultural technology has been found to be a constraint to technology adoption. For instance, the elimination of subsidies on prices of seed and fertilizers since the 1990s due to the World Bank-sponsored structural adjustment programs in sub-Saharan Africa has widened this constraint (Muzari *et al*., 2013). Previous studies on determinants of technology adoption have also reported high cost of technology as a hinderance to adoption. The study done by Makokha *et al*. (2001) on determinants of fertilizer and manure use in maize production in Kiambu county, Kenya reported high cost of labor and other inputs, unavailability of demanded packages and untimely delivery as the main constraints to fertilizer adoption. Cost of hired labor was also reported by Ouma *et al*. (2002) as one among other factors constraining adoption of fertilizer and hybrid seed in Embu county Kenya. Wekesa *et al.* (2003) when analyzing determinants of adoption of improved maize variety in coastal lowlands of Kenya found high cost and unavailability of seeds as one of factors responsible for low rate of adoption. The above literature implies that there is an association between access to inputs and adoption of INRM technology. This lays basis for a study to establish the role of access to inputs on the adoption of INRM technology to fill the knowledge gap.

2.5.6 Rural Infrastructure

Agricultural extension cannot be abstracted from the necessity for investment in rural infrastructure, including for information, communication, transport as well as education and training (IFAP, 1995). Without an effective rural infrastructure, farmers cannot obtain information they require for INRM technology and agricultural production and marketing. Without effective regional infrastructure, adoption of INRM technology, agricultural development and trade cannot take place. This requires better transport and telecommunication links between developing country cities and countryside. There is need for a study to establish the association between rural infrastructure and adoption of INRM technology since this information is lacking in most parts of Kenya.

2.5.7 Off-farm Income

Off farm income has been shown to have a positive impact on technology adoption. This is because off-farm income acts as an important strategy for overcoming credit constraints faced by the rural households in many developing countries (Reardon *et al*., 2007). Off-farm income is reported to act as a substitute for borrowed capital in rural economies where credit markets are either missing or dysfunctional (Ellis & Freeman, 2004; Diiro, 2013). According to Diiro (2013) off- farm income is expected to provide farmers with liquid capital for purchasing productivity enhancing inputs such as improved seed and fertilizers. For instance, her study when analyzing the impact of off-farm earnings on the intensity of adoption of improved maize varieties and the productivity of maize farming in Uganda, Diiro reported a significantly higher adoption intensity and expenditure on purchased inputs among households with off-farm income compared to their counterparts without off- farm income.

However not all studies have shown positive relationship between off-farm income and the adoption of improved techngies. Some studies on technology that are labor intensive have shown negative relationship between off-farm income and adoption. According to Goodwin and Mishra (2004) the pursuit of off-farm income by farmers may undermine their adoption of modern technology by reducing the amount of household labor allocated to farming enterprises.

Off-farm income from informal and formal non-agricultural employment proved quite important in fostering adoption of INRM technology (Wasula, 2000). Cash is essential in the hiring of labor for the construction and maintenance stover/trash lines or for planting agro forestry trees, as well as for purchase of inorganic fertilizer (Wasula, 2000). At existing productivity levels and production scales, the high-population-density small farm system of Western Kenya might not be generating sufficient investible surplus to remain self-sustaining in the absence of off farm income to invest in sustainable agricultural intensification, including INRM technology (Marenya *et al.,* 2003). It is therefore necessary to establish the relationship between off-farm income and the adoption of INRM technology for enhancing the adoption of these technology.

2.5.8 Access to Market

Markets are common centers both for producers, consumers and traders (Tadesse, 2007). Agricultural markets are characterized by many constraints e.g. poor infrastructure and price fluctuation among others (Reardon *et al*., 2000). The lack of market information represents a significant impediment to market access especially for smallholder producers and adoption of INRM technology. It substantially increases the cost of INRM technology, transaction costs and reduces market efficiency (Mwale, 1998). For any one crop, the marketing chain consists of multiple middlemen each taking a margin at every stage of this chain and eventually it is the smallholder farmer who bears the brunt of low income. The study conducted by Rahmeto (2007) and Taha (2007) on adoption of improved onion and haricot bean technology respectively has shown significant relationship to the nearest market. It is vital to establish the role of access to market on the adoption of INRM technology in order to improve on their adoption by small scale farmers.

2.5.9 Social Groups

Participation in social groups provides the opportunity and sharing of ideas and experiences through interpersonal and inter-farm visits. Social participation is important because it indicates extent of contact, which farmers have with organized groups and other public services and mass media (Blackburn *et al.,* 1982). It reflects the degree of contact beyond the farmers' reference groups and the potential for outside channels of direct influence. Farmers' involvement in social group activities integrates them into the social fabric of the community. This is achieved through farmers religious, social and political or self-help groups. They provide forum for improving dialogue among farmers, thereby providing opportunity for efficient ways of ascertaining consensus on opinion about the relevance of technology being presented to them (Norman *et al.*, 1989). According to Blackburn *et al.,* (1982), participation in social groups is important because it indicates the extent of contact, which farmers have with organized groups and other public services and mass media. Groups provide forum for improving dialogue among farmers, thereby providing opportunity for efficient ways of ascertaining consensus on opinion about the relevance of technology being presented to them (Norman *et al.*, 1989). The relationship between membership in social group and adoption is associated with interpersonal networking and exchanges between adaptors and non-adaptors of technology (Wasula, 2000). This enhances the ability of group members to adopt INRM technology.

Belonging to a social group enhances social capital allowing trust, idea and information exchange (Mignouna *et al.,* 2011). Farmers within a social group learn from each other the benefits and usage of a new technology. Uaiene *et al*. (2009) suggests that social network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other. Studying the effect of community based organization in adoption of corm-paired banana technology in Uganda, Katungi and Akankwasa (2010) found that farmers who participated more in community-based organizations were likely to engage in social learning about the technology hence raising their likelihood to adopt the technology. Although many researchers have reported a positive influence of social group on technology adoption, social groups may also have a negative impact on technology adoption especially where free-riding behavior exists.

Foster and Rosenzweig (1995) when studying adoption of Green Revolution technology in India found that learning externalities within social networks increased the profitability of adoption, but also farmers appeared to be freeriding on their neighbors' costly experimentation with the new technology. Bandiera and Rasul (2002) as cited by Hogset (2005) suggests that, learning externalities generate opposite effects, such that the more other people engage in experimentation with a new technology, the more beneficial it is to join in, but also the more beneficial it is to free-ride on the experimentation of others. As a result of these contradictory effects, Bandiera and Rasul (2002) propose an inverted U-shaped individual adoption curve, implying that network effects are positive at low rates of adoption, but negative at high rates of adoption. This implies that being a member of a social group can lead to enhanced adoption of INRM technology, necessitating further analysis to establish this fact.

The literature above has provided vital information on the influence of institutional factors on the adoption of INRM technology. These studies have presented mixed results as shown above. Others indicate that some institutional factors promote the adoption of INRM technology while others indicate that there is no association between institutional factors and adoption of INRM technology. Further, majority of the studies have been carried out on one single improved technology.

The lack of consistency in findings demonstrate the possible institutional factors specific technology responses to adoption and hence the need for further research into the influence of institutional factors on the adoption of INRM technology. Besides while some studies have illustrated positive effects, others have demonstrated that the effect can be both positive and negative and is technology dependent. The study therefore aimed at examining the influence of institutional factors on the adoption of INRM technology to clarify these issues.

2.6 Socio-Cultural Factors Influencing Technology Adoption

Socio-cultural factors are complex and focus on knowledge, beliefs, arts, morals, laws and customs and any other capacities and habits acquired by man as a member of a society. These factors are important because a member of the society needs to know them in order to participate in various activities (Tylor, 2006). Normally, in any society, the social issues are actions taken by individuals and have close interconnectedness with other people. The culture aspect of a society is concerned with questions of shared social meanings, that is, the various ways we make sense of the world. The meanings are generated through signs, most notably those of language (Cole, 2005). That is, culture is understood to be a fact of place. In so far as culture is a common whole way of life, its boundaries are largely locked into those of nationality and ethnicity (Barker, 2008). Cultures are not pure, authentic and locally bound. They are the synergic and hybridized products of interactions across space (Bhabha, 1994). Culture is the peoples' way of life. This refers to norms, rules and attitudes that govern the meaning of certain activities for individual and groups. They also may govern the organization of activities and behaviour of individuals in the course of participation in such groups (Ongugo, 1992). Activities that are designed around existing cultural and social structures, taking into consideration local customs, beliefs, values and even taboos, are socio-cultural. Farmers' adoption of INRM also vary with socio-cultural practices of the community and that adoption by an enforced policy frequently do not work (Young, 1989). Young (1989) argues that conservation is likely to be most effective where it is conducted with the active cooperation of farmers, in their perceived interests and integrate other measures of Agricultural improvements.

The extent of INRM technology and the involvement of the local farmers are directly related to the flexibility of the land tenure system (Adayoju, 1984). This shows that land tenure is crucial in the adoption of INRM technology by farmers (Binswanger, 1980). Land tenure refers to possession or holding of the rights associated with each parcel of land. Most farmers in Kenya find it unacceptable and unattractive to invest in tree planting on land which is not confirmed legally as theirs (Tengnas, 1994). Related to land tenure is also tree tenure. Farmers who do not own the land tend to feel they cannot possibly own the trees hence lack the need to plant them. In Vihiga district, Kenya, women insisted on the issue of sorting out tree ownership before being persuaded to plant trees (Ipara, 1992). In Kitui secure tree and land tenure and a relative freedom to harvest trees and sell products were found to be an incentive for farmers to adopt INRM technology (Makindi, 2002).

Certain traditional beliefs have also been found to be a factor in the adoption of INRM practices. In Kenya, among certain communities, women cannot plant trees because doing so is believed to be an act of ownership over land (Gichuki and Njoroge, 1989). In other communities, trees belong to men regardless of who plants them. In Western Kenya for example, there are distinct tree species for men and women (Kerkhof, 1992). Women are not allowed to plant certain tree species- it's believed if she does she becomes barren. Ipara (1992) noted that among communities that hold these beliefs and taboos, traditional land tenure and ownership rights are based on male patrilineage. Certain tree species are associated with certain beliefs and bad omen and therefore, should not be planted at all by community members even if they are beneficial in any way. It is further noted by Ipara (1992) that tree planting decisions in many communities is a domain of the male head of the household. However, the author also found out that female headed household had more land under trees than male headed households. This explains the role of women in society, which meant they get affected more in case of scarcity of forest resources (Mutoro, 1997). The study on community participation in wildlife conservation around Ol Donyo

Sabuk National Park Machakos District Kenya, by Lelo (1994) found out that women were more crucial stakeholders in environmental management and conservation than men. These studies clearly show that women cannot be ignored in the INRM activities and if put on forefront, women achieve more than men.Nyerere (1988) also observed that less than half of the population couldn't develop the Nation alone without women participation.

Culture is all the beliefs, attitudes and customs that people share with one another. Vanderwiele (2004) identified factors such as beliefs, attitudes and customs as significant problems to widespread adoption of Natural Resource Management technology in Liberia. Interwoven into the primary issues of vulnerability and assets in explaining respondent' and households' willingness and ability to adopt Natural Resource Management practices, is the function of cultural traditions, beliefs and attitude in Liberia (Vanderwiele, 2004).

Closely related to land tenure is the issue of tree tenure. Farmers who do not legally own land tend to feel they cannot possibly own the trees and hence see no need of planting them. Ipara (1992), noted that women in Vihiga District Kenya, called for sorting out of the issue of tree ownership before being persuaded to plant them. This is because men are believed to be the owners of land and even when women plant trees on such farms, men always have express rights to cut them down for their own benefits without consulting the women. This weakens women participation in agro forestry practices. In Kitui District Kenya, it was found out by Makindi (2002) that secure tree and land tenure and a relative freedom to harvest trees and sell products were an incentive for farmers to adopt tree planting. Land ownership rights and gender equity in the tree tenure system can greatly promote INRM technology

2.6.1 Influence of Cultural Beliefs and Power

The society comprise numerous kinds of social structure, such as firmly marked kin groups, political hierarchies and societies for diverse purposes: training adolescent boys and girls in appropriate behavior, protection against enemies or curing illnesses. Cultural beliefs have enormous influence in regulating the social and economic life of people (Vanderwiele, 2004). Vanderwiele (2004) hypothesized that the lack of progress in West African tribes in no small measure to their socialistic totality, pulling down and destroying the progressive individual, or sacrificing him deliberately to their conservative ideas. Inventive genius was not only suppressed, it was a taboo in such a system.

The general perception is that due to cultural beliefs, women may have little decision making authority in farming (Ani, 2002). Among the challenges faced by women are permission to attend training, household responsibilities, particularly young children; lack of tools; and poor health (Rahmeto, 2007). Understanding and addressing these issues is essential if women are to be included in any type of outreach or developmental program (Ani, 2002). Due to cultural traditions and social norms, women may have little decision making authority in farming and ownership of key resources (Ani, 2002).

A study by Vanderwiele (2004) in Liberia found that total effect of cultural beliefs in a Liberian community was low adoption of INRM technology. A person does not want to appear outwardly successful. Personal wealth is also opposed by rival poisoning. Any individual inclined to be too progressive for the community as a whole, especially if his family standing did not allow it, is doomed eventually to destruction by some jealous rival, or even by common consent of the other men leading to low adoption of INRM technology. These findings have parallels to a study of

Zimbabwean farmers. Perceptions of vulnerability to witchcraft as a result of showing too much interest in neighbors' fields provided a constraint to INRM technology adoption and diffusion of farmers learning from their neighbors (Meinzen, Adato, Haddad & Hazell, 2003). Researchers listed above have demonstrated the role of cultural belief on the adoption of INRM technology. It is therefore necessary to evaluate further in order to understand how cultural beliefs influence the decision to adopt INRM technology in order for us to build case that will influence the practice of adoption of INRM technology for sustainability.

Traditions are formed over generations because they are believed to be the best or most appropriate way of doing something (Dunn *et al*., 2000). Nyasimi *et al.* (2008) at Sauri Millennium Village document that development in Africa are bound to fail due to the strongly embedded and practiced socio–cultural beliefs, rites, and norms. In particular, the socio–cultural practices are hindering women's accessing critical resources and from becoming active participants in development activities. According to Khadiagala (2001), cultural practices may not only restrict implementation of development programs but can restrict participation as well. This study was to establish if tradition/customs influence participation of women in tree growing in the study area. There are traditional beliefs or taboos about cutting or planting tree species among the Luo (Diamond, 1992). Cohen and Atieno-Adhiambo (1989) assert that in Luo community, it is a taboo for a woman to plant finger euphorbia. Korir (2002) similarly notes that in Kakamega district of western Kenya, lack of women's participation in tree growing is perpetuated through various taboos and beliefs. Harris (1940) argues that cultural values influence not only the original adoption or rejection of an innovation but also how the new idea is to be inter-grated into the existing way of life. The District Forest Officer's, report for Bondo and Siaya districts portray that cultural practices prohibit women from actively participating in environmental conservation measures like tree growing is common (DFO, 2009).

2.6.2 Cultural Traditions and Social Norms

Vanderwiele (2004) found out that the INRM technology were completely unfamiliar to the Liberians. Respondents from all the four villages frequently made it clear that they did not understand INRM technology and the cultural traditions did not allow them to learn and adopt INRM technology. Because of cultural traditions some people were not convinced at first while others experienced neighbours who ridiculed them.

Certain traditional beliefs are found to be a factor in the farmers' adoption of Agro forestry technology. Among some communities in Kenya, women cannot plant trees because doing so may mean ownership of land (Gichuki and Njoroge, 1989). In some communities, trees belong to men regardless of who plants them. There are distinct men and women tree species in Western Kenya (Kerkhof, 1992). For example the traditional Fig trees are only planted by men and women are not even allowed to cut branches from such trees – "She will become barren", communities that hold these beliefs and taboos, traditional land tenure and ownership rights are based on male patronage (Ipara, 1992). Certain tree species are associated with bad omen and are not allowed to be planted at all by community members however beneficial they may be. It was also believed that tree planting decisions in many communities are the domain of male heads of household. These traditional beliefs and taboos in modern societies should be discarded so as farmers move with the changing Agricultural technology as they hold key to conservation of our Natural Resources. In some communities in Kenya, like Kikuyu's and among the Luo of South Nyanza, people placed curses on trees so as to protect them (Leakey, 1977). Among the

Luo of South Nyanza, there were traditional taboos about cutting or planting of certain tree species (Diamond, 1992).

2.6.3 Cosmopoliteness

Cosmo politeness is the degree of orientation of the respondents towards outside the social system to which he/she belongs. It is measured in terms of frequency of visits to outside village. Cosmo politeness is expected to have increase the rate and level of adoption since it does provide more chance of exposure to external information (Derbe, 2006). The literature has demonstrated the role of visit outside a farmer's social system on adoption of INRM technology. However, this literature is not very clear and exhaustive and as a result there is need for a study to interrogate this variable in to get concrete information on this.

2.6.4 Leadership Status

Usually participation in the community development activities is perceived as a willingness of a people to work together. The relationship between leadership and adoption of INRM technology is associated with interpersonal networking and exchanges between adopters and non-adopters of INRM technology (Tesfaye, 2006). Roling (1988) generalized that progressive farmers are more cosmopolites, eager for information; they are interested to extension advice; and have more homophiles with extension workers in that it is easy for them to communicate with each other. Farmers who have awareness about the existence of the INRM technology continue in the search of further knowledge about the package to evaluate its importance so as to take the further measures. . Farmers who have some position in any local organizations are more likely to be aware of new information and practices (Tadesse, 2008). Therefore, it was expected that there would be positive and significant relationship between leadership and the adoption of INRM technology. It is demonstrated above that, farmers who take up leadership roles in social groups are better adoptors of INRM technology. There is need for more data on the influence of leadership status on the adoption of INRM technology by cross checking the data by more than one method in order to make this finding thorough and convincing.

Farmers' decision to adopt INRM technology in preference to other alternative technology depends on complex factors. Farmers have subjective preference for INRM technology characteristics which could play a major role in technology adoption. Adoption or rejection of INRM technology by farmers may reflect rational decision making based on farmers' perceptions of the appropriateness or inappropriateness of the technology under investigation (Adesina and Zinnah, 1993).

Most of the work done on adoption behavior has focused only on independent variables. Duvel (1991) is perhaps the only researcher who did research on psychological aspects of technology transfer and adoption in South Africa. He developed a "revised program model" which offers a big scope for improvement in extension directly influenced by a new approach towards behavior change. In 1994 he also developed a model of technology transfer in agricultural development on the assumption that certain "intervening" variables influence adoption behavior directly, while the influence of more independent variables only shows its effect via the intervening variables. Further, he developed a model to determine adoption behavior and found that personal and environmental factors are the independent variables, while needs, knowledge and perception are the independent variables and adoption of practices and efficiency are the dependent variables. Non-adoption of INRM technology can be traced back to unwillingness or incapability related to aspects of perception and knowledge to adopt (Duvel, 1994).

Following Duvel (1975) and Habtemariam (2004) studies on the influence of intervening variables on adoption behavior and production efficiency in Ethiopia, adoption behaviours and production efficiency were hypothesized to be a function of personal and environmental factors, which in turn are divided into independent and intervening variables identified by Habtemariam, (2004). Empirical evidence provided by Duvel (1975) on the role of perception on behavior and behavior consequences supports the assumption that the influence of the independent variables becomes manifested in behavior via the intervening or mediating variables. Subsequent findings by Louw and Duvel (1975) have reaffirmed that the mediating function of perception together with needs knowledge.

Studies by Mahboubi *et al.,* (2005) and Stonehouse (1991) found perception to be a prerequisite to INRM technology adoption in Zarnin Gol watershed, Golostan Province, Iran. Rogers (2003) on the other hand states that perception of a technology leads to its adption or non-adoption. De Souza et *al.,* (1999) found that the adoption of INRM technology will increase as farmers have positive perception of negative effects of chemicals on health and environment in Espirito Santo, Brazil, while Hall *et al.,* (2009) revealed perceived importance of sustainable practices is significant influential factor on the adoption of INRM technology. Tosakana *et al.,* (2010) found that farmers' perceived yield risk and uncertainty was an important factor influencing the adoption of INRM technology in North West and Range region. Information sources play an important role in decision-making process to reduce risks and uncertainties to enable farm households to make right decision on the adoption of INRM technology in Metema, Woreda North, Gondar Zone, Ethiopia (Petros, 2010). Alonge and Martin (1995) showed that farmers' access to mass media (TV and Radio) was identified to relate with the adoption of INRM technology. However, in study's Ngombe *et al.*, (2014), radio was the factor that had no influence on the adoption of INRM technology in Zambia.

Roling (1988) generalized that progressive farmers are more cosmopolites, eager for information; they are interested in extension advice; and have more homophiles with extension workers in that it is easy for them to communicate with each other. Farmers, who have awareness about the existence of the new INRM technology, continue in the search of further knowledge about the package to evaluate its importance so as to take further measures.

Bagheri (2010) and Eric *et al*. (2013) developed a set of different sustainable index items related to conservation of the natural environment, farming management, profits, cultivation modes and problems of human and animal health to measure farmers' sustainable agricultural perception.

It is evident from these studies that socio-economic, socio-cultural and institutional factors influence the adoption of INRM technology in general. However, the studies have majorly concentrated on the large scale intensive agriculture practiced by the large scale farmers. The influence of these factors on small scale farmers has received little attention. Besides, no comprehensive study has been conducted in Ndhiwa to assess the level and influence of socio economic, socio cultural and institutional factors on the adoption of INRM technology.

Although previous studies have compiled many different indicators of farmers' sustainable agriculture perception, these indicators have focused on mostly sustainable concepts and practices of input uses, farming management, problems related to the environment and natural resources management. However, to measure farmers' perceptions towards INRM technology in general, it is vital to develop more indicators related to sustainable consumption, production, cooperatives and agricultural extension and to take into consideration some social-cultural issues surrounding INRM technology. Hence, the present study was conducted to bridge this gap.

