Determinants of Choice of Improved Maize Seeds in Arid and Semi-Arid Areas of Kenya: The Case of Yathui Division of Machakos District

BY

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Declaration

I, David Makau Kalia Nyamai, declare that this thesis is my original work and has not been presented for a degree in any other university.

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Dedication

This thesis is dedicated to my father Nyamai Kalia, my mother Agnes Nyamai, with much gratitude for their tremendous sacrifices during my early years of education in primary and high school, my wife Naomi Makau and sons Allan and Kennedy for their support and encouragement.

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Finally, I would like to thank my family for encouraging me and for understanding why I had to be away from home for the period of the study.

Acronyms and Abbreviations

ADC	Agricultural Development Corporation
AGMARK	Agricultural Market Development Trust
ASAL	Arid and Semi Arid Land
CBS	Central Bureau of Statistics
CBO	Community Based Organisations
CIMMYT	International Maize and Wheat Improvement Centre.
FAO	Food and Agriculture organization
IAD	Institutional Analysis and Development
ISAAA	International Service for the Acquisition of Agri-biotech Application
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspectorate Services
KFA	Kenya Farmers Association
KSC	Kenya Seed Company
MDG	Millennium Development Goals
MoA	Ministry of Agriculture
NGO	Non Governmental Organization
NCPB	National Cereals and Produce Board
OPV	Open Pollinated Varieties
PMCA	Participatory Market Chain Approach
RoK	Republic of Kenya
WSC	Western Seed Company

Abstract

Smallholder farmers in arid and semi-arid parts of Kenya can increase maize yields by growing improved varieties that are available through formal seed markets. Smallholder farmers' access to improved germplasm, however, is limited. The objective of this study was to understand how the seed maize market channels are structured, the bottlenecks to them operating more efficiently, effectively and equitably, and to identify the factors that influence the choice of smallholder farmers in the arid and semi-arid areas of Machakos District.

Data was generated by use of qualitative and quantitative research methods. Qualitative data on the structure of the seed input market chains in the study area was followed by a household survey of 150 random sampled households. The sampled households were interviewed using a structured questionnaire. Logit model was used to analyze quantitatively factors influencing farmers' choice of improved maize seeds.

The study findings showed that extension contacts, access to credit, membership to farmer groups and experience with improved maize varieties positively influence the likelihood of farmers' choice of improved maize seeds. Cost of seeds, distance to output markets and to extension service, unavailability of improved high yielding maize varieties at the farm level, and transaction costs negatively influenced choice of improved maize seeds. The study reveals a large unexplored formal maize market.

It is recommended that government implement policies that empower smallholders such strengthening extension service and encouraging players outside government to provide the service, make credit more accessible to smallholders and organize farmers into producer groups. It is further recommended that maize seed dealers make seeds available by penetrating closer to farmers.

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1.1. Introduction

Maize is the most important staple crop for over 90 percent of the population in Kenya (International Service for Acquisition of Agri-biotech Application (ISAAA), 2001). It is important for food security, and generation of farm income and rural employment. It accounts for more than 20 percent of all agricultural production and 25 percent of agricultural employment in Kenya (Republic of Kenya, 2004). Kenya produces about 2.4 million tones of maize per year on 1.5 million ha of land (FAO STAT, 2002). Maize production in Kenya takes place under both small– and large–scale farming systems with the former accounting for 75-80 percent of total production (Kamidi et al., 1999).

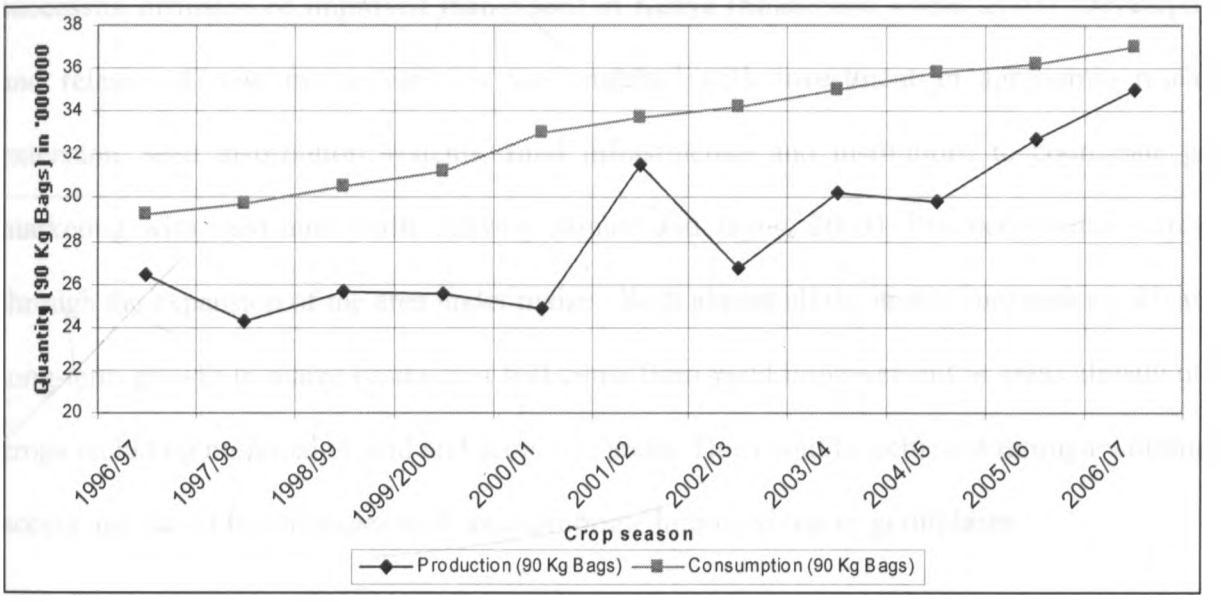
The Economic Review of Agriculture Report, Ministry of Agriculture (MoA) (2007) notes that Kenyans consumed 2.62 million tones of maize in 2002 representing 40-45 percent of their total calorie consumption. According to this report, maize consumption has risen steadily through the years to above 3 million tones in 2006. The Kenyan population is projected to continue growing at 3 percent per year (World Bank, 1995; FAOSTAT, 2001). Despite efforts to ensure food security in Kenya, production continues to fall short of consumption therefore necessitating imports (MoA, 2007). The country produced 2,454, 930 tonnes of maize in 2004 and imported 241, 757 tonnes to cover the deficit while in 2005 an amount of 2,918,157 tonnes were produced occasioning imports of 49,621 tonnes. Maize consumption is currently estimated at 36 million bags (see Table 1 and Figure 1). The demand for maize is growing at 0.7 percent annually and, hence, consumption is likely to continue to grow faster than production.

