FACTORS INFLUENCING ADOPTION OF DROUGHT TOLERANT WHEAT VARIETIES IN THE ARID AND SEMI-ARID LANDS OF NAROK AND KAJIADO DISTRICTS-RIFT VALLEY PROVINCE OF KENYA

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DECLARATION AND RECOMMENDATION

DECLARATION

I declare that this Thesis is my original work and has not been submitted in this or any other form for the award of a degree in any other University.

Signed…….. Date…….

Alice Chesambu Ndiema

(ED12/0172/06)

RECOMMANDATION

This Thesis has been submitted with our approval as University Supervisors.

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I am grateful to God Almighty for making it possible for me to achieve what I have now. However a candidate success can never be the work of one person. There are many actors namely sponsors, academic advisors, lecturers, colleagues, friends and close relatives. In recognition of all these, I wish to thank them for walking with me along this tough journey. This study was made possible through the memorandum of understanding (MOU) between Egerton University and KARI-Njoro who provided an enabling environment for my studies. To them I say thank you. I also wish to thank the farmers of Ololung'a in Narok district and Isinya in Kajiado district for their infallible information and for responding positively to the study. I wish to thank my supervisors; Professor Abdillahi A. Aboud, Professor Miriam M. G. Kinyua and Dr. F. U. Ngesa for their guidance throughout my study. I wish to thank Mr. John W. Kamundia of KARI-Njoro biometrician for being an excellent data analyst. Special thanks go to my Husband Prof. C. K Ndiema and our children Victor, Lynnette, Steven and Mike for showing concern during my studies. To all and others I have not mentioned, may God Bless all.

DEDICATION

This study is dedicated to my family and all the wheat farmers in arid and semi-arid lands of Kenya. Let me pay special tribute to my husband Prof. C. K. Ndiema for his invaluable support and encouragement and our children, Victor, Lynnette, Steven and Mike for their love and patience. I also wish to pay great tribute to my late father Nelson Kimtai Ngeywo, may God rest his eternal soul in peace, my mother Esnarh Chesiriken Kimtai who never ceased praying for me and taught me to have hope and faith at all times. Their inspiration will always reign in me therefore wish to thank them for wishing me success. This study is also dedicated to anyone who may legitimately derive benefit from it for posterity‘s sake.

ABSTRACT

Adoption of agricultural technologies by farmers is influenced by a number of factors, which include the farmer and farm attributes, technology characteristics and institutional factors. It is on this premise that drought tolerant varieties (DTV) of wheat were developed for production in Arid and Semi Arid Lands (ASAL). This study was designed to assess low adoption by describing and comparing factors that have influenced adoption of DTV in the (ASALs) of Narok and Kajiado districts of Rift Valley Province-Kenya. A sample size of one hundred and eight (108) wheat farmers with seventy two (72) from Ololung'a division of Narok district and thirty six (36) from Isinya division of Kajiado district were randomly selected by use of random numbers sampling technique. Farmers' perceptions of DTV of wheat, adoption levels and the influence of personal, socio-economics and institutional factors on adoption were investigated. The data was collected using a validated questionnaire and analyzed using SPSS for windows. Generally, the adoption levels were very low. Farmer perception on (DTV) was very low (0.9%) with majority of the farmers (77.8%) being uncertain of the objective of the technology and its benefits Eighty seven point nine percent (87.9%) of the farmers identified input cost as a major constraint and 85.1% lacked the relevant information. Opportunities for adoption cited by 91.6% of the respondents included the availability of the required seed. There was no statistical significant difference in perception between the farmers of Narok and Kajiado districts. However, there were significant differences in adoption levels with the average percentage for Narok mean of 1.58 being higher than Kajiado mean of 1.33 with a t-test value of -2.497; ($P<0.014$; $\alpha=0.05$. Age, gender, and education did not have any statistical significance relationship in the adoption of DTV but farm size, land tenure system and extension services were statistically significant.

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AEZ	Agro-Ecological Zone
ASAL	Arid and Semi-arid lands
CIMMYT	Centre for Maize and wheat Improvement
DDP	District Development Plan
DTV	Drought Tolerant Varieties
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistics
GOK	Government of Kenya
KARI	Kenya Agricultural Research Institute
LH	Lower Highland Zones
LM	Lower Midland Zones
NDP	National Development Plan
UH	Upper Highland Zones

CHAPTER ONE

INTRODUCTION

1.1 Background Information

About one fifth of the developing world's wheat (*Triticum aestivum* L) is grown in areas that are regarded as arid and semi-arid lands (ASALs) for crop production because of drought, heat and soil problems (Torkamani, 2005; CIMMYT, 1997). Despite these limitations the world's arid and semi-arid lands and cropping environment are increasingly crucial for food security in developing world. Worldwide, land with inherent characteristics for arable crop production continues to decline, while population growth and demand for wheat are rising. Therefore gains in wheat production in ASAL environments are important because it is unlikely that increased production in the favourable environments will be sufficient to meet the projected growth demand for wheat from the present to 2020 (Alary *et al*, 2007; Ekboir, 2002).

Wheat is an important cereal crop in Kenya and ranks second after maize in its cereal crop priority. Increased population growth, urbanization and change in eating habits have lead to increased wheat demand. Therefore, this has led to the introduction of the crop to the traditionally non-wheat producing lowland regions below 1800 metres above sea level where it is now grown in both small scale and large-scale farms.

In Kenya, wheat farming in the high rainfall areas faces a number of challenges that influence efforts to increase land under wheat in ASALs. These lands form 83% of the country land mass. Such challenges include farmers' preference for other enterprises that are more suitable to high rainfall areas (Republic of Kenya, 2002). The dry areas, as characterised by low and unreliable moisture challenged researchers to experiment on

drought tolerant varieties of wheat and proper management in ASAL through participatory on-farm trials. The trials, undertaken in Makueni showed the existence of great potential to increase wheat hectarage and production output by small holder and large scale farmers in ASAL of Kenya (FAO, 2002). The challenges presented by ASALs include natural conditions such as low, unreliable and erratic rainfall, poor soils, pests and diseases and unsuitable technologies as witnessed and experienced by farmers in the region (Bett, *et al*, 1999). The full potential of exploiting the ASALs for increased wheat production has been hampered by the farmers' personal and socio-economic characteristics and institutional inefficiencies. The most critical of the technical discrepancies is the poor or lack of adoption of drought tolerant varieties of wheat (Rehman *et al*, 2007; Republic of Kenya, 2002).

Personal and socio-economic characteristics that are important in influencing adoption include: farmers' perception of drought tolerant varieties, age, gender, and education level, income and land size. Institutional inefficiencies, which are important, include, land tenure system, credit provision, marketing and extension services which have hampered the adoption of drought tolerant wheat varieties.

Horizontal expansion of wheat growing areas in recent years is taking place by moving into non-traditional areas formally considered unsuitable for wheat production (FAO, 2002). Most countries seek to address the problem of low self-sufficiency in wheat and the resultant drain on foreign exchange from wheat imports by introducing the crop in non-traditional wheat areas mainly in the arid and semi-arid lands. In Kenya, it has been introduced in Kajiado, Lower Narok, Machakos, Naivasha, Koibatek and Transmara among other districts (Kinyua, 1997). This creates the need to promote drought tolerant

varieties of wheat which will be suitable for these ASALs areas. However, wheat competes with different land uses and enterprises under complex tenure arrangements such as communal grazing and wildlife.

1.2 Statement of the Problem

Adoption of drought tolerant varieties of wheat has been very low among the farming communities in the arid and semi-arid lands (ASAL) of Ololung'a division of Narok and Isinya division of Kajiado districts. This state of affairs has persisted despite the development and existence of drought tolerant varieties of wheat for the region. This is manifested by continued crop failure experienced by farmers while they grow inappropriate varieties and crops. Although this may be caused by various factors, including personal characteristics, socio-economic, institutional, and technical factors, poor or lack of adoption of drought tolerant varieties of wheat is suspected to be one key factor. Thus, there was need for a study to identify and describe factors influencing adoption of drought tolerant varieties of wheat in arid and semi-arid land of Kenya, which are vast and cover about 83% of Kenya's total land surface and support approximately 25% of the human population. Such a study needed to specifically measure levels of adoption of drought tolerant wheat varieties and come up with specific recommendation on mechanisms of technology transfer in the ASAL of Kenya. Hardly has such a study been done in ASAL areas of Narok and Kajiado districts.

1.3 Purpose and Objectives of the Study

The purpose of the study was to identify and describe factors that influenced adoption of drought tolerant varieties of wheat in ASAL areas of Kenya so as to suggest remedies from the findings.

The following specific objectives were therefore formulated to guide the study.

i) To identify farmers' perception concerning drought tolerant wheat varieties (DTV) in arid and semi-arid districts of Narok and Kajiado.

ii) To determine and compare adoption levels of DTV of wheat by farmers of Narok and Kajiado districts.

iii) To determine the influences of farmers' personal and socio-economic factors on adoption levels of DTV in Narok and Kajiado districts;

iv) To determine the influences of institutional factors on adoption of DTV in Narok and Kajiado districts, including the institutions of land tenure, credit provision, marketing, and extension services

1.4 Hypotheses of the Study

The following four null hypotheses were tested for specific objectives i) through to vi);

$H\emptyset_1$: There is no statistically significant difference in perception of farmers of Narok and Kajiado districts regarding the attributes of drought tolerant wheat varieties.

$H\emptyset_2$: There is no statistically significant difference in adoption levels of Drought Tolerant wheat Varieties by farmers of Narok and Kajiado districts.

$H\emptyset_3$: There is no statistically significant influence between farmers' selected personal and socio-economic factors and adoption levels in Narok and Kajiado districts.

$H_{ø4}$: There is no statistically significant influence between institutional factors and adoption levels of DTV of wheat in Narok and Kajiado districts.

1.5 Significance of the Study

The potential to increase wheat production in Kenya is dependent on movement of the crop to non-traditional areas. This study therefore provides credible feedback to wheat researchers, extension agents and policy makers on how to improve dissemination of drought tolerant wheat varieties in the ASAL. Extension agents will hopefully use the information to promote and accelerate the level of adoption of drought tolerant wheat varieties among the farmers in arid and semi-arid land of Kenya and other parts of the world with similar conditions will benefit from the results of the study

1.6 Scope and Limitation of the Study

The study confined itself to examining the adoption of drought tolerant wheat varieties through the assessment of the farmers' personal and socio-economic characteristics (age, gender, level of education, income and land size) and the institutional factors (land tenure system, credit provision, marketing and extension services) in Narok and Kajiado districts of the Rift Valley Province-Kenya. The study covered two divisions from the districts, which were large with populations scattered and far apart.

1.7 Assumptions

The main assumption here was that there were some factors that would enhance adoption of drought tolerant wheat varieties in the ASAL, and so increase wheat production. These factors need to be accentuated to assist the farmers in ASAL and this country to increase wheat production and improve socio-economic status of the communities. It was also assumed that appropriate technologies were available for farmers in the arid and semi-arid land of Kenya for adoption.

1.8 Definition of Terms

Adoption is a decision to make continued use of an innovation as the best course of action available and excludes occasional use of the idea, object or practise. In this study adoption will refer to sustained use of the correct agricultural technologies as stipulated. It means use of drought tolerant varieties for wheat production and may include, the associated land preparation and time of planting, fertilizer and seed rate, which will be measured by assessing the levels of adoption.

Agro-Ecological Zone is a land resource-mapping unit defined in terms of climate and/or land cover, and having a specific range of potential and constraints for land use

Agricultural Extension service is a two way communication/training process involving adults learning techniques whose aim is to improve knowledge and change of attitude. This will eventually lead to adoption of new technologies and improve skills for both farmers and extension workers with a view of increasing and improving farmer's incomes and productivity on a sustainable basis

Agricultural Extension service provider is one who specializes in provision of extension services and they include individuals, private firm, farmers' organization, community based organization, non governmental organization, university department, parastatal organization or government department that provides or supplies extension services to farmers in any country.

Arid and semi-Arid lands (ASAL) are ecologically fragile and susceptible regions with frequent erratic rainfall, droughts, which impact negatively on social and economic conditions of the inhabitants and maintain a state of aridity.

Household comprises 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 communality of life in that they are answerable to the same head and share a common source of food.

Innovation is 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 may have been developed by farmers. Adams (1984) defines innovation as new ideas, methods practices or techniques that provide the means of achieving sustained increase in farm productivity and income.

Off-farm income generating activities are activities outside farming, which an individual can take part in, which brings income to the individual.

Perception according to Van den Ban and Hawkins (1992), perception is the process by which people receive information or stimuli from the environment and transforms it into psychological awareness. Ones' individual perception will differ markedly from another in the same situation because of individuals previous experiences. In this study perception refers to the opinion of farmers regarding various attributes of drought tolerant varieties of wheat.

Production is processes of using resource inputs to make goods and provide services. It requires labour, capital and raw materials used in different combinations under certain entrepreneurship to produce one or more products.

Small holder is a farming unit characterized by small size of the farm enterprise, which in wheat production case is 20 hectares and less. A medium holder will have 21-100 hectares, while large-scale holder will have more than 100 hectares

Socio-economic for the purpose of this study will be the study of behaviour of farming community of a particular region and how they manage their resources to influence their wellbeing in terms of income, education including standard of living.

Wheat production technology is the systematic application of scientific knowledge to practical purpose within a practical context, which means doing things in the farm to the attainment of certain set goals in wheat production efficiency.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Literature related to wheat production in Arid and Semi-Arid Lands (ASAL) of Kenya is reviewed in this chapter. The review includes aspects of adoption of drought tolerant wheat varieties and their features, personal characteristics, socio-economic, and institutional factors that can influence adoption.

2.2 Characteristics of Agriculture in Arid and Semi-Arid Lands of Kenya

Agriculture of arid and semi-arid lands in Kenya is characterized by smallholder subsistence farming whose practices encompass both arable and livestock components. Wheat is the most widely grown food crop in the world, although its production is not able to keep abreast with its demand. Currently horizontal expansion of wheat production is taking place by farmers moving into the non-traditional areas formerly considered unacceptable for farming (FAO, 2002). An effort was undertaken as early as 1990 in Kenya to develop a sustainable wheat production technology for the altitude zones below 1700m above sea level previously used by pastoralist (Alary *et al*, 2007; Tanner and Mwangi, 1992).

Many countries attempting to grow wheat in this environment have to deal with farmers who are not familiar with bread wheat and thus, culturally may have limited interest in crop production. Given the low yields of 0.9 tons per hectare at farm level compared to 6 tons per hectare at research level (Kimurto, *et al*, 2000) create a need to assess adoption of developed drought tolerant wheat varieties. The arid and semi-arid

environment common in ASALs regions, also experience a limited financial incentive for potential wheat production. It is important to recognize that agriculture is a dynamic sector full of changes where farmers build on their own experience and that of their neighbours to refine the way they manage their farming system (Marra *et al*, 2003; CIMMYT, 1999). Farmers are managers of complex resource system instead of simply commodity producers (Ortiz-Ferrara *et al*, 2007; Bellon, 2001; Chambers and Jiggins, 1986). Change in natural conditions, resource availability and market development also present challenges and opportunities, which farmers respond to. In addition, farmers learn about new technologies from various organizations, research and extension systems. It is therefore essential that each organization be able to follow results of their efforts and understand how these technologies fit into the complex pattern of agriculture. Reasons for studying adoption of agricultural technologies include improvement and assessing effectiveness of the technology.

Olembo (1989) expressed the general need of most African countries to develop agricultural technologies appropriate for the marginal areas of the continent. It is also important that the technologies developed should accompany mechanisms that will maintain sustainable agriculture and natural resources management (Lee, 2005). This is of critical importance for Kenya with marginal areas amounting to 83% of the country's land area. There is a fast decline of the high potential areas in Kenya due to industrialization, urbanization and over-cropping. Crop production continues to be a major occupation of the rural population which accounts for a large share of total agricultural output. However, wheat production has stagnated at 270,000 tons per year but occasionally drops to as low as 180,000 tons per year in dry periods. The main wheat

production districts include Nakuru, Narok, Uasin/Gisu, Tran-Nzoia and Nyandarua (Acland, 1980; Kamidi, 1995; Kinyua, 1997). Table 1 shows the food crop production trends in Kenya for the past five years.

Table 1: Food Crops Production Trends from 1997 to 2002 in ('000') in Kenya

Crop	Description	1998	1999	2000	2001	2002
Maize	Area (ha)	1,500	1,565	1,571	1,500	1,500
	Production (tons)	2,400	2,300	2,200	2,700	2,700
Wheat	Area (ha)	149	128	132	132	132
	Production (tons)	263	190	181	180	180
Sorghum/Millet	Area (ha)	122	141	142	140	141
	Production (tons)	90	110	82	80	81
Root/tubers	Area (ha)	203	235	231	230	236
	Production (tons)	1,285	1,895	1,415	1,350	1800

Source: FAO. 2003

There is a marked fluctuation in the area under wheat and other cereals like sorghum and millet production from 1997 to 2002 although the consumption of sorghum and millet have been falling due to change in eating habits, low productivity, and narrow range of their uses.

Table 2 shows crop supply and demand in Kenya with particular emphasize on wheat.

Table 2: Supply and Demand Projection for Major Food crops ('000' tons)

Crops	Description	2001	2002	2004	2006	2008
Maize	Production	2,700	2,700	2,970	3,155	3,600
	Demand	2,880	2,880	3,060	3,240	3,420
Wheat	Production	216	234	288	351	360
	Demand	720	783	837	900	990
Sorghum/millet	Production	81	90	117	108	117
	Demand	63	63	99	72	77
Irish potatoes	Production	1000	800	1000	1000	1000
	Demand	700	700	780	820	82

Source: Republic of Kenya, 2002

The trends for popular crops like wheat are unpredictable such that as the demand goes high, the production is not increasing at the same rate. This trend may point out adoption by farmers, which can fluctuates and can go as low as 2.7% in areas like Njoro and Rongai division of Nakuru district (Ndiema, 2002) and may show discrepancy in development and adoption by farmers (Baerenklau and Knapp, 2007).

Table 3 shows the number of drought tolerant wheat varieties that have been developed, tested and released for up-take by farmers in the ASAL of Kenya since 1994.