The study of adoption of agricultural innovations has received considerable attention from social scientists. Focusing primarily on the initial stages of Green revolution technology adoption and diffusion, Feder, Just and Zilberman (1985) concluded all farm size, risk and uncertainty, human capital, labor availability, credit constraints, and tenure security were the most important factors determining adoption of decisions.

The more recent literature has added emphasis on learning and portfolio selection, but the core lessons from earlier decades largely remain (Feder and Umali, 1993; Rodgers, 2003; Mercer, 2004; Doss, 2006).Yet, some of the concerns raised by Feder *et al*. (1985), Mercer, (2004) and Doss (2006) on the need to study the socio-cultural determinants of adoption remain unanswered. The literature is based heavily on cross-sectional data that, in general, bias estimates of the parameters that describe adoption process if the data were collected during the process of technology diffusion (Besley and Case, 1993). Adoption is the decision to make full use of an idea, practice a new technology and is an important requirement in sustained increase in farm productivity and income. Past theories in research work on adoption and factors influencing adoption have been reviewed. In as much as adoption is important in accelerating agricultural development, utilization of INRM technology by farmers is, on the other hand still low. To ensure improvement in agricultural productivity, it is important that small-scale farmers utilize INRM technology in their farms.

However, a number of factors have constrained widespread use of these technology in most of the countries within Sub-Saharan Africa. Among these constraints are socio-cultural constraints (Anderson & Hazell, 1994; Byerlee, 1994; FAO, 1986; Karega, 2000; Ochola, 2002). Further, the studies above have focused on the technological, economics and policy issues. There is therefore need for providing a greater insight into INRM technology studies by focusing on the influence of socio-cultural factors on adoption of INRM technology. Additionally, limited information exists concerning the role of socio-cultural factors on the adoption of INRM technology, an issue which this study has assessed. Beside there are no studies that have been conducted to examine the role of socio-cultural factors on the adoption of INRM technology in Ndhiwa Sub County.

2.7 Theoretical Framework

This study was based on the diffusion and adoption theory propounded by Rogers (1995). Rodgers (1995) stated that the process of adoption consists of a series of actions and choices over time through which an individual evaluates a new innovation or idea and then decides whether to adopt or reject the practice. Rogers (1995), defined adoption process as "the mental process through which an individual passes through from first hearing about an innovation to final adoption. According to Rogers (1995), the innovation-decision theory of adoption has five steps. These steps include knowledge (awareness), persuasion (interest), decision/evaluation), implementation, (trial) and confirmation (adoption or use) (Rogers, 1995). The first stage is knowledge (awareness), where a person becomes aware of an innovation and has some idea of how it functions. The second step is persuasion – person forms a favorable or unfavorable attitude toward the innovation. Thirdly, decision/evaluation stage where a person engages in activities that lead to a choice to adopt or reject the innovation. Fourth stage is implementation stage where a person puts an innovation into use and last stage is confirmation (adoption/use) of the innovation. Here a person evaluates the results of an innovation-decision already made.

It is also striking according to this theory that, for most members of a social system, the innovation-decision depends heavily on the innovation-decisions of the other members of the system too. This follows diffusion studies that have demonstrated a mathematically consistent sigmoid pattern (the S-shaped curve) of over-time adoption for innovations that are perceived to be consequential by potential adopters, when the decisions to adopt are voluntary, and with attendant logically related propositions, qualifying this literature as a theory of social change (Green, Gottlieb, & Parcel, 1991). Many studies have shown a predictable over-time pattern when an innovation spreads, the now familiar S-shaped cumulative adoption curve (Green, Gottlieb, & Parcel, 1991). The “S” shape is due to the engagement of informal opinion leaders in talking about and modeling the innovation for others to hear about it. That is, after a small percentage of system members adopts an innovation, relatively rapid adoption by the remaining members occurs and then a period in which the holdouts finally adopt. In that case, factors that affect adoption of the innovation-decision include a cost-benefit analysis where the major obstacle is uncertainty (Rogers, 1995). The newness and unfamiliarity of an innovation infuse the cost-benefit analysis with a large dose of uncertainty. People will adopt an innovation if they believe that it will, all things considered, enhance their utility (Rogers, 1995). So, they must believe that the innovation must yield some relative advantage to the idea it supersedes (Rogers, 1995). Also, in consideration of costs, people determine to what degree the innovation would disrupt other functioning facets of their daily life. They will also consider whether that innovation is compatible with existing habits and values, its complexity.

For a successful innovation, the adopter distributions follow a bell-shaped curve, the derivative of the S-shaped diffusion curve, over time and approach normality (Rogers, 1995). Diffusion scholars divide this bell-shaped curve to characterize five categories of system member innovativeness, where innovativeness is defined as the degree to which an individual is relatively earlier in adopting new ideas than other members of a system. These groups are: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards (262). The personal characteristics and interaction of these groups illuminates the aforementioned domino effect. Innovators are venturesome types that enjoy being on the cutting edge (Rogers, 1995). The innovation’s possible benefits make it exciting; the innovators imagine the possibilities and are eager to give it a try. The implementation and confirmation stages of the innovators’ innovation-decisions are of particular value to the subsequent decisions of potential adopters. Early adopters use the data provided by the innovators' implementation and confirmation of the innovation to make their own adoption decisions. If the opinion leaders observe that the innovation has been effective for the innovators, then they will be encouraged to adopt. This group earns respect for its judicious, well-informed decision-making, and hence this group is where most opinion leaders in a social system reside. Since opinion leader adoption is a good indicator that an innovation is going to be adopted by many others, these conformity-loving members are encouraged to adopt (Rogers, 1995).

So a large subsection of the social system follows suit with the trusted opinion leaders. This is the fabled tipping point, where the rate of adoption rapidly increases. The domino effect continues as, even for those who are cautious or have particular qualms with the innovation, adoption becomes a necessity as the implementation of the innovation-decisions of earlier adopters result in social and/or economic benefit. Those who have not adopted lose status or economic viability, and this contextual pressure motivates adoption (Rogers, 1995). In other words, well-informed opinion leaders communicate their approval or disapproval of an innovation, based on the innovators' experiences, to the rest of the social system. The majority of the population will respond by rapidly adopting. Thus, analysis suggests that the spread of an innovation hinges on a surprisingly small point: namely, whether or not opinion leaders vouch for it (Rogers, 1995).

Below is a conceptual model for diffusion of innovation theory developed by Rogers (1995).

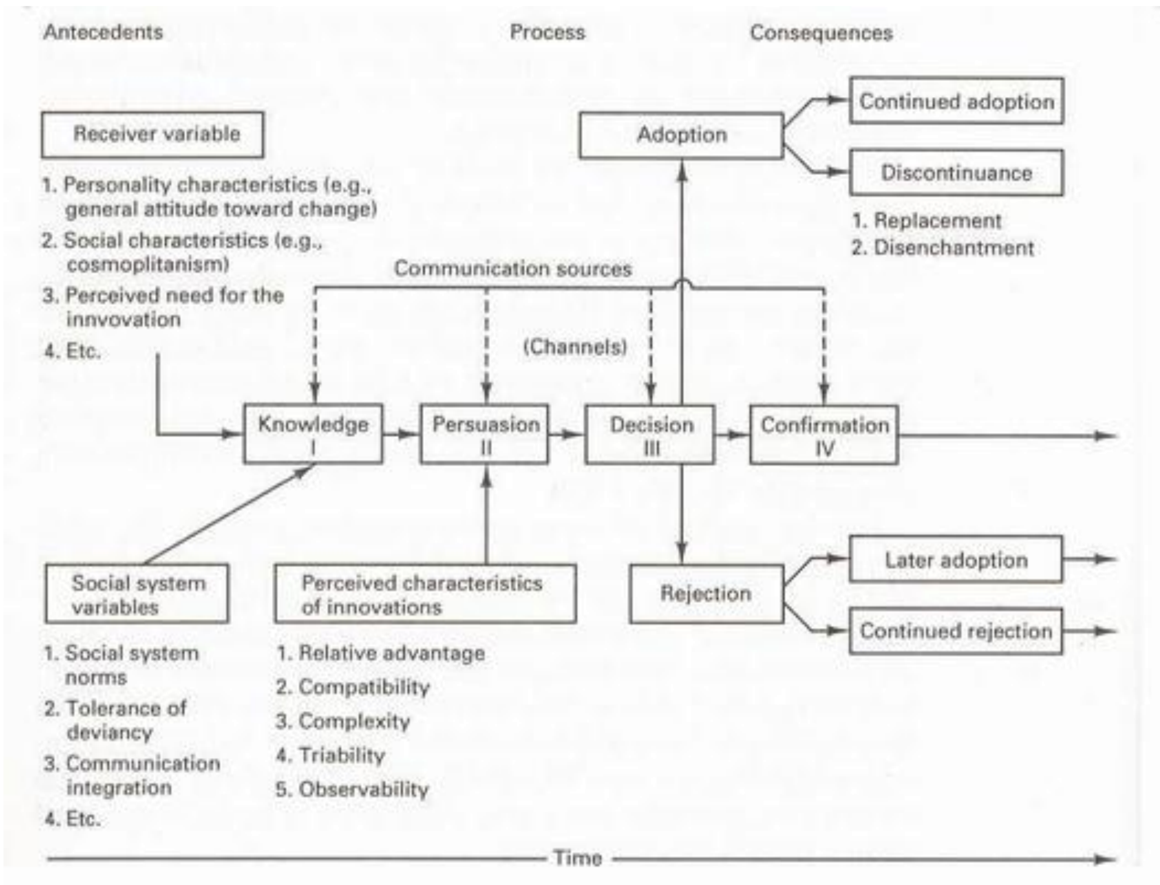

Figure 1:Diffusion of innovation model. Source: Rogers (1995).

This theory has been adopted by different scholars in trying to explain adoption of innovations. For example, a sociologist by the name Coughenour (1991) used it and developed a model with three sub-systems: innovative, practitioner and communicative. The first stage is innovative subsystems, which asks the question the essential question of from where the new ideas emerged. For example, sources of new ideas/innovations include universities, ‘think tanks’ research institutes, and industrial and governmental research laboratories. The cardinal duty of the innovative sub-system is to invent/discover innovations. The INRM technology were the efforts of the innovative subsystem (2) the second subsystem within the model is the communicative subsystem. This subsystem deals with the ways the technology are extended to the final users.

The communicative subsystem includes mass media, churches, sales organizations of commercial firms, governmental and private agencies charged with information spread, university extension service. Extension services have served as the model for most other change agencies. These change agencies extend innovation/technology using different media channels (3) the third subsystem in the model is the practitioner subsystem. These are those individuals, farmers, social organizations, engaged in the use of the innovations.

In adopting this theory, the potential adopters of an innovation must learn about the innovation, be persuaded as to the merits of the innovation, decide to adopt, implement the innovation, and confirm (reaffirm or reject) the decision to adopt the innovation. In this study, socio-economic, socio-cultural and institutional factors were regarded to be factors that affect the adoption of INRM technology among small scale farmers in Ndhiwa division. These factors are inherent in the extension context. This study focused on personal characteristics, socioeconomic, sociocultural and institutional factors upon which the speed of the adoption process is based. It shows that use of agricultural extension agent should at this stage intensify efforts to give the farmers more information and practical experiences in order to ensure adoption.

Rogers (1983, 2003) suggests five groups of important factors influence the rate of adoption of an innovation: perceived attributes of the innovation; type of innovation-decision; communication channels; the nature of the social system; and the extent of change agents" efforts in promoting the use of the innovation. The rate of adoption is measured as the number of individuals that adopt a technology within a specified period of time; the perceived attributes are said to explain between 49 and 87 percent of variance in the rate of adoption. The characteristics of innovation that determine its rate of adoption and might be used in analysing and predicting the rates of adoption include relative advantage, compatibility, complexity, trialability and observability (Rogers, 1983, 2003).

Rolling (1988) criticised this theory as being top-down‟ in orientation and therefore flawed by its lack of attention to farm variables in its packaging. Other shortcomings include: implementation problems especially in the case of choice of contact farmers (Moore, 1984), lack of research-extension linkage (Chapman, 1988), and poor linkage with farmers at field level (Dejene, 1989). The diffusion theory is also said to assume that all members of a social system are potential adopters. Although sometimes adoption may fail due to an innovation being a bad idea or it not fitting within the socio-economic context, this theory does not seem to assume so. The theory is also biased toward individualism and suggests that laggards and late innovators are responsible for their failure to adopt, yet the social systems have collective responsibilities (Kiptot, 2007). Equality gaps are also another criticism of this theory. Goss (1979) also criticised the classic diffusion model that it lacks applicability to a cross-cultural context.

Some of the critics of the diffusion model have indicated that adoption does not necessarily follow the suggested stages from awareness through to confirmation as it is not always necessary to trial a new innovation. However, the classic diffusion model does not postulate so but argues that the concept of innovation is subjective and that individual users reach particular stages at different times (Guerin & Guerin, 1994). And as we will see later, the findings of this study show that trialling of agroforestry technology is critical to increasing its adoption. Despite several criticisms, the diffusion of innovation theory forms the basis of most of the adoption and diffusion research, with parts of the theory still being applicable even with it being a linear top-down model that ignores farmer innovations and the complexity of the smallholder farmers‟

social circumstance. According to Guerin and Guerin (1994) this diffusion theory has made a valuable contribution and is still a useful model for the analysis of the adoption of agricultural innovations, and that other conceptual model of adoption, though varied in their details, do recognise the multistage decision process and act as complements to it. Malik (1991, quoted in Guerin & Guerin, 1994) argued that there is no single diffusion or extension model that can satisfy all situations in need of the technology transfer.

2.8 Conceptual Framework

The conceptual framework (figure 2.3) outlines the approach that was used to study the determinants of small scale farmers' decision to adopt INRM technology in the study area. The conceptual framework of this study is based on the principle of innovation-decision described by Rogers (1995). Rodgers (1995) stated that the process of adoption consists of a series of actions and choices over time through which an individual evaluates a new innovation or idea and then decides whether to adopt or reject the practice.

The farmers start from a stage of being aware or knowledgeable of new technology, to forming a positive or negative attitude towards and ultimately deciding whether to adopt the technology or not. According to Rodgers (1995), the technology is passed from its source to end users through a medium (mass media, opinion leaders, on-farm or on-station demonstrations, and farmers' field days) and its diffusion and adoption by users is dependent to a great extent on the personal attribute of the individual user, socio-economic, socio-cultural and institutional factors. This study sought to establish the factors that affect adoption of INRM technology among smallholder farmers in Ndhiwa division.

This study was guided by the conceptual framework in Figure 2.3. This study was limited to the socio-economic, socio-cultural and institutional factors which were independent variables and it was hypothesized that these variables have a positive and direct influence on the adoption of INRM technology among small scale farmers in Ndhiwa division. This relationship was moderated by factors such as government policies and community cooperation. Below is a conceptual framework illustrating, a model that defines the interrelations between socio economic characteristics, institutional and socio-cultural factors that were determinants of adoption of INRM technology.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a description of how the research was carried out. It consists of the research design, study location, population of the study, sample size and sampling procedures, instrumentation, validity, pilot testing and reliability, data collection procedures, data organization and analysis. Justifications of the designs are also provided in the respective sections.

3. 2 Research Design

The study employed a cross-sectional survey utilizing an *ex-post-facto* approach. This type of design involves data collection after a naturalistically occurring event (Casley & Kumar, 1992; Fraenkel & Wallen, 2000). This approach involves collection of information from a sample that has been drawn from a population that has received a natural treatment not designed by the researcher (Fraenkel & Wallen, 2000). This design was appropriate for the study since it facilitated the collection of information from a sample of a population in order to describe their characteristics as they relate to the “fact”. In this study, the characteristic of sampled small scale farmers was described and related to the adoption of INRM technology.

3.3 Study Area

The study was carried out in Ndhiwa division of Homa Bay County. It is one of the eight divisions of Homabay County in Western Kenya, located in the southwestern part of Kenya along Lake Victoria. It is located between longitude 34^0 12’ and 34^0 40’ east and latitudes 0^0 28’ and 0^0 40’ south (G.O.K, 2001). Ndhiwa division is inhabited mainly by the Luo community. The division has a population of approximately 115, 122, with an annual growth of 2.7%. The division has a mean density of 270 persons per square kilometer but the distribution within the division is influenced by the availability of road infrastructure and climate (G.O.K, 2011). The female/male sex ratio is 110/100 with the youth and labour force comprising 23% and 47.8%, while the dependency ratio is 100:110. The division is further sub divided into 4 wards and villages. It has a population of 43,231 small scale farmers (G.O.K, 2011). According to Jaetzold and Schmidt (1982), the division lies in lower midland (lm3) agro-ecological zone. It is situated at an altitude of 1200-1400m above sea level. The mean rainfall is about 1300mm received in a bimodal pattern. The division has three types of soils; black cotton soil (vertisol), silt loam, clay loam (luvisoils) with drainage being poor in some of the soils (Jaetzold & Schmidt, 1982).

Agriculture is the lifeline of the sub county's economy employing over 60% of the residents. Smallholder farming is the dominant land use practice accounting for about 86.8% of land cultivated in the division (G.O.K, 2011). The cultivation of food crops is dominated by maize, sorghum and bean production (G.O.K, 2011). The annual cereal production in 2011 was 41,520 tones as compared to its cereal demand of 41,819 tones.

The high use of firewood and charcoal contributes to deteriorating tree and vegetation cover exposing the soil to severe degradation especially on hill tops, a trend that threatens future livelihood activities. Agronomic and soil science research in recent years has shown that soil nutrient mining, monocroping and continuous cropping is widespread in Ndhiwa division, undermining the ability of many agrarian households to produce enough food supplies for subsistence (Smaling *et al.,* 1993; Van der Bosch *et al.,* 1998; Titonnel, 2003; FAO, 2004). For instance, Smaling *et al*. (1993) report average annual net mining of 42 Kg nitrogen/ha, 3Kg phosphorus/ha, and 29 Kg potassium/ha from the soils in this region.

Ndhiwa is one of the least densely populated divisions of Homabay County. The sub county has a primary school enrolment of rate of 75.5% and one of the least secondary school enrolments in Western Kenya at 15.7% (Kenya County Fact Sheet, 2011). The sub county has a 27.7% malnourishment rate of children less than 5 years of age. Additionally Ndhiwa division has an absolute poverty level of 77.49%, low agricultural production at an average of less than 4 bags per hectare of most cereals, land degradation, monthly mean income of Kshs. 3,852 and a 20.28% unemployment rate (KCFS, 2011). This therefore indicates that Ndhiwa division is one of the least developed sub counties in Western Kenya. This calls for a study on the determinants of the adoption of INRM technology that could restore soil fertility and improve agricultural productivity leading to food security and rural development in Ndhiwa division.

Farming is the main economic activity and is characterized by low input–low output farming. The farming system incorporates crops and livestock. Maize, sorghurm and beans are the most common crops. Recent studies found that soil nutrient balances are seriously in deficit (Jaetzold *et al.,* 2005). With declining soil fertility and buildup of *Striga hermonthica,* a parasitic weed of many cereals increases, the net effect has been the decline in production of crops and food shortages in the region, which has the potential to produce enough food for its increasing population. The yields of most crops are 2-5 times lower than the potential. The yield of maize, the staple food crop, for example, is generally less than one ton per hectare in a season compared to six tons per ha obtainable from on-farm research trials (Jaetzold *et al.,* 2005). Thus, enhancement of soil fertility is an impetus for improved agricultural productivity and poverty alleviation in Ndhiwa. The study area was selected because it experiences experience low soil fertility, high poverty levels and INRM technology was introduced in the division. In contrast, divisions differ in agricultural potential, farming systems, population densities and culture.

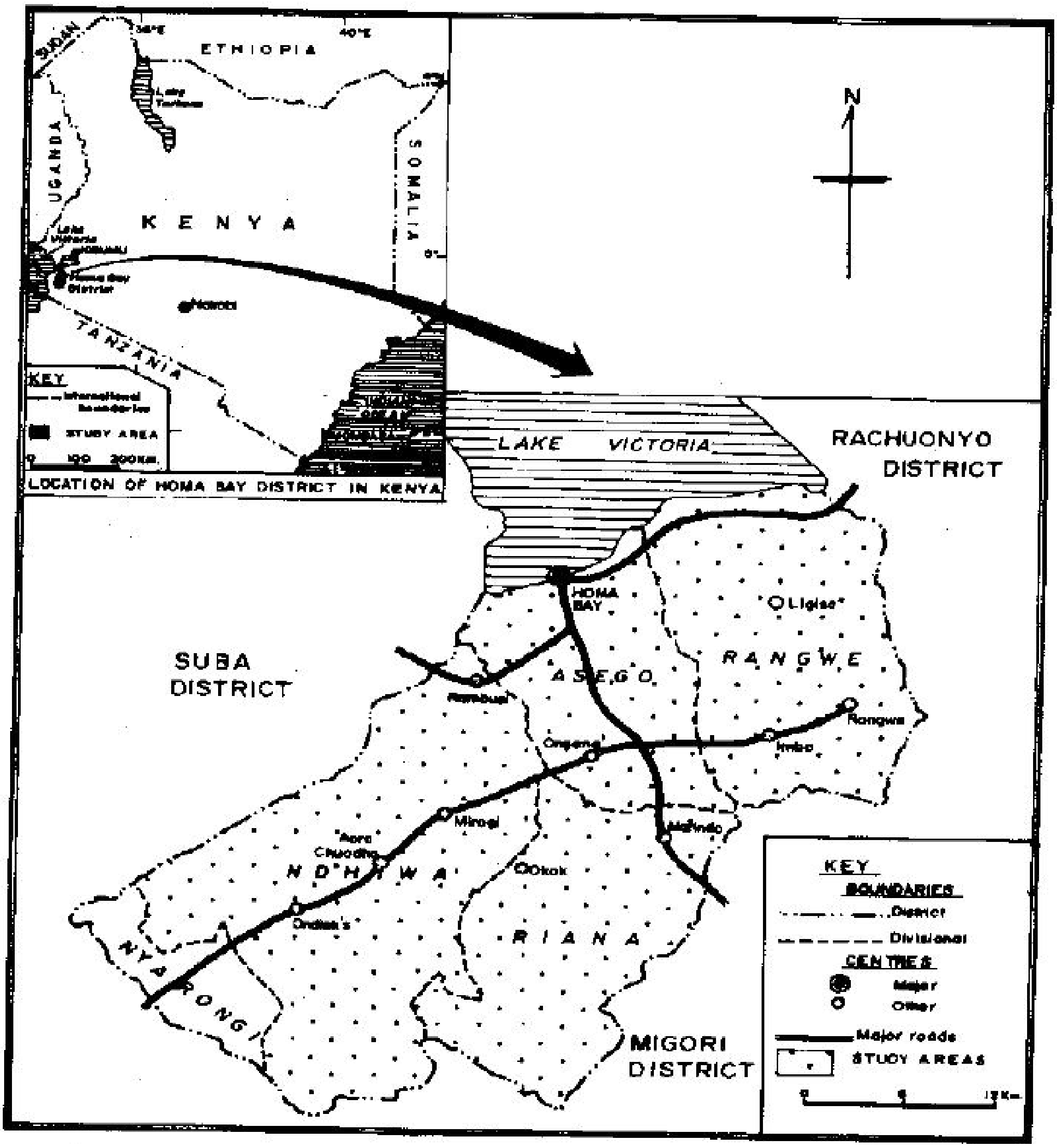

Figure 3.1 Location map of the study area

Figure 3.2: Location map of the study area

3.4 Study Population

The study population was 43,231 small scale farmer's in Ndhiwa division (G.O.K, 2014). The small scale farmers were selected as the basis for the study because they act as units of both production and consumption of natural resources. Key informants to supplement the information were also identified from the Ministry of Agriculture and opinion leaders (Sub County administrator, chiefs, assistant chiefs and Members of County Assemblies) in the Sub County.