Table 1: Maize Production, 2003 - 2008

Year	2003	2004	2005	2006	2007	2008
Area (ha)	1,670,914	1,819,817	1,760,618	1,888,185	1,615,304	1,793,757
Production (90 Kg bag)	30,120,530	27,249,721	32,423,963	36,086,406	32,542,143	26,302,219
Tons	2,713,561	2,454,930	2,918,157	3,247,777	2,928,793	2,369,569
Average yield (bags/ha	1.62	1.35	1.66	1.71	1.81	1.32

Source: MoA, Kenya (2009)

Figure 1: Maize Production and Consumption, 1996-2007



Source: MoA, Kenya (2006)

The performance of the maize sub-sector in Kenya is constrained by both abiotic and biotic factors as well as social, economic, institutional and political factors (MoA, 2004). Among the challenges facing maize production is low yields achieved by smallholders, which are as low as 20% of the potential (MoA, 2006). Maize production is limited by the variability of rainfall onset and distribution, along with prolonged dry spells during the growing season, poor crop husbandry and inadequate use of farm inputs. This often results in depressed yields and food

deficits (Nadar and Faught, 1984, Keating et al., 1992). Areas most susceptible to low per capita food production and food insecurity in Kenya are concentrated in the arid and semi- arid regions (Biamah, et al., 2000). Unavailability of suitable maize varieties and related technologies such as the use of fertilizers are the most critical problems facing smallholder farmers in these regions.

Kenya needs to increase maize productivity and production to meet the growing demand and reduce imports of the commodity into the country and save the country of foreign exchange earning. Growth in smallholder maize production in the 1960s and 1970s was attributed to successful diffusion of improved maize seed in Kenya (Smale and Jayne, 2003). Development and release of new maize varieties was matched with investment in agronomic research, extension, seed distribution systems, rural infrastructure and institutions to coordinate grain marketing with seed and credit delivery (Smale and Jayne, 2003). Production also increased through the expansion of the area under maize. With almost all the arable land under cultivation, long-term growth in maize production will come from yield improvement in areas already under crops including marginal or arid and semi-arid areas. This could be achieved through widespread access and use of technologies such as appropriate improved maize germplasm.

Development of improved maize varieties in Kenya has resulted in the systematic release of maize hybrids and open-pollinated maize varieties (OPVs). Since the 1950s, over forty new varieties have been released (Japhether et al., 2006). Previous studies (Karanja (1990), Hassan (1998), and Smale and Jayne (2003), indicate that most of hybrids and OPVs released by different maize varietal development programmes in Kenya are suitable to the country's diverse agro-climatic conditions. Thus adaptable maize varieties for different regions in the country have

not been a constraint to production. Despite this, however, smallholder access to improved varieties in arid and semi-arid parts of Kenya has been minimal.

Farmers source maize seeds through a number of marketing channels in Kenya (MoA, 2004; Bett et al., 2006). The channels are grouped into formal and informal maize seed marketing channels. Commercial seeds stockists, consisting of both private and public sector agents, constitute the formal channels, while own seeds, exchange with other farmers and purchase through local grain markets constitute informal channels. Enhancing gains in yield and yield stability among smallholder farmers in the arid and semi-arid lands depends on their having access to improved hybrids and OPVs via the formal market.

1.2. Problem statement

Improved maize varieties have been available in Kenya for over 50 years but uptake of these varieties has been limited. Despite the government campaigns to encourage the use of improved maize varieties, studies indicate that only 30% of maize area in Kenya like the rest of sub-Saharan Africa is planted under hybrid maize (Pixley and Banziger, 2002; Longyintuo, 2005, Japhether et al., 2006). 70% of smallholder farmers continue to use local and recycled maize varieties including Open pollinated varieties (OPV) (Ligeyo, 1997; Onyango 1997; Onyango *et al* 1998; Pixley and Banziger, 2002). Findings from previous studies (Longyintuo, 2005; Ayieko and Tschirley, 2006) showed that continued recycling of seeds is responsible for persistence yield reduction among smallholders. Yield reduction of recycled OPVs is reported to be about 5 percent while that for recycled hybrids can be as high as 32 percent (Pixley and Banziger, 2002). Smallholder farmers acquire improved maize seeds through formals seeds channel (Bett et al., 2006, Muhammad et al., 2003). However, the structure of these chains, involvement, interests,

roles and relationships of different actors, determine how efficiently, effectively and equitably the channels operate in delivering seeds to farmers. However this information is not well documented.

Access to improved maize seeds by smallholder farmers in rural areas of Kenya remain a major problem (Kamau, 2002; MoA, 2004). Small-holder farmers have different needs and require maize seeds of diverse varieties and of multiple traits. These farmers encounter difficulties in obtaining maize seeds that meet their specific requirements. This is because they have to find out who sells or grows what maize variety, characteristics and performance of the maize of interest. The farmer must then negotiate the terms of transaction with the seed provider. This entails high transaction costs to individual farmers. A number of studies have shown that high transaction costs, among other factors, are responsible for slow response to policies favoring commercialized crop production in developing countries (Dorward et al, 1998; World Bank 2005).

Studies indicate that large numbers of African smallholders face higher transaction costs than those in any other region in the world (Delgado, 1995). In spite of the extensive literature on the functioning of agricultural markets in less developed countries, very few studies have addressed the effects of transaction costs on market institutions in Africa (Bryceson, 1993, Barret 1997). Given the widely held view that high transaction costs explain why some farmers do not participate in the market, understanding transaction costs in maize seed value chains is crucially important. Although transaction costs have been shown to affect access to improved maize seeds by smallholders, these have not been quantified.

To increase farmers' access to improved seed, researchers and development practitioners need to understand how the seed maize market channels are structured, the bottlenecks to them operating more efficiently, effectively and equitably, and the factors influencing the choice of smallholder farmers. However, information on maize seed market chain structures including the chains' operations and factors influencing the choice of smallholders is not well documented.

1.3. Objectives

The main objective of this study is to analyze the determinants of choice of improved maize seed in arid and semi-arid areas of Yathui Division of Machakos District of Kenya.

The specific Objectives were;

1. To analyse the involvement, interests, relationships and roles of different actors in the marketing and distribution of seed maize in the study area.
2. To examine the determinants of farmers' choice of improved maize seeds.
3. To measure and compare transaction costs of farmers in different maize seed marketing channels

1.4. Hypotheses

For the specific objectives 2 and 3, the following hypotheses will be tested

1. Farm and farmers' socio economic characteristics do not influence farmer's choice of improved maize seeds.
2. Contacts with extension service providers does not influence farmers' choice of improved maize seeds.
3. There are no differences in transaction costs between the formal and informal seed maize marketing channels.

For Objective 1, the following questions were answered:

1. What kind of seeds are smallholder farmers using?

2. Who are the actors and what are their roles in seed maize marketing?

3. How are the involvement, interests and relationships of major chain actors?

1.5. Justification

Maize plays a crucial role in the welfare of many rural and urban populations in Kenya. The crop is grown on two out of every three farms in Kenya (MoA, 2007). Kenyans derive a number of benefits such as food, income, and rural employment from maize production. Maize is the leading staple food in Kenya and accounts for a large proportion of rural household income. It is one of the major commodities in all farm products marketing channels and is relatively easy to add value to, making it possible to generate several products. Some of these include: cooking oil, flour, maize germ, bran, and breakfast cereals. Maize is also an intermediate product in the dairy industry as it is a constituent of the animal feed formulation.