Table 3: Drought tolerant wheat varieties (DTV) developed and released for ASAL

D TV	Year of release	Altitude in meters	Yield bags/ha
Duma	1994	Below 1800m	22 bags/ha
Ngamia	1994	Below 1800m	20 bags/ha
Mbega	1994	Below 1800m	36 bags/ha
Chozi	2000	Below 1800m	22 bags/ha
Njoro BW1	2001	Below 1800m	26 bags/ha

Source: KARI annual report 2005

The biggest challenge here is generation, dissemination and adoption of drought tolerant wheat varieties for wheat production in the ASAL of Kenya. The national demand is estimated at more than 990,000 tons per year while production is as low as 360,000 leading to importation to meet the difference (Government of Kenya, 2002b). The current research activities include development of suitable wheat varieties for conventional high potential and arid and semiarid lands of Kenya.

2.3 Wheat growing in Narok and Kajiado districts

Wheat growing in Narok has been has been going on since 1969 while in Kajiado the white farmers started growing wheat as early as 1930. This practice continued until 1980 when more indigenous farmers decided to adopt growing of wheat. In the subsequent years, farmers were unable to continue cultivation of wheat because their yields were on the downward trend. By 1994 Kenya Agricultural Research Institute (KARI-Njoro) had formed a research team charged with the responsibility of developing

varieties that were drought tolerant and these were developed, tested and released for adoption.

2.4 Ten years of breeding for ASAL areas of Kenya

Wheat has been grown in Kenya since the turn of the 20th century at first by large-scale farmers and later by small-scale producers (Kinyua, 1997). It was traditionally cultivated in the high attitudes ranging from1, 800 meters to 3,000 meters above sea level. The main wheat producing districts in Kenya include Nakuru, Uasin/Gishu, Narok, Trans-Nzoia and Nyandarua (Acland, 1980; Kamidi, 1995; Kinyua, 1997). Small-scale production is found in Eastern Kenya mainly Meru, and Laikipia districts. Recently wheat has been introduced into lower dry lands areas of Machakos, Naivasha, Koibatek and Lower Narok among others (Kinyua, 1997). There has been a slow growth rate of wheat production (0.9%) while consumption of wheat products, spurred by population growth, urbanization and changing consumption habits has been increasing by 5.1% per year (FAO, 2002) and this has been met through imports. Between 1972 and 1991, wheat imports increased at the rate of 13.1% per year. Over a period of twenty (20) years (1980-2000), Kenya has gone from being self sufficient in wheat to being a net importer to meet its consumption needs (FAO, 2003).

Farming in the ASAL of Kenya is characterized by smallholder subsistence farmers whose practices encompass both arable and livestock components. An effort has therefore been undertaken as from 1990 in Kenya to develop a sustainable wheat production technology for the altitude zones below 1,700 metres above sea level previously used by pastoralists (Tanner and Mwangi, 1992). The environmental

conditions under this zone represent a major challenge to the development of a viable wheat production system. Unfortunately, countries attempting to grow wheat in this environment have to deal with farmers who are not familiar with bread wheat and thus, culturally may have limited interest in producing the crop. The low yields common in this environment limit financial incentive for potential wheat production (Tanner and Mwangi, 1992).

2.5 Characteristics of innovations that influence adoption

Characteristic of innovations that influence their adoption include the relative economic advantage a farmer anticipates to get, triability, compatibility, complexity and observability of technology (Ortiz-Ferrara, *et al*, 2007; Vago, 1990; Rogers, 1995). These characteristics are only real in as far as they are recognized or perceived by the potential adopters. The way potential adopters perceive the characteristics of an innovation may in fact differ widely from the actual or inherent characteristic of an innovation. The characteristics justify the need to study and understand the perception of farmers about every innovation developed in order to understand their reaction towards it (Xavier *et al*, 2006). Technology developed for farmers has various characteristics that influence farmers' judgement or perception as acceptance or rejection of its use (Makokha *et al*, 1999; Gollin, *et al*, 2005).

2.5.1 Relative economic advantage

This refers to the degree to which an innovation is considered superior to the idea or products it replaces. It is determined in terms of efficiency, cost, novelty or perceived advantage (Marra, *et al*, 2003; Vago, 1990; Rogers, 1995). It is often expressed in terms

of economic profitability but can also have other social dimensions such as low initial cost, low perceived risk, saving in time and effort. Small-scale farmers place considerable emphasises on short-term profitability associated with the adoption of an innovation but are equally equipped by its social dimension. Adams (1984) suggests that the profitability needs to be at least 30% over the previously used practise in order to guarantee adoption. Therefore, an innovation that will lead to 30% improvement of farmer's condition will be a better innovation. Agricultural technologies may have the advantage of increasing yields at research level but not at farmer's level as postulated by (Salasya, 1999; Honlonkou, 2004). However, perceived relative advantage or profitability of an innovation increases the probability of that innovation being adopted.

2.5.2 Compatibility with farmers values, experiences and goals

This is the degree to which an innovation is perceived as being consistent with the existing values, past experience, goals of the farmer and existing farm technology (Graft *et al*, 2006; Vago, 1990; Adams, 1984). It is a feature that is positively related to the rate of adoption of innovation. Thus a technology that is not consistent with farmers existing socio-cultural values, beliefs, past experiences, farmers felt needs, their management objectives, level of farm technology and stage of farm development is likely to be rejected. Values in particular are important because they govern people's taste and preferences by influencing their needs and objectives.

2.5.3 Triability of technology by farmers

Farmers may want to experiment with new innovation to observe its efficiency before actually adopting it on large scale. This implies that those innovations that can be tried on a limited basis are more likely to be adopted because they minimise risks to the

adopter. Triability of an innovation as perceived by the farmer is positively related to its rate of adoption (Diagne, 2007; Rogers, 1983; Roling, 1990). Technologies that can be separated into smaller units tend to be adopted more easily than those that do not lend themselves to such divisions. Farm inputs such as improved seed, chemical fertilizer and pesticides can be procured in small quantities and tried out on the farm before being introduced on large scale (Adams, 1984). Triability of any innovation therefore, reduces the risk factor for farmers because it helps the farmer to see for themselves the performance of the technology under their circumstances.

2.5.4 Complexity of agricultural technology

Refers to level of difficulty associated with use of new agricultural practice. The rate of adoption may be put on a complexity-simplicity continuum, and as a rule the adoption rate of an innovation will be slower when it is perceived as complex by members of a social system (Abdulai and Huffman 2005; Vago, 1990). Farmers are required to possess the necessary skills before some agricultural innovations can be used in ways that will produce desired outcomes. Most farmers especially small scale, farmers do not possess technical skills required to use complex agricultural technologies effectively. Simple and flexible innovations are preferred. This is because they are easily understood. Simple innovations are easily understood and probably accepted more easily than complex innovations by members of a social system. For example getting farmers to adopt a package of disc plough, improved seed, pesticide and chemical fertilizer at the same time could be too complex for farmers in general, and in particular small holder farmers. Though complex innovations may be accepted finally, they are likely to take a

lot of time before they are introduced into a farming system. Farmers therefore must develop the requisite skills before they adopt such innovations.

2.5.5 Observability of working agricultural technologies

Innovations should show performance results. Items such as clothes or durable goods are highly observable and facilitate the rate of adoption. The crucial point, according to Rogers (1983), is the characteristics that are perceived by members of a social system, for this is what governs their response. On-farm trials designed to test innovation or technologies under farmer's conditions are considered to be essential (Gizsche, 2006). These must involve the target farmers if they are to see the superiority of the technology. Studies relating to the features of innovation and their rate of adoption have been fewer and also inconsistent. There are varied rates of adoption of innovations attributed to utility or importance of need fulfilled by the innovation, the immediacy of results after application, the ease with which the innovation can be communicated and the cost of adopting the innovation.

2.6 Process of Adoption

Most agricultural innovations originate from research stations and manifest themselves in material form in the farmers' field, for example new chemicals, fertilizer application rates, or new high yielding varieties. The decision to make full use of an idea, practice or technology as the best course of action available is adoption (Ajayi *et al*, 2003; Vago, 1990). The following sets of stages which demonstrate the adoption process have been proposed;

Knowledge stage- one becomes aware of the existence of innovation and can form a favourable or unfavourable opinion about it. Extension agents need to provide adequate information so that when people form opinions they should be from an informed position. To form sound or positive opinion, the new idea should be consistent with farmers' needs, attitudes and current practices (Miyata and Manatunge, 2004). Interest stage- the individual becomes interested in the idea and seeks more information. Evaluation stage- the individual makes a mental evaluation of the new idea to his/her present and anticipated future situation and makes the decision either to try it or not. Trial stage- the individual uses the innovation on a small scale to determine its utility. Adoption stage- the individual accepts the innovation and commits oneself to its use.

This model however is too simplistic in nature and has a number of deficiencies. For example it implies that the process always ends in adoption while in some cases rejection may occur (Ajayi *et al*, 2003; Rogers, 1995). The five stages may not occur in the specified order and indeed some of them may be skipped. A good example is evaluation, which may take place throughout the five stages and even after adoption has taken place. Adoption by farmers depends on what is being adopted and the reasons for adoption. The latest trends tend to encourage the adoption of a package of innovations rather than discrete single innovations. This is because farmers do not perceive these packages in whole but they see them in parts (Abdulai *et al*, 2005).

Therefore other approaches that are comprehensive and purposive have been proposed, at knowledge stage a farmer becomes aware of the existence of an innovation and can form a favourable or unfavourable opinion about it. Extension agents need to provide adequate information so that when people form opinions they should be from an

informed position. Sound or positive opinion of a new idea should be consistent with farmer's needs, attitudes and current practices. This will persuade farmers to form and change their attitudes. Once a person has gathered sufficient information about new ideas and how it is related to their situation, they are able to forms an attitude towards the new innovation. Selective perception of the idea is important at this stage because it is the stage through which the farmer considers the innovation. It also helps farmer to assess the consequences of the innovation and the appropriateness of the innovation to his/her situation (Graft *et al*, 2006: Rogers, 1995). Advantages and disadvantages of the innovation are considered and this helps to reduce the uncertainty involved. The attitude developed about an innovation may lead to adoption or rejection of the innovation (Mugisha *et al*, 2004).

At decision stage an individual gets involved in activities with the tendency to either adopt or reject the new idea. If a farmer forms a favourable attitude to the innovation he/she is likely to use it. Due to uncertainty, an individual will tend to test the innovation on small-scale and assess if it shows a certain level of relative advantage in relation to reducing cost or increase production of current practice or practices that make work easier (Rehman *et al*, 2007). If the practice does not rate well within the farmer's perception it is rejected. The rejection can be active if farmers use the innovation and put it on halt to try it again if it can work.

Implementation stage occurs when a farmer puts an innovation into use. Farmers find more information on where and when to obtain innovation. During this stage individuals find out how to use the innovation and likely problems to be encountered and possible opportunities for solving the problems. An innovation preferred by a farmer ends

up as an institutionalised or regularised part of a farmer's present operation. The implementing stage can also result in the termination of the innovation decision process (Rehman *et al*, 2007; Farquhar and Surry, 1994)

Confirmation and final stage of adoption where the farmer seeks reinforcement for the decision already made and confirms the use of the innovation as long as it is superior to other practices. On the other hand a farmer may reverse his/her decision if he is exposed to some conflicting messages about the innovation or encounters problems without solutions (Faturoti, *et al*, 2006; Roger, 1995; Surry, 1997).

The above adoption processes focuses on farmers' characteristics as the main constraint of adoption. It assumes that barriers to adoption are largely psychological due to risk aversion, which is linked to farmers' conservative attitudes. These conservative attitudes vary among individuals of different educational levels, gender, age, and social status. Based on the degree of conservativeness, farmers have been classified as either early adopters or late adopters. This theory assumes that early adopters are less risk averse and will adopt innovations early. These innovations are adopted with considerable time lag by other farmers who observe their performance on the early adopter farms (Vago, 1990).

2.7 Conditions for Adoption

There are certain conditions that must exist before one can accept to use an innovation. Members of a farming community should perceive a problem exists, which cannot be effectively resolved using existing practices. The farming community must be aware of the innovation and its relevance to their perceived needs. It should be able to

produce benefits, which include increase income, and cost effective. It must lend itself to easy adoption and continued use. It must be consistent with the social system and in harmony with peoples' social values (Peters *et al*, 2003; Rogers, 1995).

2.7.1 Risks and uncertainty

Risks and uncertainty introduce predictability of an innovation especially agricultural innovation, which have been found to introduce technical risks to the production process (Baerenklau, and Knapp, 2007). The degree of uncertainty of receiving expected benefits from integrating new agricultural technologies and techniques into existing farming systems has implications for a farmer's acceptance of using the innovation. A subsistence farmer is always cautious when making adoption decision because crop failure or reduction in output due to failure to achieve expected production goals can result in loss of meager earnings from land holding and possible starvation of the family (Wubeneh, and Sanders, 2006; Napier, 1991). Under such condition farmers are reluctant to adopt any technology, which introduce high levels of uncertainty into the operation of the farming systems. Though farmers are risk takers, in their farming practices, they tend to forego high yields that result from the correct farming practices in favour of greater certainty that the rains have just started and will continue. At the beginning of each season, farmers have high expectations developed from past experience concerning the probable onset, amount and distribution of rains, pest and disease incidences possible occurrence.

2.7.2 Personal and socio-economic characteristics that influence farmer adoption

2.7.2.1 Age of the farmer

Studies relating to farmer's age to his/her adoption behaviour reveal conflicting results with some showing positive relationships while others reflect strong negative relationship. Amudavi (1993), however, found no relationship between age and adoption. Rogers, (1995) argues that younger and more educated farmers are more inclined to adopt new practises. Adoption may vary as a function of stage in life cycle of a farmer and family.

2.7.2.2 Gender of the farmer

Gender in this study referred to both biological and social constructed differences between men and women. Sex and gender were not differentiated but used interchangeably (Doss and Morris, 2001; Quisumbing, 1996). Gender division of labour is critical as the division of power, control and skill shaped the production process determining farm output and income (Dadi *et al*, 2004). Women in Sub-Saharan Africa engage more in food production, while men produce cash crop like wheat although the trends are changing.

The World Bank (1993) reported that there was no significant difference between the male-headed households and female-headed household in adoption. Oywaya (1995) in a study conducted in Machakos district, Kenya, found significant gender difference in adoption rates. This was attributed to the fact that women were more committed to farm work than their male counter-parts and hence could easily put into practice what they learned from the extension officers. Women are more available for farm work than the

men who may be involved in off-farm employment making women better adopters of innovations than men.

2.7.2.3 Farmers Level of Education

Literacy plays an important role of enabling farmers to get access to written material, thereby facilitating their awareness of information (Weir and Knight, 2004). Farmers whose ability to read and write is low tend to be disadvantaged in utilizing information. Education increases managerial competence and, therefore, enhances ability to diagnose, assess, comprehend and respond to financial and production problems (Molnar, 1985). It also enables him to choose wisely from a stock of available technology and how to efficiently manage once the technology has been adopted. In addition, knowledgeable farmers assist researchers in guiding their focus.

A study on farmers in two localities showed that formal education, in addition to other personal factors, was significant within each study area in so far as adoption of farm practices was concerned (Chitere, 1985; Ndiema, 2002). These, among other diffusion studies suggest strongly that level of education is associated with adoption of technology. There is a strong positive relationship between farmers level of education and adoption behaviour (Chitere, 1985). This is consistent with other studies on maize (Misiko,1976; Amudavi, 1993). This showed that among farmers, who had adopted the use of high yielding varieties, 25% were illiterate, 65% had primary level of education and 11% had secondary school education. Sing and Santiago (1997) found that the farmer's educational attainment influenced farm earnings in Mexico. In Africa, several studies have shown a positive relationship between farmer's education and farm productivity (DSE, 1992; Kahn, 1991; Knight and Shabot, 1990; Maliyamkono, *et a,l* 1982).

2.7.2.4 Land size

Farms of different sizes may present different context of adoption. Large-scale farms are a base for expansion and a source of materials, which can be spread over a greater number of out put units. Kibende *et al*, (1990) in a study of adoption in Ethiopia, found that land size was the most significant factor affecting the adoption of agricultural technology. A survey in Kenya, has also, isolated land size as the most important variable affecting farmer innovativeness (Wubeneh and Sanders, 2006; Roling, 1990). The study in Kenya revealed that access to land for most innovative farmers was almost three times higher than that of the least innovative. This is because farmers with large farms can experiment with innovations to see their results before adopting on large scale. Amudavi, (1993) however, found no significant relationship between this variable and the adoption of Maize related technology in Western province.

2.7.2.5 Level of Farm Income

Although there are hopes for improved levels of farm income through structural changes and reforms for better economics performance, the *per capita* income had dropped to as low as US$ 50 by 1995 among smallholders farmers in Sub-Saharan Africa (African Development Bank, 1995). Income drop resulted from the drop in agricultural productivity occasioned by civil wars, drought, global politics, socio-economics circumstances especially low prices and environmental degradation (Rehman *et al*, 2007; World Bank, 1993). Income being a good indicator of the economic position of a farmer provides a base for realistic expectation for farm productivity. To acquire material technology usually is considered in terms of accompanying cost, which in turn has implications to a farmer's purchasing power, which in essence is a function of income.

This is in addition to other factors such as age, education, input source, market distance, and credits facilities.

Farmers from higher economic status have higher access to resources and institutions controlling resources necessary for effective adoption of technology (World Bank, 1993). In most cases adopters of innovation are largely opinion leaders who tend to occupy higher socio-economic status, which is positively related to adoption (Isham, 2002; World Bank, 1993; Adams, 1984).

2.7.2.6 Labour availability and utilization by farmers

New technologies are classified as either labour-intensive or labour saving. It requires farmers to efficiently allocate and mobilize labour to be used on an innovation while simultaneously considering the size and needs of the family. Labour intensive technologies are likely to impede small-scale farmers from adopting new innovations (Wubeneh and Sanders, 2006). In situations where labour-intensive technologies lead to labour shortages, an incidence of increased market wages could arise prompting farmers to seek for labour saving technologies thereby discouraging adoption. The allocation of household labour to different tasks is determined to a great extent by existing social and cultural facets within a household. Ndiaye and Safranko, (1988), emphasized that such factors are important determinants of labour availability and technology adoption. They also argue that ascribed roles and expectations within a family unit tend to constrain labour mobility and poor development. The consequences are that labour required for labour intensive technologies are reduced, leading to non-adoption.

2.7.3 Institutional factors influencing farmer adoption

2.7.3.1 Land Tenure

Land tenure is an important institutional arrangement that is important in diffusion of information of any agricultural technology. Farmers must perceive benefits accrued from investment made in new technologies before considering change of current farm practices. This implies that farmers should have rights to land resources, which they are operating if technology improvements have to be implemented (Perz, 2003; Mugisha *et al*, 2004; Ogunlana, 2004). However, farmer's right to land resource should not be interpreted to mean that private ownership is the only form of land tenure which enhances adoption of technology, in this respect the issue is rights rather than the form of rights to land resources.