3.5 Sample Size and Sampling Procedure

The sample was obtained from a list of 43,231 small scale farmers households obtained from Ndhiwa Sub County Development Office. The sample size was derived from the study population using the coefficient of variation (Nassiuma, 2000). This is because for most surveys or experiments, a coefficient variation of at most 30% is usually acceptable. The study took a coefficient variation of 21% and a standard error of 0.02. The formula given by Nassiuma (2000) is;

$$n = \frac{NC^2}{C^2 + (N-1)\, e^2}$$

Where n =sample

N = population

C= covariance

e = standard error

The number of households for Ndhiwa division was;

$$n = \frac{43231 \times (21\%)^2}{(21\%)^2 + (43231)\,(0.02)^2}$$

=220 households

The four locations of the small scale farmers households was the criterion for stratified proportionate random sampling. All the small scale farmers households in the four locations were purposively sampled to enable random selection of households to be included in the study. Systematic random sampling procedure was then applied to select the number of households in each stratum (Table 3.1). Purposive sampling technique based on the progressiveness of farmers was applied to identify 40 farmers to participate in the focus group discussion. Saturated sampling technique was used to select the 40 farmers to participate in the FGDs. A total of 40 small scale farmers were selected to participate in the four FGDs.

From each location, two categories of target group, viz the small scale farmers households and key informants were targeted. Among the key informants target category, one Sub County Agriculture Extension Officer, five subject matter specialists from Ndhiwa Sub County and one ward Agricultural Extension Officer from each ward gave a total of seventeen key informants. From the second category of key informants (1 divional administrator, 4 chiefs, 12 assistant chiefs and 4 MCA) were purposively selected yielding twenty key informants. They supplemented the information from the small scale farmers. The entire sampling matrix yielded a total sample size of 297 for the proposed study.

Table 3.1: Sampling by location in Ndhiwa Division, Homa Bay County.

Sampling Unit	Farmers	%	Sample
North Kanyamwa	9880	23	50
South Kanyamwa	12700	30	65
Central Kanyamwa	8700	20	45
West Kanyamwa	11751	27	60
Total	43031	100	220

3.6 Data Collection Methods

The study involved use of mixed methodology where both qualitative and quantitative data collection techniques were used. This ensured that data was cross checked to make it thorough and convincing. The data collection methods included;

3.6.1 Questionnaires

Questionnaires were administered to the first sub-category (220 small scale farmers) selected for the study. Questionnaires were considered ideal because of the ease of administration and scoring of the instrument besides the results being readily analyzed as stated by Ary, Jacobs & Razarieh, (1979) and FAO, (1990c). The items on the questionnaire were developed on the basis of the objectives of the study. The questionnaire captured data on the socio-demographic characteristics of the respondents, the degree of adoption of INRM technology, socio-economic determinants of the adoption of INRM technology, socio-cultural determinants of the adoption of INRM technology and the institutional determinants of the adoption of INRM technology.

3.6.2 Key Informant Interviews (KII)

Key Informant Interviews with relevant items was developed for the 37 key informants. The key informant interview was considered appropriate for extension officers from the Ministry of Agriculture and opinion leaders because they had varied literacy levels. Thus the face to face interview was used to obtain in-depth information from the key informants regarding their opinion on the determinants of the adoption of improved NRM practices in Ndhiwa division.

3.6.3 Focus Group Discussion

Focus group discussion (FGD) guideline was developed for the 40 small scale farmers who were purposively selected based on progressiveness and gender. A total of four FGDs were held. FGDs were important in obtaining information that could not be easily obtained through face-to-face interview or questionnaire. For this method, forty small scale farmers were brought together in four groups each comprising of four women, three men and for youths to discuss the topic. A guideline to aid discussion was prepared beforehand and a range of aspects of the topic will be explored. Brainstorming techniques were used to explore the topic.

3.6.4 Validity

The questionnaire was tested in order to check its content, construct and face validity. Content validity was to ensure that the instrument contained was an adequate sample of the domain of content it is supposed to represent. Face validity delt with format of the instrument and included aspects like clarity of printing, font size and type, adequacy of work space, and appropriateness of language. Construct validity determined the nature of psychological construct or characteristics being measured by the instrument. Experts in research, supervisors and peers from the department of sociology and anthropology, Maseno University helped in the review to ensure that the instrument accurately measured the variables it intended to measure in the study.

3.6.5 Reliability

According to Frankel and Wallen (2000), reliability refers to the consistency of the scores obtained and how consistent they are for each other individual from one administration to another and from one set of items to another, and also from one set of times to another. The instrument was pre-tested with a sample of 20 households similar to the study area. This was done in the neighboring sub-county, Rongo that has similar characteristics to the study area. The number 20 was chosen for pre-test because according to Kathuri and Pals (1993) it is the smallest number that can yield meaningful results on data analysis in a survey research. The results of the pilot-test indicated a reliability coefficient of 0.7 for the whole instrument using the cronbach's alpha coefficient. More items were added into the questionnaire to improve its reliability.

3.7 Data Analysis

All the data collected from the study was analyzed in an ongoing process. Quantitative data was processed, coded and analyzed using Computer Statistical package for Social Sciences (S.P.S.S version 13). For objective one, the results were presented by use of descriptive statistics, namely percentages and frequencies. For hypothesis 1, chi-square and ANOVA was used to determine the relationship between independent variables and dependent variable. Chi-square was used to determine the relationship between independent variables and dependent variable for hypothesis 2 and 3. Qualitative data was transcribed and subsequently, themes and sub-themes derived. The themes and subthemes were then presented as they emerged by summarizing the findings using appropriate verbatim quotes.

3.8 Ethical Consideration

Upon receiving authority letter from Graduate School of Maseno University, a research permit that allows this research to take place was sought from the Kenya National Council for Science and Technology. The research was conducted in accordance with the standard research ethics. Informed consent was sought prior to data collection. Anonymity and confidentiality was also upheld. An appointment for administration of questionnaires to the respondents was prepared with the assistance of the village headmen. The principal researcher guided and supervised the fieldwork during data collection. The instruments were then administered to household heads to collect the required data in face-to-face interview and their responses recorded accordingly.

3.9 Definition of Variables and Hypothesis

Dependent variable: The dependent variable in this study is the level of adoption which indicates intensity of adoption of INRM technology. Level of adoption in this case is a continuous dependent variable. Intensity of adoption refers to adoption level indicating level of farmers' use of INRM technology.

Independent (explanatory) variables: The independent variables of importance in this study are those variables which are thought to have influence on level of adoption of INRM technology. These include socio-economic, institutional and sociocultural variables.

These explanatory variables are defined as follows:

Mass media exposure: Mass media plays an important role in the adoption of agricultural technology. Access here is defined as an ownership of any of the two mass media. A person who has an access to radio and television will be given a value of 1 and similarly the one who has no access to either of the two will be given a value of 0. Access to radio and television is expected to have positive influence on the adoption and intensity of adoption of INRM technology.

Access to credit: Access to credit enables a farmer to adopt the technology which otherwise may not have been affordable for him. It is a dummy variable, which takes the value 1if the farm household uses credit and 0 otherwise. Use of credit will influence the adoption of INRM technology positively (Kidane, 2001).

Access to market: Access to market was hypothesized to be positively related to the probability of adoption of innovation. If the household is located near a market, they tend to buy improved agricultural inputs and they can have easy access to sell their product in the market. Therefore, the variable was treated as a dummy variable in that if the household has access to market it was coded 1 and 0 otherwise. As market distance increases adoption and intensity of adoption was expected to decrease (Dereje, 2006) and (Rahimeto, 2007)

Contact with extension agent: This refers to the number of contacts a farmer had with extension agent to take advice in the last cropping season. Therefore extension contact is hypothesized to have a positive influence on farmers' adoption of INRM technology. It is believed that frequent contacts will enhance the exposure of farmers about INRM technology (Abrhaley, 2007) and (Kidane, 2001).

Farmer's age: Famers age and adoption of technology are believed to be associated. As farmer's age increase, it was expected that the farmer will become conservative. Therefore it is hypothesized that farmers' age and adoption are expected to relate negatively. As a farmer's age increases, probability of adoption is expected to decrease, Dereje (2006) and Rahmeto (2006).

Farming experience: Measured in number of years since a respondent started farming on his own. Experience of the farmer is likely to have a range of influences on adoption. Experience will improve the farmers' skill in production operations. Higher skill increases the opportunity of not undertaking the traditional enterprise. Farmers with higher experience appear to have often full information and better knowledge and able to evaluate the advantage of the technology, (Chilot, 1994).

Sex of the farmer: Nominal variable used as dummy (1 if male, 0 female). Gender difference is found to be one of the factors influencing adoption of new technology. Due to many socio-cultural values and norms, male have freedom of mobility and participation in different extension programs and consequently have greater access to information. Therefore, it is hypothesized that male farmers are more likely to adopt INRM technology (Taha, 2007) and (Mesfin, 2005).

Household head education level: This represents the level of reading and writing and formal schooling attended by the household head. It is expected that educated household head can make better decision to adopt INRM technology than non-educated ones. Here, education extends from read and write to attending regular school education. In this study, this variable was treated as a dummy variable and was coded if the household head can read and write as well as attend the regular school education as 1 and 0, otherwise. Adoption is expected to correlate positively as education increase (Girmachew, 2005) and (Derje, 2006).

Cosmo politeness: Is the degree of orientation of the respondents towards the outside the social system to which he/she belongs. It is measured in terms of frequency of visits to outside the village. Cosmo politeness is expected to have positive relationship with the dependent variable since it provides more chance of exposure to external information, (Derbe, 2006).

Labor availability: Farmers who have access to labor are expected to adopt innovation more than those who lack labor accessibility since improved technology required more labor. The variable has been treated as continuous variable measured by man equivalent of the family labor. As labor accessibility increase, adoption is expected to increase and correlate positively, (Birhanu, 2002) and Endrias, 2003).

Farm income: Households that have more farm income are likely to adopt more innovation than those who have less income because farmers with more farm income have better opportunity for credit. In this study it was assumed that farm income and adoption would be related positively. As farm income increases, adoption of INRM technology is expected to increase and correlate positively, (Birhanu, 2002) and (Endrias, 2003).

Off-farm income: Off-farm income increases the income of the household and develops the capacity to invest in technology adoption. It is a dummy variable that takes a value of 1 if the farm household members participate in off-farm activities and 0 otherwise. Participation in off-farm activities will be expected to positively influence farmers adoption decision (Dereje, 2006) and (Rahimeto, 2007).

Participation in cooperative society: Cooperative serves as an important source of credit and input. Due to this, a farmer who is a member of cooperative society has more chance to get credit for farm inputs. It is a dummy variable which takes value 1 if a farmer participates and 0 otherwise. Therefore, being a member of cooperative society will expected to have positive and significant relationship with adoption of INRM technology, (Taha, 2007).

Leadership status of the respondent: Farmers who have experience of leadership and better social status are more likely to adopt INRM technology than others who do not have such experiences. The variable was coded as 1 if the farmer has leadership qualities and experience and 0 otherwise. Therefore it was assumed that such experience and exposure would increase the adoption of INRM technology positively, (Dereje, 2005).

Participation in field days: It is measured by the number of times the farmer has participated in the field das in the last three years. Participation in field days is expected to positively influence farmers' adoption level of INRM technology, (Edlu, 2006).

Farm size: It refers by the size of land owned by a farmer and is measured in hectare. A farmer who has relatively large plot of land can rent part of his land to run his crop production activities. Therefore, the size of land will positively affect the level of adoption of INRM technology, (Dereje, 2006).

3.2 :Hypotheses

Hypotheses	**Independent Variable**	**Dependent Variable**	**Method of Analysis**
Ho1: Socioeconomic factors do not significantly influence the adoption of INRM technology in Ndhiwa division	Farmers Age	Level of adoption of INRM technology	One way ANOVA
	Gender	Level of adoption of INRM technology	Chi-square
	Level of education	Level of adoption of INRM technology	Chi-square
	Gross monthly farm income	Level of adoption of INRM technology	One way ANOVA
	Farm Size	Level of adoption of INRM technology	One way ANOVA
	Household size	Level of adoption of INRM technology	One way ANOVA
	Off-farm income	Level of adoption of INRM technology	Chi-square
	Farming experience	Level of adoption of INRM technology	One way ANOVA
Ho2: Institutional factors do not significantly influence the adoption of INRM technology in Ndhiwa division	Land tenure	Level of adoption of INRM technology	Chi-square
	Access to credit	Level of adoption of INRM technology	Chi-square
	Access to quality inputs	Level of adoption of INRM technology	Chi-square
	Access to market	Level of adoption of INRM technology	Chi-square
	Membership in social groups	Level of adoption of INRM technology	Chi-square
	Farmers contact with extension	Level of adoption of INRM technology	Chi-square
	Participation in extension events	Level of adoption of INRM technology	Chi-square
	Exposure to mass media	Level of adoption of INRM technology	Chi-square
	Interaction with governmental, non-governmental, Cooperatives and CBOs	Level of adoption of INRM technology	Chi-square

Ho_3: Sociocultural factors do not significantly influence the adoption of INRM technology in Ndhiwa division	Cultural beliefs	Level of adoption of INRM technology	Chi-square
	Cultural traditions and social norms	Level of adoption of INRM technology	Chi-square
	Cospomoliteness	Level of adoption of INRM technology	Chi-square
	Leadership status	Level of adoption of INRM technology	Chi-square

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the study in relation to each objective, research question and hypothesis. The chapter begins with a presentation of the general characteristics of the respondents followed by the adoption level then the objectives and hypotheses, and finally a summary of results. The results of each objective are discussed first and then immediately followed by the related hypothesis.

4.2 The Level of Adoption of Integrated Natural Resource Management Technology

This part presents the analysis of results based the first objective of the study. This was; to determine the level of adoption of INRM technology among small holder farmers in Ndhiwa Division, Homa Bay County, Kenya. The INRM technology were based on use of inorganic fertilizer and manure, agro forestry and stover lines.

The results obtained indicated that out of the 220 (100%) respondents 18 (8.2%) farmers used inorganic fertilizer, 55 (25.0%) farmers, used manure, 22 (10.0%) farmers practiced agro forestry and 10 (4.5%) farmers had stover lines in their farms. Farmers who had adopted at least one of the four INRM technology were 47.7% (105). On the other hand, the remaining 115 (52.3%) had not adopted any of these technology. According to Table 4.1 below, it was noted that out of the four INRM technology studied, it was only the use of manure that could be judged as the most adopted by the respondents, where (25%) of the respondents had employed the practice. Table 4.1 presents results of how farmers adopted INRM technology.

Table 4.1 Adoption rate of INRM technology

Technology	Frequency	Percentage
Manure Use	55	25.0
Stover lines	10	4.5
Agro forestry	22	10.0
Fertilizer Use	18	8.2
Non adopters	115	52.3
Total	220	100

This shows that the adoption of INRM technology in Ndhiwa division is low. It was noted that the low adoption of INRM technology was attributed to non-availability of INRM technology and affordability on the part of the respondents due to high cost. This situation was also observed by Wasula (2000) in his study on the influence of Socio-economic factors on the adoption of agro forestry related technology in Njoro and Rongai Divisions, Kenya.

FGD results from farmers also indicated that some people are aware of the technology like fertilizer and agro forestry but such technology are priced out of their reach. Even in relatively better off regions only a few participants said they use fertilizer and agro forestry. In some cases, some of the FGD participants expressed awareness of the INRM technology but cited lack of knowledge on whether such technology are affordable or easily accessible. During FGD with farmers, it was noted that some of the discussants were aware and interested to use INRM technology, but not all did. One male discussant indicated that,

> "Even though we are aware of the benefits of manure from farm animals and interested in using the manure, it is not always available and when it became available, it was limited in quantity and expensive and consequently, it would not be within the reach of most poor rural farmers. The use of fertilizer is also known to all (100%) of us but only a few of us have eventually adopted fertilizer use. None of us use fertilizer and stover lines in our farms while only a few of us practice agroforestry". "We long to use fertilizer but we cannot afford". The use of stover lines in the farms is impossible due to its additional labor and time requirement".

The farmers who had adopted manure from animal waste attributed this to the need to improve on the productivity of their farms. They also indicated that they buy the manure from those who own cows, sheep, goats and chicken and in some cases from neighboring divisions. During FGDs one female farmer also pointed out that;

> "Use of stover lines in the farms is impossible due to its additional labor and time requirement. The cost of fertilizer is very high and hence low adoption ". We are ready and willing to adopt INRM technology but we cant afford them. Those who can afford can only buy very little fertilizer because of high cost of the fertilizer."

Majority of Key informants from the sampled institutions cited the rising cost of fertilizer and tree seedlings as a major budgetary constraint. *"Everything is going up in price, even fertilizer and tree seedlings are expensive these days".* Similarly, majority of key informants from the sampled institutions cited additional labor and time requirement for use of stover lines in the farms to be a hindrance to its adoption. The few adoptors stressed on the need to conserve soil and improve productivity even though the technology was expensive.

This indicates that there was low adoption rates for INRM technology. All the practices as a complete package were adopted by only 8.2% of the respondents. Further analysis revealed that in all the INRM technology studied, the respondents were more aware, interested and tried them but did not adopt them. This proves that awareness of INRM technology, interest in it, and even trial do not automatically lead to adoption. This means that there could be other factors that interfere with adoption of these technology. Additionally, the data indicated that there was low adoption of INRM technology even though the technology had been in existence in Ndhiwa division for a long time.

Farmer's interest in adopting INRM technology may be constrained by inadequate information about that INRM technology, which may in part be caused by inability of the extension personnel to reach the farmers. This was noted to have hampered the adoption of INRM technology. It has been reported that most farmers stick to old INRM technology as a result of economic inability on the part of the farmers to afford the cost of innovations, risk involved, ignorance of existence of innovations and their attitude (Wasula, 2000).This was also noted in this study in Ndhiwa division. The low adoption of some of INRM technology could be as a result of high prices, relative scarcity, and poor presentation of the technology to farmers, unavailability of the technology and inability of extension agents to facilitate their adoption as was also observed by Wasula (2000) in his study on adoption of agroforestry related technology in Njoro and Rongai Division, Kenya. This findings agree with the innovation –decision theory of adoption which describes vividly the processes through which a farmer undergoes before finally adopting any technology. The concept of individual differences makes it possible that individual contact farmers do not adopt technology at the same time. In this case farmer farmers characteristics influences adoption of INRM technology.

4.3 Socio-economic Characteristics

In this study two hundred and twenty farmers were selected from the Ndhiwa division. The farmers were selected from the four wards in the division. The farmers were asked to respond to a set of questions on the socio-economic factors that influence the adoption of INRM technology. The factors included gender, age, level of education, size of household, income, farm size and off-farm income.

4.3.1 Age Distribution of Farmers

The farmers were asked to indicate the category of their age, 43% of the respondents in the adopters category indicated that they were between the ages of 31-40 years while 48% of the non-adopters were in this age category. Table 4.2 presents the frequencies and percentages of age group of the farmers interviewed.

Table 4.2: Age distribution of the farmers

Age group	Adopters (n=105)	Non-adopters (n=115)
15 -20 years	4 (3.8%)	2(1.7%)
21-30	20(19%)	30(26%)
31-40	45(43%)	55(48%)
41-50	28(26.6%)	20(17.4%)
51-50 years	8(7.6%)	8(7%)
Total	105(100%)	115(100%)
Mean	35.5	
SD	32.2	
F Value	0.384 NS	
P Value	0.765	

As shown in Table 4.2 above, forty five out of one hundred and five adopters (43%) interviewed indicated that they were between the ages of 31-40 years. The average total age of respondents was, 35.5 years with the standard deviation of 32.2. The maximum age of the respondents was 60 years while the minimum age was 20 years. The results revealed that a majority of the adopters were between the ages of 31-40. This is a prime age when the farmers are very active and ready to risk by adopting technology delivered to them. According to a key informant, the young and energetic were highly involved in INRM within the study areas. He added that the young were flexible, more likely to be dynamic and willing to take risks associated with farming with hope of improving their income levels. A 40 year old female discussant during FGDs also narrated that:

> "Young people are able to burn charcoal and make firewood which they sell to households in the market centers and ; one sack goes for Ksh 1200 and a donkey carry's four sacks. They have the energy to go for one trip and get Ksh 2400 shillings by midday which they can use to buy inputs and thus promote the adoption of INRM technology and their households food security. This is because woodfuel is a basic need and customers are always available".