Previous studies (Byerlee, 1996) quoted in Rankow et al., (2003) showed that widespread access to improved seeds, fertilizers and other agricultural technologies has a profound impact on aggregate incomes, including the incomes of smallholder farmers. Use of improved maize seeds lead to increased maize production and hence food self-sufficiency. However, there exists little information on maize seed market channels structure, the bottlenecks to them operating more efficiently, effectively and equitably, and only a few descriptive analyses of factors influencing use of improved seeds in the study area. No qualitative or quantitative study has been carried out to generate information on the determinants of choice of improved maize seed channels to access improved seeds. Thus, this study aims at filling up this information gap by providing

information on factors that influence access to improved maize seeds, which has been regarded as limited.

Sustainable access to improved seed maize would lead to increased yields in the study area, accelerated economic growth and improvement of the wellbeing of small-holder farmers (MoA, 2004). An increase in improved maize seed use will lead to increased maize productivity in the semi-arid and arid parts of Kenya that are frequented by high incidences of droughts and hence increased food maize sufficiency. These areas mainly rely on government relief maize supplies, a situation that occasion annual maize imports for the country. Self-sufficiency in maize production will reduce imports of the commodity into the country and save the country foreign exchange earning.

The information generated in this study will help in informed decision making on changes in infrastructure, policies, institutions and processes that will ensure increased and sustainable maize production in the arid and semi-arid areas of Kenya. In particular, the information will be used to draw inferences regarding appropriate policy interventions on research, extension and access to credit, which will enhance access and use of improved maize seeds in arid and semi-arid areas of Kenya

The information will further enable AMS project (CIMMYT) develop mechanisms that provide a larger number of small-holder farmers in ECA region with sustainable access to seed of improved stress and nutritionally enhanced maize varieties that offer significantly greater yields and yield stability under conditions of drought, low fertility and striga (CIMMYT, 2006).

1.6 Organization of the thesis

The thesis is organized into five chapters. Chapter one covers the introduction. The introduction includes the importance of maize in Kenya, seed maize distribution system, problem statement, objectives and hypotheses to be tested, justification for the study and organization of the thesis. Chapter two contains a review of the seed marketing channels and determinants of choice of improved maize seeds as well as some relevant work on the subject both in Kenya and outside Kenya. Chapter three gives an account of the methodology used in the study. This includes the sources, collection procedures, analysis and organization of data. Chapter four contains qualitative, descriptive and regression analysis results and the major findings of the study. Chapter five gives conclusions and recommendations of the study.

2.0. Literature review

2.1 Seed maize market and seed marketing channels

The arid and semi-arid lands are characterized by low erratic rainfall of upto 700mm per annum, periodic droughts and different associations of vegetative cover and soils. McCown and Jones, (1992) note that more than 80% of Kenya is classified as arid and semi-arid lands characterised by low and erratic rainfall (between 100-700mm per annum) and fragile ecosystems that are unsuitable for permanent rain-fed agriculture. The areas are characterised by low access to improved maize seeds by smallholder farmers (Nyoro, 2002; Smale and Jayne, 2003; Muhammed et al., 2003; de Groote et al., 2005; Bett et al., 2006). Farmers acquire improved maize seeds through formal marketing or distribution channel.

Stern et al. (1996) defines marketing channel as a set of interdependent organizations involved in the process of making a product or service available for consumption or use. According to Crawford (1997), in a distribution or marketing channel, firms and individuals take title, or assist in transferring title, to a good or service as it moves from the producer to the final consumer or industrial user. The fundamental activity in marketing channels is the transaction, i.e., the act of exchange between economic agents (Achrol et al., 1983). The channel follows a vertical structure where products flow from producer to the ultimate consumer and in which actors meet each other at markets. Producers, wholesalers and retailers as well as other channel actors exist in channel arrangements to perform marketing functions i.e. business activities which contribute to the product flow.

Maize seed market channels are channels through which farmers access maize seeds and include own stocks, exchange with other farmers and purchase of grain maize as seed through local markets which constitute informal channels. Commercial seed stockists, government or research outlets and relief supplies on the other hand constitute formal channels.

2.2 Factors influencing choice of improved maize seeds

At variety uptake stage, improved maize variety is viewed by farmers as an input and a technology (Longyintuo, 2005). A number of factors influence smallholders' decision to use improved seed maize. These include policy environment, physical infrastructure, socio-economic factors and transaction costs. Longyintuo (2005) point out that as an input and a technology, maize seed purchase choices are influenced by government policies, infrastructure, prices of substitutes, farmers' socioeconomic circumstances as well as farmers' anticipation of free seed issued by the government or NGOs. In summary, Longyintuo (2005) identified the bottlenecks in the seed input channels to include: high price of improved maize seed and related inputs such as fertilizer, long distances to input and output markets, poor access to input credit in the rural settings, poor infrastructure for technology dissemination, natural hazards such as drought which influence profitability of technologies, inappropriateness of technologies, e.g., hybrids which farmers want to recycle, reduced contacts between farmer and extension worker, lack of information on the technology and its attributes and weak linkages among stakeholders to ensure effective technology dissemination.

On high costs of seeds, farmers are rational and to them, it must be profitable to use improved maize seeds. Lower maize seed prices could increase use of improved maize seeds accessed via

formal maize seed market channels other factors being constant. Some of the suggested ways of lowering maize seed prices include: effective market information flow, lowering seed companies' overheads and mark-ups, shortening the seed market chains and increased efficiency in seed distribution (MoA, 2004). In Kenya, maize prices were liberalized in 1993, thus prices depend on demand and supply situations, and most cases very low compared to the cost of production.

Lack of credit is frequently mentioned by most farmers as a constraint to use of improved maize seeds (Winter-Nelson and Temu, 2002, Kibaara, 2005). Access to credit by farmers enhances their purchasing power and this in turn may increase purchases of improved seeds. A large proportion of farmers citing lack of credit as the reason for not using improved maize seeds may, however, not use for the purpose, even if provided. In most cases this results from unwillingness to risk the consequences of being unable to repay credit from the income generated from the sale of maize. This may explain why smallholders do not seek credit from commercial banks.

Unavailability of maize seeds is a major constraint to smallholders' access to improved maize seeds (Bett et al., 2006). Unavailability of improved seed to farmers may be occasioned by local impediments such as poorly developed and inefficient distribution network. Long distances between distribution outlets and difficult transportation facilities make it costly for farmers to obtain the desired seeds. At times, even when outlets are within reach of smallholders, timing in terms of sourcing, supply and distribution in relation to the cropping calendar or the type of seed available may not be the desired one. Nyangito & Karugia (2002a) noted that seed market liberalization was, for instance, intended to provide farmers with a wide choice of high quality

seed at competitive prices at the right place and time. This was to be achieved through improved seed purity, production, and marketing efficiency. However, de Groote et al., (2005) point out the importance of proper distribution systems to be in place as well as adequate transport infrastructure to decrease transaction costs.