2.7.3.2 Contact with Extension

Extension is traditionally considered as a means of providing a link between agricultural research and farmers. It is a means of transmitting new technologies to farmers and current problems to research. It is also a means of transmitting technical advice to the farmers to assist them improve their productivity and incomes (Honlonkou, 2004; Miyata and Manatunga, 2004; Garfoth, 1982). To facilitate transmission of technology transfer, extension ensures that adequate amount of high quality information about the technology is accessible to the farming community. The information helps farmers to increase adoption rates by providing information that reduces technical uncertainty.

In a study by Chitere (1985) to establish the extent to which farmers adopt recommended practices, it was found that nearly all farmers in an area previously

occupied by Europeans settlers were knowledgeable about improved farming practices. It was also observed that farmers adopt improved farming practice largely because of early exposure to intensive extension education, which indicates that adoption of innovation is the outcome of learning and communication implies that farmer's decision to accept or reject an innovation is to some extent determined by the type of communication between farmer and extension agent (Adegbola and Gardebroek, 2007; Marsh *et al*; Franzel *et al*, 2001).

Several studies have indicated a positive relationship between contact with agricultural information sources and adoption (Moser and Barrett, 2006; World Bank, 1993). Farmers who have been exposed to an intensive extension education adopted many agricultural innovations, in contrast to neighbours who are not exposed to extension campaigns. Ascroft *et al* (1993) best illustrate the importance of contact with source of information in a study in Tetu division, Kenya. They showed that information on planting distance of maize production has been distorted in more than 25% of the cases of second hand information. Axinn and Thorat (1972) explained that agricultural extension was critical for agricultural production. It converts peasant farmers to scientific managers who are able to change the nation from food deficit to food exporters and this will give dignity to farm life.

2.7.3.3 Access and availability of Credit

The main hindrance to agricultural production among the farming communities is source of financial assistance. Matuschke *et al*, (2007) and Ascroft, (1973) found out that most progressive farmers were able to obtain loans. This shows that the credit institutions normally disadvantage small and less influential farmers with credit conditions thereby

suppressing their capacity to adopt innovations (Rehman *et al*, 2007; Pearse, 1974). Under normal circumstances, the criteria for accepting loan applications from farmers take into account the appropriateness of the technology, economic status, character and reputation of the farmer. Although credit may appear quite rational to a farmer, social forces outside their control dictate the propensity of adopting technology.

A survey in Mbeya on adoption of improved wheat technology, established that fertilizer usewas influenced by credit availability, land size, extension and hired labour (Moser and Barrett, 2006; CIMMYT, 1999). To be optimally effective, wheat production require more fertilizer, improved seed, right timing at planting to perform well. These inputs require capital in form of credit, a strong facilitator in enhancing access to new technologies (Hudson and Hite, 2003; Isham, 2002; Muasya and Mwakha, 1996). Those farmers who don't get access to credit due to non-availability or because the delivery of the technology is ill timed are therefore disadvantaged in using available technology. Most farmers may therefore not follow the recommended practices due to inaccessibility to financial resources.

2.7.3.4 Social Participation

Participation in social groups provides the opportunity for sharing of ideas and experiences through interpersonal and inter-farm visits. Social participation is important because of the need of farmers to be in organised groups and other public services and mass media (Black Burn *et al*, 1982). It reflects the degree of contact beyond the farmer's primary reference groups and the potential for outside channels of direct influenc, particularly where the project or technology affects the local community, (Ortz-Ferrara, 2007; Aboud, 1989). Farmer's involvement in various social group activities integrates

them into the social fabric of the community. This is achieved through involvement of farmers in religious, social, and political or self-help groups. They provide a forum for improving dialogue among farmers, thereby providing opportunities for efficient ways of ascertaining consensus on opinions about the relevance of technologies being presented to them (Wubeneh and Sanders, 2006; Norman *et al*, 1989d; Aboud, 1982).

2.8 Theoretical Framework

Diffusion of innovation pioneered in 1943 by Bryce Ryan and Neil Gross of Iowa State University traces the process by which a new idea or practice is communicated through certain channels over time among members of a social system. The model describes the factors that influence people's thoughts, actions and process of adopting a new technology (Ryan and Gross, 1943; Rogers, 1995). This study therefore focused on farmer's characteristics as the main constraint of adoption. It assumed that barriers to adoption are largely psychological due to risk aversion, which is linked to farmer's conservative attitude. These conservative attitudes vary among individuals of different educational levels, age, gender, land size and social status. Based on the degrees of conservatives, farmers have been classified as either early adopters or late adopters. The assumption here is that early adopters are less risk averse and will adopt innovations early. These innovations will then be adopted with considerable time lag by other farmers who observe the performance of early adopter farms (Rogers, 1995). Everest Rogers in a book called *Diffusion of Innovation* states that factors affecting adopters of any innovation could be grouped into three categories, Personal and socio-economic (land

size, gender, education, age, income, and marketing) and institutional (credit access, extension and land tenure system).

In each category there are variables that are thought to interact with each other as they affect adoption. The three categories were adapted and extended for the study on adoption of drought tolerant varieties of wheat in arid and semi-arid land of Narok and Kajiado districts highlighting the personal, socio-economic and institutional factors in wheat production.

The arrows therefore, show the relationship among the different enabling elements in adoption. The arrows pointing on both sides with reference to personal factors and institutional factors indicate a relationship where government policies may influence farmers' characteristics such as credit provision to motivate farmers to adopt. Then, the farmers' personal characteristics may influence the type of services from government that the farmers receive. A single pointed arrow shows the direction of relationships in a less democratic situation. For example, the effectiveness of marketing of farmers' produce may be determined by whether the markets are liberalized or not which depend on government policy. In a more democratic environment the arrows would point both ways for example the government policy would determine whether market for farmers produce are liberalized or not taking into account the farmers' interest and priorities.

Factors influencing the adoption of new agricultural technologies are therefore divided into three categories, personal, (gender, education, age), Socio-Economics (income, land size) and institutional factors (credit access, extension, and land tenure). These factors and other issues that are critical in adoption include profitability, triability,

complexities, observability, and compatibility of the technology which are intervening factors and test farmer perception.

CONCEPTUAL FRAMEWORK

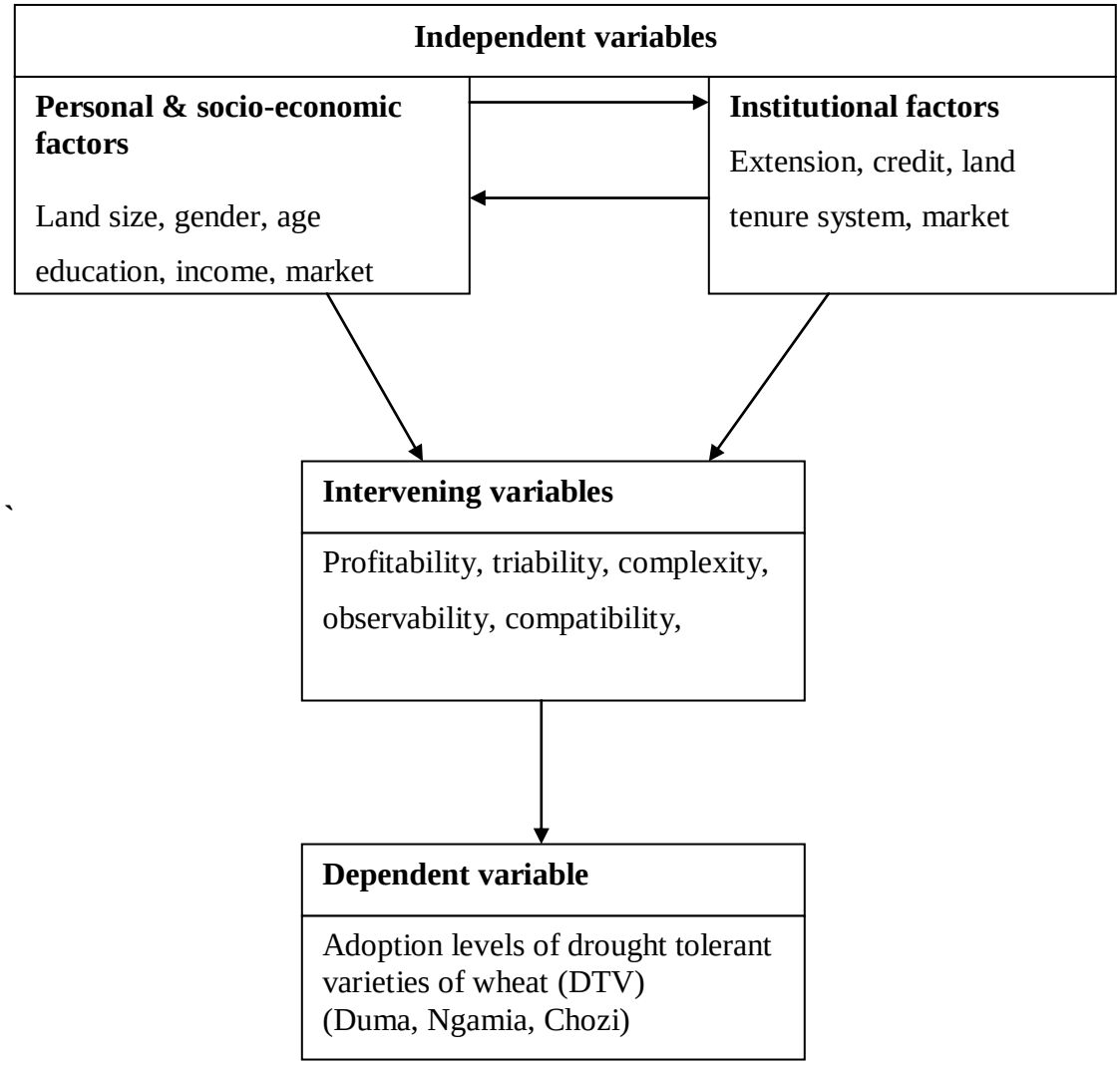

Figure 1: Factors influencing adoption of drought tolerant wheat varieties in ASALs.

2.9 Summary

Literature review in this study revealed a variety of issues related to factors that could influence adoption of drought tolerant varieties of wheat in arid and semi-arid lands of Narok and Kajiado districts of Kenya. Although ASAL areas of Narok and Kajiado district have relatively high potential in wheat production, the trend has been downward. Consequently farmers have suffered from yield reduction which has lead to food insecurity and dependence on relief food annually. This is mainly attributed to a number of constraints which are political and economic constraints, insecurity, unfavourable climatic conditions, poor input supply unfavourable marketing system, lack of sufficient extension services, common use of old inappropriate varieties .

In summary, the conceptual framework used three main factors to help in analysis namely; personal factors, socio-economic factors and institutional factors. The main measures of drought tolerant wheat varieties in this study were adoption levels.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The data in this study were obtained through a sociological enquiry research technique conducted between March 2006 to March 2007 in Narok and Kajiado districts, Rift Valley Province of Kenya (see location of districts in Figure 2 and Figure 3). The study aimed at determining the adoption levels of drought tolerant varieties of wheat and comparing the adoption between Narok and Kajiado districts where technologies were developed, tested and disseminated to the communities of these arid and semi-arid lands of Kenya.

Field research involved administering questionnaires to sampled farmers through interview schedules.

3.2 Research Design

The design for the study was *Ex-post facto*, which according to Tuckman (1988) uses a sociological enquiry (survey) to examine effects of naturally occurring influence of independent variables on the dependent variable. The study started with a pilot study carried out in Makueni district. An exploratory survey was carried out in Narok and Kajiado districts. The study involved key informants who were experts among the farmers, public and private sectors that had knowledge of the community under study. Finally a questionnaire was administered to one hundred and eight (108) sampled wheat farmers in the two districts.

The dependent variable in the study was the level of adoption of drought tolerant wheat varieties. The independent variables included personal factors (land size, gender, education level, perception and age), socio-economic factors (marketing and income) and institutional factors (credit, extension services and land tenure system).

3.3 Location of the Study

The study was carried out in Ololung'a division of Narok district and Isinya division of Kajiado district of the Rift Valley Province-Kenya. The pastoral Maasai community, whose farming system is based on livestock, mainly inhabit these two districts. Narok district is situated in the south western tip of Kenya and is divided into seven divisions, namely, Mau, Osupuko, Ololung'a, Limotiok, Olokurto, Forest/Game parks and central divisions.

Ololung'a division is divided into five (5) location and eleven (11) sub-locations. It lies between latitudes 0^0 50' and 2^0 05' south and longitude 35^0 58' and 36^0 05 east. It occupies an area of over 17,128km^2. The average rainfall is below 500-1800mm per annum, with the lowest amount recorded of 50mm on the Loita plains. The large central plains are very dry with unreliable rainfall and infertile soils. Wheat is grown in Lower Highland zone (LH4), the Upper Midland (UM and UM6) zone is for ranching. Most of the land in Narok falls under the category of trust land, and less than half under mixed farming while large scale companies and have introduced large scale cultivation of wheat barley and rapeseed. The soils of the district are diverse ranging from mountain soils to those on plains and seasonal swamps.

Kajiado district consists of almost entirely of ranching zones except for small areas near Kilimanjaro. It is bordered by the Republic of Tanzania to the Southwest, Taita-Taveta district and Kiambu district. The district is divided into six divisions namely Central (Isinya), Magadi, Loitokitok, Mashuru, Namanga and Ngong. Central (Isinya) division is divided into twelve (12) locations and twenty six (26) sub-locations.

Major food crops grown in the district are maize and beans although the district is suitable for drought tolerant crops such as millets and sorghum. At present the district relies on two main cash crops, cotton and wheat (Government of Kenya, 1997b).

Map of Kenya showing the Location of Narok and Kajiado districts

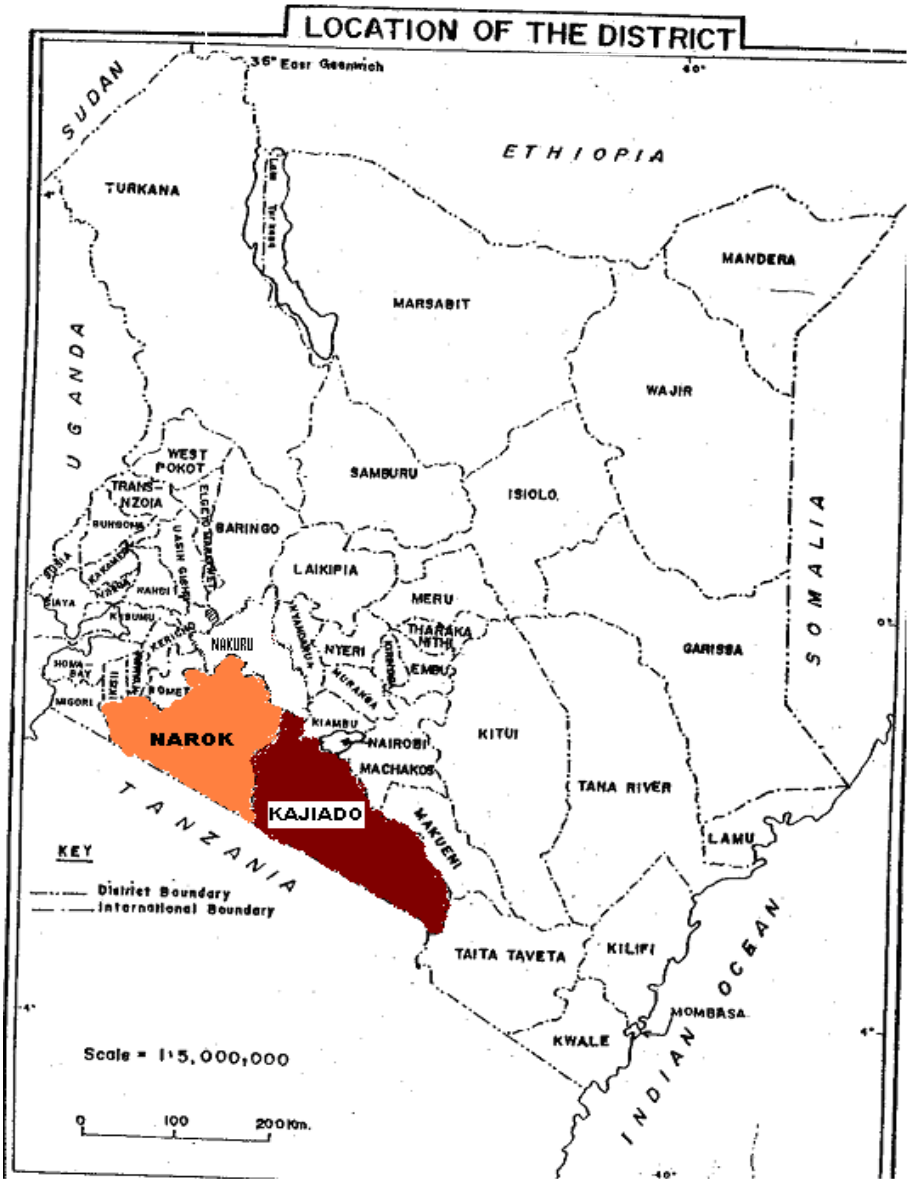

Figure2: Map of Kenya showing the location of Narok and Kaijado districts in colour

Source: Government of Kenya 1997a

Rift Valley Province Map

Figure 3: Map of the Rift valley province

Source: KenyaWeb.com

Kajiado district cover 21,105 square kilometres lying in the Agro-Ecological Zone of UH2-3 to LH2-LM6. Soils are diverse Mollic Andosol with an altitude of 500 - 2500 metres above sea level with an annual rainfall of 500 - 1250 millimetres. The mean temperature range between 10^0C to 30^0C and it lies between latitude 1^0 0' and 3^0 0' south and longitude 36^0 5' and 37^0 5' east.

Ololung'a division of Narok district and Isinya division of Kajiado district were identified and chosen primary because of the history, experience and existing background information on wheat production, introduced more than five years ago, making it possible to carry out useful adoption studies. Wheat in Narok was in existence as early as 1969, with 8,657 hectares under wheat, producing 13.09 bags per hectare (Rift valley Province Report, 1969). In Kajiado the white settlers introduced wheat as early as 1930 where production was as low as 6 bags per hectare. This resulted in less wheat production in Kajiado district than in Narok district.