A 65 year old male discussant indicated:

> "The way young people cultivate their parcels of land is different from the way the elderly do. They dig deep in the soils and are even able to push the plough deep and thus the land is well tilled. During planting, the seeds go deeper and take longer to experience the low rainfall compared to those planted on shallow ground and thus the harvest is also higher".

One 76 years old female household head narrated that:

> "My son and his wife died four years ago when their two children were in upper primary school. None of my other children took them in and therefore I took them in. They are now in high school and look up to me to till the land and provide food for them. Even though my back is painful, I have to go to the farm because these children have to eat when they come home. However, I don't manage to produce much since it's impossible to leave the house sometimes due to my arthritic legs and hence I cant afford inputs".

This narration demonstrate that dependants following the demise of parents due to HIV and other diseases/ causes increase the burden to provide food by the elderly. This influences the adoption of INRM technology as resources to hire labour to work the land are few and the physical ability of the elderly to work in the farms is also low.

One way ANOVA analysis was run to check whether there is a significant mean difference in age between the adaptors and non-adaptors. The result of F-test showed that there was no significant mean difference (F=0.384, P=0.765) among adoption categories implying the absence of significant relationship between age and adoption of INRM technology (Table 4.2). This therefore rejects the theory that there is significant mean difference in the age of adoptors of INRM technology in Ndhiwa division, Kenya. The studies by Dereje (2006) and Abrhaley (2007) on assessment of farmer's evaluation criteria and adoption of improved bread wheat varieties in Akaki, Ethiopia and farmer's perception and adoption of integrated striga management technology in Tahtay adiabo woreda, Ethiopia respectively also reported absence of significant relationship between age and adoption of new technology.

Age is one of the demographic factors that is useful to describe households and provide indication about the age structure of the sample and the population. In tradition societies, age serves as an important indicator of the individual's position in the society, older farmers will be in a position to experience much with their traditional farming practices, with old age a farmer become more risk averse to new technology and is expected to be less responsive to newly introduced agricultural technology (Rahmeto, 2007).

The role of age in explaining technology adoption is somewhat controversial. It is usually considered in adoption studies with the assumption that older people have more farming experience that helps them to adopt new technology (Wasula, 2000). On the other side, because of risk averting nature of older age farmers are more conservative than the youngest one to adopt new technology. The risk of adopting INRM technology arises from the high cost of production. Due to this fact age was thought to have a negative relationship with the adoption of INRM technology (Wasula, 2000).

Younger farmers may incur lower switching costs in implementing new practices since they only have limited experience and the learning and adjusting costs involved in adopting INRM technology may be lower for them (Ndiema, 2002). Rodgers (1983) argued that younger and educated farmers are more inclined to adopt new practices. This was supported by Wasula (2000), who found that the age of a household head had significantly influenced the adoption of contour vegetative strips in Njoro Division of Nakuru County.

The studies of Ndiema (2002) on assessment of factors affecting the adoption of wheat production technology by farmers in Njoro and Rongai Divisions of Nakuru District and the influence of socio-economic factors on the adoption of agroforestry technology in Nakuru District respectively also reported the presence of relationship between age and adoption of new technology. Farmers who are within age group 31-40 years tended to be more active in practical, "hands-on" activity as compared to older farmers (Wasula, 2000). Findings of Million and Belay (2004) also shows that age had a significant negative influence on the adoption of fertilizers. This findings agree with the innovation –decision theory of adoption which describes vividly the processes through which a farmer undergoes before finally adopting any technology. The concept of individual differences makes it possible that individual contact farmers do not adopt technology at the same time. In this case age of the farmer influences adoption of INRM technology.

4.3.2 Gender Distribution of Farmers

Results from the analysis revealed that out of 220 farmers interviewed 124 (56%) farmers were female compared to 96 (44%) farmers who were male as indicated in Table 4.3. However out of 105 adopters 65 (61.9%) farmers were male compared to 40 (38.1%) who were female. This shows that male farmers were more likely to adopt INRM technology than female farmers. Table 4.3 presents the gender distribution of the farmers interviewed.

Table 4.3: Gender distribution of farmers

Gender	Adopters (n=105)	Non-adopters (n=115)
Male	65(61.9%)	31 (30%)
Female	40(38.1%)	84(70%)
Total	105(100%)	115(100%)

*** P<0.05, Chi-square value = 12.768, df=3, p=0.015**

During FGD with sampled farmers, one youthful farmer pointed out that:

> "Beliefs, cultural traditions, attitudes and social norms such as trees and land belong to the men are deterrent to the adoption of INRM technology by women farmers. Culture, socio-economic environment and level of income are the major factors influencing gender roles and decision making in the household as well as access to resources in Ndhiwa. In this region traditional attitude still persist; women bear the burden of water and fuel collection and other household labor. Cultural tradition still hold strong and income levels are relatively low, women bear the burden of household labor while men are not expected to sit and relax at home."

Findings from the key informant interviews also indicated that land and trees belong to men hence women farmers had no incentive to conserve the soil leading to low adoption of INRM technology. Key informant data also, indicated that women easily adopted cheap but labour intensive INRM technology such as pruning, mulching, and trenching and organic fertilizer application. This was attributed to the fact that women paid close attention to working on their farms, unlike the males who were involved in many other economic activities. Key informant data further indicated that most of the women who held control over resources were widows while others had their husbands working away from home. Hence the opportunity to access and control land for crop production for domestic consumption and sale. This attribute was basically due to the inability of most women to own land for farming which predominantly belonged to males.

The variation in the gender of respondents was due to the ease in the availability of women within the homes. It was also due to substance abuse where some men were in shopping centers drinking *Chang'aa* as explained by a leader FGD discussant.

> "It is hard to find men in the homes, some of those who did not leave for the city, leave the house for the shopping centre to get *alcohol(chang'aa)* . Beside changaa , others sit close to the bus stop playing drafts with bottle tops . They go home at night to sleep and wake up early in the morning for the Same".

Respondents indicated that most men were not present in their homesteads but could be easily located at the shopping centers in small circles either talking, playing draft while a significant number were drinking changaa. This was further supported by a female focus group discussant who narrated that:

> "Most of us women stay close to home because of the children, when they come home from school, we have to be there. The household chores and farm work compels the women to stay at home and take care of things while the men have moved to the cities in search of employment while others loiter in the shopping centers".

To further explain the high number of women available in the households, an informant from the Catholic Diocese of Kitui engaged with community projects with the residents further reported that women are involved in the farm to a higher percent than men and therefore their availability in the household was also higher.

One of the male focus group discussants had this to say:

> "How can we be at home when the family needs have gone too high, the produce from the farm are low and we therefore have to secure food and other family need outside the home while the women stay home and take care of the children".

A female focus group discussant stated that:

> "Women are concerned with food needs since they are the ones left with the children most of the time. The tradition in the area is: during working period, men 'die' but during harvesting they 'resurrect' same case applies to educating children. The area tradition is that men 'die' and come back to life when everything is fine. This has brought a big conflict".

The agricultural extension informant however indicated that majority of the men were the heads of their households and transferred income earned in the cities or in the neighborhood back to their families and thus making it possible for the female respondents who were the majority food secure. He indicated that in a significant number of households men are still responsible for providing food for the family and only a few have abdicated their role as providers.

Majority of the women attributed this gender disparity to land tenure insecurity and this in return lowered their investment INRM technology. The females also advanced that the high level of insecurity in property rights interfered with their desire to adopt banana improvement technology. This is in accordance with a previous study conducted by Whitehead (1985) who advanced that traditionally, most women do not own land for farming. In his study, Whitehead (1985) further argued that historically, women's access to land in most African cultures was based on status within the family and involved right of use, not ownership (Whitehead, 1985). Aliber and Walker (2006) also advanced that although married women had user rights over their husbands' land, the husbands in most cases have more exclusive rights over the land's disposal (Aliber & Walker, 2006). Therefore, it was concluded that due to lack of ownership over productive resources by women compelled them not to pay close attention towards adoption of improved agricultural technology.

Indeed it was revealed that gender played a significant role regarding agricultural development in the African context. This is due to the fact that women were found to be playing play a key role in food production and making significant contribution to household food security. This is in line with a study which was conducted by Food and Agricultural Organisation (FAO, 2006). Findings in this study were also found to be in line with an earlier study by Doss (2001) and Ellis (2000) which revealed that women were found to be the main food producers, but however, lacked access to and control over the means of production such as secure land tenure and control of labour (Doss, 2001; Ellis, 2000).

The results of chi-square analysis (chi-square = 12.768, p=0.005) revealed that there is a significant relationship between gender and the adoption of INRM technology at 95% level of confidence. Regarding the relationship of household's gender with adoption of INRM technology, this study reported that household's gender has positive effect on adoption in favor of males. This shows that gender was related to adoption of INRM technology because majority of the adopters were male farmers which concurs with Oywaya (1995) who found significant differences in adoption between the male headed households and female headed households in Machakos, Kenya. This confirms that gender has a positive relationship with the adoption of INRM technology in Ndhiwa Sub County.

Culture dictates that household tasks such as cooking, cleaning and caring for the young while men engage in activities such as farming, casual jobs and construction (Ani, 2002) . This therefore slows down the pace rate of adoption of INRM technology by women farmers (Ani, 2002). This is the case of adoption of INRM technology in Ndhiwa Sub County based on the findings of this study. This finding is also in agreement with Phiri *et al.,* (2003) who found out that proportionately more men planted trees than women primarily because married women need consent of their husbands before planting trees. Previous studies have found gender difference to be one of the factors influencing adoption of new technology. Due to many socio-cultural values and norms, males have freedom of mobility and participation in different meetings and consequently have greater access to information.

This confirms that a gender differential is one of the important factors influencing adoption of INRM technology in Ndhiwa division. Due to long lasted cultural and social grounds in many societies of developing countries, women have less access and control to household resources and also have less access to institutional services (Techane, 2002).

The general perception is that due to cultural beliefs, women may have little decision making authority in farming (Ani, 2002). Among the challenges faced by women is permission to attend training, household responsibilities particularly caring for young children, lack of tools, and poor health related to the productive and reproductive gender roles. Understanding and addressing these issues is essential if women are to be included in any type of outreach or developmental program. Confirmation through key informants revealed that this is true even in the present day and age. This findings agree with the innovation –decision theory of adoption which describes vividly the processes through which a farmer undergoes before finally adopting any technology. The concept of individual differences makes it possible that individual contact farmers do not adopt technology at the same time. In this case gender of the farmer influences adoption of INRM technology.

4.3.3 Level of Education of Farmers

Farmers were asked to indicate the highest level of education they attained. As shown in Table 4.4 below fourty-five (43%) adopters interviewed had at least upper primary level of education while 26 (25%) farmers had lower primary school level of education. Those with secondary level of education and above were 28 (20%). Majority of the respondents were in the upper primary category. From Table 4.4, it can be seen that majority of the farmers had low level of education. Table 4.4 below presents the frequencies and percentages of the level of education of the farmers.

Table 4.4: Level of education of the farmers

Age group	**Adopters (n=105)**	**Non-adopters (n=115)**
None	5 (4.8%)	10(8.7%)
Lower Primary	26(25%)	33(28.7%)
Upper Primary	45(43%)	53(46.1%)
Secondary School	28(20%)	15(13%)
Tertiary	9(7%)	4(3.5%)
Total	105(100%)	115(100%)

P<0.05, Chi-square=12.097, df=3, P=0.007

According to an Agricultural Extension Worker in the study area, using INRM technology in most cases required a high level of education in order for the technology to be efficiently and effectively adopted. One of the prominent farmers in the study area advanced that formal education affects adoption of INRM technology. He added that formal education enhanced the farmers' logical capability to obtain, as well as process and understand information that was considered relevant for adoption of INRM technology. He concluded that formal education greatly affected the farmers' decisions to adopt improved technology. The results were confirmed by a discussant regarding the large number of primary level educational attainment by a majority of the respondents. A female discussant narrated that:

> "Most parents were and some are still ignorant on the benefits of education and believe class 8 is the epitome. They don't want to struggle in paying fees. Someone schooled up to class 7 and married a class 6 drop out and now have a very hard time providing for their children since they have no skills apart from farming. This contribute to the low adoption of INRM technology especially with the failing rains since they don't have any other way to make money for inputs".

The above narration implies that as the educational level increased the adoption of INRM technology improves and food security also increase. The agricultural extension informant indicated that households with secondary education and above paid attention to planting quality seeds, primary tillage and weather forecast information disseminated by the agricultural extension officer from the meteorological department. They did not require much follow up and this enabled them to get the most from their lands and thusthe adoption of INRM technology.

To see the relationship and the intensity of relationship, the chi-square test was conducted. The result of chi-square test (chi-square=12.097, P=0.007) revealed that there is significant association between education and the adoption of INRM technology. This confirmed that there was a positive relationship between level of education and adoption of INRM technology since a majority of the respondents (45%) were in the upper primary and below level of education category, a factor that contributed to the low adoption of the INRM technology. The result of this study is in agreement with the studies conducted by Taha (2007) reported significant relationship of education with the adoption of improved onion production package. Similarly Addis (2007) and Mahdi (2005) reported positive and significant relationship of education with the adoption of technology. According to an earlier study conducted by Waller *et al.,* (1998); and Caswell *et al.*, (2001), education was found to affect technology adoption as well as increased farm productivity levels. In their study, they revealed that education created a psychologically favorable mental attitude for the effective and efficient acceptance of new technology.

Education is very important for the farmers to understand and interpret the agricultural information coming to them from any source (Rahmeto, 2007). A better educated farmer can easily understand and interpret the information transferred to them by development agent (Rahmeto, 2007). INRM technology are knowledge intensive and require considerable management input (Barret *et al., 2002).* Formal schooling may enhance or at least signify latent managerial ability and greater cognitive capacity hence lead to adoption of INRM technology. This is in agreement with Amudavi (1993), Chitere and Dourve (1985), and Wasula (2000) who in their respective studies found that education is a significant factor in facilitating awareness and adoption of agricultural technology.

The findings of this study are also in consistent with many of the previously conducted studies, for example, Itana (1985); Chilot (1994); Kansana (1996); Asfaw *et al*., (1997); Mwanga *et al.,*(1998) and Tesfaye e*t al.,* (2001) have reported positive and significant relationship of education with adoption. Similarly, Nkonya *et al.,* (1997) reported positive relationship of education with adoption and intensity of adoption of improved maize seed indicating that each additional year of education increases the probability and intensity of adoption by 5%. This findings are in agreement with Rogers (1995), defined adoption process as “the mental process through which an individual passes through from first hearing about an innovation to final adoption. The innovation-decision theory of adoption has five steps”. These steps include knowledge (awareness), persuasion (interest), decision/evaluation), implementation, (trial) and confirmation (adoption or use). According to the theory the individual seeks knowledge of and skills which will ultimately affect the adoption process. Education ttherefore make an individual be able to acquire skills and knowledge that will enhance the adoption of INRM technology. Education enhances ones ability to receive and understand information but affects adoption behavior (Ragland and Lal, 1993).

4.3.4 Gross Monthly Farm Income of Farmers

Farm income refers to the total annual earnings of the farmers from sale of agricultural produce after meeting daily household requirements (Wasula, 2000). In this study farm income was estimated based on the sales of crop produce, livestock and livestock products. The major cash income for sample farmers in the study area was from sale of crops. Greater percentage of the adopters (98%) indicated that they got less than Kshs 10,000 as gross income while two percent indicated that their gross monthly income was more than Kshs 10,000. Table 4.5 presents the levels of gross monthly income of farmers.

Table 4.5: Approximate level of gross monthly farm incomes of the farmers

Monthly farm income	Adopters (n=105)	Non-adopters (n=115)
3,000	46 (44%)	53(46%)
3,001-6,000	7(6%)	50(43%)
6,001-10,000	50(48%)	12(11%)
10,000	2(2%)	0(0%)
Total	105(100%)	115(100%)
Mean	4,500	
SD	2300	
F value	4.222	
P value	0.007	

As depicted in Table 4.5 above, the average income for the total sample households was Kshs 4,200. The minimum and maximum farm income was 3,000 and 10,000 respectively.

ANOVA analysis (F=4.222 and P=0.007) was conducted to test the relationship of farm income and adoption of INRM technology and test result showed significant mean difference among the farmers. The results from ANOVA proves that gross monthly farm income of farmers has a positive influence on the adoption of INRM technology as also indicated by majority 89% of the non-adopters who had a gross monthly income of less than Kshs 6,000. This low income level contributed to the low adoption of INRM technology. Farm income is one of the sources of capital to purchase farm inputs and other household consumable goods in this region.

Household farm income can be used as a proxy to working capital because it determines the available capital for investment in the adoption of technology and it is a means through which the effect of poverty can be assessed (Wasula, 2000). According to World Bank (2000), poverty is the main cause of environmental degradation. One way of measuring the household's poverty is through income. Low income hinders the ability of farmers to purchase agricultural inputs such as seeds and inorganic fertilizers. This was confirmed by this study in Ndhiwa division, where low income had hindered the ability of farmers to purchase farm inputs leading to low adoption of INRM technology as indicated by the key informants interviewed.

This is in agreement with Wasula (2000) who found out that household farm income has a big bearing on the adoption of agro forestry technology by small scale farmers in his study on Influence of socio-economic factors on adoption of agro forestry related technology in Njoro Division, Kenya. Farmers from higher economic status have access to resources and institutions controlling resources necessary for the effective adoption of technology (World Bank, 1983). Farm income is believed to be the main source of capital for purchasing agricultural inputs such as seeds and inorganic fertilizers. Thus, those households with a relatively higher level of farm income are likely to purchase improved seeds or other essential agricultural inputs and adopt INRM technology. Farm income therefore enhances the adoption of improved agricultural technology. This is consistent with the findings of Wasula (2000), who found that farm income had a significant relationship with the adoption of soil conservation measures. Studies by Kidane (2001); Birhanu (2002); Techane (2002) and Yishak (2005), have found that farm income has a positive influence on adoption of improved agricultural Technology. This is the case in Ndhiwa Division as found from FGD and further confirmed by the key informants interviewed.

4.3.5 Farm Size

As shown in Table 4.6 below, (46.9%) adopters indicated that they owned less than 2 hectares of land while only (54.1%) indicated that they owned between 3 and 5 hectares. On the other hand, more than a half (73%) of the non-adopters owned less than 2 hectares. Table 4.6 presents the average size of land owned by farmers.

Table 4.6: Land owned by the farmers

Land in HA	Adopters (n=105)	Non-adopters (n=115)
10	6 (5.7%)	4(3.5%)
7-9	8(7.6%)	7(6.1%)
4-6	42(40%)	20(17.4%)
1-3	27(25.8)	26(22.6%)
1	22(21%)	58(50.4%)
Total	105(100%)	115(100%)
Mean	3.9	
SD	2.2	
F value	19.537	
P value	0.275	

According to findings obtained from one of the key informant interviews with an agricultural extension worker in the study area, farm-size contributed to limiting the adoption of INRM technology. It was also revealed during the FDGs that adoption of INRM technology required considerably large farm area for their adoption and that it was the farmers with adequate farm land who readily adopted these technology. It was also revealed that the prevailing land tenure systems in the study area encouraged land fragmentation thus hindering the effective adoption of INRM technology.

A male discussant reiterated that,

> “majority of the households have small parcels of land. In my family, we are five brothers and each one of us is married with children. Our father left us with 4 acres of land and we have not managed to buy more. When our mother divided the land into 6 portions - one for self -, we all got less than an acre. We intensively cultivate this land with my family and only my eldest brother gets enough food for his family from one harvest to the next. This is because he leases two acres from his wife‘s family. For the rest of us, we harvest just enough to last a few months and then depend on purchases from the market and we cannot afford to buy most farm inputs”.

From the verbatim narratives, it was evident that owning small parcels of land which then had to be divided amongst the family members affected the adoption of INRM technology negatively as it reduced the land available to the household for agricultural production. Households with large farm sizes also had the leeway of diversifying in crop production and livestock rearing. Some could also lease the land out to neighbors who gave them extra income to support their families and buy inputs. This was evident from a male focus group discussant that indicated that he owned 12 acres of land and his children had moved to the city and supported him financially. He therefore didn‘t need to cultivate the whole parcel since he didn‘t have many people to feed apart from his two grandchildren. His neighbor however had less than 2 acres and a large family. The neighbours leased out the land and the money obtained from the lease helped him in buying seeds for planting and some shopping.

The agricultural extension informant indicated that:

> “In this area, the value of land has gone high due to new institutions coming up which is transforming the people‘s lives since they get jobs. They therefore don‘t mind selling land since they can get household income from off farm activities and the failing rains aren‘t helping the situation”.

The above assertion confirms the findings of this study where increased numbers of households are losing their land not only from subdivision, but also from sale of land which resultantly affect the amount of produce obtained for these rural families. FDGs confirmed that most households had small parcels of land. Some were smaller than an eighth and thus households with no ability to lease out land had to find off farm activities to afford daily meals. This exacerbated the household food insecurity in these homes and led to low adoption.

These results confirm the findings of some earlier studies by Banerjee *et al.*, (2008) and Larkin (2005) who assured that those farmers with larger farms were more likely to pay close attention towards adopting improved farming technology.