Information on the right variety of maize and quantities (seed rate) to use enhances improved maize seeds use. In Kenya, information on type and seed rate of maize seed use is made available to farmers by agricultural extension staff or through the public media. However, de Groote et al., (2005) note that after liberalization, the number of agricultural staff was reduced substantially.

Studies by Nyoro (2002) and de Groote et al., (2005) indicated that prior to liberalization; major successes in maize production and productivity were facilitated by policy environment that enabled government interventions. Government agencies dominated agricultural research and extension. Public institutions such as the Kenya Agricultural Research Institute (KARI) developed new seed varieties; seed multiplication was in the hands of the Kenya Seed Company (KSC) while extension and distribution of the new technologies was done by Ministry of Agriculture and a net work of parastatals respectively. Increased state involvement in the form of controlled pricing and marketing systems led to stronger input and grain marketing chains. The expansion of state marketing infrastructure facilitated the disbursement of credit and subsidized inputs to smallholders by state agencies (Smale and Jayne, 2003). Institutional arrangements such as interlocked transactions were used to assist the farmers acquire seeds and to address transaction costs (Doward et al., 1998).

According to Shepherd and Farolfi (2000), marketing boards controlled marketing of most agricultural commodities almost entirely by 1980s. Failure by these boards to perform their functions effectively (Thomson and Terpend, 1993) and the large budget deficits to which the agricultural policies contributed (Smale and Jayne, 2003) were some of the reasons for donor pressure on governments to undertake market liberalization that led to a reduced state involvement in seed production and distribution. Many developing countries dismantled the state marketing boards that had previously exerted control marketing and prices of agricultural commodities (FAO, 2004). Although liberalization of the seed sector in 1996 paved the way for private sector participation, it has had mixed results due to lack of enabling institutions that support market and private sector development and lack of proper institutional arrangements to fill the vacuum left by state withdrawal – especially in marginal areas. For example, after disengagement of the public sector in supplying subsidized inputs, fertilizer use has dropped markedly in the low potential areas (Wanzala et al., 2001, Dixon et al, 2004).

Current policies and existing seed market chains are inadequate in promoting the growth of the maize seed industry (Kamau, 2002). There have been few initiatives to support the private sector and to develop the public institutions required for privatized marketing system to function effectively (Doward et al., 2004). As noted in CIMMYT (2007), there is need for reassessment of policies espousing state withdraw from markets in poor economies.

Transaction costs faced by farmers are one of the factors that determine their market participation and adoption of new technologies (Pingali et al., 2005). Transaction costs arise in both input and output markets. Due to high transaction costs, smallholder farmers may not have

full access to technology, information, input supplies and profitable market outlets. According to Coase (1937), transaction costs are the full costs of carrying out exchange. These costs are associated with exchanging, including informational costs of finding out prices and quality, service record, availability, durability, etc, of a product, and costs of contracting and enforcing that contract (Besley, 1994)

Transaction costs are costs that arise from search of information, contract making and enforcement of contracts and market participants do not attach a price to these costs directly (Randolph and Ndungu, 2000). Assumptions of the neoclassical economic model suggest an ability by all parties in an exchange to process the exchange at zero cost. Previous studies (Njoroge, 1996; and Onchere, 1998) used neoclassical economic theory to analyze the constraints arising from regulatory, institutional, and policy environments in which producers and market intermediaries operate. However, less emphasis has been given to insights offered by New Institutional Economics (NIE), regarding the role of transaction costs in constraining the producer from taking advantage of emerging technologies in maize production. Yet, producers often face high transaction costs, which potentially may be important in determining access to and use of improved maize seeds. In the NI E, Coase (1937) argues that market exchange is not costless and such transaction costs are incurred by participants in an exchange to initiate and complete the transaction.

Transaction costs are often subdivided into search of information costs which include the costs of obtaining information about the product and its price as well as the trading partner, negotiation costs and monitoring or enforcement costs (Hobbs, 1997, Gabre-Madhin 2001). Transaction

costs will differ between households due to household characteristics and due to differences in incentives created for them to participate in a particular marketing channel.

Unlike production costs, transaction costs are very difficult to measure because they represent the potential consequences of alternative decisions (Klein *et al.,* 1990). Most studies result to use of proxy variables to capture transaction costs (Hobbs, 1997 and Gong *et al.*, 2007).

Coase (1937) examined factors affecting the organization of production systems in a market-hierarchy framework. In such a framework, organizational criterion is minimization of production and transaction costs. Frank and Henderson (1992) confirmed a significant relationship between transactions costs and vertical coordination in US food industry. The participation of any producer in the marketing arrangement is determined mainly by transaction costs and benefits (Doward, 2001). Being a rational agent, a producer chooses one channel over the other minimizing his/her production and transaction costs while maximizing the benefits subject to certain limiting factors.

Finally, socio-economic factors that influence improved maize seed use and hence choice of formal maize seed market channels includes risks and uncertainties of certified maize seed use. Farmers who are risk averse do not choose formal maize seed market channels to access improved maize seeds because of risks and uncertainties in farming which could be due to bad weather, pests and disease incidences or product prices.

2.3 Adoption of improved maize seeds

Ouma *et al*, (2002) reviewed the socio-economic and technical factors that affect uptake or the purchase choice of improved maize and fertilizer in Embu district, Kenya and the role of credit in improved maize and fertilizer adoption. Specifically, the study described the socio- economic factors of the study area and the improved maize seed and fertilizer adoption practices. Factors that influence adoption were then determined. The study found out that agro-ecological zones, gender, and extension were significant in explaining adoption of improved maize seed while, education, age and membership of farmers group were significant in determining amount of basal fertilizer used. This study evaluated factors influencing the choice of improved maize seeds under arid and semi-arid environment.

Salasya et al (2007 focused on the factors that influenced farmer adoption of stress-tolerant maize hybrid (WH502) in Western Kenya. The study considered the maize variety attributes, socio-economic factors as well as sources of information about the maize variety. The study found out that the maize attributes that influenced adoption were high yield, early maturity and non-logging while important socio-economic factors were farm size, level of education and cattle ownership. Poor storability and poor husk cover were found to discourage adoption. Neighbours were found to play a more important role than extension service in making the maize variety known to farmers. Whereas Salasya et al study focused on maize attributes, socio-economic factors and sources of information to farmers, it did not consider transaction costs as a factor influencing adoption of hybrid maize. This study considered maize attributes, socio-economic factors and sources of information to farmers as well as transaction costs that smallholder farmers incur in search of improved maize seeds.

Kamau (2002) studied the Kenyan seed industry in a liberalized environment and found out that the potential market for improved seed is high yet not being fully targeted. The market was found to be shrinking as more farmers plant local varieties and recycled seed. Access to improved germplasm was found to be restricted by a number of factors that include: the highly fragmented structure and behaviour of farmers, poor access to credit (seed in not attractive venture for commercial banks), high price margins for companies, agents and stockists that contribute to high seed prices for farmers, lack of information on the opportunities on both demand and supply side of the market and the performance of various players in the market, and macro-economic environment, interest, fees, costs and revenues. These factors impact negatively on the effective demand for seed, and may also have an effect of pushing traders and farmers to informal markets so as to avoid these costs. The study, however, focused mainly on the legislative and regulatory framework of the industry while the current study addressed itself to factors influencing smallholder choices at the farm level.