3.4 Population

The population of the study comprised all the (101) wheat farmers in Ololung'a division of Narok district with the district's population census being 9,000, and (50) wheat farmers from Isinya division of Kajiado district with the population census being 7,861, as per 2001 census.

Table 4: Population of farmers in the study area of Narok and Kajiado districts

District	Division	Locations	Sub-locations	Population	Wheat farmers
Narok	Ololun'nga	5	11	9,000	101
Kajiado	Isinya	12	26	7,861	50
Total		17	37	16,861	151

Source: Government of Kenya, 1997

3.5 Sampling Procedure

The sampling procedure used was cluster sampling. This procedure was used because the population (the wheat farmers) were clustered and scattered over a large geographical area. Using a tabulated data from Kathuri and Pals, (1993) a list of all the members of a cluster was compiled and by use of random numbers, samples drawn from each cluster unit to form the required sample of one hundred and eight (108) farmers, which was a good representative of the one hundred and fifty one (151) wheat farmers in the two districts.

There were five key informants involved in gathering historical information about wheat farming.

Farmers were randomly selected from each cluster using a proportionate random sampling that formed a study sample of seventy two (72) wheat farmers from Ololung'a in Narok district, and thirty six (36) wheat farmers from Isinya in Kajaido district forming the sample size of one hundred and eight (108) farmers for the two districts. Simple random sampling technique was used to select farmers from each cluster and random numbers employed to get the required number.

3.6 Working Research Objectives and Hypothesis

Four hypotheses were stated to address specified objectives. These hypotheses are designed to address the postulated relationships between the dependent variable namely the level of adoption of drought tolerant varieties (DTV) of wheat and the independent variables namely, personal factors (age, gender, education level, land size), institutional factors (extension and credit access, land tenure) and socio-economic factors (income and marketing).

3.6.1 First research objective and hypothesis

The first research objective is to identify farmers' perceptions concerning drought tolerant wheat varieties (DTV) for wheat production among farmers in arid and semi-arid districts of Narok and Kajiado. These are perceptions of the farmers' in terms of their knowledge and opinion on drought tolerant wheat varieties as relating to their features. It is postulated that features of the technology play an important role in influencing decision to adopt a technology which in turn influences production of wheat in ASALs of Kenya Thus the following hypothesis is stated:

Hypothesis1: There is no statistically significant difference in the perceptions of farmers from Narok and Kajiado districts regarding drought tolerant wheat varieties.

Thus, the perception of farmers from both districts were collected and compared

3.6.2 Second research objective and hypothesis

The second research objective is to determine and compare the adoption levels of drought tolerant wheat varieties for wheat production by farmers in Narok and Kajiado districts. It is postulated that adoption of drought tolerant wheat varieties will enhance

production of wheat in the study area and hence in the country at large. Thus the following hypothesis was stated;

Hypothesis 2: There is no statistically significant difference in adoption levels of Drought Tolerant wheat Varieties by farmers of Narok and Kajiado districts.
Thus, adoption levels of wheat farmers in the two districts were determined and statistical test of differences between the two districts undertaken

3.6.3 Third research objective and hypothesis

The third research objective is to determine the influence of farmers' personal and socio-economic characteristics and adoption level of drought tolerant wheat varieties in Narok and Kajiado districts. These personal characteristics include (age, gender, education, land size and income). It is postulated that personal and socio-economic characteristics of wheat farmers either individual or in combination would significantly influence, the adoption and adoption levels of drought tolerant varieties of wheat in the study area. Thus the following hypothesis was stated:

Hypothesis 3: There is no statistically significant relationship between farmers' selected personal and socio-economic characteristics (namely age, gender, education, land size, income and market) and adoption level of Drought Tolerant wheat Varieties.

3.6.4 Fourth research objective

The fourth research objective was to determine the influence of institutional factors on adoption level of drought tolerant wheat varieties in Narok and Kajiado districts namely (extension, land tenure, marketing and credit). It is postulated that institutional factors either individual or in combination would significantly influence adoption and adoption level of drought tolerant wheat varieties in the study area. Thus the following hypothesis was stated:

Hypothesis 4: There is no statistically significant relationship between institutional Factors (extension, land tenure system, marketing and credit provision) and adoption level of DTV.

3.6.5 Fifth research objective

The fifth research objective is to determine, from the findings of this study and other sources, suggested recommendations to enhance adoption and other improvements for wheat production in the arid and semi-arid lands of Kenya. It is postulated that recommendations made with developed guidelines, will inform agricultural and wheat production policy in ASALs to improve food production in Kenya and other areas with similar conditions.

3.7 Instrumentation

The main instrument used for data collection was a questionnaire, which was administered to sampled farmers in the area of study. Two sections were developed in the questionnaire. The first section contained structured questions on personal, socio-economic factors and institutional services which included respondent's background. The second section contained questions designed to collect all relevant information on farmers' perception and adoption of drought tolerant wheat varieties. The questionnaire was developed based on the four objectives of the study.

3.7.1 Validation of instrument

A draft questionnaire was submitted to three experts in the Department of Agricultural Education and Extension of Egerton University who reviewed contents for validity. Useful comments were incorporated to improve the focus and effectiveness of

the questionnaire. Validity of the questionnaire was ensured through discussion of the items with experts from the department, and in-build cross validation

3.7.2 Piloting and reliability

Reliability of the instruments was determined through pre-testing questionnaire using twenty (20) wheat farmers from Makueni district. The district has similar characteristics in the light of the two districts of Narok and Kajiado districts similar arid and semi-arid, social and economic conditions. The reliability coefficient was determined using Cronbach's alpha coefficient and the results showed a reliability coefficient of 0.815 which was above the 0.70 threshold for accepted reliability (Mwangi, 1993). Adoption was measured as a discrete variable where farmers who cultivated and used drought tolerant wheat varieties were considered as adopters, and levels of adoption were categorized as "very high", "high', "moderate" , "low", very low" and "non-adopters".

3.8 Data collection

At the commencement of the research two District Agricultural Officers were contacted to organize schedules with key informants in each study division to provide information about the community and people's attitude towards drought tolerant wheat varieties adoption and behaviour. The researcher visited each district to confirm farmers' acceptance and consent to be involved in the study.

They were then briefed on the purpose and objectives of the study. Random numbers were used to sample farmers from each cluster. One frontline extension worker in each Division was involved in the exercise. Questionnaires were administered to farmers at their homes. The head of each household responded to the questions.

3.9 Operationalisation of variables

The following nine (9) variables in the four study hypothesis will be defined and measured as follows:

3.9.1 Farmers' perception

This is a variable in the first hypothesis and defined in this thesis as the respondent farmers' awareness and knowledge about some important features of drought tolerant wheat varieties. It is measured by soliciting the respondents' agreement to four features of the wheat drought tolerant varieties, in statements in which they indicate whether they "Strongly Agree", "Agree", "Uncertain", "Disagree" and "Strongly Disagree"

The four features are: (1) that the DTV technology has sufficient relative advantage and thus more profitable; (2) that DTV technology is consistence with farmers' objectives values, experiences and goals; (3) that the DTV technology lends itself to triability and observability; and (4) that the DTV technology is not complex.

These four features were summed up to compute an index of "perception" with a range of scores from 4 to 20 with the respondent demonstrating best perception being the one who will answer "Strongly Agree" to all or most of the statements and so score 20 or so.

Farmers' perceptions are compared between the respondents in the two districts, Narok and Kajiado.

3.9.2 Adoption levels of the drought tolerant varieties of wheat

Adoption level is a variable in the second study hypothesis, used to compare the levels of adoption of drought tolerant wheat varieties between respondent farmers in the

two study districts. In hypotheses three and four, it serves as the dependent variable where its relationships with personal and socio-economic factors and institutional factors respectively are tested. In this study adoption levels is defined as respondent farmers' use of the drought tolerant wheat varieties. It is measured by a question seeking to determine the respondent's own assessment of the degree of his/her use of the drought tolerant wheat varieties. The variable categories ranged from "Not used", "Very low degree use", "Moderate use", "High degree use", "Very high degree use".

3.9.3 Personal and socio-economic characteristics

These include age, gender, education, land size and income.

3.9.3.1 Age

This is one of the respondents' personal characteristics in the third study hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested.

In this study age is defined as the number of years the respondent farmer has lived since birth. It is measured as a categorical variable with five age categories, namely: "15-25 years", "26-35 years", "36-45 years" "46-55" and 56 years and above.

3.9.3.2 Gender

This is another personal characteristic of the respondents in the third study hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested.

In this study gender is defined as the biological distinction between males and females among the respondent farmers.

It is measured as a categorical variable with male and female categories.

3.9.3.3 Education

This is yet another personal characteristic of the respondents in the third study hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested. In this study education is defined as the number of years the respondent farmer has spent in formal education. It is measured as a categorical variable with four education categories, namely: no schooling; primary school level; secondary school level; and tertiary level.

3.9.3.4 Land size

This is another respondents' personal characteristic in the third hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested. In this study land size is defined as the areas in hectares of the family/household land that is used or to be used for farming activities. It is measured as a categorical variable with five size categories, namely; 20 hectares and less; 21-50 hectares; 51-100 hectares; 101-500 hectares; 501 hectares and more.

3.9.3.5 Income

This is another respondents' personal characteristic in the third study hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested. In this study income is defined as the amount of money accruing from sale of wheat over the last year. It is measured as a categorical variable with four income categories, namely: KES 5,000 and less; KES 5001-10,000; KES 10,001-25,000; KES 25,001 and above

3.9.4 Institutional factors

These include extension, land tenure system, marketing and credit

3.9.4.1 Extension

This is one of the institutional factors in the fourth study hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested. In this study extension is defined as the respondent farmers' deliberate contact with various sources of information and advice used to enhance the performance of drought tolerance wheat varieties technologies. These include information and advice from research, formal extension, fellow farmers, and others. It is measured by summing up of responses from four "Yes-No" questions soliciting farmers' own assessment of their respective contacts with the four sources of information and advice. The variable "Extension" was represented by an index formed from the four "Yes-No" responses.

3.9.4.2 Land tenure

Land tenure system is another institutional factor in the fourth study hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested. In this study land tenure system is defined as the respondent farmers' kind of land ownership that is involved in the use of drought tolerant wheat varieties technologies. It is measured by farmers' own declaration as to whether their land is "personally owned", family owned", "rented/hired" "communally owned"

3.9.4.3 Marketing

Marketing is another institutional factor whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested in the fourth hypothesis. In this study marketing is defined as easy availability and accessibility of

wheat market by respondent farmers. It is measured by a question seeking to determine the respondent's own assessment of the ease of accessing markets for grown wheat through responses to "Yes" and "No" questions. The responses were summed up to form an index of "Marketing" with two categories, namely; "Easily Accessible" and "Not easily accessible".

3.9.4.4 Credit

This was the last of the institutional factors in the fourth study hypothesis whose relationship with respondent farmers' adoption levels of drought tolerant wheat varieties was tested.

In this study credit is defined as the respondent farmers' access to input resources in form of cash or kind to assist in farming and enhancing the performance of drought tolerant wheat varieties. It is measured by farmers' response to a "Yes- No" question probing whether they respectively accessed credit in the last five years or not.

3.10 Data analysis

Two basic data analysis procedure used were descriptive and analytical. Descriptive procedure in form of frequency distribution analysis was applied to describe the study's primary variable and the associate indicators items mainly as they related to the study objectives and hypotheses. Analytical procedure was used to determine and describe variables relationships.

Specifically, descriptive analysis were undertaken for the nine (9) variables in the hypothesis, discussing the frequency distribution as they relate to adoption of drought tolerant wheat varieties. Testing of the four hypotheses was then undertaken using

crosstabulation (Chi-square) analysis for categorical variables and correlation analysis for bi-variate relationship with categorical variables. T-test was used to compare performance and difference between the districts of Narok and Kajiado.

The researcher used α=0.05 level for significant test and as a point at which to reject null hypothesis if the probability of obtaining the result by chance is α=0.05 or less. The Statistical Package for the Social Sciences (SPSS) was used for analysis.

Table 5: Summary of objectives hypothesis and statistical analysis

Objectives	Hypotheses	Independent variables	Dependent Variable	Statistical Analysis
To identify farmers' perceptions concerning drought tolerant wheat varieties for wheat production among farmers in arid and semi-arid lands districts of Narok and Kajiado	$H\emptyset_1$: There is no statistically significant difference in perception of farmers from Narok and Kajiado districts regarding drought tolerant wheat varieties	Perception, knowledge	Adoption of DTV	T-test
To determine and compare adoption levels of drought tolerant wheat varieties for wheat production by farmers of the two districts	$H\emptyset_2$: There is no statistically significant difference in adoption levels of DTV of wheat between farmers in the Narok and Kajiado districts	Perception, knowledge	Adoption of DTV	T-test
To determine the influence of farmers' personal and socio-economic characteristics, adoption of drought tolerant varieties for wheat production in the two districts;	$H\emptyset_3$: There is no statistically significant relationship between farmers' selected personal and socio-economic characteristics and adoption of DTV	Gender, age, education, land size, and income	Adoption levels	Chi-square
To determine the influence of institutional factors on adoption of DTV of wheat in the two districts including land tenure, credit provision, marketing and extension services	$H\emptyset_4$: There is no statistically significant relationship between institutional factors and adoption of DTV	Land ownership credit, marketing and extension	Adoption levels	Chi-square

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The chapter presents and discusses the results of the study carried out among the wheat farmers in Ololung'a division of Narok district and Isinya division of Kajiado district. More details on how key independent variables influenced dependent variable, are carefully analyzed and discussed. Constraints and opportunities in adoption of drought tolerant wheat varieties are examined in the proceeding chapters. The primary purpose of this study was to determine and describe factors influencing adoption of drought tolerant wheat varieties by farmers for increased wheat production in the arid and semi-arid (ASAL) of Narok and Kajiado districts.

Frequency distributions of key study variables are presented and discussed beginning with farmers' perception, opinion and knowledge concerning drought tolerant wheat varieties (DTV), and the assessment on the degree of use of the technology by farmers in Narok and Kajiado districts. The chapter then presents and discusses personal and socio-economic characteristics including; age, gender, education level, land size, market and income, followed by institutional factors including; land tenure system, credit access, and extension services. The percentages of realized technology up-take of drought tolerant varieties (DTV) by respondents are documented. Finally in this section detailed information and description of respondents' from Narok and Kajiaado districts and possible policy implication of the study highlighted for recommendation.

The chapter therefore presents the results of the study in relation to each objective and hypothesis with the primary purpose of determining and describing constraints and

opportunities for adoption of drought tolerant wheat varieties in Ololung'a of Narok and Isinya of Kajiado districts of Rift Valley Province of Kenya and also investigate how independent variables may have influenced adoption levels of DTV.

4.2 Farmers' perceptions of attributes of DTV of wheat in the ASAL Narok and Kajado districts

The first objective of the study was developed to identify farmers' perception concerning the features of drought tolerant wheat varieties (DTV) and adoption by farmers in arid and semi-arid lands (ASAL) of Narok and Kajiado. The objective discussed issues that imply that farmers must perceive that the technology has sufficient relative advantage over and above the current practice. This was assessed through expression by the respondent on the degree of perception.

Table 6: Farmers' perception concerning relative advantage/profitability of DTV of wheat

Farmers perception	Responses	Percentages
Strongly Agree	0	0%
Agree	5	4.6%
Uncertain	64	59.3%
Disagree	29	26.9%
Strongly disagree	10	9.3%
Total	108	100

Table six shows that majority of the farmers 59.3% were uncertain of the relative advantage that could be achieved from planting drought tolerant wheat varieties and this contradicts Amaza *et al*, (2008) who found that higher yields of improved maize varieties

influenced its adoption. The second group 26.9% disagreed on the fact that DTV were of any advantage in their farming activities while only 4.3% agreed that drought tolerant wheat varieties had an advantage over the previous practice of planting other varieties. The implication of this was that majority of the farmers are uncertain of DTV. It was therefore necessary to assess the farmers' objectives in wheat farming and development of DTV. Table 7 demonstrates the response of the farmers in relation to their farming objective.

Table 7: Farmers' perceptions on objectives of growing DTV of wheat

Farmers' perception	Response	Percentages
Strongly agree	1	0.9%
Agree	7	6.5%
Uncertain	84	77.8%
Disagree	4	13.0%
Strongly disagree	2	1.9%
Total	108	100

The results show that more farmers 77.8% were uncertain about DTV development while 0.9% strongly agreed that DTV were consistent with their farming objective. These objectives included past experience of total crop failure that farmers had experienced. Some farmers' felt needs to improve their social cultural values could not fit in and therefore, 13.0% of the farmers disagreed on compatibility of DTV technology. Values in particular govern peoples taste and preference with 1.9% of farmers strongly disagreeing that there is a chance that DTV technology could not make any difference to the farmers

in ASAL and therefore moving to other crops much more easily than adopting DTV. However the low percentage of farmers who agree with development of DTV was unexpected because DTV have been in existence since 1994.

The other perception farmers expressed was assessment on developed technology and triability at farm level by the farmers. Farmers' response to triability of new technology was 54.6% who were uncertain.

Table 8: Farmers' perceptions of triability of drought tolerant wheat varieties

Farmer perception	Responses	Percentages
Strongly agree	0	0%
Agree	24	22.2%
Uncertain	59	54.6%
Disagree	13	12.0%
Strongly disagree	12	11.1%
Total	108	100

Farmers in general may want to try a new technology so as to observe its efficiency before adopting it. The implication here is that technologies must be able to lend themselves for limited trials as Abdulai and Huffman, (2005) established on new technology variation in terms of adoption due to observation period. In this analysis the results showed that uncertainty still prevailed with 54.6% of the farmer being uncertain, while 22.2% agreed that it was possible to try DTV on small scale for observation. This means that the 22.2% were willing to provide a small portion of their land for the purpose of trial so that they can observe the performance of the DTV technology among other varieties known to them. The other 12.0% disagreed on accepting to provide any part of

their farm for trials with 11.1% strongly disagreeing. These are farmers who would rather watch their neighbours adopt a technology first before they can attempt the same. This concurs with Kamara *et al*, (2006) who found that the more the farming experience the higher the intensity of adoption

Complexities presented by technologies were assessed by seeking to understand if drought tolerant wheat varieties were a complex technology for farmers in ASAL to form an opinion.