The average total land holding of the sample households was 3.9 hectares. The minimum and maximum total land holding ranges from 1 to 10 hectares. One way analysis of variance (F=19.537, P= 0.275) statistical analysis revealed mean difference statistically among adoption categories. This confirms the influence of farm size on the adoption of INRM technology. This is also indicated by the fact that majority (56%) of the adopters owned more than 6 ha and (73%) of the non-adaptors who had less than 3 ha of land. Larger land holdings are associated with greater wealth and increased availability of capital. Farmers with larger landholdings are more likely to invest in INRM technology that increase productivity (Hanjra et al., 2009; Jayne et al., 2010). Therefore, the size of landholding is expected to have a positive influence on adopting of INRM technology. This had therefore led to the low adoption of INRM technology. Land is the main asset of farmers in the study area. As observed by Smaling *et al.*, (1997) farmers in the study area used both their own land and also rented farms for crop production. The probability of adopting INRM technology was positively influenced by the total farm size operated by a farmer. Land is perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector (Rahmeto, 2007).

Farm size influences households' decision to adopt or not to adopt new technology as articulated by key informants. It also influences the scale of technology use (Rahmeto, 2007). The result of this study confirms the earlier findings of Getahun (2004) and Mesfin (2005). Tadesse (2008), found that peasants decision to retain conservation structures were positively significantly related to the per capita availability of cultivatable land and land parcel in Ethiopia highlands. The policy lesson for research and extension is that INRM technology development must emphasize that new methods prove remunerative even at small scale operation in order to improve its adoption by farmers (Tadesse, 2008) . Farmers with large size farms adopt more advanced farm practices than small holders (Amudavi, 1993).

4.3.6 Household Size

Household Family size in the study was considered as the number of individuals who reside in the farmers' household. As indicated in Table 4.7 below, 66 (62%) out of one 105 adopters indicated that they had more than six members in their families. Thirty nine (37.1%) out of one hundred and five indicated that they had less six members in their households. Table 4.7 presents the average size of the households.

Table 4.7: Number of members in farmers' households

No in Household	Adopters (n=105)	Non-adopters (n=115)
10	20(19%)	16(13.9%)
9-10	22(21%)	20(17.4%)
7-8	24(22.0%)	20(17.4%)
5-6	18(17.1%)	22(19.1%)
3-4	15(14.3%)	26(22.6%)
2	6(5.7%)	11(9.6%)
Total	105(100%)	115(100%)
Mean	7.9	
SD	1.3398	
F value	1.396 NS	
P value	0.247	

The total average household size for the sample households was 7.9 members with standard deviation of 1.3398. The minimum family size of sampled households was 2 and maximum was 10 persons. The analysis of one way ANOVA (F=1.396 and P=0.247) shows the absence of significant mean difference between adoption categories. The study confirms the earlier findings of Taha (2007) and Yishak (2005) that household size had no influence on the adoption of wheat production technology in Ethiopia.

This indicates that household size had no influence on the adoption of INRM technology hence no positive relationship between the adoption of INRM technology and family size. Large family size may be an indicator for availability of labor in the family provided that there are more people within the range of active labor force (Tadesse, 2008). Based on this study, this variable did not have a positive and significant relationship with adoption of INRM technology. The number of members per family was not significant and positively associated with adoption of INRM technology (Tadesse, 2008). Family labor assumes great importance given that low incomes constraints financial liquidity for hiring wage laborers, and given possible moral hazard problems associated with non-family labor calling for considerable supervision (Tadesse, 2008). Given that the bulk of labor for most farm operations in this region is provided by the family members rather than hired labour, lack of adequate family labor accompanied by inability to hire labor can seriously constraint adoption of INRM technology as observed by Tadesse (2008).

Million and Belay (2004) noted that INRM technology require high labor force and farmers use family members and hired labour to fulfill the requirement. Farmers who have such labour opportunities generally adopt improved agricultural technology (Tadesse, 2008). A household with large working force will be in a position to manage labor intensive INRM technology activities. This will increase household's possibility to adopt INRM technology. The result of this study was in contrast with the earlier findings of Getahun (2004) and Yishak (2005) who found lack of positive association between large family size and adoption of INRM technology. However some studies have also reported the positive effect of household labor availability on adoption of improved agricultural technology. For instance, Million and Belay (2004) in their study on factors influencing adoption of soil conservation measures in southern Ethiopia, found positive effect of household's labor availability on adoption of soil conservation measures.

4.3.7 Off-farm Income

Household's off-farm income can be used as a proxy to working capital because it determines the available capital for investment in the adoption of INRM technology and it is a means through which the effect of poverty can be assessed (Wasula, 2000). Table 4.8 presents the off-farm income of the households. As illustrated in Table 4.9, forty six (43.8%) of the adopters indicated that they get more than Kshs 5,000 as gross off-farm income.

Table 4.8: Approximate level of monthly off-farm incomes of the farmers

Monthly off-farm income	**Adopters (n=105)**	**Non-adopters (n=115)**
3,000	7 (6.7%)	53(46%)
3,001-4,000	2(1.9%)	50(43%)
4,001-5,000	50(47.6%)	10(9%)
5,001-10000	46(43.8%)	2(2%)
Total	**105(100%)**	**115(100%)**

P< 0.005, Chi-square value =6.894, df=3, P=0.410

Monthly off-farm income had significant relationship (X^2 = 6.894, df 3, P= 0.410) with adoption of INRM technology. The slightly high level of adoption for formal employment was thus explained by a focus group discussant:

> "Formal employment helps maintain a steady flow of income which is unaffected by the rains. These households comfortably obtain inputs and food for their families without depending on the farm. They buy the inputs and foods in bulk during the harvest season if they have not harvested well which take them through to the next harvest. Majority of them don't sell their produce because they can source money to cater for other needs from their salaries. But for the majority of us who depend on the farm for food and cash, we have to sell some of our food stuff to take care of family needs like school fees and when the produce is no more, we cannot afford to provide inputs and three meals a day when other casual jobs are not available".

The above narration demonstrate that majority of the respondents relied on farming for their income. The agricultural extension informant reported that since the area is rural, majority depends on farming for their livelihood and that explains the high level of food insecurity since the farming is rain fed. One of the male discussants indicated that the main source of income was farming, but households also engage in casual work because the rain keeps failing. The *boda boda* business had also been very helpful to young people some of whom help support the family.

The results confirm the finding of Rahimeto (2007).This implies the importance of off farm income on the adoption of INRM technology. This was a contributing factor to the low adoption of INRM technology indicating a positive relationship between off farm income and the adoption of INRM technology. This could have led to the low adoption of INRM technology. Participation in off-farm activities had significant relationship with adoption of INRM technology (Ndiema, 2002). In most part of rural Kenya, off-farm employment is viewed as transitory situation, and only considered necessary as income source for low earning farm community. In this study area, grain trading, vegetable trading, teaching and daily labor were found to be some of the off-farm activities in which sample households were participating. Hence those households who have got an engagement in off-farm employment are understood to raise their annual income (Wasula, 2000). During slack periods many farmers may earn additional income by engaging in various off farm activities (Ndiema, 2002). This is believed to raise their financial position to acquire INRM technology hence they will be better adoptors (Ndiema, 2002). Therefore, in this study, it was hypothesized that there is a positive correlation between participation in off-farm activities and the adoption of INRM technology

Farmers from higher economic status have access to resources and institutions controlling resources necessary for the effective adoption of INRM technology (World Bank, 1983). This is consistent with the findings of Wasula (2000), who found that farm income had a significant relationship with the adoption of soil conservation measures. This low off farm income as indicated by key informants in this study had hampered the adoption of INRM technology in Ndhiwa Sub County leading to the low adoption.

4.2.8 Farming Experience

Farming experience refers to the number of years that one has been engaged in the practice of crop and animal production. As indicated in Table 4.9 below, nine (9%) out of one hundred and five adopters indicated that their farming experience was more than 8 years while 96 (91%) indicated that their farming experience was between 5 and 6 years. Table 4.9 presents the levels of farming experience of the respondents.

Table 4.9: Approximate farming experience of farmers

Farming experience in years	Adopters (n=105)	Non-adopters (n=115)
1-5	46 (44%)	53(46%)
6-7	50(47%)	50(43%)
8-9	7(7%)	10(9%)
10	2(2%)	2(2%)
Total	105(100%)	115(100%)
Mean	7.5	
SD	3.21	
F value	2.051 NS	
P value	0.110	

With regard to the study sample, the minimum farming experience of sample household was 1 and the maximum was 10 years. On an average the sample households had 7.5 years of farming experience. As depicted in Table 4.10 and from ANOVA, the results of this study is in contrast to the assumption, where farming experience was expected to have positive relationship to the adoption of INRM technology. Farming experience has no significant mean among the farmers (F= 2.051, P=0.110). This indicated that farming experience did not have positive relationship with the adoption of INRM technology. Therefore, this result shows that there is no positive relationship between farming experience with adoption of INRM technology. The result is in contradiction with the findings of Rahmeto (2007) and Chilot (1994) who observed that experience of farmers has effect on their managerial know-how and decision making . Ani (1998) and Iheanacho (2000) also indicated that farming experience of farmers to a large extent affects their managerial know-how and decision making. Besides, it influences the farmers' understanding of climatic and weather conditions as well as socio-economic policies and factors affecting farming.

Experience of the farmer is likely to have a range of influences on adoption and will improve farmers' skill at production (Tadesse, 2008). A more experienced farmer may have a lower level of uncertainty about the innovation's performance (Tadesse, 2008). Farmers with higher experience appear to have often full information and better knowledge of new technology and are able to evaluate the advantage of the technology considered. Therefore, it was hypothesized that farming experience has a positive influence on adoption of INRM technology (Tadesse, 2008). The above findings on the influence of socio-economic factors on the adoption of INRM technology are in agreement with the diffusion and adoption theory propounded by Rogers (1995) and also previous research work carried out by various researchers on determinants of adoption of INRM technology. The innovation –decision theory of adoption which describes vividly the processes through which a farmer undergoes before finally adopting any technology. The concept of individual differences (socio-economic factors) makes it possible that individual contact farmers do not adopt technology at the same time. In this case the socio-economic factors influences adoption of INRM technology.

4.4 Institutional Factors Determining Adoption of INRM Technology by Small Scale Farmers

The study sought to find out the influence of institutional factors on the adoption of INRM technology. The farmers were asked to respond to a set of questions on the institutional factors that have influence on the adoption of INRM technology. The factors included land tenure, access to credit, source of inputs, membership in social groups, access to market and contact with extension.

4.4.1 Land Tenure

Results from data analysis as shown in Table 4.10 shows that a significant majority (over 80%) of the respondents owned land privately while only 17.1% owned land communally. While a minority (2.9%) had rented land.

Table 4.10: Land ownership status by farmers

Monthly income	Adopters (n=105)	Non-adopters (n=115)
Communal	18 (17.1%)	30(26.1%)
Private	84(80%)	85(73.9%)
Rented	3(2.9%)	0(0%)
Total	105(100%)	115(100%)

***p>0.05 chi-square value =2.751df=8 p=0.518**

Data analysis by cross tabulation using chi-squared test, revealed that there was no significant association between land tenure and the adoption of INRM technology (chi-square value 2.75, df =8, $p > 0.518$). Therefore the null hypothesis was not rejected indicating that there was no evidence from the available data to suggest that there was a significant relationship between land tenure and adoption of INRM technology. Land is the main asset owned by farmers in the study area. Farmers in the study area use both their own land and also rent land for crop production (Smaling *et al.,* 1997). Land tenure provides farmers with full rights of land ownership and usage thus influencing the decision to participate in natural resource management. Land ownership with title deeds accords the farmers the right to usage (security of tenure) thus creating an incentive to farmers to adopt new, long term and even riskier technology (Rahmeto, 2007). These findings concur with Current *et al.,* (1995) where land ownership did not seem to have a significant effect on the adoption of agro forestry systems in Central America and Caribbean. According to Current *et al.,* (1995) what seemed important was how farmers feel about their property with or without the land ownership. The results of this study are also in harmony with the findings of Mulugeta (2000); Yishak, 2005 and Mesfin (2005). This finding confirmed that there was no positive association between land tenure and the adoption of INRM technology in Ndhiwa hence the low adoption of INRM in Ndhiwa Sub County, Kenya.

However this findings contradicted the study by Tengnas (1994), who found out that in Kenya most farmers find it unacceptable and unattractive to invest in tree production on land that is not legally theirs. This is also supported by Busienei (1991), who found out that the low participation in Agro forestry activities in Ainabkoi Division of Uasin Gishu District was due to lack of title deeds. This finding also disagrees with the theory of Adoption-Diffusion Model which is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems and supported by socio-economic factors. This model was proposed by a sociologist Milton Coughenour (1991).

4.4.2 Access to Credit

Analysis of data as shown in Table 4.11 below revealed that 82% out of 105 adopters had not used credit as compared to nineteen who had accessed credit. The result on credit accessibility by respondents is summarized and presented in Table 4.11.

Table 4.11: Access to credit by farmers

Use of credit	Adopters (n=105)	Non-adopters (n=115)
Yes	19(18.1%)	10(8.7%)
No	86(81.9%)	105(91.3%)
Total	105(100%)	115(100%)

Chi-square value =11.783, df=4,P=0.007

In addition, a local leader in one of the key informant interviews explained that adoption of INRM technology required resources in order to be implemented and this was limited by inaccessibility to credit facilities. According to another participant, these resources included labour, as well as some farm implements and all these required cash. Therefore, with access to credit funds made available to farmers, it would facilitate the farmers to effectively and efficiently adopt INRM technology with ease. A farmer in one of the focused group discussions, revealed that there was a tendency for farmers to obviously adopt agricultural innovations if they had access to credit which would enable them afford to purchase farm implements and afford to pay for labour as well as other relevant resources required for the adoption of banana improvement technology.

Findings obtained from the focused group discussions revealed that access to credit affected farmers in adoption of INRM technology. Access to credit was advanced by the participants as among the key elements prerequisite for facilitation adoption of agricultural technology to improve agricultural production and hence poverty reduction. Majority of the participants in key informant interviews explained that access to credit enabled and facilitated farm households have capacity to acquire and the recommended agricultural inputs.

In this study too, this hypothesized preposition is supported by the significant relationships which exist between access to credit and adoption of INRM technology (chi-square value =11.783, df=4,P=0.007) . The results indicated that majority of the farmers had not accessed credit facilities, a factor that could have contributed to the low adoption of INRM technology. This showed that there was a significant relationship between access to credit and adoption of INRM technology. This finding concurs with Ascroft *et al.*, (1973) where only 5% of the progressive farmers obtained loans. Access to credit is way of improving farmers' access to new technology. Farmer's ability to purchase inputs such as improved seed and fertilizer is particularly important. The formal sources of credit in Kenya are Cooperative societies, saving and credit societies, banks, self-help groups and farmer's organizations. Farmers who have access to credit can minimize their financial constraints and buy inputs more readily (Wasula, 2000)).

Lack of credit is disadvantageous to farmers who operate on a small scale level and are less influential to the credit sector (Legesse, 1992; Teressa, 1997). Poor credit conditions may also be another reason that suppresses the capacity to adopt an innovation (Legesse, 1992; Teressa, 1997). Although credit may appear quite rational to a farmer, social forces outside his control dictate his propensity to adopt the technology. The optimal effective INRM technology require cash for labor that is used in constructing stover/trash lines, planting trees and purchase of chemical fertilizer. Credit therefore is a strong facilitator in enhancing effective access to INRM technology. Farmers without cash and no access to credit will find it very difficult to adopt INRM technology. Previous authors verified this preposition (Legesse, 1992; Teressa, 1997). It is expected that access to credit will increase the probability of adopting INRM technology (Legesse, 1992; Teressa, 1997). Findings in this study correspond with the findings of Zeller *et al*,. (1997), who concluded that ability of a household to bear risks was to a greater extent is largely dependent upon the ability to access to credit facilities (Zeller *et al*,. 1997). This finding agrees with the theory of Adoption-Diffusion Model Which is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems and supported by socio-economic factors like credit. This model was proposed by a sociologist Milton Coughenour (1991).

4.4.3 Access to Quality Inputs and Equipment

Information on input use was collected and summarized as in Table 4.12 below. According to Table 4.12, (76.2%) of 105 adopters had not used quality inputs as compared to (23.8%) who had used quality inputs. Majority of respondents (76.2%) that they had not accessed inputs for INRM technology. Furthermore majority of respondents reported delay and high cost of fertilizer as problems of inputs.

Table 4.12: Access to inputs and equipment by farmers

Access to inputs	Adopters (n=105)	Non-adopters (n=115)
Yes	25(23.8%)	10(8.7%)
No	80(76.2%)	105(91.3%)
Total	105(100%)	115(100%)

P<0.05, chi-square value=40.037, df=16, P=0.001

Analysis by cross tabulation using chi-square, test, revealed a significant relationship between access to inputs and adoption of INRM technology (chi-square value=40.037, df=16, P=0.001). The null hypothesis was therefore, rejected and the alternate accepted which showed that there was a significant relationship between access to inputs and adoption of INRM technology.This implies importance of time, quality and price in input delivery. This could have been the reason for the low adoption of the technology. This showed that there was a significant relationship between access to credit and adoption of INRM technology. This finding concurs with Ascroft *et al.*, (1993) where only 5% of the progressive farmers obtained inputs from reputable source. This is disadvantageous to farmers who operate on a small scale level and are less influential to the input and credit sector as observed by Rahmeto (2007). Input delivered by an institution will have its own impact on adoption of a given technology and production and productivity of crops (Ndiema, 2002).

4.4.4 Access to Market

Information obtained from data analysis as shown in Table 4.13 below shows that a significant majority (73.3%) of the adopters utilized their farm produce for subsistence. Only a minority (26.7%) used their produce for commercial purposes.

Table 4.13: Access to market by farmers

Access to market	**Adopters (n=105)**	**Non-adopters (n=115)**
Subsistence	77(73.3%)	85(73.9%)
Commercial	28(26.7%)	30(26.1%)
Total	105(100%)	115(100%)

***P<0.005, chi-square value= 32.546, df=4, P=0.000**

Data analysis by cross tabulation using chi-square test, revealed significant relationship between use of farm produce and adoption of INRM technology (chi-square value= 32.546, df=4, P=0.000). The null hypothesis was therefore, rejected and the alternate accepted which showed that there was a significant relationship between access to market and adoption of INRM technology.

During FGD participants identified access to market as an institutional factor and explained that the distance taken to travel from home to the nearest market were 2km and 15 km respectively. This shows that majority of the farmers grow crops for subsistence use and cannot not access the market easily. The agricultural extension informant explained that buyers offer low and exploitative prices to local farmers. He further mentioned that once the harvest season is over, the prices sometimes double from what producers sold.

A focus group discussant narrated that prices were very low when selling at the local market. Shop keepers and brokers bought a kilogram of maize at KSh.20 which was very low considering the intensive labor invested to produce. When purchasing the same product from the shops, the consumer bought the same kilogram of maize at KSh.50. These sentiments were also echoed by a village elder focus group discussant who narrated that the prices are low when selling farm produces but high for the same produce when they are buying. They therefore are forced to sell everything because of low prices to meet a single need. Middle men (brokers) were also explained for the lack of effect access to market had on adoption of INRM technology. A female focus group discussant indicated that brokers availed themselves door to door asking whether one is selling, they would tell respondents in the households to inform them when ready to sell. This tempted household heads until eventually they gave in and sold to this ready market. Brokers were also seen to contribute largely to theft of cereals reserved for food whenever they went door to door especially when one of the spouses was away. From the above explanation, the nature of the market is exploitative for the households as they are denied good prices for their produce and in return purchase consumer goods at Discussants indicated that the local market sheds in the shopping centers were many but they were empty or with few sellers. Shops selling cereals were also few and in most cases, only one in the shopping areas was active. This revealed that despite markets being accessible to the farmer; few individuals had monopoly over the shopping center making price control difficult since there was little competition. Accessibility to markets relate to household food security in that farmers are able to access the right inputs for planting, accessible food outlets, less or no transport needed to travel to the market and thus all the money can be used to purchase the required food item, and access to market also means access to market information which promote the adoption of INRM technology. In Kanyamwa West location however, discussants indicated that high prices due to monopoly of traders made input prices high as well as other food items. This compelled farmers to plant uncertified seeds and thus low produce which lowers the adoption of INRM technology and promoted food insecurity.

This therefore outlines the importance of access to market for small scale farmers. This proved to be the reason for the low adoption of INRM technology. These findings agree with the findings of Reardon *et al.,* (2001) where only 8% of the less progress farmers had access to the market. The lack of market information represents a significant impediment to market access especially for small holders' produce. It substantially increases transaction costs and reduces market efficiency (Mwale, 1998). These findings also agree with the findings of Tadesse (2007) who found that market disadvantage small, less educated and less influential farmers.

4.4.5 Membership in Social Groups

According to Table 4.14 above, 50.5% out of the adopters were not members of any social group as compared to 49.5% who were members various social groups.

Table 4.14: Farmer's membership in social groups

Social group	Adopters (n=105)	Non-adopters (n=115)
Input supply	10(9.5%)	2(1.7%)
Marketing	6(5.7%)	2(1.7%)
Co-operatives	2(1.9%)	1(0.9%)
Youth groups	6(5.7%)	4(3.5%)
Women groups	18(17.2%)	16(13.9%)
CBOs	10(9.5%)	7(6.1%)
None	**(50.5%)**	83(72.2%)
Total	**105(100%)**	**115(100%)**

P<0.05, chi-square value=11.625, df=13, P=0.0344

The chi-square analysis result (chi-square value=11.625, df=13, P=0.0344) shows significant relationship of contact of extension agent with the adoption of INRM technology This confirms that membership in social groups influences the adoption of INRM technology in the study area and therefore the low level of adoption of INRM technology was as a result of the low level of access to extension services. Farmer groups play a vital role in improving members' knowledge and experience to access to production resources as well as increasing negotiating strength and establishing product certification and label (Barham and Chitemi, 2009). Unfortunately, majority (50.5%) of the adopters never participated in farmer groups. This showed that there was a significant relationship between membership in social group and adoption of INRM technology. This is a factor that had contributed to the low adoption of INRM technology.