The Ministry of Agriculture (2004) used value chain analysis to study the status of maize seed industry in Kenya. The study employed the value chain analysis to identify the main seed maize market channels, their function, roles and relationships. It identified legal and regulatory constraints, seed pricing, poor infrastructure, inadequate promotion of new varieties as well as poor quality of the seed in the market as the major bottlenecks in the seed chains. The study, however, covered the whole country and concentrated on how value is added across different parts of the chain. The current study laid emphasis on how the chains operate or don't operate and the farmer circumstances in the arid and semi-arid areas.

Winter-Nelson and Temu (2002) assessed the effect of coffee transaction costs on input market participation in a liberalized market in Tanzania while considering other factors such as output price, distance to markets, past experience with improved agricultural inputs, social capital and farm and farmer characteristics. Results of the study revealed that transaction costs play a major role in determining access and used of inputs among coffee farmers in Tanzania. The study also revealed that output price, membership to farmer associations, past experience with inputs, and distance to output markets are major determinants of input market participation. According to this study, output price, membership to farmer associations, and past experience with inputs increase access and use of improved agricultural inputs while and distance to output markets reduces access to improved inputs. Although this study focused on coffee input market chains, it generated very important insights on transaction costs on farmer access to agriculture inputs. This study focused on transaction costs on farmers' participation in maize seed input markets.

A study in Kenya by Rankow et al (2003) indicated that transaction costs are a major determinant of choice of market channel. The study used distance to markets as proxy for transaction costs and survey data from a sample of 324 Kenyan maize farmers located in 6 maize agro-climatic zones in Kenya. Their study showed that transaction costs lower market participation among smallholders maize farmers in Kenya. They attributed these results to poor infrastructure (road, telephone etc.) investment in the rural areas.

The foregoing past studies have shown that there are many factors influencing the choice of marketing channels. The major factors revealed are farm characteristics, transaction costs, socio-economic factors, policy environment and institutional access (markets, credit and extension).

These factors are, however, region specific depending on farmer circumstances. Since these circumstances vary with agro-ecological zones, this study attempted to isolate factors that are responsible for choice of improved maize seeds in arid and semi-arid areas.

The studies were either adoption studies or employed valued chain analysis approach which is very theoretical. The current study used a mixed method approach. The study used participatory market chain approach (PMCA) that seeks to generate group innovations based on a well-led and -structured participatory process that gradually stimulates interest, trust and collaboration among actors in the market chain. Various actors in the market chains were involved and participatory market chain approach (PMCA) was used to identify various marketing channels, different stakeholders, their interests and roles as well as capture factors and trends that shape the market chain environment leading to increased channel efficiency. PMCA has been used to analyze maize seed in chains in La Frailesca in southern Mexico (CIMMYT, 2007). Government policy on provision of seed subsidy on hybrids and OPVs was found to influence the types of seeds farmers were using. Here in Kenya, PMCA has not been widely used. The study found PMCA to have been used only in Aloe market chain analysis in West Pokot district (Hellin et al, 2005). This study used PMCA to analyse maize seed input chains in the study area.

3.0. Methods of the study

In order to address the objectives of this study several methodological tools were combined. This chapter gives, the conceptual background, a description of the data sources, data collected, an overview of the study area in terms of its size and climate. It also gives an account of the data collection procedures, data analysis and the various analytical tools used.

3. 1 Conceptual Background

This study employs the market map framework (see Hellin et al, 2005) and institutional analysis and development (IAD) approach (Dorward, 2001, Kirsten and Vink, 2005) to gain an understanding of different actors in the seed input chains and the relationships between them and to determine the functioning of the chains.

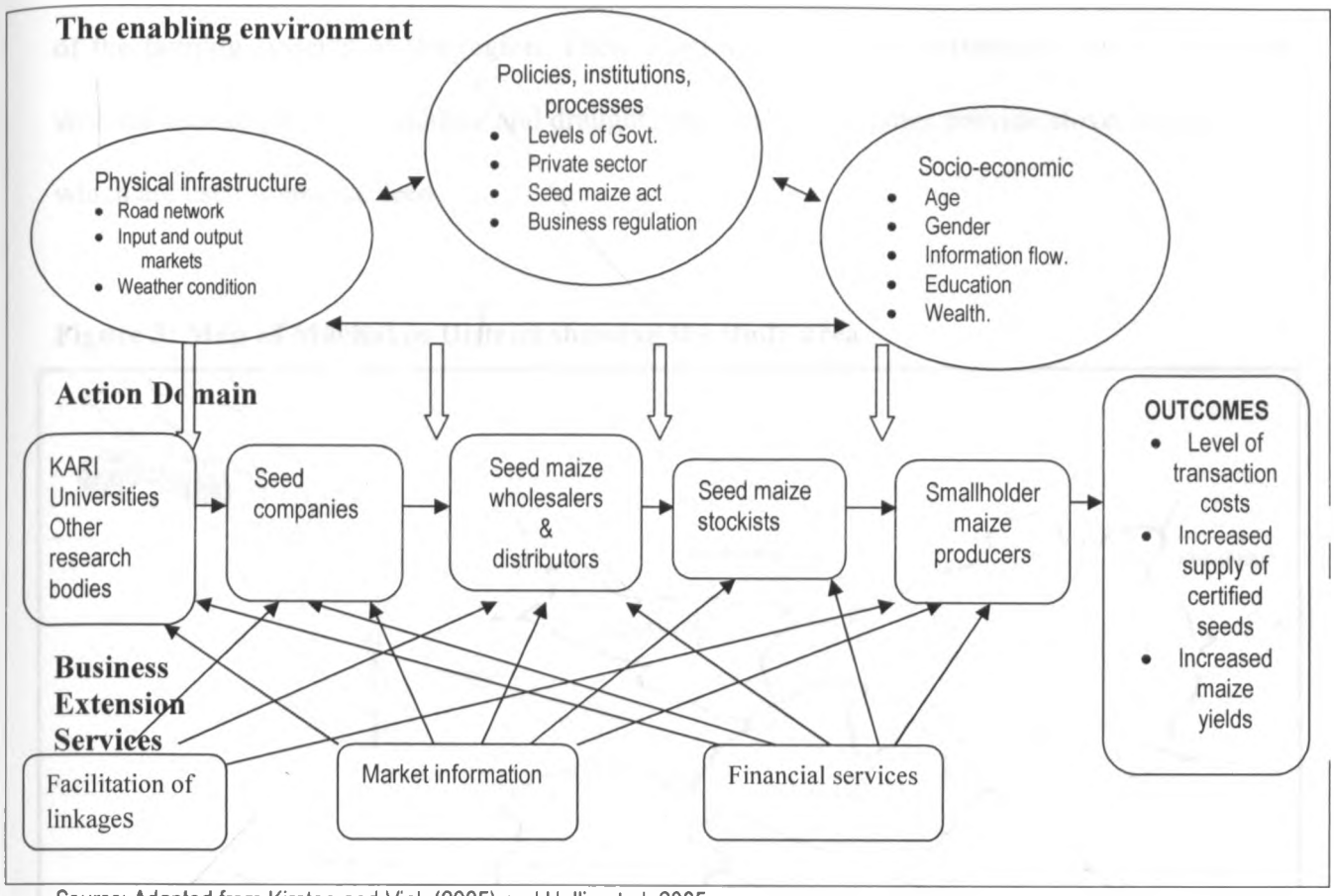
The basic structure of this approach involve exogenous set of variables (enabling environment) which influence situations of actors (or players in the market channels) and the behavior of those actors in those situations, leading to outcomes, which then feed back to modify both the exogenous variables and the actors and their situations. The outcome is dependent on the actors, nature of the activity and institutions in place. If the institutions are enforceable then they have impact on the activity hence outcome which also impacts the institutional environment. The heart of the framework is the identification of the 'action domain' which defines the spheres of activity and interest of analysis (Dorward, 2001). The main activity is maize seed marketing which can be formal or informal. The actors in this action domain are those who actually own and transact a particular product as it moves through the market chain. They include Smallholder producers, traders, processors, transporters, wholesalers and retailers. Transaction costs arise from the