Table 9: Farmers' perception of complexities of the drought tolerant wheat varieties

Farmers perception	Responses	Percentages
Strongly agree	1	0.9%
Agree	10	9.3%
Uncertain	72	66.7%
Disagree	25	23.15
Strongly disagree	0	0%
Total	108	100

The study showed that 66.7% of the farmers in ASAL were uncertain about drought tolerant wheat varieties. There were those who believed that the technology was complex in that they could not understand and lacked necessary skills for using the technology. About 23.1% of the farmers disagreed that the technology was complex with only agreeing DTV 9.3% was a complex technology. The crop failure that the farmers had experienced over the years made it difficult for them to understand the difference between the previous wheat varieties and the current drought tolerant wheat varieties.

Having assessed farmer perception in general the researcher then sought to assess the significant difference in perception by farmers in Ololug'a of Narok and Isinya of Kajiado districts.

4.3 Adoption levels of drought tolerant wheat varieties by farmers in ASAL of Narok and Kajiado districts

The second objective was to determine and compare adoption levels of drought tolerant wheat varieties by looking at the levels of adoption. Having found that farmers perception was low in both districts it was then necessary to establish whether farmers were aware of drought tolerant wheat varieties developed and recommended for the region Determination of DTV was done with the understanding that the level of awareness by farmers about DTV was medium which was confirmed by response which showed that 50.0% of the farmers were aware of drought tolerant varieties with the same percentage 50.0% being unaware of the technology in the study area.

Table 10: Farmer awareness of DTV in Narok and Kajiado districts

District	No	Percentages	Yes	Percentages	Total
Narok	30	41.7%	42	58.3%	72
Kajiado	24	66.7%	12	33.3%	36
Total	54		54		108

The study revealed that farmer's awareness concerning drought tolerant wheat varieties was not the same in the two districts. This is supported by the fact that more farmers who were aware of drought tolerant wheat varieties were from Narok district 58.3% compared to Kajiado 33.3%. It also means that the need to increase information dissemination about

drought tolerant varieties in Kajiado should be given more emphasis by the ministry of agriculture and all other service providers in the area. Extension agents should be more active in Kajiado in promoting suitable wheat varieties for increased wheat production. This phenomenon was also assessed by examining the presence of drought tolerant varieties found in the area of study. In figure 4 shows Duma was known by 5.6%, Ngamia 2.8% and Chozi 18.5% and others 73.1%. The highest percentage of farmers planted varieties that were not suitable in the region which resulted in low yields because they were not developed for drought condition as experienced by (90.8%) of the farmers.

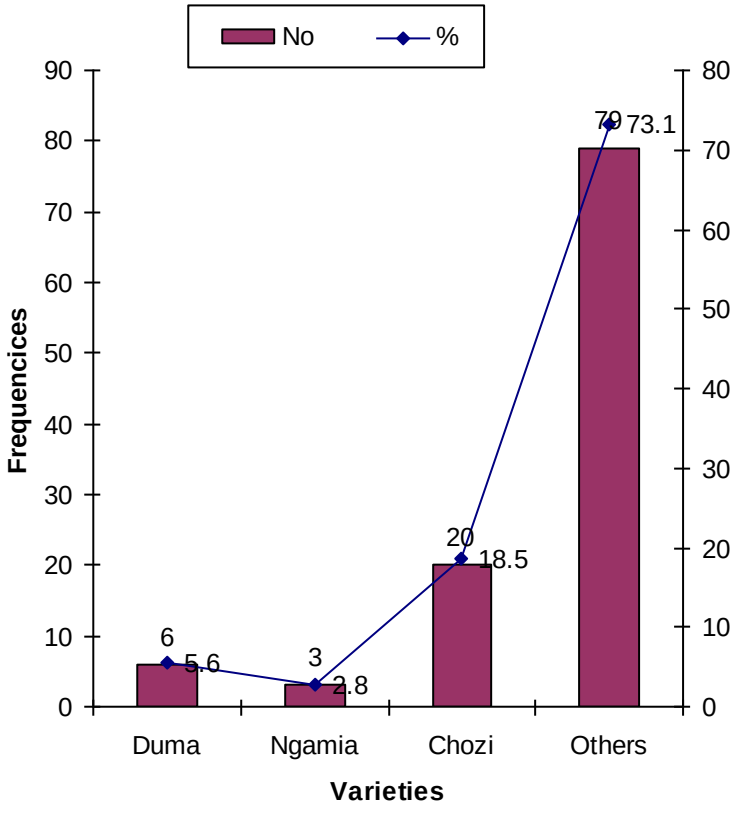

Figure 4: Current use of DTV in the study area

There is a clear indication that information on drought tolerant wheat varieties is wanting and therefore the need to increase information dissemination about drought tolerant

varieties in Kajiado should be given a lot of emphasis. Drought tolerant wheat varieties have been in existence since 1994. The researcher having found that awareness was high but use of drought tolerant wheat varieties was low then assessed adoption levels of the technology at the same time compare the difference in uptake of the technology. This was assessed through the degree of using the technology by the respondent.

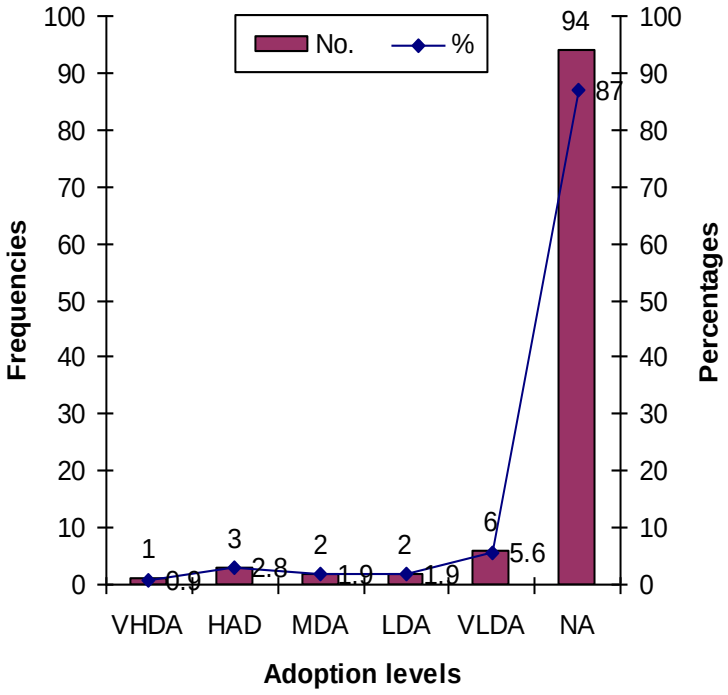

Figure 5: Adoption levels of DTV in study area

Key: VHDA-Very High Degree of Adoption, HAD-High Adoption Degree,
MDA- Moderate Degree of Adoption, LDA-Low Degree of Adoption,
VLDA-Very Low Degree of Adoption, NA-Not Applicable

The analysis on figure 5 showed that adoption levels ranged from 0.9% using the technology while 87.0% did not use drought tolerant wheat varieties. The highest numbers of farmers (87.0%) did not use drought tolerant wheat varieties due to lack of

knowledge (51.9%) and unavailable seed (50.9%) is attributed to this situation. The study demonstrated how farmers are similar in choosing the technology to apply in their farming objectives. Drought tolerant varieties were not popular to 87.0% of the farmers and this was attributed largely to lack of information (56.3%) on drought tolerant wheat varieties. This concurs with the focus group discussion which showed that there was total lack of information on drought tolerant varieties for wheat production was an issue, lack of seed (63.8%), high cost production (87.95), unfulfilling market (78.7%), poor credit availability (85.0%) and lack of machinery (42.5%), Table 12.

4.3.1 Constraints in adoption of DTV in ASAL of Narok and Kajiado districts

Wheat is the most widely grown food crop in the world although it is not able to keep abreast with its demand. Horizontal expansion of wheat in recent years is taking place by moving into the non-traditional areas formerly considered unacceptable for production (FAO, 2002). An effort was undertaken as early as 1990 in Kenya to develop a sustainable wheat production technology for the altitude zones below 1700m above sea level previously used by pastoralist (Tanner and Mwangi, 1992). The environmental conditions under this zone represent a major challenge to the development of a viable wheat production system. Given the low yields of 0.9 tons per hectare at farm level compared to 6 tons per hectare at research level (Kimurto, *et al* 2000) create a need to assess adoption of drought tolerant wheat varieties.

Low up-take of technologies in the study area was attributed to a number of constraints which included lack of knowledge (54.6%) being the top most. The cost of the technology in general hindered 53.7% of the farmers from technology up-take

Table 11: General constraints adoption of drought tolerant wheat varieties

Constraint	No	Yes	N/A
Expensive	30(27.8%)	58(53.7%)	20(18.5%)
Inaccessible	46(42.6%)	47(43.5%)	15(13.9%)
Lack knowledge	32(29.6%)	59(54.6%)	17(15.7%)
Unavailable	46(42.6%)	47(43.5%)	15(13.9%)

The cost of technology remains a challenge to majority of the wheat farmers under study with 87.8% finding cost of inputs to be very high and lack of information 85.2% on current varieties as shown on Table 12. Movement of information from research to the end user shows that there is a gap that so far has not been filled. According to Buck *et al,* (2007) the problem of hunger is not only linked to world food production but also to deficiencies in distribution of vital information and access to production technologies, cultural, social, political, ideological, economic, structural and even war related constraints. Farmers lacked critical information on drought tolerant varieties meaning that what was developed for the region was not available to the farmers in ASAL. Other factors like high cost of input experienced by 87.96% of the farmers, uneven market structure 78.70%, fluctuating price of wheat 78.70% and lack of credit 78.70% were of major concerns to the respondents.

Technology use is also judged according to the extent farmers use the technology to achieve the stated objectives. This was demonstrated by farmers putting great emphasizes on pest and disease control

Table 12: Major Constraints in adoption of DTV in ASAL of Narok and Kajiado

Constraint	Response No	Response Yes	N/A
Lack knowledge	57(52.77%)	50(46.29%)	1(0.92%)
Wildlife interference	74(68.52%)	33(30.55%)	1(0.92%)
Lack of DTV	38(35.18%)	69(63.88%)	1(0.92%)
Lack of information	15(13.88%)	92(85.18%)	1(0.92%)
Other enterprises	64(59.25%)	43(39.81%)	1(0.92%)
Lack of credit	26(24.07%)	81(75.0%)	1(0.92%)
Wheat prices	22(20.37%)	85(78.70%)	1(0.92%)
Wheat market	22(20.37%)	85(78.70%)	1(0.92%)
Lack machinery	61(56.48%)	46(42.59%)	1(0.92%)
Input costs	12(11.11%)	95(87.96%)	1(0.92%)
Pest and diseases	38(35.18%)	69(63.88%)	1(0.92%)

Farmer's choice of technology is dictated by their objectives and economic base. The choice of crop protection against pest and diseases springs from losses experienced by farmers over the years.

4.3.2 Opportunities for adoption of DTV in ASAL of Narok and Kajiado districts

The study explored possible opportunities for wheat production to flourish in the arid and semi-arid lands found that farmers preferred that DTV should be availed (91.2%) within the area of study through demonstration (76.9%). Superior variety will give farmers a chance to choose among various varieties the most suitable one. Constant

demonstration will create awareness which will in turn enhance adoption. Diagne, (2006) found that adoption can be realized by successful and constant demonstrations.

Table 13: Farmers' responses on opportunities for adoption of DTV in ASAL

Opportunities	Response No	Response Yes
Demonstrations	25(23.14%)	83(76.85%)
Remove wildlife	93(86.11%)	15(13.88%)
Provide DTV	9(8.33%)	99(91.66%)
Alternative enterprises	73(67.59%)	34(31.48%)
Subsidize wheat production	30(27.77%)	78(72.22%)
Liberalize wheat production	73(67.59%)	35(32.40%)

Farmers would also adopt these technologies if production of wheat is subsidized (72.22%) as opposed to liberalization of the industry (32.40%) which farmers prefer in the region.

The opportunities available and possible remedies are further strengthened by the fact the only 5.56% of farmers in the region used drought tolerant varieties with the majority 73.15% growing varieties that are inappropriate in the region. This in turn lead to low yields with the farmers moving away from cultivation of wheat in ASAL. Farmers still believe that subsidizing wheat production will encourage more farmers to cultivate wheat as a commercial crop.

4.3.3 Wheat production trends in ASAL of Narok and Kajiado district

Table 15 shows how farmers in previous years have moved from cultivating wheat in more than one thousand hectares of land to less than one to ten hectares of land.

Table 14: Farmers trends in wheat production in the study area

Period	1-10ha	11-20ha	21-100ha	101>1000ha
Before 1990	65(60.2%)	25(23.1%)	8(7.4%)	6(5.6%)
Year 2007	53(49.1%)	19(17.6%)	5(4.6%)	12(11.1%)
Future plans	46(42.6%)	23(21.3%)	4(3.7%)	14(13.0%)

Farmers have continued to move away from wheat production such that only 42.6% have plans to cultivate wheat compared with the previous number of farmers in the category of 1-10ha where 60.2% were cultivating wheat this shows a decline from 1990 to 2007 for all categories except farmers cultivating more than five hundred hectares of land. The data available at geographical information system 1999 shows that wheat was introduced in Kajiado as early as 1930 by the white settlers while Narok district started cultivation of wheat by 1970s. Kajiado farmers then moved out of growing wheat due to low yields experienced at farm level yearly. It was then re-introduced into the district in 1981 by the Ministry of Agriculture as a major cash crop. Wheat was unable to improve in terms of land area and lack of sufficient rains was identified as the single most important constraint. This in turn challenged the researchers to develop drought tolerant varieties which have then released into the area by 1994. Five drought tolerant wheat varieties have since been released for adoption by farmers in the ASAL of Narok and Kajiado districts and other areas with similar condition. In conclusion, the inherent characteristics of DTV affected perception of farmers in both districts.

4.4 Influences of personal and socio-economic characteristics on adoption of drought tolerant wheat varieties by farmers in Narok and Kajiado districts

The study used social, institutional and personal characteristic to assess their influence on technology up-take by farmers in ASAL of Narok and Kajiado districts. These characteristics included personal characteristics (age, gender, land size and education level), socio-economic factors (market, and income) and institutional factors (extension services, credit accessibility and land tenure system) in the area of study. This section includes discussion on technology utilization by farmers and how each variable influenced adoption of drought tolerant wheat varieties. This section provides detail statistical significant relationship between technology up-take and various independent variables.

4.4.1 Gender distribution of respondents in Narok and Kajiado districts

Gender in this study referred to biological and social constructed differences between men and women. Sex and gender were not differentiated but used interchangeably as used by Quisumbing, (1996). The distribution of farmers by gender in the study area was described by the cultural roles played by members of a society which is described either as male or female. In general wheat is a male dominated crop in the area of study.

Table 15: Gender distribution in Narok and Kajiado district

Gender	Frequency	Percentage
Male	92	85.2%
Female	16	14.8%
Total	108	100

Gender analysis shows that 85.2% of the respondents were males. The male dominance in wheat production is reflected in the number of respondents in the study. The culture of farmers in the ASAL is such that a commercial crop like wheat is a preserve of the males. The study looked at members of the society who did more work in the wheat farm but as much as females' respondents were less in total but they all agreed that 74.1% of the work was done by women as shown on Table 17

Table 16: Gender and labour provision in ASAL of Narok and Kajiado districts

Gender and labour	Response	Percentage %
Males	20	18.5
Females	80	74.1
Both	8	7.4
Total	108	100

In practice women did more work than men who provide only supervisory roles. Women perform tasks like seed preparation, seed dressing and organization during planting time. Although several tasks were shared there was gender division of labour. The study showed that females were more concerned with provision of food while men worked on income generation. This is because a socio-economic level of a farmer and his household

is understood through the level of income accrued from different sources both in the farm and outside the farm. In this study majority of the farmers 34.3% earned more than Kshs.50, 000 from wheat production while 25.0% earned less than Kshs.10, 000 from wheat production. This particular result pushed majority of the farmers to drop cultivation of wheat. According to research recommendation drought tolerant varieties yields per hectare should be more than twenty five (25) bags per hectare.

4.4.2 Age distribution of respondents in Narok and Kajiado districts

Studies relating to farmer's age to his/her adoption behaviour reveal conflicting results with some showing positive relationships while others reflect strong negative relationship.

Table 17: Age distribution of wheat farmers in Narok and Kajiado districts

Age	Respondents	Percentages
15-25years	17	15.7%
26-35years	20	18.5%
36-45years	33	30.6%
46-55years	12	11.1%
>56years	26	24.1%
Total	108	100

In this study the age factor showed that 30.6% of the respondents were of the age bracket 36-45 years which is the most productive age of the members of the society. It also shows that 75.9% were in their prime working age. The study also assessed the relationship between age of the farmers and adoption of drought tolerant wheat varieties for ASAL

and it showed that there was no statistically significant relationship between age and adoption of drought tolerant varieties.

4.4.3 Educational levels of respondents in Narok and Kajiado districts

Literacy plays an important role of enabling farmers to get access to written material, thereby facilitating their awareness of information. Farmers whose ability to read and write is low tend to be disadvantaged in utilizing information. In this study the analyzed data showed that more than half (50.9%) of the 108 respondents had obtained secondary education while (22.2%) had no education with (7.4%) had attained tertiary level of education.

Table 18: Education level of respondents in Narok and Kajiado districts

Education	Response	Percentage (%)
Informal	24	22.2%
Primary	21	19.4%
Secondary	55	50.9%
Tertiary	8	7.4%
Total	108	100

Education levels attained is a crucial factor is the ability of an individual to participate in development process. Education increases an individual ability to assess new ideas and form an informed decision to take up new ideas or drop them all together.

4.4.4 Land size of respondents and distribution in Narok and Kajiado districts

Farms of different sizes may present different context of adoption. Large-scale farms are a base for expansion and a source of materials, which can be spread over a

greater number of out put units. The assessment on land sizes found in the study area showed how farms of different sizes may present different levels of adoption. Large farms are a base for expansion and a source of materials, which can be spread over a greater number of out put units. In this study majority of the farmers owned farms and also operated on small land sizes below 20 hectares (54.6%) as demonstrated on Table 20 while farmers with over 1000 hectares of land were only (3.7%)

Table 19: Land size distribution in ASAL of Narok and Kajiado districts

Land size	Respondents	Percentage
<5-20 hectares	59	54.6%
21-50 hectares	25	23.1%
51-100 hectares	14	13.0%
101-500 hectares	6	5.6%
501->1000 hectares	4	3,7%
Total	108	100

This shows that falling land sizes in wheat production is common with farmers with land size below 50 hectares.