In this study, membership in social group was also identified and explained by the respondents during FGD as involvement in any informal and formal organizations as a member. Farmers who are members of any local organization are more likely to be aware of new information and INRM technology (Wasula, 2000). Therefore it was expected that there would be positive and significant relationship between membership in social group and the adoption of INRM technology. This finding agrees with the theory of Adoption-Diffusion Model Which is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems and supported by socio-economic factors . This model was proposed by a sociologist Milton Coughenour (1991).

4.4.6 Farmers Contact with Extension

According to Table 4.15 below, (61%) adopters (87%) non-adaptors had not interacted with extension staff. Table 4.15 below gives the relationship between extension contacts and adoption of INRM technology.

Table 4.15: Farmers contact with extension staff

Contact with extension	Adopters (n=105)	Non-adopters (n=115)
Yes	41(39%)	15(13%)
No	64(61%)	100(87%)
Total	105(100%)	115(100%)

P<0.05, chi-square value=12.695, df=13, P=0.0441

A prominent female farmer also stressed the need for agricultural extension workers to avail and ensure that farmers got technical assistance to disseminate information required to effectively and efficiently adopt the INRM technology. It was suggested that exposure to information on INRM technology was a vital factor that would influence the adoption behaviour patterns of the banana farmers. Participants in FGDs stressed the need for greater exposure to information in order to enhance awareness concerning banana improvement technology.

An agricultural extension worker also pointed out that there was a diversity of Institutional inefficiencies during the process of development as well as delivery of relevant information including technical assistance from the relevant national agricultural extension systems.

During one of the focused group discussions, a participant explained that he had obtained information about INRM technology from special editions in newspaper publications. Another farmer added that he tried to implement the INRM technology and registered a large measure of success in terms of productivity as compared to using the non-improved technology.

A prominent farmer explained that many farmers in the study area acquired information regarding INRM technology form workshops and seminars previously conducted within the study area. She said that,

> "Many farmers implemented the INRM technology suggested by Agricultural Extension Workers and other by farmers copied from those farmers that had adopted the technology after realising the benefits that accrue in terms of returns to productivity."

The Divisional Agricultural Extension Officer further asserted that inaccessibility of some parts of the study area due to lack of transport facilities and poor infrustructure in terms of road and communication networks hindered effective transport and communication to the affected places in Ndhiwa division. Findings in this regard are in accordance with Awotide *et al*., (2013) in their study about technology adoption. They contended that access to information about improved farming practices and agricultural technology was essential to increase the extent of adoption.

The major source of agricultural information for farmers is extension agents. The frequency of visits or availability of extension service is perhaps the single variable that emerged significantly in most of research work on technology transfer and adoption (Asfaw et al, 1997; Kedir, 1998). It is hypothesized that frequency and timely contact with extension workers will increase a farmers' probability of adopting technology.

The chi-square analysis result (chi-square value=12.695, df=13, P=0.0441) shows significant relationship of contact of extension agent with the adoption of INRM technology. The earlier researchers, Girmachew (2005), Abrhaley (2007) and Kidane (2001) also reported similar results.

This proves that access to extension influences the adoption of INRM technology in the study area and therefore the low level of adoption of INRM technology was as a result of the low level of access to extension services. It can be argued that extension measured in terms of use and type of information is important in adoption of INRM technology. However it was difficult to rate the extension service in this study in terms of its adequacy and usefulness since the scope of the study was limited to only INRM technology. These findings agree with those found by Chitere (1985) where it was found out that nearly all the farmers in an area previously occupied by European settlers were knowledgeable about improved farming practices. It was also observed that farmers adopt improved farming practices largely because of early exposure to intensive extension education. Several studies also indicated a positive relationship between contact with agricultural information sources and adoption (World bank, 1993). These also agree with Tadesse (2008) who found that the level of expertise manifested by farmers with intensive extension contact was consistently higher than that of other farmer.

4.4.7 Participation in Extension Events

In this study, participation in training, demonstration, field day, visit by extension staff, visit to extension staff and agricultural shows were considered as the most important extension events by the farmers. The results of farmers' participation in different extension events in relation to adoption of INRM technology is discussed below. To describe the level of farmers' participation in extension events, farmers were asked eight questions on the various activities bringing together the extension agents and farmers. The responses from the farmers are summarized in Table 4.16. The analyzed data indicates that more than half of the farmers (76.2%), were never visited by individual extension officers in the past one year. While 23.8% were visited at different level of frequency (Table 4.16 below).

Table 4.16: Number of times farmers participated in individual visit by extension staff to farmers

Adoptors			**Non Adoptors**		
No of Times (N)	F	%	No of Times (N)	F	%
0	80	(76.2)	0	102	(88.7)
1	10	(4.8)	1	5	(4.3)
2	8	(7.6)	2	8	(7)
3	2	(1.9)	3	0	(0)
4	2	(1.9)	4	0	(0)
5	1	(1)	5	0	(0)
>5	2	(1.9)	>5	0	(0)
Total	105	(100)	Total	115	(100)

P<0.05, chi-square value=12.695, df=13, P=0.0441

The data revealed positive relationship between visits made by individual extension agent and adoption of INRM technology as indicated by chi-square result ($P<0.05$, chi-square value=12.695, df=13, P=0.0441). Further 76.2% of the non-adaptors indicated that they had never been visited by extension staff. This implies that most farmers had not participated in individual visit by extension staff and this had led to the low adoption of INRM technology by farmers in Ndhiwa Sub County.

Visits made by extension agent to farmers are an important input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practice properly (Rahmeto, 2007). Participation in extension events is an input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practices properly (Rahmeto, 2007). If a farmer has no skill and technical know-how about certain technology, he/she may have less probability of its adoption. The skill acquired through extension helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation (Tadesse, 2008).

The knowledge and skills acquired through training by extension agent helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later (Rahmeto, 2007). They can properly implement technology package as per the recommendation (Tadesse, 2008). This result is in complete agreement with findings reported by Rahmeto (2007) who confirmed positive and significant relationship between contact with extension agent and adoption of improved haricot bean technology package. Other researchers, Girmachew (2005), Abrhaley (2007) and Kidane (2001) also reported similar results. This findings are in agreement with Rogers (1995), defined adoption process as “the mental process through which an individual passes through from first hearing about an innovation to final adoption. The innovation-decision theory of adoption has five steps”. These steps include knowledge (awareness), persuasion (interest), decision/evaluation), implementation, (trial) and confirmation (adoption or use). According to the theory the individual seeks knowledge of and skills which will ultimately affect the adoption process. Education ttherefore make an individual be able to acquire skills and knowledge that will enhance the adoption of INRM technology.

This findings are in agreement with Rogers (1995), defined adoption process as “the mental process through which an individual passes through from first hearing about an innovation to final adoption. The innovation-decision theory of adoption has five steps”. These steps include knowledge (awareness), persuasion (interest), decision/evaluation), implementation, (trial) and confirmation (adoption or use). According to the theory the individual seeks knowledge of and skills which will ultimately affect the adoption process. Extension therefore imparts skills and knowledge that will enhance the adoption of INRM technology.

4.4.7.1 Group Visits by Extension Agents to Farmers

As indicated in Table 4.17 below Seventy nine out of one hundred and five adopters interviewed (65.7%) were not visited by a group of extension agents while 34.3% had been visited at different level of frequency in the past one year (Table 4.17).

Table 4.17: Number of times farmers participated in group visits by extension staff to farmers

Adoptors			Non Adoptors		
No of Times (N)	**F**	**%**	**No of Times (N)**	**F**	**%**
0	69	(65.7)	0	89	(77.4)
1	20	(19.0)	1	15	(14.3)
2	9	(8.5)	2	7	(16)
3	1	(1)	3	1	(1)
4	0	(0)	4	0	(0)
5	3	(2.9)	5	0	(0)
>5	3	(2.9)	>5	0	(0)
Total	**105**	**(100)**	**Total**	**115**	**(100)**

This shows that majority of the farmers had not participated in group visits by extension staff to farmers. This was found to be one of the factors that had led to the low adoption of INRM technology. Group visits made by extension agents to farmers are an important input to improve farmers' performance (Tadesse, 2008). It equips farmers with new knowledge and skills, which help them to perform INRM technology properly. If a farmer has no skill and technical knowledge about a INRM technology, he/she may have less probability of its adoption (Tadesse, 2008).The skill acquired through training helps to carry out a new technology effectively and efficiently.

Where farmers are well trained in new practice, they may not need outside support later. They can properly implement INRM technology package as per the recommendation (Rahmeto, 2007). This result is in complete agreement with findings reported by Rahmeto

(2007) who confirmed positive and significant relationship between contact with extension agent and adoption of improved haricot bean technology package. Other researchers, Girmachew (2005), Abrhaley (2007) and Kidane (2001) also reported similar results. The results from above provides useful information that indicates that participation in group visits by extension agents to farmers enhances the adoption of INRM technology by farmers in Ndhiwa Sub County, Homa bay County, Kenya.

4.4.7.2 Visits Made to Extension Officers by Farmers

Table 4.18 clearly indicates that, from the total sampled farmers, 38.1% adopters had visited extension officers at different level of frequency while majority of the farmers interviewed (61.9%) indicated that they had not visited extension officers in the past one year.

Table 4.18: Number of times farmers participated in visits made to extension officers by farmers

Adoptors			**Non Adopters**		
No of Times (N)	**F**	**%**	**No of Times (N)**	**F**	**%**
0	65	(61.9)	0	102	(88.7)
1	19	(18.1)	1	5	(4.3)
2	8	(7.6)	2	3	(2)
3	5	(4.8)	3	2	(1.9)
4	3	(2.9)	4	0	(0)
5	3	(2.9)	5	0	(0)
>5	2	(1.9)	>5	0	(0)
Total	**105**	**(100)**	**Total**	**115**	**(100)**

This proves the importance of visits made to the extension agents by farmer. This was one of the reasons for the low adoption of INRM technology. This proved that there was a positive relationship between visits made to extension agents by farmers and the adoption of INRM technology. Visits made to extension agents by farmers are an important input to improve farmers' performance (Tadesse, 2008). It equips farmers with new knowledge and skills, which help them to perform new INRM practice properly. If a farmer has no skill and technical knowledge about INRM technology, he/she may have less probability of its adoption (Tadesse, 2008). The skill acquired through training by extension agents helps to carry out a INRM technology effectively and efficiently. If farmers are well trained in INRM technology, they may not need outside support later. They can properly implement INRM technology package as per the recommendation (Tadesse, 2008).

4.4.7.3 On Farm Demonstrations

Table 4.19 below indicates that only 77% of total adopters interviewed had not participated in on farm demonstration and while rest 23.9% indicated that they had attended on farm trial.

Table 4.19: Number of times farmers participated in on farm demonstrations

ADOPTORS			**NON ADOPTORS**		
No of Times (N)	F	%	No of Times (N)	F	%
0	81	77.1	0	98	85.2
1	16	15.2	1	16	13.9
2	1	1	2	1	1
3	2	1	3	0	0
4	0	0	4	0	0
5	0	0	5	0	0
>5	5	4.8	>5	0	0
Total	**105**	**100**	**Total**	**115**	**100**

This implies the importance of on farm demonstration in the adoption of technology. This had contributed to the low adoption of INRM technology. This showed that there was a positive association between on farm demonstration and adoption of INRM technology. On farm demonstration in this study means accepting new practices and put in the field in the form of trial with close supervision of extension agents and then inviting others to see how he/she perform it. In this finding, most farmers who participated in on farm demonstration were of adopter categories. The probable reason for this difference is that extension agents may select the one who accept technology easily to put in to practice according to the recommendation

Demonstration means undertaking field trial with farmers with the aim of creating a learning site for the surrounding farm community (Tedesse, 2008). On farm emonstration is an important method of extension to create concrete awareness among farm community. This situation may facilitate the adoption of INRM. It is also a means of diffusing information to neighboring farmers to see and then adopt INRM practice into their farm (Tedesse, 2008). When farmers have a chance to participate in practicing demonstrations they may develop know-how about the fitness of the INRM technology package within their socio-economic conditions, this enhances them to take further measures, either to use or not to use INRM technological package. Similar results were identified by Edlu (2006).

4.4.7.4 On Station Demonstrations

Demonstration is an important method of extension to create concrete awareness among farm community. Table 4.20 indicates that 69.5% of total adopters interviewed had not participated in on farm demonstration while only 31.5% indicated that they had attended on station trial. On station demonstration in this study means accepting new practices and put in the field in the form of trial with close supervision of extension agents and then inviting others to see how he/she perform it. In this finding, most farmers who participated in on station demonstration were of the adopter categories.

Table 4.20: Number of times farmers participated in on station demonstrations

Adoptors			**Non Adoptors**		
No of Times (N)	**F**	**%**	**No of Times (N)**	**F**	**%**
0	73	(69.5)	0	103	(89.6)
1	20	(19.0)	1	11	(9.6)
2	10	(9.5)	2	1	(1)
3	0	(0)	3	0	(0)
4	0	(0)	4	0	(0)
5	0	(0)	5	0	(0)
>5	2	(2.0)	>5	0	(0)
Total	**105**	**(100)**	**Total**	**115**	**(100)**

Chi-square test indicated that, there was a significant (chi-square=13.133, P=0.015) relationship between farmers' participation in demonstration and the adoption of INRM technology. This underscores the importance of on station demonstration on enhancing the adoption of INRM technology. This low level of participation in on farm demonstration had led to the low level of adoption of INRM technology. This is in agreement with the findings of Tedesse (2008) who found out that there was a positive relationship between demonstration and adoption of technology in Ethiopia. This therefore means that Participation in demonstration significantly and positively influenced the adoption of INRM technology (Tedesse, 2008). Demonstration means undertaking field trial with farmers with the aim of creating a learning site for the surrounding farm community (Tedesse, 2008). This situation may facilitate the adoption process (Tedesse, 2008). It is also a means of diffusing information to neighboring farmers to see and then adopt the practice into their farm. When farmers have a chance to participate in practicing demonstrations they may develop know-how more about the fitness of the package with their socio-economic conditions, this enhances them to take further measures, either to use or not the technological packages (Tedesse, 2007. Similar results were identified by Edlu (2006) in a study on extension coverage and utilization by different categories of farmers in Gurage Zone, Ethiopia. The data above therefore proved that there was a positive relationship between on station demonstration and the adoption of INRM technology in Ndhiwa Sub County, Kenya.

4.4.7.5 Attending Agriculture Society of Kenya (A.S.K) Shows

Table 4.21 clearly indicates that only 14.4% of adaptors attended ASK shows at different levels of frequency while majority 85.7% had not attended any agricultural shows in the past 5 years. They explained that most shows are organized far away from their homes.

Table 4.21: Number of times farmers had attended A.S.K shows

Adoptors			Non Adoptors		
No of Times (N)	**F**	**%**	**No of Times (N)**	**F**	**%**
0	90	(85.7)	0	92	(80)
1	7	(6.7)	1	7	(7)
2	3	(2.9)	2	8	(7)
3	0	(0)	3	3	(2)
4	0	(0)	4	5	(4)
5	0	(0)	5	0	(0)
>5	5	(4.8)	>5	0	(0)
Total	**105**	**(100)**	**Total**	**115**	**100)**

Chi-square=18.837, df=9,P=0.027

This finding highlight the importance of participation in A.S.K shows on the adoption of INRM technology. This therefore means that Participation in ASK shows had significant influence the adoption of INRM technology. This also means that an increase in farmers' level of participation in extension events like Agricultural Shows will increase adoption and intensity of adoption of INRM technology (Rahmeto, 2007). The lack of participation in A.S.K shows had caused the low adoption of INRM technology. Therefore, extension has to give emphasis to such means of transferring agricultural information to farmers. Agricultural Show is one of the most popular methods of transferring technology. Conducting shows is a good way of convincing other farmers to adopt new technology (Tedesse, 2008).

In the Agricultural Shows farmers will get an opportunity to observe how the new technology is put in to practice (Tedesse, 2008). This situation may facilitate the adoption process. The result of this is in agreement with the findings of many authors. For instance, Tesfaye *et al.*, (2001) reported that attendance of Agricultural Shows, field days, on- farm demonstration and training contributed positively to farmers' adoption decision. In the same line, Asfaw *et al.*, (1997) and Yishak (2005) in their studies of determinants of adoption of improved maize technology in Ethiopia and Damote Gala Wareda found that farmers' presence in agricultural Shows and demonstration had positive and significant relationship with adoption. Taha (2007) also reported the same result.

4.4.7.6 Participation in Field Days

Table 4.22 clearly indicates that from the total sample farmers 42.9% farmers had attended field days at different level of frequency while majority of the farmers (86.1%) had not attended any field day in the past one year. The participation of respondents in the field day with varying level of frequency can be observed in Table 4.22.

Table 4.22: Number of times farmers participated in field days

Adoptors			Non Adoptors		
No of Times (N)	**F**	**%**	**No of Times (N)**	**F**	**%**
0	60	(57.1)	0	99	(86.1)
1	16	(15.2)	1	11	(9.6)
2	9	(8.6)	2	4	(3.5)
3	4	(3.8)	3	1	(0.9)
4	1	(1)	4	0	(0)
5	0	(0)	5	0	(0)
>5	15	(14.3)	>5	0	(0)
Total	**105**	**(100)**	**Total**	**115**	**(100)**

Chi-square=18.837, df=9,P=0.027

To determine the relationship between participation in field days and the adoption of INRM technology chi-square analysis was conducted. The chi-square analysis showed (chi-square=18.837, P=0.027) that there existed a significant relationship between them at 95% level of significance.

The above finding confirms the importance of field days in adoption of INRM technology. Majority of the farmers had not attended any field day. This had resulted to the low level of adoption of INRM technology. Field day is one of the most popular methods of technology transfer. Conducting field days on farmers' field is a good way of convincing other farmers to adopt new technology (Yishak, 2005). In field day neighboring farmers will get an opportunity to observe how the new technology is put into practice in the field. This situation may facilitate the adoption process (Yishak, 2005). The result of this is in agreement with the findings of many authors. For instance, Tesfaye *et al.,* (2001) reported that attendance Agricultural Shows, field days, on- farm demonstration and training contributed positively to farmers' adoption decision. In the same line, Asfaw *et al.*, (1997) and Yishak (2005) in their studies of determinants of adoption of improved maize technology in Ethiopia and Damote Gala Wareda found that farmers' presence in Agricultural Shows, field days and demonstration had positive and significant relationship with adoption. Taha (2007) also reported the same result.

4.4.7.7 Attendance of Workshops and Seminars

Table 4.23 above shows that out of 105 adaptors interviewed 26.7% had attended workshops and seminars while seventy seven farmers (73.3%) did not attended workshops and seminars related to INRM technology (Table 4.23).

Table 4.23: Number of times farmers participated in workshops and seminars

Adoptors			Non Adoptors		
No of Times (N)	**F**	**%**	**No of Times (N)**	**F**	**%**
0	(77)	73.3	0	102	(88.7)
1	(10)	9.5	1	7	(6.1)
2	(7)	6.7	2	1	(1)
3	(9)	8.5	3	5	(4.3)
4	(1)	1	4	0	(0)
5	(1)	1	5	0	(0)
>5	(0)	0	>5	0	(0)
Total	**(105)**	**100**	**Total**	**115**	**(100)**

Chi-square=29.674, df=12, P=0.003

To determine the relationship between training and the adoption of INRM technology, chi-square test was computed. The chi-square analysis showed that (chi-square=29.674, P=0.003) there was a significant relationship between the two. This confirms that attendance of workshops and seminars is very important to facilitate the adoption of INRM technology. This therefore proves that attendance of workshops and seminars influence the adoption of INRM technology in the study area.

Training is an important input to improve farmers' performance. It equips farmers with new knowledge and skills, which help them to perform new practice properly. If a farmer has no skill and technical know-how about certain technology, he/she may have less probability of its adoption (Tadesse, 2008).

The skill acquired through attendance of workshops and seminars helps to carry out a new technology effectively and efficiently. If farmers are well trained in new practice, they may not need outside support later. They can properly implement technology package as per the recommendation. Concerning farmer's attending training programmes (Rehmeto, 2007). This result is in complete agreement with findings reported by Tedesse (2007) who confirmed positive and significant relationship between attendance of workshops and seminars and adoption of improved haricot bean technology package. Other researchers, Girmachew (2005), Abrhaley (2007) and Kidane (2001) also reported similar results. This findings are in agreement with Rogers (1995), defined adoption process as "the mental process through which an individual passes through from first hearing about an innovation to final adoption. The innovation-decision theory of adoption has five steps". These steps include knowledge (awareness), persuasion (interest), decision/evaluation), implementation, (trial) and confirmation (adoption or use). According to the theory the individual seeks knowledge of and skills which will ultimately affect the adoption process. Training enables an individual to acquire skills and knowledge that will enhance the adoption of INRM technology.

4.4.8 Exposure to Mass Media

Mass media plays a great role in providing information in shortest time possible with large area coverage. As compared to other communication channels, its effect on behavioral change is weak as it mainly deals with awareness creation. In this study farmers' exposure to mass media was measured by the ownership of radio or TV by sample households. In this study mass media exposure is assumed to have positive relationship with adoption of INRM technology. The survey result on mass media exposure of sampled farmers is provided in Table 4.24 below. As indicated in Table 4.24 below in terms of radio listening habit of the farmers in the study area, 41% of them did not listen to radio programs whereas 2%, 28% and 29% of the respondents have monthly, weekly and daily listening habit (Table 4.24).

Table 4.24: Distribution of respondents with respect to radio listening habit

Frequency of adaptors contact with radio	Frequency	Percent
Never	43	41
Monthly	2	2
Weekly	29	28
Daily	31	29
Total	**105**	**100**

Chi-square=12.618, df=3, P=0.054

To determine the relationship between training and the adoption of INRM technology, chi-square test was computed. The chi-square analysis showed that (chi-square=12.618, P=0.054) there was a significant relationship between the two. It also was noted in FGD that majority of radio listeners in the study area do not pay attention to agricultural programs. Lack of attention to agricultural radio program may be attributed to unfamiliarity of the language and also lack of awareness on the importance of the program. This could be due to the fact that agricultural radio programs were not given top priority by farmers in the study area rather the priority was for other non-agricultural programs. It was also attributed to lack of favorable attitude towards the program.