interactions, such as change of property rights, and activities of different actors a long the maize seed market chains. In the context of maize seed marketing transaction costs include those costs as 'the costs of searching for a partner (or group) or information search, bargaining with potential partners to reach an agreement, transferring the products, monitoring the agreement to see that its conditions are fulfilled, and enforcing the exchange agreement.

The framework enables mapping out the market chain structure, identification of value chain actors and diagnosis of the key enabling environment issues, as well as assessment of the service needs or support for actors. Value chains are mapped and analyzed using participatory value chain analysis which may include qualitative and quantitative research tools. The mapping begins with the delineation of the value chains, the flow of maize seeds from seed producers to smallholders along the chains, the value chain actors, the enabling environment and the service providers (Figure 2).

The action domain includes the activities (value chains), institutions and actors. The value chains environment and operating conditions are influenced by an enabling environment (Hellin et al, 2005) that consists of policy, legal, physical, political and socio-economic environment. The policy environment determines the type of market channel structure the actors operate in, with the legal framework influencing the institutions at play. The physical environment such as transportation and communication infrastructure influences the performance of the actors while the socio-economic environment affects farmer demand for seeds and other farm inputs (Kirsten and Vink, 2005). The value chain actors are supported by business and extension services or business development services to remain competitive in their business.

Figure 2: Seed maize market chain map



Source: Adapted from Kirsten and Vink (2005) and Hellin et al, 2005,

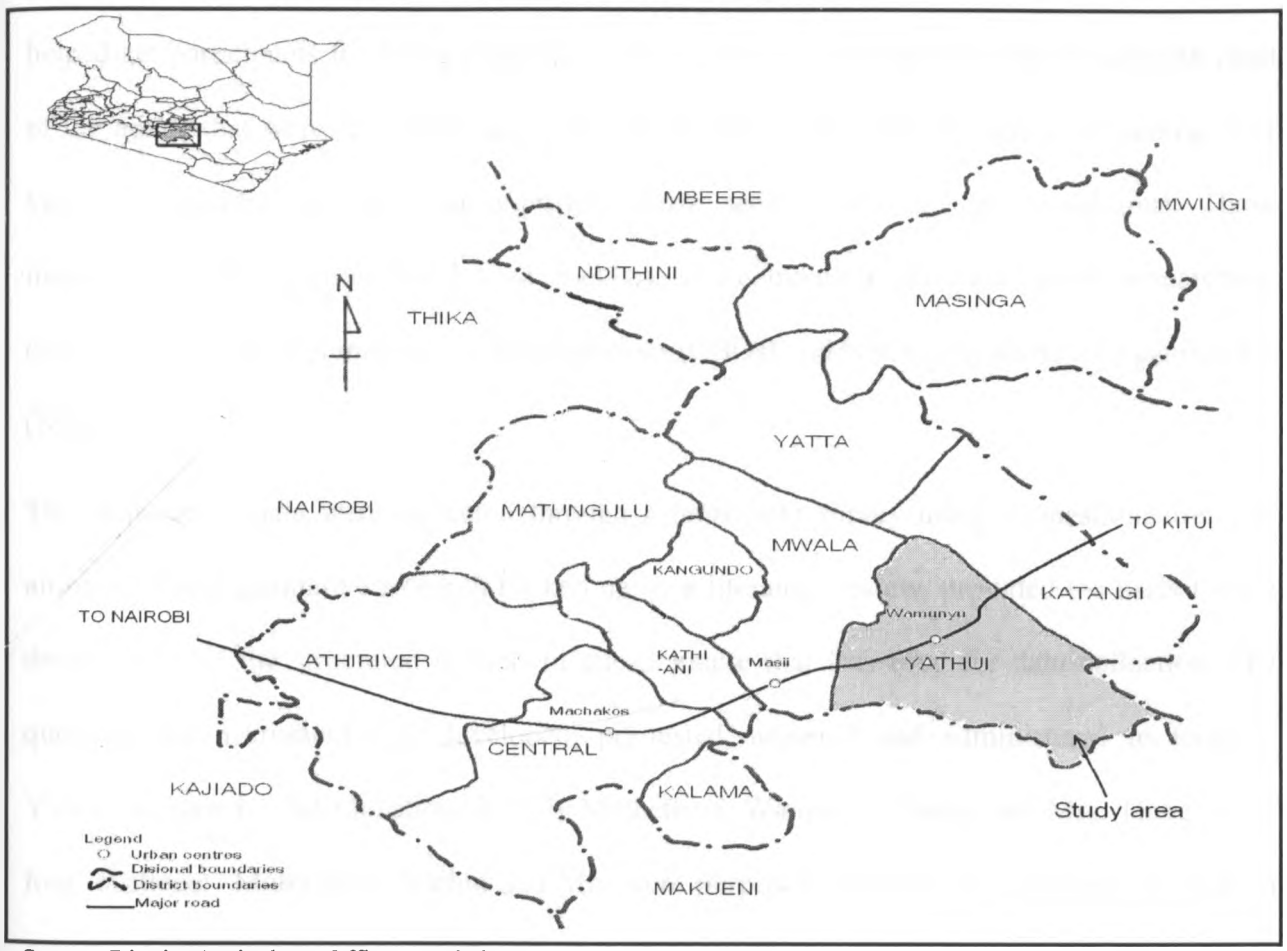
3.2 Study Area

The study was conducted in Yathui division of Machakos District in Eastern Kenya (See Fig 3). The area was purposely selected because it falls under the arid and semi arid areas of Kenya. The Division has a total population of 79,162 persons and 13,718 farm families. The study area lies in Agro-Ecological Zones 4 and 5 with an average of 650mm rainfall per year.