4.4.5 Respondents' income from wheat production and marketing

The other socio-economic factor that makes a difference is income level of a farmer and his household accrued from different sources both in the farm and outside the farm. In this study majority of the farmers 34.3% earned more than KES.39, 000/ha at the price of KES. 1,800 per 90kg bag of wheat while 25.0% earned less than KES.10, 000 from wheat production. These particular results pushed majority of the farmers to drop

cultivation of wheat considering the input cost that was over and above the revenue. According to research recommendation drought tolerant varieties yields per hectare should be more than twenty five (25) bags per hectare which should translate to KES 45,000.

Table 20: Farmers income from wheat in Narok and kajiado districts

Income	Response	Percentages
KES<5000	18	16.7%
KES 5001-10,000	27	25.0%
KES 10,001-25,000	26	24.1%
KES above 25,000	37	34.3%
Total	108	100

Lack of organized market, unstable prices, cost of production and transportation particularly in Kajiado where the terrain is complex. This phenomenon affected a large population of wheat farmers with 78.7% of the farmers founding it difficult to market their wheat product with many brokers taking advantage of the open market situation. This therefore contributed negatively to adoption of recommended drought tolerant varieties ASALs of Narok and Kajiado. Liberalization policy of the market industry also made it difficulty for the government of Kenya to step in and normalize the prices for the sake of the farmer. This left farmers at the mercy of the brokers who exploited the majority of the farmers. The situation was made worse by the yields achievable in ASAL of Narok and Kajiado districts. As shown on Table 22 the yields ranged between 6bags/ha to 22 bags/ha.

Table 21: Wheat yields achievable in ASAL Narok and Kajiado districts

Bags/hectare	Response	Percentage%
<10bags/ha	58	51.9%
11-20bags/ha	42	38.9%
21-30bags/ha	9	8.3%
>31bags/ha	1	0.9%
Total	108	100

The majority of the farmers (51.9%) could only achieve an average of less than 10bags per hectare in an area where the expected yields of Kenya Duma is 25bags per hectare which would translate to an income of between Kshs. 10,000 to Kshs.45,000. This means that the majority of the farmers operated at a loss when the yields were as low as 10bags/hectaere. This would translate to Kshs.18, 000 depending on the buying price which keeps fluctuating due to the liberalized wheat market. The consequences of this were a fall away of farmers from wheat production. The general move away from wheat production by farmers, particularly those operating below 20 hectares have moved away to other preferred crops like maize and beans.

4.5 Influences of institutional factors on adoption of drought tolerant wheat varieties by farmers of Narok and Kajiado districts.

The study used institutional factors to assess their influence on technology up-take by farmers in ASAL of Narok and Kajiado districts and it included (extension services, credit accessibility and land tenure system) in the area of study. This section

includes discussion on technology utilization by farmers and how each variable influenced adoption of drought tolerant wheat varieties.

4.5.1 Land tenure system of respondents of Narok and Kajiado districts

Farmers are dynamic in decision making particularly when it comes to up-take of new ideas. The idea must provide relative economic advantage over their current practices. Adam (1987) argues that small scale farmer's place considerable emphasizes on short term profitability that will be associated with adoption of new technology. Table 22 shows that majority of land ownership category was high on personal ownership (64.8%). This means that they had title deeds of the land which allows them to perform farming activities of their choice. In so doing they can be able to envisage benefits that would come from adopting Drought Tolerant Varieties. It is also expected that willingness to consider investing in DTV would be done much more easily when land under production is owned. The study showed that about 23.1% hired land for wheat production. However, in the study area there were also farmers who still operate under communal (8.3%) type of land and (3.7%) still use family land for crop production

Table 22: Land tenure system in ASAL of Narok and Kajiado districts

Land ownership	Respondents	Percentage
Personal	70	64.8%
Rent/hire	25	23.1%
Communal	9	8.3%
Family	4	3.7%
Total	108	100

This shows that majority of the farmers owned land and this allowed the farmer to capture benefits from new technologies. The willingness to consider investing in new ideas was done more easily when land under production is owned. However, those who rent/hire land (23.1%) were willing to invest heavily for higher profit. Right to land as a resource increases the propensity of technology adoption by farmers although (Mugisha *et al*, 2004) found land tenure to be a reason for no-adoption of Integrated Pest Management (IPM) in Uganda.

Kajiado district is suitable for drought tolerant crops such as millet, sorghum although maize and beans are preferred due to their easy in utilization at farm level. Narok district on the hand has few farmers who engage in large scale wheat, barley and rapeseed production.

4.5.2 Extension services for wheat farmers in Narok and Kajiado districts

Extension is traditionally considered as a means of providing a link between agricultural research and farmers. It is a means of transmitting new technologies to farmers and current problems to research. It is also a means of transmitting technical advice to the farmer to assist them improve their productivity and income (Honlonkou, 2004; Miyata and Manatunga, 2004; Garfoth, 1982). On Table 23 it is clear that majority 65.7% does not have access to extension services and only 19.4% had access to this critical service.

Table 23: Extension services for farmers in ASAL of Narok and Kajiado districts

Extension	Number of Respondents	Percentages
Response No	71	65.7%
Response Yes	21	19.4%
Response N/A	16	14.8%
Total	108	100

Having examined extension service provision, the study looked at other sources of information available to the farmers in the ASAL which could be used to improve uptake of technologies. To facilitate transmission of technology transfer, extension ensures that adequate amount of high quality information about the technology is accessible to the farming community. The information helps farmers to increase adoption rates by providing information that reduces technical uncertainty.

These included research institutions, fellow farmers and institutions found in the region like NGOs.

Table 24: Other extension service providers in Narok and Kajiado districts

Service providers	Respondents	Percentages%
NGOs	39	36.1%
Fellow farmers	41	38%
Research institutions	13	12%
N/A	15	13.9%
Total	108	100

Table 24 shows, that there was heavy reliance on fellow farmers (38.0%) for information and non-governmental organizations providing information to 36.0% of the farmers and research institutions to 12.0% of the farmers.

4.6 Hypotheses Testing

Four hypotheses were tested to determine the relationship between the chosen independent variables and adoption of drought tolerant wheat varieties as the dependent variable. The first hypotheses were developed to test the differences that exist in the two districts about drought tolerant wheat varieties. The last two tested the relationship between the independent variables and the dependent variable.

4.6.1 Farmers' perceptions difference concerning drought tolerant varieties by farmers in Narok and Kajiado districts

The hypothesis of the above objective stated that there was no statistical significant difference in perception by farmers of Ololung'a in Narok district and Isinya in Kajiado districts concerning drought tolerant wheat varieties

The hypothesis for this objective was that there was no significant difference in perception of drought tolerant wheat varieties by farmers in Narok and Kajiado districts.

The study assessed the significant difference in the two districts in terms of perception of drought tolerant varieties. Table 25 shows that there was no significant difference in perception of drought tolerant varieties by farmers in Narok and Kajiado in terms of relative advantage. The average perceptions associated with relative advantage of the technology for Narok 2.54 was slightly lower than the average for Kajiado 2.69 with a t-test=-1.034; $P \leq 0.303$ at $\alpha=0.05$ was not significant. The null hypothesis was therefore

rejected and the alternative accepted. The farmers in the two districts had similar perception on profitability of drought tolerant varieties. This was explained by the fact that majority of he farmers were uncertain of the relative advantage of drought tolerant wheat varieties and how DTV related to their farming objectives and whether they could be tried on small scale basis. The study concurs with the findings of Oladele and Fawole, (2007) on farmer perception of relevance of agriculture technology in South-western Nageria. Complexities presented by technology to farming communities created averseness in farmers and this concurs with Wubeneh and Sanders, (2006) who found that farmers perceptions of technology characteristics influenced adoption.

Table 25: T-test analysis on differences in farmers' perception between Narok and Kajiado districts on adoption of drought tolerant wheat varieties

Farmers' perception	Narok		Kajiado				
	Mean	**STD**	**Mean**	**STD**	**df**	**t-test**	**P value**
DTV Advantage	2.54	0.730	2.69	0.710	106	1.03	0.303NS
DTV Consistent	2.89	0.545	2.97	0.560	106	0.74	0.460NS
DTV Triable	2.92	0.960	2.81	0.710	106	0.62	0.400NS
DTV Complex	2.90	0.675	2.83	0.378	106	0.57	0.569NS

* $P<0.05$, NS: Not significant

The results were similar with perceptions of farmers concerning of DTV with farmers' farming objectives where Narok mean was 2.89 compared to Kajiado mean 2.97 with a t-test 0.742 with an associated probability $P\leq0.460$ at $\alpha=0.05$ was not significant. This was similar with perception of farmers concerning of DTV and the ability to be tried on farmer's field where Narok mean was 2.92 compared to Kajiado mean 2.81 with a t-test

0.615 with an associated probability P≤0.40 at α=0.05 was not significant. This was also similar with perception of farmers concerning of DTV with complexities that come with the technology and found that Narok mean was 2.90 compared to Kajiado mean 2.83 with a t-test 0.573 with an associated probability P≤0.568 at α=0.05 was also not significant. However insignificant these four variables may be, they are the most important in wheat production. Efforts must therefore be made to ensure that farmers in both Narok and Kajiado are aware of drought tolerant wheat varieties in wheat production to achieve the desired yields as recommended by research. The fact that no significant difference was found means that both Narok and Kajiado farmers experience difficulties in accessing these technologies. Therefore, emphasis be put on constant field demonstrations and promotion of drought tolerant varieties in the ASAL of Narok and Kajiado district to improve farmer perception. Farmer perception showed slight variation and it has the potential to affect the eventual adoption. The perception of farmers on DTV emphasizes the need for a demand driven technology as opposed to supply-driven strategy. Farmers should therefore be allowed to participate in research. This study concurs with Amaza, *et al*, (2008) who found that perceived profit has higher chances of adoption

4.6.2 Significant differences in adoption levels of drought tolerant wheat varieties in ASAL of Narok and Kajiado districts

The hypothesis for the second objective sought to establish if there was any statistical significance difference in adoption levels of drought tolerant wheat varieties by farmers in Narok and Kajiado districts. The three major aspects included awareness, knowledge on drought tolerant varieties and extent of using drought tolerant varieties of wheat.

Table 26: T-test analysis on differences between Narok and Kajiado in adoption of drought tolerant wheat varieties

	Narok		Kajado				
Adoption levels	Mean	STD	Mean	STD	df	T-test	P value
DTV Awareness	1.58	0.496	1.33	0.478	106	-2.497	0.014*
DTV use	4.43	1.005	4.67	1.121	106	1.107	0.271NS
DTV adoption	1.38	1.091	1.17	0.697	106	-1.085	0.281 NS

* P<0.05, NS: Not significant

The second hypothesis was that there was no statistical significant difference in adoption levels of drought tolerant wheat varieties by farmers of Narok and Kajiado districts. The assessment established that there was a significant difference with the average percentage for Narok mean 1.58 being higher than Kajiado mean 1.33 with a t-test -2.497; ($P<0.014$; $\alpha=0.05$) was statistically significant. Therefore the hypothesis that there was no statistical significant difference between Narok and Kajiado in adoption of DTV was rejected and the alternative accepted which states that there was a statistical significant difference in farmers' awareness in the two districts. The study analyzed use of drought tolerant varieties by farmers in Narok and Kajiado and found that the average percentage in terms of drought tolerant wheat varieties use by farmers in Narok mean 4.43 and Kajiado mean of 4.67; ($P\leq0.271$; $\alpha=0.05$) was no statistical significant difference. The null hypothesis which stated that there was no statistical significant difference in use of drought tolerant varieties by farmers in Narok district and Kajiado district was therefore accepted. However insignificant this aspect of adoption may be, they are the most important in wheat production in ASAL. Efforts must therefore be made to ensure that farmers in both Narok and Kajiado use suitable wheat varieties in wheat production to

achieve the desired yields as recommended by research. The fact that no significant difference was found means that both Narok and Kajiado farmers experience difficulties in using these technologies. Therefore, strategies should be developed towards provision of this major technology. This can be made possible through constant provision of information on drought tolerant wheat varieties, field demonstrations and promotion of drought tolerant varieties in the region. In awareness, farmers of Narok are more aware of drought tolerant wheat varieties than those in Kajiado district. The study contradicts Wubeneh and Sanders, (2006) on farm level adoption of sorghum in arid and semi-arid lands (ASALs) of Ethiopia. However, there are other challenges facing adoption of these varieties and the study therefore decided to look at other social, institutional and personal characteristics that would positively or negatively influence adoption of wheat production in the arid and semi-arid lands of Narok and Kajiado districts of Kenya. α=0.05) was no statistical significant difference. The null hypothesis which stated that there was no statistical significant difference in use of drought tolerant varieties by farmers in Narok district and Kajiado district was therefore accepted. However insignificant this aspect of adoption may be, they are the most important in wheat production in ASAL. Efforts must therefore be made to ensure that farmers in both Narok and Kajiado use suitable wheat varieties in wheat production to achieve the desired yields as recommended by research. The fact that no significant difference was found means that both Kajiado and Nsrok farmers experience difficulties in using these technologies. Therefore, strategies should be developed towards provision of this major technology. This can be made possible through constant provision of information on drought tolerant wheat varieties, field demonstrations and promotion of drought tolerant varieties in the region. In awareness,

farmers of Narok are more aware of drought tolerant wheat varieties than those in Kajiado district. The study contradicts Wubeneh and Sanders, (2006) on farm level adoption of sorghum in arid and semi-arid lands (ASALs) of Ethiopia. However, there are other challenges facing adoption of these varieties and the study therefore looked at other social, institutional and personal characteristics that would positively or negatively influence adoption of wheat production in the arid and semi-arid lands of Narok and Kajiado districts of Kenya.

4.6.3 Chi-square relationship between personal and socio-economic factors and adoption of DTV

4.6.3.1 The gender influence on adoption of DTV

Chi-square relationship and adoption of drought tolerant varieties were carried out to assess if any significant relationship existed and how gender influenced adoption in ASAL of Narok and Kajiado districts. The study showed that there was no significant relationship between gender and adoption of drought tolerant wheat varieties and therefore DTV as a new technology was independent of gender with χ^2 calculated =2.59 with 1 degree of freedom was lower than χ^2 critical value =3.841; $P \leq 0.459$ at α =0.05. This concurs with findings by Doss and Morris, (2001) on adoption of maize in Ghana where technology adoption decision dependent on access to resources rather than gender but contradicts Adesina and Chianu, (2002) who found that farmer characteristics that influenced adoption included the gender of the farmer and contacts with extension agents.

Table 27: Chi-square relationship between gender and adoption of drought tolerant varieties

Personal characteristics	**Drought tolerant varieties**				
Gender	Duma	Ngamia	Chozi	Others	Total
Male	5	3	19	65	92
Female	1	0	1	14	16
Total	6	3	20	79\	108

χ^2 cal. = 2.59 1df χ^2 critical = 3.841 P≤0.459 at α=0.05

4.6.3.2 The influence of age on adoption of DTV

The proportion of farmers who have adopted use of the correct drought tolerant varieties in ASAL was the same across the age groups. The results shows that the use of the new varieties for ASAL is independent of age as demonstrated by χ^2 calculated 12.93 at 12 degrees of freedom χ^2 critical value 21.03; P≤0.37 at α=0.05which was obtained from farmer's age group and use of recommended varieties. Therefore, the null hypothesis, which stated that there was no statistical significant relationship between age of the farmer and his/her ability to adopt new technologies, is accepted. This finding concurs with Dadi, (2004) who found that education, age and gender have little or no influence on adoption behaviour of farmers in Ethiopia. This factor was therefore eliminated as one of the constraining factors to adoption of drought tolerant wheat varieties in ASAL of Narok and Kajiado districts.

Table 28: Chi-square relationship between age and adoption of DTV of wheat

Varieties	15-25yrs	26-35yrs	36-45yrs	46-55yrs	>56yrs	Total
Duma	0	0	4	1	1	6
Ngamia	0	1	1	0	1	3
Chozi	7	3	5	1	4	20
Others	10	16	23	10	20	79
Total	17	20	33	12	26	108

χ^2calculated =12.93 12 degrees of freedom χ^2 critical= 21.03 P≤0.37 at α=0.05

4.6.3.3 The influence of Education on adoption of DTV

On assessing the relationship between education level and technology adoption, the study was able to establish that no statistically significant relationship exists between education level and adoption level of drought tolerant varieties although education should influence adoption. The proportion of farmers who have adopted use of the correct drought tolerant varieties in ASAL was the same across the education levels. The results show that the use of the new varieties for ASAL is independent of education level of the farmers as demonstrated by χ^2 calculated 12.39 at 9 degrees of freedom with a χ^2 critical value 16.92; P≤0.17 at α=0.05 which was obtained from farmer's education levels and adoption of drought tolerant wheat varieties. Therefore, the null hypothesis, which stated that there was no statistical significant relationship between education level of the farmer and his/her ability to adopt new technologies, is accepted. This finding concurs with Dadi, (2004) who found that education, age and gender have little or no influence on adoption behaviour of farmers in Ethiopia. Studies by Weir and Knight, (2004) contradict this finding in that it shows that education level of a farmer encourages early adoption on.

On the other hand Sigh and Santiago, (1997) found that the farmers educational attainment influenced farm earnings in Mexico. However, this factor in this study was not significant and therefore cannot be associated with failure of the constraining factor to adoption of drought tolerant wheat varieties in ASAL of Narok and Kajiado districts.

Table 29: Chi-square relationship between education and adoption of DTV

	Drought tolerant wheat varieties				
Education levels	**Duma**	**Ngamia**	**Chozi**	**Others**	**Total**
Informal	0	0	7	17	21
Primary	0	1	5	15	21
Secondary	4	2	7	42	55
Tertiary	2	0	1	5	8
Total	6	3	20	79	108

χ^2 cal. = 12.39 9df χ^2 criti. = 16.92 P≤0.17 α=0.05

4.6.3.4 The influence of land size on adoption of DTV

The results shows that the use of drought tolerant wheat varieties for ASAL is dependent of land size that farmers own The analysis under land size showed that χ^2 cal. = 51.49 with 12 degrees of freedom was higher than χ^2 criti.= 21.03; P<0.000 α=0.05 obtained from farmer's land size and adoption of drought tolerant wheat varieties.