Result of chi-square analysis (Chi-square=12.618, df=3, P=0.054) showed that there is a significant relationship between mass media with the adoption of INRM technology.

This therefore confirms that mass media contact had positive and significant relationship with adoption of INRM technology. The result of this study is consistent with the findings of Kidane (2001) and Getahun (2004) who found out that mass media contact had positive and significant relationship with adoption of improved wheat and maize varieties in Tigray, Ethiopia.

The adoption process of agricultural technology depends on access to information and on the willingness and ability of farmers to use information channels available to them (Tadesse, 2008). The role of information in decision-making process is to reduce risk and uncertainties to enable farmers to make the right decision on adoption of improved agricultural technology. Mass media play the greatest role in provision of information in the shortest possible time over large area of coverage (Rahmeto, 2007). However, as compared to other communication channels, its effect on behavioral change is weak as it is limited to awareness creation than skill development (Tadesse, 2008). But, as far as awareness is pre-requisite for behavioral change, still its role cannot be underestimated. Hence, mass media exposure was expected to positively influence adoption and intensity of adoption of INRM technology (Tadesse, 2008). This findings are in agreement with Rogers (1995), defined adoption process as "the mental process through which an individual passes through from first hearing about an innovation to final adoption. The innovation-decision theory of adoption has five steps". These steps include knowledge (awareness), persuasion (interest), decision/evaluation), implementation, (trial) and confirmation (adoption or use). According to the theory the individual seeks knowledge of and skills which will ultimately affect the adoption process. Mass media transmits skills and knowledge that will enhance the adoption of INRM technology.

4.4.9 Farmers interaction with governmental, non-governmental organization, local cooperatives and community based organizations.

Analyzed data in Table 4.25 below presents results on farmers' interaction with various development organizations (governmental, non-governmental organizations, local cooperatives and community based organizations) for adoptors and non adoptors. Interaction with development agent is supposed to have a direct influence on the adoption behavior of farmers (Rahmeto, 2007). When there is contact with development agent, there is the possibility of farmers being influenced to adopt agricultural innovation (Rahmeto, 2007).

Table 4.25: Farmer's interaction with various organizations (Adopters and Non adopters)

Adopters

Organization	**Interaction**							
	Never		**Often**		**Rarely**		**Total**	
	N	%	N	%	N	%	N	%
Government Organization	71	67.6	27	25.7	7	6.7	105	100
NGO	72	68.6	26	24.8	7	6.7	105	100
Local cooperative	98	93.3	5	4.8	2	1.9	105	100
CBO	59	56.2	28	26.7	18	17.1	105	100

chi-square =9.116, P=0.028

Non Adopters

Organization	**Interaction**							
	Never		**Often**		**Rarely**		**Total**	
	N	%	N	%	N	%	N	%
Government Organization	77	84.3	15	11	3	2.6	115	100
NGO	100	86.9	26	9.5	4	3.5	115	100
Local cooperative	98	85	7	6.1	10	8.7	115	100
CBO	88	76.5	15	13	12	10.4	115	100

chi-square =9.116, P=0.028

4.4.9.1 Interaction with Government Organization

As indicated in Table 4.25 above the majority (67.6%) of total adaptors had not interacted with governmental organizations and the rest 32.4% had interacted with government organizations at different level of level of frequency.

Interaction with cooperative society had a significant relationship (chi-square =9.239, P=0.031) with the adoption of INRM technology at 95% confidence level. This significance relationship between interaction with government and adoption of INRM technology is an indication for the importance of government organizations in supporting agricultural production particularly crop farming

Interaction with government organization had a significant relationship with the adoption of INRM technology (Table 4.25). The government plays a great role in providing information and extension service to farmers (Rahmeto, 2007). A farmer who interacts with government organization has more chance to get information and training in agricultural production (Rahmeto, 2007). Therefore, interaction with government organization was expected to have positive and significant relationship with adoption of INRM technology (Rahmeto, 2007).

The significant relationship (Table 4.25) between membership and interaction with government organizations and adoption is an indication for the importance of government organizations in supporting agricultural production. Farmers who had interacted with government organizations were found to be better in access to and use of extension information (Tadesse, 2008). This agrees with the study carried out by Nkonya e*t al.*, (1997) who found out that there was positive and significant relationship between interaction with development agent and adoption of improved maize seed and fertilizer in North Tanzania.

5.4.9.2 Interaction with Cooperative

The membership of cooperative society and interaction with cooperative society had a significant relationship with the adoption of INRM technology (Table 4.25). Ninety eight (93.3%) of the adopters were found to be non-members of any local cooperative society and had never interacted with any local cooperative society and the rest 6.7% were reported to be members and had interacted with cooperative societies at different level of frequency.

As was expected, interaction with cooperative society had a significant relationship (chi-square =9.116, P=0.028) with the adoption of INRM technology at 95% level of confidence. This significance relationship between membership of a cooperative society and adoption of INRM technology is an indication for the importance of rural financial institutions in supporting agricultural production particularly crop farming. Cooperative members were found to be better in access to and use of credit services. Cooperatives serve as an important source of rural credit and input supply (Tadesse, 2008). A farmer who is a member or service cooperative has more chance to get credit. Therefore, the membership in cooperative and interaction with cooperative has been observed to have positive and significant relationship with adoption of INRM technology (Tadesse, 2008).

The significant relationship between membership and interaction with cooperative society and adoption of INRM technology is an indication for the importance of cooperatives in supporting agricultural production. In previous studies Cooperative members were found to be better in access to and use of credit services (Tadesse, 2008). This agrees with the study carried out by Nkonya e*t al.*, (1997) who found out that there was positive and significant relationship between interaction with development agent and adoption of improved maize seed and fertilizer in North Tanzania.

4.4.9.3 Interaction with Non-governmental Organization

The interaction with non-governmental organization had a significant relationship with the adoption of INRM technology (Table 4.25). The majority (68.6%) of total adaptors had not interacted with non-governmental organizations and the rest 31.5% had interacted with non-governmental organizations at different level of frequency. Non-governmental organizations play a great role in providing information and extension service to farmers. A farmer who interacts with non-governmental organization has more chance to get information and training in agricultural production (Tadesse, 2008).

As was expected, interaction with NGOs had a significant relationship (chi-square =9.236, P=0.035) with the adoption of INRM technology at 95% level of confidence. This significance relationship interaction with NGOs and adoption of INRM technology is an indication for the importance of NGOs in supporting agricultural production particularly crop farming. The significant relationship between interaction with nongovernmental organizations and adoption is an indication for the importance of non-governmental organizations in supporting agricultural production. Farmers who had interacted with non-governmental organizations were found to be better in access to and use of extension information. Key informants from public institutions identified NGOs such as CARE, C-MAD, GIZ and AEP as some of the NGOs that have programmes in the division. This agrees with the study carried out by Nkonya e*t al.,* (1997) who found out that there was positive and significant relationship between interaction with development agent and adoption of improved maize seed and fertilizer in North Tanzania.

4.4.9.4 Interaction with Community Based Organization (CBO)

Interaction with community based organization had a significant relationship with the adoption of INRM technology (Table 4.25). The majority (56.2%) of total adaptors had not interacted with community based organizations and the rest 43.8% had interacted with community based organizations at different level of levels.

As was expected, interaction with CBO had a significant relationship (chi-square =8.236, P=0.178) with the adoption of INRM technology at 95% level of confidence. This significance relationship between interaction with CBO and adoption of INRM technology is an indication for the importance of CBOs in supporting agricultural production particularly crop farming. Community based organizations play a great role in providing information and extension service to farmers (Tadesse, 2008). A farmer who interacts with community based organization has more chance to get information and training in agricultural production (Tadesse, 2008). Therefore, interaction with community based organization was hypothesized to have positive and significant relationship with adoption of INRM technology (Tadesse, 2008).

The significant relationship between interaction with community based organizations and adoption is an indication for the importance of community based organizations in supporting agricultural production Nkonya e*t al.*, (1997). Farmers who had interacted with community based organizations were found to be better in access to and use of extension information (Rahmeto, 2007). This agrees with prior expectation and confirms the study carried out by Nkonya e*t al.*, (1997) who found out that there was positive and significant relationship between interaction with development agent and adoption of improved maize seed and fertilizer in North Tanzania. This finding agrees with the theory of Adoption-Diffusion Model Which is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems and supported by socio-economic factors . This model was proposed by a sociologist Milton Coughenour (1991). Interaction with various organizations enhances the adoption of INRM technology.

The above findings were also in agreement with the diffusion and adoption theory propounded by Rogers (1995) and also previous research work carried out by various researchers on determinants of adoption of INRM technology. Rodgers (1995) stated that the process of adoption consists of a series of actions and choices over time through which an individual evaluates a new innovation or idea and then decides whether to adopt or reject the practice. The speed with which people move from one stage to another varies from one person to another and depends on institutional factors that can subsequently affect the adoption of the technology. This results of this study proved that the majority of institutional factors were positively related to the adoption of INRM technology in Ndhiwa Sub County, Homa bay County, Kenya.

4.5 Influence of Socio-Cultural Factors and Adoption Level of INRM Technology

The farmers were asked to respond to a set of questions on the socio-cultural factors that have influence on the adoption of INRM technology. The factors identified by the farmers included, perception about INRM technology, leadership status, cultural beliefs, cultural traditions, cosmopoliteness and social norms.

4.5.1 Cultural Beliefs

According to Table 4.26 above, 83.8% out of 105 adopters indicated that cultural beliefs influenced the adoption of INRM technology as compared to (16.2%) who disagreed. This was further reinforced by FGD. The cultural beliefs that farmers identified to be a hindrance to adoption of INRM technology are that some tree species cause death and loss of soil fertility, women are not allowed to grow trees and trees are owned by men.

Table 4.26: The relationship between cultural beliefs and adoption of INRM technology

Cultural beliefs	Adopters (n=105)	Non-adopters (n=115)
No	17(16.2%)	10(8.7%)
Yes	88(83.8%)	105(91.3%)
Total	**105(100%)**	**115(100%)**

Chi-square=9.116, df=3, P=0.028

Results from analysis by chi-square indicated that there was a significant relationship (chi-square=9.116, P=0.0028) between cultural beliefs and the adoption of INRM technology.

Using interview schedule with key informants and guided discussions with two women groups and elders, it came out clearly that traditions/customs influence participation of women for it is a taboo in the society for women to grow *Euphorbia triculli*, *Agave sisalana, Albizia coriaria, and Tamarindus indica.* The above responses from respondents, key informants and women groups agree with the findings of According to Rocheleau (1992), that certain tree species may have culturally defined gender specific and ownership restrictions. It is alleged that if a woman plants a tree, she will become barren and her husband will die Chavangi (1984). Human beings tend to internalize the beliefs of people around them especially during childhood and cling to the minds for long periods to come. Normally, beliefs/norms influence human beings ehaviour/attitude. Some beliefs may be true while may not be true but because not many people can risk to confirm otherwise, the belief stays.

Findings from the key informant interviews also revealed that land and trees belong to men hence women farmers had no incentive to conserve the soil leading to low adoption of INRM technology. During FGD with farmers, one female farmer pointed out that,

> "beliefs, cultural attitudes and social norms such as trees and land belong to the men were deterrent to the adoption of INRM technology by women farmers since trees and land belong to men most women are not motivated to adopt INRM technology even though they are aware that the INRM technology could restore soil fertility and improve agricultural productivity in this area".

This therefore confirmed that there was a significant relationship between cultural beliefs and the adoption of INRM technology and underscores the importance of cultural beliefs on the adoption of INRM technology. This agrees with the findings of Ani (2002) that cultural beliefs were significantly related to the adoption of new recommended farm practices. Traditional culture and beliefs play a powerful role in influencing people's decision making and actions (Ani, 2002).

Traditionally, women have a lesser role than men in the decision making process that affect and control their own lives and those of their homesteads and entitlements (Flintan, 2003; Muir, 2006). Papadopoulus (2010) concludes that culture has some positive attributes which include: that it organizes individuals life daily, weekly, annually and the prevailing customs and traditions bind individuals to the group, that it provides individuals with the face–to-face human interaction and tactile contact that are needed for human development and survival and, that it gives a sense of belonging to a group that is collectively wiser than any individual. Phiri *et al.* (2003) establish that proportionately more men plant improved fallow than women primarily because married women need consent from their husbands before planting trees. This finding is agrees with the theory of Adoption-Diffusion Model. This model is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems. This model was proposed by a sociologist Milton Coughenour (1991). In this case the socio-cultural subsystem influenced the adoption of INRM technology in Ndhiwa.

4.5.2 Cultural Traditions and Social Norms

According to Table 4.27 above, 85.7% out of 105 adopters indicated that cultural traditions and social norms influenced the adoption of INRM technology as compared to (14.3%) who thought otherwise.

Table 4.27: The relationship between social norms and adoption of INRM technology

Traditions & social norms	Adopters (n=105)	Non-adopters (n=115)
Yes	90(85.7%)	105(91.3%)
No	15(14.3%)	10(8.7%)
Total	**105(100%)**	**115(100%)**

Chi-square=12.065,P= 0.006, df=3

In order to understand the relationship between social norms and the adoption of INRM technology, chi-square test was conducted. The result of chi-square test (Chi-square=12.065,P= 0.006, df=3) revealed that there is a significant relationship between social norms and the adoption of INRM technology. During KII, participants identified cultural traditions such as land is owned by men, women are not supposed to attend meetings and take leadership roles and the head of the household has to plant trees first before others plant as some of the cultural traditions influencing adoption of INRM technology. Additionally field observations and confirmation through key informants from public institutions revealed that this is true even in the present day and age. Some of the beliefs when women defied beliefs/norms include deaths of their children and husbands and because death is feared, no woman is ready to experiment. A belief is located in the brain of a person and can greatly influence decisions. At triangulation stage, it came out clearly that key informants concurred with farmers that beliefs/norms negatively influence participation of women in tree growing. This outcome agrees with Chavangi (1984) that if a woman plants a tree, she will become barren and her husband and children will die. Beliefs and norms make people to fear the consequences especially if associated with negative consequences. The finding further agrees with that of Makindi (2002) that certain taboos and beliefs bar women and female children from planting trees.

During FGD with sampled farmers, one youthful farmer pointed out that:

> "Beliefs, cultural traditions, attitudes and social norms such as trees and land belong to the men are deterrent to the adoption of INRM technology by women farmers. Culture, socio-economic environment and level of income are the major factors influencing gender roles and decision making in the household as well as access to resources in Ndhiwa. In this region traditional attitude still persist; women bear the burden of water and fuel collection and other household labor. Cultural tradition still hold strong and income levels are relatively low, women bear the burden of household labor while men are not expected to sit and relax at home."

During FGD with sampled farmers, a 40 years old female farmer farmer also pointed out that:

> "In a polygamours home, the eldest wife is left to start cultivating her land. The elder wife was to also plant first. At harvesting time it is the same. Eating the crops is the same. This lowers the rate of adoption of INRM technology. Every agricultural practice begins with the senior members of the society hence the slow pace/rate of adoption of INRM technology".

This implies that cultural traditions and social norms are positively associated with the adoption of INRM technology in Ndhiwa Sub County, Homa Bay County. This agrees with the findings of Ani (2002) that cultural traditions and social norms were significantly related to the adoption of new recommended farm practices among rural women in Southern Ebony state, Nigeria. From the findings above, socio-cultural factors are at play. There are activities which are to be performed by men and there are those to be performed by women. However, when women perform activities which are associated with men, then they are doing them on behalf of men not on their own behalf. All activities in tree growing are for men except weeding and watering which are for women. The sentiments for discrimination of women with respect to tree growing were agreed by all respondents. The allocation of duties is discriminating against women. The finding of the study supports that of Ekisa (2010) that cultural aspects for community limits participation of women in a forestation and agr0-forestry programs.

While traditions will differ between individuals and regions, it is clear that tradition underpins the *"social organization of agriculture"*. Traditions are formed over generations because they are believed to be the best or most appropriate way of doing something (Dunn *et al*., 2000). This finding are in conformity with the theory of Adoption-Diffusion Model. This model is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems. This model was proposed by a sociologist Milton Coughenour (1991). In this case the socio-cultural subsystem influenced the adoption of INRM technology in Ndhiwa.

4.5.3 Cosmo Politeness

Cosmo politeness is the degree of orientation of the respondents towards outside social system to which he or she belongs. It can be measured by frequencies of visits to outside his or her area of residence for several reasons. It can be seen from Table 4.28 that 57.6% of the adaptors never visited the nearby town while 28.6% and 14.3% of the total adaptors visited the nearby town often and rarely respectively.

Table 4.28: Distribution of respondents on the basis of their visit to nearby town

Frequency of visit to Nearby town	**Visit**							
	Never		**Often**		**Rarely**		**Total**	
	N	%	N	%	N	%	N	%
Adopters	60	57.6	30	28.6	15	14.3	105	100
Non adopters	71	67.6	27	25.7	7	6.7	105	100

Chi-square 51.460, df=12, P=0.000

The crosstab analysis (Chi-square 51.460, df=12, P=0.000) revealed that there existed a significant relationship between Cosmo politeness and the adoption of INRM technology.
The result above confirms that most farmers had not visited nearby urban centers frequently hence the low adoption of INRM technology in the study area. Cosmo politeness as independent variable is expected to have positive relationship with the adoption of innovation (Rodgers and Shoemaker, 1971). Cosmo politeness provides more chance of exposure to external information and environment.

The main purpose of visiting the nearby town as expressed by farmers was to purchase farm inputs and sale farm produce. Some of them were visiting the nearby divisions and counties to visit friends and relatives, to get banking services, for amenities, and for entertainment purposes. This finding is agrees with the theory of Adoption-Diffusion Model. This model is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems. This model was proposed by a sociologist Milton Coughenour (1991). In this case the socio-cultural subsystem influenced the adoption of INRM technology in Ndhiwa.

4.5.4 Leadership Status

As indicated in Table 4.29, from the total adopters 33.3% participated in different leadership status at different local organizations and the rest 66.7% did not participate in leadership. From the non-adopters group 17.4% participated in leadership while 82.6% did not.

Table 4.29: The relationship between leadership status of respondents and adoption of INRM technology

Participation in Leadership	Adopters (n=105)	Non-adopters (n=115)
Yes	35(33.3%)	20(17.4%)
No	70(66.7%)	95(82.6%)
Total	**105(100%)**	**115(100%)**

Chi-square= 18.429, P=0.000, df=3

Chi-square (Chi-square= 18.429, P=0.000, df=3) statistical analysis revealed that there is a significant relationship between adoption of INRM technology and leadership status. This revealed that there is significant relationship between adoption and leadership influence on the adoption of INRM technology. This is because most respondents had not participated in leadership (Table 4.30) hence the general low adoption of INRM technology.

Participation in the community development activities is perceived as a willingness of a person to work together (Rahmeto, 2007). The relationship between leadership and adoption is associated with interpersonal networking and exchanges between adopters and non-adopters of technology (Tadesse, 2008). In this study leadership was identified by farmers as involvement of the respondents in any informal and formal organizations as a member and leader. Additionally Key Informants stressed the farmers who had leadership roles were better adaptors of INRM technology. The findings of this study are in line with the findings of Tesfaye (2006) where he detected the relationship between leadership and adoption of rain water harvesting technology. Similar results were identified by Tadesse (2008) who confirmed significant and positive relationship between leadership status and adoption of improved onion production package in Fogera district, South Gandar, Ethiopia.

Findings from this study indicated that while most socio-cultural variables had a positive influence on the adoption of INRM technology some variables had no influence on the adoption of INRM technology in Ndhiwa division. The findings agrees with the theory of Adoption-Diffusion Model. This model is a macro framework for examining a large social group as a diffusion system. This model states that, technology adoption takes off from innovative to communicative and practitioner sub-systems. This model was proposed by a sociologist Milton Coughenour (1991). In this case the socio-cultural subsystem influenced the adoption of INRM technology in Ndhiwa.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter summarizes the study by highlighting the methodology used in the study, location, sample population and research findings. Conclusion and recommendations are also discussed in this chapter.

5.2 Summary

This study was set to investigate the determinants of the adoption of INRM technology in Ndhiwa division, Homabay County, Kenya. This study was prompted by the need to have farmers adopt INRM technology and also mainstream them as part of their farming systems so that they could realize its potential. The interest to study the adoption of INRM technology resulted from the author's previous involvement with development research in INRM technology among smallholder farmers and the realisation that despite the potential that INRM technology has to improve livelihoods, it was not being adopted to the level that its impact could be achieved. INRM technology have potential to address land productivity, to increase crop, tree and fodder production, and address immediate food needs. It also has capacity to ameliorate the environment, and increase farmer's incomes. In view of INRM technology' potential to increase land productivity, various extension initiatives including on-farm research, have been pursued to promote INRM technology.

These possibilities have persuaded various development organizations to promote INRM technology in Western Kenya. Most of the smallholder farmers in rural Kenya are faced with many challenges pertaining to their livelihoods including food, nutrition, and health challenges. They therefore prefer to adopt agricultural technology that translate into immediate results. They require a lot of encouragement to invest in technology such as INRM technology that require them to wait even a few years before they can achieve the benefits. With INRM technology, farmers need to invest at least two to three years in tree growing before they can get benefit from their investment. Therefore, farmers need to be helped so that they consider trialling INRM practices and eventually adopt them.

The study was also necessary because of the performance of crops has remained low even after the introduction of INRM technology. The low adoption levels of the technology affect the overall crop production in the area. The general objective of this study was to investigate the factors that influence the adoption of INRM technology among the smallholder farmers in Ndhiwa division, Kenya. It was assumed at the outset of this study that adoption of INRM technology was a function of socio-economic, institutional and socio-cultural factors. One research question and three hypotheses were developed for this study: 1. what is the level of adoption of INRM technology in Ndhiwa division? 1. Socio-economic factors do not significantly influence the adoption INRM technology by small-scale farmers in Ndhiwa division, Kenya. 2. Institutional factors do not significantly influence the adoption INRM technology by small-scale farmers in Ndhiwa division. 3. Socio-cultural factors do not significantly influence the adoption INRM technology by small-scale farmers in Ndhiwa division. Therefore, addressing research questions 1 and hypotheses 1 to 3 provides a useful summary of the findings of the factors that are critical to the understanding of the adoption of INRM technology.