The zones are characterized by low maize yields of below 1.5 tons/ha per annum (de Groote et al., 2005). Rainfall is bimodal with the long rains (March - May) with a peak in April and the short rains (October - December) with a peak in November. Rain is erratic in total amount and distribution, a situation that exposes the area to frequent crop failures and droughts. Farming is

dominated by smallholder farmers and mixed farming of crops and livestock is the main feature of the farming systems of the region. There is strong interaction between livestock and crops with the former providing manure and draught power while the latter provide stover and residues which are used as animal feed.

Figure 3: Map of Machakos District showing the study area



Source: District Agriculture Office, Machakos

3.3 Sampling procedures and data collection

Data for this study were generated using qualitative and quantitative research methods (Tenge et al., 2004, Hellin et al, 2005). Such an approach was to ensure factors that are qualitative in nature, hence do not easily fit into econometric models, yet influence smallholders' access to

improved maize seeds are captured. The qualitative research began with field visits to the study area, interviews and discussions with key informants and groups of farmers to identify the existing maize seed market chains and get information on various actors involved in the chains in the area. Key informants for the interviews were purposely selected to include different actors in maize seed and locals with long experience in maize production in the area, including extension workers, researchers, seed dealers and farmers. Contacts established during these interviews helped get participants for focus group discussions. This was followed by interviews with most of the actors that were identified during the initial field visits, with the aim of obtaining their views on smallholder access to improved maize seed, their roles and constraints. Those interviewed at this stage included; seed stockists, seed companies, extension agents, researchers, credit providers, Community Based Organisations (CBOs) and Non Governmental Organisations (NGO).

The quantitative data were collected through a household survey using a questionnaire. The aforementioned qualitative research backed up by a literature review, provided the basis for the development of the structured household questionnaire that was used for data collection. The questionnaire instrument was developed, pre-tested, adjusted and administered to farmers. Yathui Division has four locations namely Muthetheni, Wamunyu, Yathui and Miu. Three out of four locations: Muthetheni, Yathui and Miu were purposely selected since Wamunyu location falls in a commercial centre. A list of all the households in all 74 villages of the 3 locations formed the sampling frame. Simple Random sampling was employed to obtain a representative sample of 150 households from the Division. Beside the questionnaires, group discussions, in-depth interviews with key informers, extension officers among others provided the context with which the survey data was analysed.

Data collected using the household interviews include: farm and farmer characteristics data (age, education, gender, farming experience), resource characteristics data (seed use including type, source, quantity, reasons for preferences of different type of maize seeds), institutional data (access to credit, access to extension service, distance to markets, and prices of seeds and grain maize) and transaction costs data (time spent on information search engaging in maize seed transaction).

Data on time spent in information search in relation to acquisition of maize seed was converted to transaction costs by multiplying it with the actual wage rate in the agricultural sector in the division and adjusted for the period of the year when work is locally available.

3.4 Data analysis

For factors influencing the choice of maize seed marketing channels, content analysis, descriptive statistics and logistic regression were used. Data entry was done using SPSS data builder. Descriptive analysis was done using SPSS and Excel while STATA software was used for regression analysis.

3.5 Analytical methods

3.5.1 Participatory market chain Analysis

Participatory market chain value analysis was used to determine the seeds that farmers use and start gaining understanding involvement, interests, relationships and roles of different actors as well as their problems. Participants included: seed sellers, farmers, extension staff, micro-credit organizations, community based organization and NGO representatives. Participants discussed their interests/activities, the services that they require and get/do not get, sources of information that they require and the constraints they face. The discussions further generated information on: the types of seeds that they are handling, reasons for handling the seeds, buying and selling price, who they purchased the seeds from, who they sold to, location of the suppliers, who they interacted with in the course of business and the sources of the information that they require and finally opportunities they can individually and jointly exploit.

Each marketing channel and channel actor was identified by the type of maize seeds handled and transactions that took place between maize seed sellers at each stage along the marketing channel as seeds moved from the seed source to the producer. By mapping out the trail of each transaction for each trader interviewed and grouping together the transaction that followed the same pattern to the producer, the major maize seed marketing channels were delineated, and the different chain actors, relationship and roles were identified.

3.5.2 Estimating determinants of choice of improve maize seeds

Analysis of the determinants of use of an innovation such as improved seeds use draws heavily from the adoption-diffusion framework on one hand and from factor demand theory on the other. Such analysis may include socio-cultural-economic determinants at the farm household level, role of prices, environment and policy factors.

This study used the adoption-diffusion framework to analyze the determinants of choice of improved maize seeds. Smallholders were assumed to be consumers of agricultural technology inputs and hence categorised as adopters and non-adopters of improved maize seed varieties. As illustrated by Leagan (1979) in the behavioural differential model, decision to adopt a technology is a behavioural response arising from a set of alternatives and constraints facing the decision maker. The adoption decision can be related to a set of alternatives and constraints facing the decision maker in the following theoretical model.

Decision = f (alternative, constraint)

Subject to, welfare criterion (e. g. higher profitability or utility).

In this study, it is hypothesized that the choice of improved maize seeds is determined by institutional, physical infrastructure, farm and socio-economic factors and transaction costs factors. This relationship can be presented as follows:

M_i = f (IN, DM, FH, FC, TC)

Where

M = Choice of improved maize seeds: M_i=1or 0

IN= Institutional factors (credit, extension, etc)

DM= Distance to markets in KM

FH= Farm household socio-economic factors

TC= Transactions costs

The choice of improved maize seeds is discrete in its nature, involving 'either-or' choices and the models of qualitative choice are relevant (Pindyck & Rubinfield, 1997). Since the dependent variable in these models is not continuous but discrete in its value, ordinary least square (OLS) regression is inappropriate (Pindyck & Rubinfield, 1998). Further, because of the problem of heteroscedasticity, OLS estimates of β will not be efficient. It may lead to wrong conclusions based on parameter estimates hence the limitation in using this model.

Logit and probit models are appropriate when the dependent variable is discrete usually taking two values 0 or 1. The structural model is specified as (Bharati *et al*, 1993 and Maddala, 2001)

$$Yi = \beta o + \beta_1 Xi + \mu \qquad (1)$$

Where $Y_i = 1$ or 0

In many adoption studies, a logit or probit model is specified to explain whether or not farmers choose a given technology (Green and Ng'ong' ola, 1993; Kaliba et al., 2000, Verbook, 2003). The predicted values can be interpreted as probabilities of using improved technology, which fall within the 0-1 limits. The choice of the model is dependent on the distribution function used for the stochastic term. A logistic distribution leads to the logistic model while a standard normal distribution leads to probit model. Logistic and cumulative normal distributions are similar and using either will basically lead to the same results (Maddala, 1983).Moreover, Green (2000) argues that it is difficult to justify the choice of one distribution over the other on theoretical grounds. This study assumed a logistic distribution and specified logit model to evaluate factors influencing the choice of improved maize seeds.

In the logit model, the probability of choosing improved maize seeds or formal seeds (Y= 1) or (Y=0) is evaluated. The model relates to the choice probability P_1 to explanatory variable X_1 in such away that the probability remains between 0 and 1. The model assumes a variable y^* which is expressed in the following equation (Pindyck & Rubenfield, 1991; Green, 1997).

$$Y^* = \beta o + \sum_{J=1}^{K} \beta iXij + \mu i \qquad (2)$$

Y* is linearly related to the observed X's through the structural model (2).