Table 30: Chi-square relationship between land size and adoption of DTV

	Drought tolerant wheat varieties				
Land sizes	**Duma**	**Ngamia**	**Chozi**	**Others**	**Total**
<5-20-20 hectares	0	0	11	48	59
21-50 hectares	3	1	8	13	25
51-100 hectares	1	0	1	12	14
101=500 hectares	0	1	0	5	6
501->1000 hectares	2	1	0	1	4
Total	6	3	20	79	108

χ^2 cal. = 51.49 12df χ^2 criti. = 21.03 P<0.000 α=0.05 α=0.05

Therefore, the null hypothesis, which stated that there was no statistical significant relationship between land size of the farmer and his/her ability to adopt new technologies, is rejected and the alternative accepted which states that there is a statistical significant relationship between land size and adoption of drought tolerant wheat varieties in ASAL of Narok and Kajiado districts. The results concur with Fuglie and Kaseak, (2001); Mugisha, *et al,* (2004) who indicated that adoption of Integrated Pest Management (IPM) groundnut in Uganda was significantly influenced by land size. It also concurs with Amaza, (2008) who found farm size, extension, credit access to greatly influence adoption of improved maize varieties. The study also concurs with Kibende (1990); Ndiema (2002) who found land size to be a significant factor in adoption and use of new technology but the findings contradict Amudavi, 1993 who found no relationship

between land size and adoption of maize technologies. Kibende (1990) in a study of adoption in Ethiopia found that land size was the most significant factor affecting the adoption of agricultural technology. A survey in Kenya also isolated land size as the most important variable affecting farmer innovativeness Wubeneh and Sanders, (2006); Fuglie *et al*, (2001); Roling, (1990). This is because farmers with large farms can experiment with innovations to see their results before adoption.

Therefore the hypothesis of independence is rejected and conclusion drawn that adoption of drought tolerant varieties are dependent on land size. Therefore, the study recommends that wheat production will be more profitable if grown in large land size than farms below twenty hectares of land.

4.6.3.5 The influence of income from wheat production on adoption of DTV

Chi-square relationship between income and adoption of drought tolerant varieties were carried out to assess if any significant relationship existed and how they influenced adoption process in ASAL of Kajiado and Narok district. The study showed that there was no significant relationship between income and adoption of drought tolerant wheat varieties and therefore DTV as a new technology was independent of income with χ^2 calculated =10.652 with 9 degree of freedom was lower than χ^2 critical value =16.92 at α=0.05.

Table 31: Chi-square relationship between income and adoption of DTV

Farm income	Duma	Ngamia	Chozi	Othors	Total
KES< 5,000	0	0	6	12	18
KES 5001-10,000	0	1	6	20	27
KES 10,001-25,000	2	0	3	21	26
KES above 25,000	4	2	5	26	37
Total	6	3	20	79	108

χ^2 calculated=10.651 9degrees of freedom, χ^2crit.= 16.92 P≤0.300; α=0.05

Therefore the null hypothesis which stated that there was no statistical significant relationship between income and adoption of drought tolerant wheat varieties was accepted and conclusion drawn that adoption of drought tolerant varieties are not dependent on income.

4.6.4 Chi-square relationship between institutional factors adoption of DTV

4.6.4.1 The influence of Land tenure system on adoption of DTV

Land tenure system is an important institutional arrangement and linked closely to diffusion of information of agriculture technology. The study looked at the relationship between this variable and adoption of drought tolerant varieties in the ASAL of Narok and Kajiado districts.

Table 32: Chi-square relationship between land tenure and adoption of DTV

	Drought tolerant wheat varieties				
Land tenure system	**Duma**	**Ngamia**	**Chozi**	**Others**	**Total**
Personal	1	2	14	53	70
Rent/hire	3	1	3	18	25
Communal	0	0	3	6	9
Family	2	0	0	2	4
Total	6	3	20	79	108

χ^2 cal. = 22.11 9df χ^2 crit. = 16.92 P<0.009 α=0.05

Land tenure system showed that χ^2 cal. =22.11, 9df, χ^2 crit. = 16.92; P<0.009; α =0.05, Therefore the hypothesis of the study stated that there was no statistical significant relationship between land tenure system and adoption of drought tolerant wheat varieties showed that χ^2 cal. =22.11, was greater than critical level 16.92 with nine (9 degrees of freedom); P<0.009; α =0.05. Therefore the null hypothesis which stated that there was no statistically significant relationship between land tenure system and adoption of drought tolerant varieties was rejected and the alternative accepted. The null hypothesis is rejected and conclusion drawn that adoption of drought tolerant varieties are dependent on land tenure system. It is clear that land tenure system is an institutional arrangement that is important in diffusion of information of any agricultural technology. Farmers must perceive benefits accrued from investment made in new technologies before considering

change of current farm practices. This implies that farmers must have rights to land resources, which they are operating if technology improvements have to be implemented and this concurs with Perz, (2003), while Mugisha *et al*, (2004) contradicts the findings of the study by suggesting that land tenure was the reason for non-adoption of IPM in Uganda. Ogunlana, (2004) concurs with the study that land tenure system was an inflexible constraint in adoption. However, farmer's right to land resource should not be interpreted to mean that private ownership is the only form of land tenure which enhances adoption of technology, in this respect the issue is rights rather than the form of rights to land resources.

4.6.4.2 The influence of extension services on adoption of DTV

For in-depth understanding of the significant relationship between other service providers, and adoption of drought tolerant wheat varieties, a chi-square statistics were performed and found that there was a statistical significant relationship between technology up-take and service provision in the ASAL of Narok and Kajiado districts.

Table 33: Chi-square relationship between extension and adoption of DTV

	Drought tolerant wheat varieties				
Information source	**Duma**	**Ngamia**	**Chozi**	**Others**	**Total**
Fellow farmers	2	1	12	26	41
Research	3	0	0	10	13
Extension	0	2	6	31	39
N/A	1	0	2	12	15
Total	6	3	20	79	108

χ^2 cal. = 17.24 9df χ^2 criti. = 16.92 P<0.045 α=0.05

The results showed that χ^2 calculated 17.24 was higher than χ^2 crititical= 16.92 at nine (9 degrees of freedom) with an associated probability P<0.045; α=0.05. Therefore the null hypothesis which stated that there was no statistical significant difference between information source and adoption of drought tolerant varieties was rejected and the alternative accepted. The null hypothesis is rejected and conclusion drawn that adoption of drought tolerant varieties in ASAL of Narok and Kajiado is dependent on information availability. Several studies have indicated a positive relationship between contact with agricultural information sources and adoption (Moser and Barrett, 2006; World Bank, 1993). This concurs with the above findings which show that adoption is dependent on information source that can assist farmers make informed decisions. Farmers who have been exposed to an intensive extension education adopted many agricultural innovations in contrast to neighbours who are not exposed to extension campaigns.

Several government policies put in place to improve agriculture in the arid and semi-arid lands (ASALS) were contained in the Strategic Revitalization of Agriculture (SRT) of the Ministry of Agriculture (Government of Kenya, 2002). In this Plan wheat production was recognized as a crop best for foreign exchange earner and moving it to the ASALs would increase its production both for foreign exchange and income generation at household level. Therefore scientists developed and dissemination of suitable varieties that were drought tolerant. Besides extension service provision, farmers needed other motivating factors put in place for them to continue cultivating wheat. This included issues like input prices marketing of the products. Majority of the farmers found cost of inputs prohibitive as show wheat fluctuating prices which pushed farmers away

from cultivation of wheat in the region. Unfortunately the government did not put in place any mechanism to protect the wheat farmers.

Generally agricultural extension services both from local and national providers have been inadequate for the past five years making dissemination of important technologies in arid and semi-arid lands like Narok and Kajiado almost impossible. The Kenya government in 1995 introduced Structural Adjustment programme so that the civil service could best service its clients. This was done reducing the number of extension agents in the field for efficiency but this further aggravated the situation

4.7 Summary of Findings

Chapter four was concerned with the presentation and interpretation of results. Descriptive statistics, t-test and chi-square were used to assist in interpretation of the data.

I a) Descriptive statistics reveal farmer perception concerning drought tolerant wheat varieties was uncertain as to what the technology was of any relative advantage, could be tried on small scale for observation and complexities presented by the technologies.

b) T-test done showed no significant difference could be found between the two districts as far as perception was concerned which is explained by the fact that majority of the farmers were uncertain about drought tolerant wheat varieties.

II a) Farmer awareness of drought tolerant wheat varieties were higher in Narok than in Kajiado district. However the majority of the farmers still cultivate other varieties other than the recommended drought tolerant wheat varieties for ASAL conditions

b) Adoption levels were very low being at 0.9%. The cited constrains being lack of knowledge, lack of information on DTV, lack of DTV, poor prices and market channels although cost of production toped the list.

c) Opportunities available for DTV adoption in ASAL of Narok and Kajiado districts included provision of drought tolerant varieties, demonstrations, subsidizing of wheat production toping the list.

III a) Socio-economic and personal characteristics showed higher number of respondents were males although more women were involved the actual work in

the wheat fields.

b) Consequently the null hypothesis showed that for gender, age, education level and income were not significant. The factors did not influence the up-take or non up-take of drought tolerant wheat varieties as a technology and therefore had no significant relationship with adoption of drought tolerant varieties.

IV a) Other factors that showed significant relationship included land tenure system, extension service provision, information source and general institutional support system that was wanting.

b) Credit, market, and expected income were found to be the other determinant of the intensity of adoption. Policy should therefore aim at strengthening wheat farmers to have improved access to credit, market and subsidy in form of inputs and a protected market.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The preceding chapter dealt with the presentation and interpretation of the findings. Frequency distribution, mean, STD, T-test and chi-square were used to assist in the interpretation of the data.

This chapter presents the summary and conclusion drawn from the findings of the study. Secondly an attempt is made to discuss the implication of the major findings and how they might affect adoption of drought tolerant wheat varieties for increased wheat production. Finally the recommendation on how the findings obtained can be applied to improve adoption of drought tolerant wheat varieties are given.

5.2 Summary

This study sought to systematically investigate factors influencing adoption of drought tolerant wheat varieties in arid and semi-arid lands of Narok and Kajiado districts. The primary purpose of the study was therefore designed to describe and compare factors that influenced adoption of DTV in ASAL of Narok and Kajiado districts of Rift Valley province-Kenya. Secondly the study was designed to determine and compare adoption levels of drought tolerant varieties for wheat production and assesses farmers' personal and socio-economic characteristics and institutional factors that might contributed to adoption. Finally make suggestion for policy makers on arid and semi-arid lands of Kenya

The study therefore addressed the following specific objectives;

i) Identify farmers' perceptions concerning drought tolerant wheat varieties (DTV) for wheat production among farmers in arid and semi-arid districts of Narok and Kajiado.

ii) Determine and compare adoption levels of drought tolerant wheat varieties for wheat production by farmers of the two districts.

iii) Determine the influence of farmers' personal and socio-economic characteristics, and adoption of drought tolerant varieties for wheat production in the two districts;

iv) Determine the influence of institutional factors on adoption of DTV of wheat in the two districts including land tenure, credit provision, marketing and extension services

v) Suggest recommendations on the above factors and other implications for wheat production in the arid and Semi-arid lands of Kenya.

The following null hypothesis were tested at $\alpha=0.05$

$H\emptyset_1$: There was no statistical significant difference in perception of farmers from the two district regarding drought tolerant wheat varieties

$H\emptyset_2$: There was no statistical significant difference in adoption levels of DTV of wheat between farmers in the two districts,

$H\emptyset_3$: There was no statistical significant relationship between farmers' selected personal and socio-economic characteristics (namely age, gender, level of education, income and farm size)

$H\emptyset_4$: There was no statistical significant relationship between institutional factors

(namely land tenure system credit provision, marketing and extension services) and adoption of DTV of wheat

a) In summary therefore, it was observed that farmer perception on drought tolerant wheat varieties showed that farmers were not sure on the benefits of the new varieties due to the experiences of crop reduced yields which lead them to change their cropping from wheat to other crops
b) Drought tolerant varieties and nine independent indicators were isolated and discussed in the study area of Ololung'a division of Narok district and Isinya of Kajiado district namely age, gender, education level, land size, land size, extension services, credit, market, and income
c) Majority of drought tolerant wheat varieties in the study area (73.9%) used unsuitable wheat varieties and only5.6% and 2.8% used drought tolerant wheat varieties.
d) Major constraints in adoption of drought tolerant wheat varieties were cost of production (87.9%), and lack of information drought tolerant varieties (85.2%)
e) Existing opportunities that can influence adoption of drought tolerant wheat varieties would include provision of drought tolerant varieties (91.6%) and use of demonstration (76.8%)
f) There is a general movement of wheat farmers from wheat production to other preferred crops reducing land under wheat particularly in Isinya of Kajiado district.

g) There was statistically significant difference in awareness of drought tolerant wheat varieties between farmers in Narok and Kajiado district due to lack of sufficient extension services in Kajiado district.

h) Critical farmer characteristics in adoption of drought tolerant varieties was land size, but age, gender and education did not influence adoption or non-adoption of drought tolerant varieties.

i) Critical institutional factors influencing adoption of drought tolerant wheat varieties were land tenure system and extension services that require emphasize which showed that farmer support system is wanting.

5.3 Conclusions

The findings covered personal, socio-economic and institutional factors of drought tolerant wheat varieties grown in Narok and Kajiado districts. Specifically, they highlighted the role personal and institutional factors which influence adoption play in adoption of drought tolerant varieties. Based on the findings, a number of conclusions were reached.

a) Farmers' perception response on farmers' farm objective in relation to DTV was very low with 77.8% of the responses being uncertain of adopting the technology as shown by the five technology features.

b) The number of farmers who have adopted drought tolerant wheat varieties is 0.9%.

c) Several constraining factors which limit adoption of drought tolerant wheat varieties are high cost of production, lack of information on the DTV technology,

wheat market, prices, inaccessible credit which was explained partly lack of sufficient institutional support.

d) The farmers' personal characteristics and institutional factors enhancing adoption of DTV that were significant included land size, land tenure, and extension services

5.4 Recommendations

The following recommendations have been made:

a) District Agricultural Officers in Narok and Kajiado districts should ensure that they implement policies that would favour increased wheat production

b) Ministry of Agriculture policy arm should put emphasis on correct minimum land size for wheat production so that it is profitable

c) Credit institutions like the Agricultural Finance Cooperation (AFC) provide more friendly loaning system that will support and protect wheat farmers.

d) Kenya Agriculture Research Institute (KARI) should undertake development of drought tolerant varieties KARI-NJoro should broaden its horizons and put greater effort in effective promotion of the technologies developed to potential adopters

e) The disseminating strategy should identify the most promising areas for adoption of DTV.

5.5 Recommendations for further Studies

The study has made the following recommendation for further research

(a) Research on farmers' perceptions be carried out in all the arid and semi-arid land of Kenya that are suitable for wheat production. This due to the fact that 83% of the land in Kenya is ASAL.

(b) Sociologist should further research into the farmers personal and institutional factors so as to identify pertinent reforms that orient the farmers to more efficient use of available technologies for increased wheat production in ASALs.

REFERENCES

Abdulai A. and Huffman W., E., (2005). The diffusion of new agricultural technologies: The case of the cow technology in Tanzania. *American Journal of Agricultural Economics,* 87, (3), pp 645-659

Aboud, A. A. (1982). Range management Extension services on pastoral societies of Kenya. (Unpublished M.Sc. Thesis), Ohio State University, USA Ohio

Aboud A. A. (1989). *The role of public involvement in wildlife-livestock conflict*: The case of Narok Ranchers in Kenya Society and Natural resources 2:319-328

Acland, J.D. (1980). *East African Crops.* London: Longman Group Limited.

Adams, M.E. (1984). *Agricultural extension in developing countries.* Intermediate Tropical Agricultural Series. Harlow Essex, England: Longman House

Adegbola P. and Gardebroek, C. (2007). The effects of information sources on Technology adoption and modification decisions. *Agricultural Economics*, 37(1), 55-65

African Development Bank, (1995). Appraisal report. Poverty alleviation report Republic of Uganda pp5-21, 45-46 Abidjan, Ivory Coast ADB

Ajayi, O. C., Franzel, S., Kuntashule, E., and Kwesiga, (2003). Adoption of improved Fallow technology for soil fertility in Zambia: Empirical studies and emerging issues. *Agro-forestry systems* 59, (3), 317-326

Alary, V., Nefzaoui A. and Jemaa M. B. (2007). Promoting the adoption of natural Resource management technology in arid and semi-arid areas" modelling the impact of spineless in alley cropping in Central Tunisia. *Agricultural systems*, 94, (2), 573-585

Amaza, P., Kwache, A., and Alpha K. (2008). Farmer perception profitability and factors influencing the adoption of Improved Maize Varieties (IMV) in the Guinea Savannah of Nogeria; http://www.tropentag.de/2008/abstract/full/253.pdf

Amudavi, M.D.(1993). Influence of socio-economic factors on adoption of maize Related technology. The case of small holder farmers in Hamisi division. (Unpublished M.Sc. Thesis), Melbourne, Australia, University of Melbourne

Ascroft, J, Roling, N., Kariuki, J. and Chege M. (1993). Extension and the forgotten farmer, Report of a field experiment, Social Science Department, Bulletin No.57, Wageningen Agricultural University

Axinn, G. H., and Thorat, S., (1972). *Modernizing world agriculture*: A comparative study of agricultural extension education, pp. 36, 216. New Delhi, Oxford and IBH Publishing Company

Baerenklau, K. A., and Knapp K. C., (2007). Dynamics of agricultural technology Adoption Age structure reversibility and uncertainty. *American Journal of agricultural economics*. 89, (1), 190-201

Bellon M. R., (2001). *Participatory research methods for technology evaluation*; A manual for scientists working with farmers. Mexico D, F, CIMMYT

Bett, C., Njoroge, K., Muhammad, L., Arith, C., Ndegwa, R. and Mwangi W. (1999). A survey of the seed industry in the semi arid regions of Kenya, Proceedings of the second socio-economic conference, 17th –19th November 1997, Nairobi: KARI

Blackburn, D. J., Brinkman, G. L., and Driver, H. C. (1982). *Understanding behaviour and economic characteristics in working with operations of small farms.* A case study in Ontario Canada, in Jones and Rolls (eds.) Progress in rural extension and community development, New York , John Wiley.

Borg, W. R. and Gall, M. D. (1993). *Educational Research.* An introduction, New York, Longman

Buck, T., Nisi, J., Salomon, N. (Ed) (2007). Wheat production in stressed environments. Proceeding of the 7th International wheat conference 27-Nov.-2nd Dec 2005, Mar Del Plata, Argentina

Chambers, R. and Jiggins J. (1986). Agricultural research for resource farmers: A parsimonious paradigm IDS. Discussion paper, 222. University of Sussex.

Chitere, P.A. (1985). Extension Education and farmers' performance in improved crop farming Kakamega district, (Kenya) *Agricultural Administration,* 18, 39-57 England.