The study used a cross-sectional survey research design utilizing an ex-post-facto approach. Data was collected from a sample of 220 farmers from different locations in the study area. Results of data analysis indicated that 47% of the farmers in the study area had adopted

INRM technology while 53% of the farmers had not adopted INRM technology. This was low given that the technology have been in existence for more than three years.

Regarding adoption of the INRM technology in relation to selected variables, a number of factors showed varying relationship. For instance family size and tenancy status seemed not to influence farmer’s adoption of INRM technology. On the other hand socio-economic factors like level of education, income, farm size, off-farm income influenced the adoption of INRM technology.

Institutional factors such as access to extension, membership of social groups, access to inputs, access to credit and market also influenced the adoption of INR technology. Additionally socio-cultural factor such as cultural traditions, beliefs and social norms and seemed to influence the farmers’ adoption of INRM technology in the study area.

Findings suggest that low adoption rates can be improved through ensuring careful implementation of extension programs. With high adoption of INRM technology, agricultural productivity is likely to increase. The evidence provided by the results suggest that with inputs being made available to farmers, offering training on how to practice these technology and exposing farmers to success stories of where these technology have demonstrable effects would increase the rate of adoption. Training can improve the odds of successfully implementing INRM technology. Farmers who are willing to participate in INRM technology can initially be identified and allowed to participate in demonstrations, trainings and field days. They can also be involved in training other new adopters. An interesting finding is that the involvement of researchers in INRM technology extension can influence adoption of INRM technology.

This goes to show that farmers trust information when it is passed on from technocrats. Therefore empowering local level extension workers is important so they can promote INRM technology with confidence and that this would motivate more farmers to participate. Extension staff needs to work closely with the farmers in order to improve their confidence with INRM technology. This is an important component of the development process.

The implications of these findings are that institutions mandated with research and developments of INRM technology have roles to play in ensuring that agroforestry is promoted and that user realise the impact of practicing it. High rates of adoption and increased impact of INRM technology could however be achieved if INRM technology became part of the priorities of the Ministry of Agriculture, development agencies and Cooperatives and funding was extended beyond research to include support for extension activities through the national budgetary system. In order for INRM technology to be adopted widely by farmers, the Ministry of Agriculture need to invest in both research and extension of INRM technology through support for INRM technology training at all levels, provision of inputs and incentives to farmers that would motivate farmers to invest in INRM technology. If INRM technology is to succeed, there must be investment in capacity building. Proper training of extension workers in order to provide them with current and accurate information on recommendations of INRM technology would benefit adoption of INRM technology.

In terms of contribution to adoption theory or where differences with current theory have been observed. First, it should be mentioned that the adoption process seems complex which is perhaps why several adoption models have been developed. However this study considered two of them in particular: the adoption - diffusion model (Rogers, 2003) and the innovation-decision model (Rogers, 1995).

The diffusion of innovations is a social process in which information about a new idea, innovation or technology is communicated from person to person (Rogers, 2003). Conceptual framework presented variables, each of which is a group of important factors that influence adoption of an innovation. This are, perceived attributes of the innovation; type of innovation decisions; communication channels; the nature of social system; socio-economic factors, institutional factors and socio-cultural factors (Rogers, 2003).

Theoretical framework has reviewed the limitations of the adoption-diffusion model. Despite those limitations, it is important to commend Rogers for providing a valuable model as a basis for adoption and diffusion studies. The model is comprehensive and including the attribute of "re-invention" to the "perceived attributes of the innovation" variable, as Rogers (2003) suggests, is commendable for INRM technology adoption. However, it would not be practical to cover all the aspects that are proposed in that model in one study. The model does not specifically account for farmer or farm variables, and I would agree with Rolings (1988) that these need attention especially in the context of this study area where these variables are so diverse.

The "type of adoption decision variable, should be considered together with the nature of the social system. This is suggested because decisions are made in most communities based on the existing social system and social networking plays a role in these situations. When Rogers looked at the types of innovation decisions and categorized them into three: optional; collective; and authority, it would appear that he was looking more from the perspective of the way institutions or organizations made decisions. In the case of smallholder farmer situations, decisions are usually individual except perhaps in the case where NGOs decide that project beneficiaries also implement a certain type of agricultural practice. The latter case usually leads to discontinuance after the end of NGO support. NGO and government decisions imposed on farmers would be good examples of authority innovation decisions. In the case of the collective innovation decisions, farmer groups and cooperatives would be good examples. Rogers was basing his categorisation on the existing structures in the developed world, most of which would be different setups to those existing in most developing countries. Therefore, if individual farmer attributes are considered as part of the model, they could cater for the optional innovation-decision since they could not be considered in isolation from farmer situations. And both the collective and authority innovation-decision types would make sense to study in tandem with the nature of the social system.

Finally this research has provided a basis for similar studies in the future. In accomplishing this research objective, this study contributes significantly to our understanding of the INRM technology adoption process. It documents types of INRM technology that are available to smallholder farmers, which if farmers adopted them, would make significant improvements to farm livelihoods.

Previous studies on adoption have concentrated on improved fallows, agroforestry and soil conservation, but this study extended knowledge by looking at INRM technology consisting of use of stover lines, manure , fertilizer and agroforestry. This study has recorded the extent of practice of these technology within the study area that can act as a basis for future studies as well as development programs.

This study adds knowledge on adoption of INRM technology transfer as well as contributing to the literature on technology adoption. It provides insights on the adoption levels of INRM technology in the study area as well as contributing to understanding of adoption of INRM technology. In addition, the study contributes to the body of knowledge on the influence of extension on adoption of INRM technology. Extension variables have in the past been rarely if ever considered. This study has identified various factors that may result in low adoption rates. If these factors are addressed at the technology diffusion planning stage, that would improve uptake of INRM technology. The study also provides a methodology that can be used to analyse factors that influence adoption, not only for INRM technology but other agricultural and natural resource management technology. The study might also provide guidance about data collection in rural communities by identifying factors to include in future studies. The findings of this study have potential to assist extension, research and other organisations involved with INRM technology development to prioritise their work based on the circumstance and needs of the farmers, as doing so would improve the adoption of INRM technology, and especially mainstreaming it alongside other agricultural technology.

5.3 Conclusion

The investigation of the determinants of adoption of modern INRM technology by small scale farmers in Ndhiwa division is timely and for great importance. This study has provided empirical on the factors influencing adoption of INRM technology. Age, household income, gender, level of education, income, farm size, family size and farming experience are keys precondition for the adoption of INRM technology to occur. Other factors that have been shown to determine adoption of agricultural technology include access to extension, membership of social groups, access to inputs, access to credit and market, cosmopoliteness and exposure to mass media.

Further, cultural traditions, beliefs and social norms seemed to influence the farmers' adoption of INRM technology in the study area. Understanding the factors that influence or hinder adoption of INRM technology is essential in planning and executing INRM technology related programmes for meeting the challenges of food production in developing countries.

Therefore to enhance INRM technology adoption by farmers, it's important for policy makers and developers of new technology to understand farmers need as well as their ability to adopt INRM technology in order to come up with INRM technology that will suit them. Due to this, institutional support should be provided in this sector, such as credit and extension to enhance the adoption of INRM technology.

5.4 Recommendations

The following recommendations have been suggested from the findings and conclusions of the study.

(i) Strategies should be developed to favor young and women farmers since they are the majority who engage in agricultural activities on the ground. Policy makers should consider provision of small credit to farmers to help them meet the cost of adoption of INRM technology. Such credits will go to purchasing of seeds, fertilizer and chemicals which are very expensive.

(ii) Ways and means of encouraging small-scale farmers to adopt INRM technology without necessarily relying on government subsidies should be developed by encouraging them to form small groups with revolving funds. Farmers should be encouraged to form groups so that they can access credit and bargain for prices of their commodities. This will lead to improved adoption of INRM technology.

(iii) Extension agents should consider improving their level of participation in joint activities. They should also consider improving the number of visits to farmer's field to understand the farmers' conditions better. Plenty of extension effort is needed in dissemination of INRM technology information. This effort could be in terms of field days, farm visits, agricultural shows, holding demonstrations that focus on new technology. This will lead to improvement in the adoption of INRM technology in Ndhiwa Sub County.

(iv) Farmers should be sensitized on socio-cultural aspects that hinder adoption of technology in the division.

(v) More emphasis should be put in place to sensitise the community members to change their attitudes towards women with respect to tree growing.

(vi)

5.5 Areas For Further Studies

- An in depth study on the effect of research, extension and farmers linkages on the adoption of INRM technology.

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APPENDICES

APPENDIX A

QUESTIONNAIRE FOR FARMERS

"Determinants of adoption of INRM practices by small scale farmers in Ndhiwa Division, Ndhiwa District, Kenya."

You have been selected among other farmers to assist in providing information on determinants of adoption of INRM practices in the Division. Any information provided will be treated with utmost confidentiality.

Please provide responses to the following items as directed.

RESPONDENT'S IDENTIFICATION AND SOCIO-ECONOMIC FACTORS

1. Questionnaire No. ____
2. Interviewees Name____
3. Location ____
4. Plot No.____
5. How old are you?

   □ Less than 20 years

   □ 21-30 years

   □ 31-40 years

   □ 41-50 years

   □ Above 51 years

6. Relationship to the household head.

   ____

7. What is your educational level (in years) spent in school?

□ None (0)

□ Lower primary (1-4)

□ Upper primary (5-8)

□ Secondary (9-12)

□ Post-secondary (>12)

8. Gender

□ Female □ Male

9. Please indicate to me the income category that would best represent your household's total monthly earnings

□ Less than 3000/=

□ 3001-6000/=

□ 6001-10,000/=

□ Greater than 10,000/=

10. In total how many people stay in your household?

____

11. Do you as a household engage in non-farm activities?

[ ] YES [ ] NO

12. (IF YES ABOVE), which are these non-farm activities?

____

____

____

____

13. What is the monthly income from the non-farm activities?________________________________

14. How long have you participated in these activities? ______________________________

15. What is the estimated size of your land in acres? ____

SECTION B (ADOPTION OF IMPROVED IRM PRACTICES)

Respond to the following items as per the instructions

Please indicate by use of (√).

16. What type of trees do you plant?

☐ Local composite

☐ Hybrid seeds

17. Do you have forested areas on your land?

☐ YES

☐ NO

18. What portion of your land is forested?

☐ More than four hectares

☐ Three to four hectares

☐ Two to three hectares

☐ One to two hectares

☐ Less than one hectare

☐ None

19. What is the benefit of these forested areas?

____

20. Do you use any fertilizer in your farm?

 Sometimes

 Yes

 No

21. Which one of the following fertilizers do you use on your sorghum crop? (Multiple responses allowed)

 DAP

 FYM

 Mixture of different types of fertilizers

 Others (specify)

22. Do you top-dress your crops?

 Yes

 No

23. Do you ever control pest and disease in your farm?

 Yes

 No

24. What methods do you use in controlling the pest and disease in your farm?

 Indigenous technology

 Chemical methods

 Cultural practices

25. What one main method do you use in conserving your soil?

□ Agro-forestry

□ Stover lines

□ Manure

[ ] Fertilizer

26. How long have you practiced the above?

____

27. How long have you been growing trees?____

SECTION C (INSTITUTIONAL FACTORS)

Respond to the questions below as directed by the respective instructions

Please indicate by use of a (√).

28. Do you own land?

[ ] YES

[ ] NO

29. IF YES ABOVE, how much do you own? ____________________________________

30. What is your family land ownership status?

□ Communal

□ Private ownership

□ Rented/Leased

□ Other (specify)

31. What acreage is under the following land use?

[ ] Pasture

[ ] Arable crops

[ ] Homestead

[ ] Fallow

[ ] Woodlots

32. What types of agricultural activities do you undertake?

[ ] Crop farming

[ ] Livestock production

[ ] Mixed farming (crop and livestock)

[ ] Agro forestry

[ ] Other (specify)____

33. Are you aware of any active self-help group/CBO/FBO?

[ ] YES

[ ] NO

34. If yes, are you a member of any self help group/CBO/FBO?

[ ] YES

[ ] NO

35. IF YES what types of agricultural organization or group do you belong to?

□ Input supply

□ Credit

□ Marketing

□ Cooperative

□ Others (specify)

36. How many organizations do you belong to?

□ More than four

□ Three

□ Two

□ One

□ None

37. What is the benefit of your membership to you as an individual?

□ Income generation

□ Improved food production

□ Crop and livestock sale

□ Merry go round

[ ] Other (specify)

38. How do you utilize your farm produce?

□ Subsistence

□ Commercial

□ Others (specify)

39. Do use farm inputs?

[ ] YES

[ ] NO

40. IF YES, what type of inputs do you use?

[ ] Improved seeds

[ ] Improved tree seedlings

[ ] Fertilizers

[ ] Organic manure

[ ] Herbicides

[ ] Pesticides

[ ] others(specify) ____

41. What is the source of your farm input?

 Agro- shop

 From the neighbors

 From family members

 Other (specify)

[ ] Market vendor

[ ] NGOs

[ ] Co-operatives/ farmers associations

 Other (specify)

42 .IF NO, why are you not using any of the farm inputs?

 Expensive

 Not available

 Tried and failed

[ ] Never tried before

[ ] Others (specify)

43. Have you ever used credit on farm activities?

 Yes

 No

44. If yes, what was the source of the credit

 Bank

 Cooperative

□ Relatives

□ Informal

□ Others (specify)

45. Which micro credit institution do you know in this area?

[ ] Saga thrift

[ ] Kenya Women Finance Trust

[ ] K-Rep

[ ] KADET

[ ] Do not know

[ ] Other (specify) ____

46. Have you ever benefited from any of these Micro Credit Institutions?

[ ] YES

[ ] NO

47. Do you interact with extension staff

 Yes

 No

48. In the past one year have you received any agricultural extension service?

[ ] YES

[ ] NO

49. If yes, where did you receive the services?

[ ] Friends and neighbor

[ ] Chiefs baraza

[ ] GOK extension officers

[ ] NGO

[ ] Public information (radio, magazines)

[ ] Other (specify)

50. How did you receive the information?

[ ] Seminars

[ ] Workshop

[ ] Field visit

[ ] Exposure visits

51. What is the level of knowledge of the household head on the following technology? Rate by selecting the appropriate level using the scale.

1- Nil; 2- Low; 3- Moderate; 4- Good; 5- Excellent

LEVEL OF KNOWLEDGE		**ARE THEY ADOPTING(1- YES; 2- NO)**
Use of certified seeds		
Crop pest and disease control		
Soil and water conservation		
Agro forestry		
Manure and fertilizer use		

52. In the past one-year, how many times have you participated in the following activities?

Contact with extension	**none**	**Once**	**twice**	**times**	**times**	**times**	**more than 5 times**
1. Individual visits by extension staff.							
2. Group visit by extension staff							
3. Visit to extension office by farmers							
4. Demonstrations on-farm							
5. Demonstrations on-station							
6. Farmers own demonstrations							
7. Barazas							
8. Shows							
9. Workshops							

53. The following statements relate to the roles played by extension agents' farmers and researchers in an on-farm research trial. Please indicate by use of a (✓) yes or no appropriately on the table to indicate the level of your agreement to the statements.

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

Statement	**SA**	**A**	**UD**	**D**	**SD**
1) Do you think the farmers are free to interact with research without involving the extension agents?					
2) Do you think you are free to modify the technology?					

3) Do you think that the technology farmers use are from the extension agents					
4) Farmers extension agents and researchers must be involved in technology generation process.					
5) Must priority setting involve farmers?					
6) Farmers can carry out on-farm research without the extension agents					
7) Can farmers be the leaders in on-farm trials?					
8) Have you ever helped extension agent's setup on farm trials?					
9) Do you think the local agro forestry composites are better than hybrid?					
10) Have you ever advised your neighbor on any agricultural practice?					

54. Indicate your access to and frequency of use of the following media material on agricultural programs related to INRM technology

Mass media	**How often do you use them**				
Radio	Never (0)	Rarely(1)	Occasionally(2)	Often(3)	Very often(4)
Television					
Leaflets					
Pamphlets					
Manuals					

Others					

55. Please indicate to me your level of interacting with each of the following institutions with respect to their Importance Services on sorghum production?

	Never – 1	Rarely - 2	Often - 3
Government organization			
Non Governmental			
Local co-operative			
Community Based Groups			
Others (specify)..			

SECTION D (SOCIO-CULTURAL FACTORS).

56. Does cultural beliefs associated with INRM technology in your society?

    [] Yes

    [] No

57. How are these beliefs associated with INRM technology?
58. How are the beliefs hindering/promoting use of INRM technology?
59. Does cultural traditions associated with INRM technology in your society?

    [] Yes

    [] No

60. How are these traditions associated with INRM technology?
61. How are the traditions hindering/promoting use of INRM technology?
62. Do you visit the nearby town or city?

[] Yes

[] No

63. How frequently do you visit the nearby town or city?

[] Daily

[] Most often

[] Once a week

[] Sometimes

[] Never

64. What is the purpose of your visit?

[] Agricultural and related like purchase/shopping/marketing

[] To visit friends/relatives

[] To get medical treatment

[] Entertainment

65. Are you involved in any activities of formal and informal institutions/organizations in your area?

[] Yes

[] No

66. Have you ever been a leader of the above?

[] Yes

[] No

67. Interviewers rating of the respondent's actual level of INRM technology adoption as compared to the optimal.

INRM technology	**Interviewers rating compared to the optimum (√)**							
	Very low(1)	**Low(2)**	**Medium(3)**	**High(4)**	**Very high(5)**			
Agroforestry								
Manure								
Fertilizer								
Stover lines								

68. What is your view on the advantages and disadvantages of INRM technology described above as a whole?

    a) Advantage is greater than the disadvantage

    b) Disadvantage is greater than the advantage

69. Give reasons for your answers above.

END OF QUESTIONNAIRE

Thank you very much for taking your time to provide requested information and may God bless you.

APPENDIX B

FOCUS GROUP DISCUSSION GUIDE FOR FARMERS: DETERMINANTS OF ADOPTION OF IMPROVED NRM PRACTICES BY SMALL SCALE FARMERS IN NDHIWA DIVISION, NDHIWA DISTRICT, KENYA.

DATE ____

FGD TEAM ____________________________________

PURPOSE OF THE FGD: To analyze the Socio-economic and Institutional determinants of Adoption of improved NRM practices in Ndhiwa division, Ndhiwa district, Kenya.

Key Theme: Understanding why households do not adopt improved NRM practices in Ndhiwa division, Ndhiwa district, Kenya.

Key questions to guide the FGD.

1. Ice breaker and introduction to purpose of the meeting.

2. What are the topics on improved NRM practices that you are exposed to?

3. What problems/difficulties did you encounter during the training?

4. To what extent do you think you are practicing what they have been taught?

5. Whom do you collaborate with as regards to the training on INRM Practices apart from the government?

6. Of the topics taught which ones did you find useful?

7. What is your opinion on the adoption of INRM practices in Ndhiwa division?

8. What is your view on the extent of agro forestry, use of Stover lines, use fertilizer and manure in management of soil in the division?

9. Which are the most important factors influencing smallholder farmer's adoption of INRM practices?

10. What is the influence of the above factors on the adoption of improved NRM practices?

11. What has been the impact of NRM on food security status of the households?

12. What do you think are some of the

(i) Customs

(vii) Attitudes

(iii) Beliefs

that promote/hinder the adoption of INRM practices in the division?

APPENDIX C

INTERVIEW (SCHEDULE) FOR KEY INFORMANTS

You are privileged to participate in this study on the Determinants of adoption of improved NRM practices by smallholder households in Ndhiwa division in your capacity as opinion leader. Your responses will be treated as a basis for policy making to better the livelihood of households in the division and nation as a whole.

1 What is your view on adoption of INRM in the division?

2. Where did you hear about improved NRM practices?

3. Was this the firs time you received formal training about improved NRM?

4. If not please tell me about other training you have received (where, when, topics)?

5. What do you think are some of the beliefs, attitudes, customs that hinder/ promote the adoption of INRM practices by farmers in Ndhiwa division?

6. Have you taught or showed someone else about a practice(s)?

7. Have NGOs or organizations come to your village?

8. Which ones?

9. What effects did the NGOs program or training have on the farmers?

10. Do you own a farm?

11. What do you grow in your farm?

12. Why did you decide to use these methods?

13. What are the sources of inputs (seeds/seedlings/fertilizer/manure)?

14. Are you satisfied with the quantity, quality and delivery time?

15. What type of INRM technology did the Ministry of Agriculture introduce?

16. How do farmers market their produce?

17. In what ways has the government, NGOs, CBOs facilitated marketing of produce?

18. What type of training/education have farmers received from the Ministry of agriculture, NGOs, CBOs on the following?

- General Cultural practice
- Natural resource Management
- Agro-forestry
- Agro processing

19. What methods do farmers use to make their soil better?

20. What do you think are the biggest problems facing farmers?

APPENDIX D

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THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss. ISAIAH KASE OKUTHE

of (Address) MASENO UNIVERSITY

P.O BOX MASENO

has been permitted to conduct research in .... Location,

NDHIWA District,

NYANZA Province,

on the topic DETERMINANTS OF THE ADOPTION OF INTEGRATED NATURAL RESOURCES MANAGEMENT TECHNOLOGIES BY SMALL SCALEFARMERS IN NDHIWA DIVISION NDHIWA DISTRICT, KENYA

for a period ending 30th APRIL, 2012.

PAGE 3

Research Permit No. NCST/RCD/10/012/03

Date of issue 13th FEBRUARY 2012

Fee received KSHS. 2000

Applicant's Signature

Secretary
National Council for Science and Technology