CIMMYT, (1999); *Wheat farmers seed management and varietal adoption in Kenya.* The Tenth Regional Wheat Workshop for Eastern, Central and Southern Africa, Addis Ababa, Ethiopia.

CIMMYT, (1997). *International Maize and Wheat improvement centre and ICARDA* 2000. *Conservation tillage; A viable option for sustainable agriculture in Central Asia*, almaly, kazakhstan and Allepo Syria

Dadi, L., Burton, M., and Ozanne, A., (2004). Duration analysis of technology in Ethiopian Agriculture. *Journal of Agricultural Economics*. 55, (3), 613-631

Diagne, A. and Demont, M., (2007).Taking a new look at empirical models of adoption: Average treatment effect estimation of adoption rates and their determinate. *Agricultural Economics*, 37, (2/3), 201-210

Diagne, A. (2006).Diffusion and adoption of NERICA rice varieties in Co'te d' Ivoire. *Developing economics*. 44, (2) 208-231

Doss, C. R., and Morris, M. L., (2001). How does gender affect the adoption of Agricultural innovations? The case of improved maize technologies in Ghana. *Agricultural Economics*, 25, (1), 27-39.

DSE, German Foundation for International Development, (19920. Annual Report. P.28. Berlin, German: DSE

Ekboir, J. (Ed), (2002). *CIMMYT 2000-2001 World wheat overview and outlook; Developing No-till packages for small-scale farmers* CIMMYT, Mexico

Farquhar, J. D and Surry, D. W., (1994). *Adoption Analysis*: An additional tool for instructional developers. Education and Training technology international, 31(1), 19-25

Faturoti B. O., Emah G. N., Isife B. I., Tenkouano A., and Lemchi J., (2006 *)*. Prospects and determinants of adoption of IITA plantain and agricultural based technologies in three Niger Delta States of Nigeria. *African Journal of Biotechnology* 5, (14), .1319-1323

Food and Agricultural Organisation, (2003). *Crop protection compendium* 2003 Edition, CABInternational Wallingford, Oxan OX10 8DE, UK

Food and Agricultural Organization, (2002). Bread wheat improvement and production. *Plant production and protection Series* No. 30, Rome Italy

Franzel S., Coe R., Cooper P., Place F., Scherr S. J., (2001). Assessing the adoption potential of Agro-forestry practices in Sub-Saharan Africa. *Agricultural systems*, 69, (1), 53-61

Funglie K. O., and Kascak C. A., (2001; Adoption and diffusion of natural resource concerning agricultural technology. *Review of agricultural economics* 23, (2), 386-403

Garforth, C., (1982). Reaching the Rural poor: A Review of Extension Strategy and Methods in J. G. E and Rolls M.J. (Eds) 1982. *Progress in rural extension and community development* 1 pp 43-70

Gollin D., Morris M., Byrlee D., (2005). Technology adoption in intensive post-green Revolution system. *American Journal of Agricultural Economics* 87, (4), 1310-1316

Government of Kenya, (1997). *Republic of Kenya Development Plan.* Session paper No. 2. National transformation for the year 2020. Nairobi, Government Printers,

Graft G., Roland-Holst D., and Zilberman D., (2006). *Agricultural biotechnology and poverty reduction in low-income countries.* World development (Oxford) vol. 34, No. 8, 1430-1445

Gtzsche, P., C., (2006). *Believability of relative risks and odds ratios in abstracts: cross-sectional study*. BMJ, 333, (7561), 231-234

Honlonkou, A. N. (2004). Modeling adoption of natural resources management technologies: The case of fallow systems. *Environmental and Development Economics*., 9, (3), 289-314

Hudson, D. and Hite D. (2003). Producer willingness to pay for precision application technology: Implication for government and technology industry. *Canadian Journal of Agricultural Economics,* 51, (1), 39-53

Isham, J. (2002). The effect of social capital on fertilizer adoption: evidence from rural Tanzania. *Journal of African economics*, 11, (1), 39-60

Kahn M., J. (1991). Attitudes of Botswana seniour secondary pupils towards agriculture. *International Journal of Education Development* 11 (3), 201-208

Kamidi, M. (1995). A review of production practices and constraints for wheat. A review of Agricultural Practices and constraints in North of Rift Valley province, Kenya Pg.107-119. KARI, Nairobi

Kathuri, N., J. and Pals, D., A. (1993). Introduction to Educational Research. Educational Media Centre, Egerton University, Njoro, Kenya.

KARI, (2005); Annual report Njoro, Kenya

Kibende, Y., Gunial K. and Coffin G. (eds.). (1990). Adoption of new technologies in Ethopia. The case of Tequlet-Bulg District Shoa Province. *Journal of agricultural economic*, H, (1727-43)

Kimurto, P. C., Kinyua, M., G., and Njoroge. (2000). Selection of Wheat (Triticum aestivum) for marginal areas of Kenya by simulating drought stress. Regional wheat workshop for Eastern, Central and Southern Africa. Addis Ababa, Ethiopia 18th – 22nd September 2000

Kinyua, M. G. (1997). Transfer of genes of resistance to yellow rust (Puccinia triifarmis L.) from wild emmer Triticum dicoccoides into commercial varieties. University of Nairobi, Kenya

Knight J. B., and Shabot R. (1990); *Educational productivity and inequality* (The East African natural experiment) pp. v-vi, 2, 23. Washington DC, USA: World Bank publication.

Lee, D. R. (2005). Agricultural sustainability and technology adoption. Issues and policies for developing countries. *American journal of agricultural economics*, 87, (5), 1325-1334

Makokha, M., Odera, H., Maritim, H. K., Okalebo, J. R., Iruria, D. M. (1999). Farmers' Perceptions and adoption of soil management technology in western Kenya. *African Crop Science Journal* 7, (4), 549-558

Maliyamkono, T. L., Ishumi, A. G. M., Wells S. J., Migot-Adholla S. E. (1982) *Training and productivity in Eastern Africa (A report of the East African University* Research project on the impact of overseas Training and development pp4-7, 385 pp. London, United Kingdom Heineman

Marra, M., Pannell, D. J., Ghadim, A. A. (2003). *The economic of risk, uncertainty and Learning in the adoption of new agricultural technologies*: where are we on Learning Agricultural systems, 75, (2/3), 215-234.

Marsh, S. P., Pannell, D. J., and Lindner, R. K. (2000). The impact of agricultural Extension on adoption and diffusion of lupins as a new crop in Western Australia. *Australian Journal of experimental agriculture*. 30, (4), 571-583

Matuschke, I., Mishra, R. R., and Quim ,M. (2007)..*Adoption and impact of hybrid wheat in India.* World development (Oxford) 35, (8), 1422-1435

Miyata, S. and Manatunge, J. (2004). Knowledge sharing and other decision factors Influencing aquaculture in Indonesia. *International Journal of water Resource development*. 20, (4), 523-536

Misiko, P.A.M. (1976). Incentives and disincentives influencing the innovation adoption In Bungoma district, Kenya. Unpublished PhD. Thesis, Ithaca, New York, University of Cornell.

Morris, M. L. and Heisey, P.W. (2003). Estimating the benefits of plant breeding research: Methodologies; issues and practical challenges. *Agricultural Economics* 29, (3), 241-252

Moser, C., M., and Barrett, C., B. (2006). The complex dynamics of smallholder technology adoption: the case of SRI in Madagascar. *Agricultural Economics*, 35, (3), 373-388.

Molnar, J. J. (1985). *Rural Sociology* Determinants of subjective wellbeing among farmers' operators; Characteristics of individual and the farms, pp141-160

Muasya, R.M, and Mwakha E., J. R. (1996). Initial wheat response to low and high rates of nitrogen and phosphorous in Kenya farrosol. Focus on Agricultural research for sustainable development in changing economic environment, Proceeding of 5th KARI Scientific Conference, Nairobi, Kenya

Mugisha, J. Ogwal-o R., Ekere, W., and Ekiyar, V. (2004). Adoption of IPM groundnut production technologies in Eastern Uganda. *African Crop Science Journal*, 12, (4), 383-391

Napier, T. L. (1991). *Factors affecting technology transfer in developing societies*, paper presented at the international conference on extension strategy for minimising risks in rain fed agriculture, India, New Delhi

Ndiaye, S. and Safranko, A.J. (1988). *Rural Sociology;* Importance of labour in adoption of modern farm inputs. 53(4) pp421-432

Ndiema, A. C. (2002). Factors affecting the adoption of selected wheat (Triticum aestivum) production technologies by farmers in Njoro and Rongai divisions of Nakuru district- Kenya. (Unpublished M. Sc. Thesis), Njoro, Egerton University.

Norman, D., Baker, D., Heinrich, G., Johas, C., Maskiara, S. and Worman, F. (1989). *Farmers groups for technology development*, Experiences in Botswana, in Chambers; Farmers innovation and agricultural research, London, intermediate Technology publication pp136-146

Ogunlana, E. A. (2004). *Renewable Agriculture and Food Systems*, 19, (1), 57-65

Olembo, N. K. (1989). Statement on behalf of participants from African countries; In Plant Biotechnology for developing countries, Proceedings of an International Symposium organised by CTA and FAO Luxembourg.

Ortiz-Ferrara, Joshi G., Chand A. K., Bhatta R., Mudwari M. R., Thapa A., Sufian d. B., Chatrath M. A., Witcoombe R., Virk J. R., Sharma D. S., R. C. (2007). *Partnering With farmers to accelerate adoption of new technology in South Asia to improve Wheat production.* Euhytica, 157, (3), 399-407

Oywaya, M. A. (1995). Socio-economic factors influencing innovation and the Participation of Women in agricultural extension programmes in Malala division of Makueni district Kenya Unpublished MSc. Thesis, Njoro, Egerton University

Pearse, A. (1974). *Social and economic implications of the large scale introduction of High yielding varieties, food grains,* Geneva, United Nations Research Institute For Social Development

Perz, S. G. (2003). Social determinants and land use correlates of agricultural technology adoption in a forest frontier: A case study in the Brazilian Amazon. *Human Ecology* 31, (1), 133-165

Peters, M. Lascano, C. F., Roothaert, R., Haan, N. C., de. (2003). *Linking research on Forage germplasm to farmers*. The pathway to increased production- A CIAT, ILRI, and IITA perspective. Field crop research, 84, (1/2), 179-188

Quisumbing, A. R. (1996). *Male Female differences in agricultural productivity, Methodological issues and empirical evidence.* World development 24 (10), 1579-1595

Rehman, T., Mckemey, K., Yates, C. M., Cooke, R. J., Garforth, C. J., Tranter, R. B., Park, J. R. (2007). Identifying and understanding factors influencing the uptake of technologies on dairy farms in SW England using the theory of reasoned action. *Agricultural systems* 94, (2), 281-293

Republic of Kenya. (2002). *National Development Plan*. Government Printers, Nairobi; Kenya

Rogers, E. M. (1995). *Diffusion of innovation*. 4th Ed. New York. The Free Press

Roling, N. (1990). *Extension science information system in agricultural development*, Cambridge Press

Ryan, B. and Gross, N. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural sociology*. 8 (1) 15-24

Salasya, B.D.S., Mwangi, W., Hugo, V., Odendo, M. A, and Odenya, J. O. (1999). Adoption of seed and fertilizer package and roles of credit in smallholder maize production in Kakamega and Vihiga Kenya, Proceeding of 2nd KARI Socio-economic Conference, Nairobi.

Sheikh A. D., Rehman T., and Yates C. M. (2003). Logit models identifying the factors That influence the up-take of new 'no-tillage' technologies by farmers in the rice-wheat and cotton-wheat farming systems of Pakistan's Punjab. *Agricultural systems*, 75, (1), 79-95

Sigh R. D., and Santiago M. (1997). *Farm earnings, education attainment and role of public policy: Some evidence from Mexico*. World development, 25 (12) 2143-2154

Surry, D., W. (1997). *Diffusion theory and instructional technology*. [Online]. Available http://intro.base.org/docs/diffusion, February 20, 1997

Tanner, D., G. and Mwangi, W. (eds.). (1992). *Seventh regional Wheat Workshop for Eastern Central and Southern Africa.* Nakuru, Kenya, CIMMYT

Torkamani J. (2005). Using a whole-farm modelling approach to assess prospects of technologies under uncertainty. *Agricultural systems.* 85, (2), 138-154

Tuckman, B., W. (1988). *Conducting educational research* (3rd Ed) San Diego: Harcourt Brace Jovanovich, New York

Uma Kumar, Vinod Kumar, and Grosbois, D. de. (2008). Development of technological capability by Cuban hospitality organizations. International *Journal of hospitality management*, 27, (1), 12-22

Vago, S. (1990). *Social change.* St. Lois University, New Jersey, Prentice Hall, Englewood Cliffs,

Van de Ban, and Hawkins, H. S. (1992). Agricultural Extension. 2nd edition pp 61-125, New York N. Y; Longman. Scientific and Technical publication

Xavier L. F., Costa R. de F., Costa E. de F. (2006). Adoption of water saving technology by growers of irrigated fruits in the Sao Francisco Valley: A comparison of perception between tenants and owner farmers. *Revista de Economia e sociologia Rural*, pp219-241

Weir, S. and Knight, J. (2004). Externality effects of education dynamics of the adoption and diffusion of innovation in rural Ethiopia. *Economic development and cultural change.*, 53, (1), 93-113

World Bank. (1993). *Evaluation of the performance of "T and V" system of extension in Kenya*; Technical Paper, No. 208, Africa Technical Department series. Washington D.C. U.

Wubeneh. N. G. and Sanders. J. H. (2006). Farm-level adoption of sorghum technologies in Tigray Ethiopia. *Agricultural systems.* 91, (1/2), 122-134

APPENDIX 1: RESEARCH QUESTIONNAIRE FOR FARMERS

The purpose of this exercise is to identify some of your reasons for adoption or non-adoption of drought tolerant wheat varieties in your farm. You have been randomly selected from the farmers in Narok and Kajiado districts of Kenya

All the information obtained through this survey will be treated as confidential and no information will be released to anyone except for this study

Instructions for Research Assistant

Tick the appropriate box for the response.

1. Date……Question No……...

Location characteristics

2. District……Division……Location……Sub-Location…….

3. AEZ……

Personal characteristics

4. Name of the farmer…….

5. Gender

Male…….□

Female…….□

6. Age

15-25…….□

26-35…….□

36-45…….□

46-55…….....□

above 56……...□

7. Education level

Informal……..□

Primary……□

Secondary……□

Tertiary……□

Farm characteristics

8. Under what kind of land tenure system is your land

Family……..□

Communal……...□

Personal……..□

Hired/rented…….□

9. What is the estimated land size of your land in hectares

<5-20ha……□

21-50ha……□

51-100 ha…….□

101-500ha……□

501->1000ha……□

10. How much of your land was under wheat last year

11. About how many 90kg bags did you harvest per hectare?

12. How much of your land is under wheat this year?

13. How much land do you plan to put under wheat next year?

14. Are you aware of Drought tolerant varieties of wheat?

Yes……...□

No……□

a) If yes, which of the following varieties do you grow?

Duma……...□

Ngamia……□

Chozi……□

Others……..□

15. To what extent do you use DTV?

Very high degree (VHD)……..…… □

High degree (HD)…….. □

Moderate degree (MD)……□

Low degree (LD)…… …□

Very low degree (VLD)……. □

Do not use (DU)……. □

16. If you use DTV where do you get seed?

Farm saved seed……□

Kenya seed company……..□

Fellow farmer……□

Stockists……...□

17. If you do not use DTV give reason

a) Expensive

Yes……..□

No……□

N/a……

b) Inaccessible

No……□

Yes……..□

N/a……..□

c) Lack of knowledge

No……..□

Yes……□

N/a……□

d) Unavailable

No……..□

Yes……□

N/a……□

e) Other reasons

No……..□

Yes……□

N/a……□

18. What are some of the major problems in cultivation of drought tolerant wheat varieties?

a) Expensive

Yes……...□

No……□

b) Lack of Information

Yes……...□

No……□

c) Inaccessible

Yes……...□

No……□

d) Other enterprise

Yes……...□

No……□

e) Wildlife fear

Yes……...□

No……□

f) Poor credit facilities

Yes……...□

No……

g) Fluctuating prices

Yes……...□

No……

h) Poor Marketing channel

Yes……...□

No……□

i) Lack of farm equipment and machinery

Yes……□

No……□

j) Expensive farm inputs

Yes……..……□

No……..……..□

k) Pests and diseases

Yes……..……□

No……□

19. Can you suggest possible solution?

a) Demonstrations

No……□

Yes……..□

b) Remove wildlife

No……□

Yes……...□

c) Provide drought tolerant varieties

No……□

Yes……...□

d) Alternative enterprises

No……□

Yes……...□

e) Subsidize wheat production

No……□

Yes……..□

f) Liberalize wheat market

No……□

Yes……..□

20. During the last five years, did you have access to any credits?

No……..……..□

Yes.……□

21. If yes, was it successful?

Yes……..……..□

No……...……..□

22. Did you use any information given by agricultural extension agents?

Yes……..□

No……..□

23. If yes, what kind of information did you use?

About drought tolerant varieties…….……□

Any other……

23. If you want information about DTV whom do you contact?

Fellow farmer ……..……...□

Research institutions……..……..□

Extension agent…….…….……□

NGOs…….……..□

Nobody……..……□

24. Do you do any off-farm jobs for income?

Yes……..……□

No…….……...□

25. What is your estimated income per year from wheat?

<5000……...□

5001-10,000……..……...□

10,001-25,000……..□

Above 25,000……..□

25. Who does most of the work in the wheat farm?

Males……..…….□

Females……□

Hired labour……..……...□

26. Members who spend more time in the wheat farm

Males……..□

Females……..……..□

Both……□

SECTION B

The following questions are for you to express your opinion on drought tolerant varieties of wheat

Answer by ticking the right box

1. Drought tolerant varieties are beneficial

Strongly Agree……...□

Agree……□

Uncertain……...□

Disagree……□

Strongly disagree……..….□

2. Drought tolerant varieties are consistent with your objectives

Strongly Agree……...□

Agree……□

Uncertain……...□

Disagree……□

Strongly disagree……..….□

3. Drought tolerant varieties can be tried on small scale without fear of loss

Strongly Agree……...□

Agree……□

Uncertain……...□

Disagree……□

Strongly disagree……..….□

4. Drought tolerant varieties present complexities in your farming system

Strongly Agree……...□

Agree……□

Uncertain……...□

Disagree……□

Strongly disagree……..….□