In equation (2), y^* not observable as it is a "latent" variable. What is observed is a dummy variable (e. g improved maize seeds choice) Y_i defined by

$Y_i = 1$ if the farmer uses improved maize, 0 otherwise.

In this model, the probability of Y is Pi, which is related to the independent variable (X) as follows (Pindyck and Rubinfeld, 1991; Maddala 2001):

$$Pi = F(Zi) = F(a + \sum_{i=1}^{n} biXi) = \frac{1}{1+e^{-z}} \qquad (3)$$

Where

$$Zi = a + \sum_{i=1}^{n} biXi$$

Pi in equation (3) is nonlinear in X and in the parameters, thus OLS cannot be used to estimate the parameters. For estimation purposes, the equation is linearized as follows:

If Pi, the probability that a household chooses improved maize seeds, is

$$Pi = \frac{1}{1+e^{-Zi}} = \frac{e^{Z}}{1+e^{Z}} \qquad (4)$$

Then 1-Pi, the probability of not choosing improved maize seeds is

$$1 - Pi = \frac{1}{1 + e^{Zi}} \quad (5)$$

$$\text{Thus } \frac{Pi}{1 - Pi} = \frac{1 + e^{Zi}}{1 + e^{-Zi}} = e^{Zi} \quad (6)$$

where $Pi/1 - P_i$ is the odds ratio in favour of choosing improved maize seeds- the ratio of the probability that a household chooses improved maize seeds to the probability that it will not.

In order to estimate the logit model, the dependent variable is transformed by taking the natural logarithm to yield "log odd" as follows:

$$Ln(P/1 - P) = Z = a + biXi + \mu i \quad (7)$$

After simplifying the above formula, the equation can be represented in the linear form as

$$Z = Ln(Pi/1 - Pi) = a + biXi + \mu i = Li \quad (8)$$

Where

Pi = Probability that Yi = 1 that a household chooses improved maize seeds.

1-Pi = Probability that Yi = 0, that household will not choose improved maize seeds.

bi = Coefficient to be estimated.

Xi = Explanatory variables

e = base of natural logarithm

Li = is called logit as it follows logistic regression.

ui = is the stochastic error term

The maximum likelihood technique was used to estimate the logit coefficients.

Variables hypothesized to influence choice of improved maize seeds

Qualitative research, backed up by a literature review helped in identifying a number of variables as being important in the household's choice of improved maize seeds. Variables used in the quantitative analysis are given in the table below.

Table 2: Variables used in the Logit Model.

Variable name	*Description/ Measurement*	*A Priori sign*
Dependent variable		
Explanatory variables	Type of maize seeds used 1=Improved, 0; Non-improved	
	Total no. extension contacts in the last year	+
	Membership to farmer group 1= member of farmer group, 0 =Not a member of a farmer group.	–
	Access to credit 1=access, 0= No access	+
	Distance to maize seed source	–
	Distance to output market	+
	Distance to motorable road	–
	Gender of the HH head 1=Male and 0 otherwise	+
	Age of the HH head in years	+ –
	Years of schooling of the HH head	+
	Total maize harvest in kgs	+
	Costs of information on seed for the first time	–
	Costs of information when getting maize seed	–
	Costs of information for improving knowledge on seed	–

The variables in the model were hypothesized to influence the choice of formal or improved maize seeds positively (+), negatively (-), or both positively and negatively (+/-). The detailed explanations of these variables are provided in the following paragraphs.

Total land size in acres

The economic status of farmers positively influences access to improved maize seed. In the context of African smallholders' farming systems and in the absence of wealth statistics of the

farmers, the variable land size was expected to capture this effect. Land size could also be viewed as important in enhancing access to credit, capacity to bear risks and access to scarce inputs such as certified seeds. Land size is therefore hypothesized to positively influence the choice of improved maize seeds.

Number of extension contacts

Extension is a major source of agricultural information that is required by farmers to make decisions on choice of seed maize. More contacts with extension service for delivery of information of maize input use are likely to result in better household' farming decisions including use of improved maize seeds. This study hypothesizes that contact with extension agents will have a positive influence on the choice of improved maize seeds.

Access to credit

Availability of credit increases purchasing power and allows farmers to buy purchased inputs for maize production. This study hypothesizes that access to credit will have a positive influence on the choice of improved maize seeds.

Distance to markets

Distance to input and output markets has been shown to influence uptake of technology and market participation (Staal et al., 1997, Langyintuo, 2005). Longer distance to commodity markets increases transactions and effectively reduces the returns to maize production. Thus farmers situated far from markets are less likely to choose improved maize seeds. It is therefore expected that this variable will negatively affect the choice of improved maize seeds.

Membership to farmer groups

This variable is a proxy for social capital. Social capital is recognized as a resource that can influence production decisions and economic outcomes (Narayan and Pritchett, 1999, Grootaert, 2001). Being a member of a farmer group, one is expected to have a positive effect on the choice of improved maize seeds.

Total Maize Yields

This variable was used to capture farmer's incentives in adopting improved maize seeds. Farmers using improved maize varieties are expected to obtain higher maize yields and therefore have an incentive to buy improved seed. These farmers are more likely to buy and use new and improved maize varieties than those with lower yields. It is therefore hypothesized that high maize yield positively influence the choice of formal maize seed seeds.

Age of the household head

Age is a human capital variable that reflects the ability of the respondent as a manager of the farm and his performance in output markets. Older household heads may have more experience in farming and therefore make better farming decisions including the adoption of improved maize seeds. However, young household heads may be more innovative and less risk averse, attributes that can make them use improved seeds. This variable can thus have positive or negative effect on a farmer's decision to choose improved maize seeds.

Education level of the household head

Educated farmers are expected to have more knowledge on improved seeds and hence a higher probability to be engaged in formal seeds. In this study, it is measured as the total number of years of formal schooling that the household underwent

Transaction costs

Transaction costs influence the choice of marketing channels (Boger, 1999, Renkow et al., 2004). Transaction costs increase the costs of production. It is hypothesized that transaction costs negatively influence the choice improved maize seeds.

Gender of the household head

Male-headed households are hypothesized to have more resource, better access to information and therefore able access seeds through the formal sources than female-headed households.

3.5.3 Estimating Transaction Costs

In this study, transaction costs are understood as ''sacrifices'' that farmers have to incur to carry out maize seed transaction. These may include opportunity costs and risks assumed among others. The study, however, limits itself to opportunity costs in terms of time. As stated above, some transaction costs are hidden costs and knowledge of opportunity costs faced by individual farmers was required. Furthermore, the concept of transaction costs did not exist as such in the terminology of smallholder farmers in the study area. The approach in this study was to identify time spent in activities related to acquisition of maize seeds and which could have been spent differently thereby representing a lost opportunity.

To obtain maize seeds that meet their individual specific requirements, small-holder farmers have to find out who sells or grows what maize variety, characteristics and performance of the maize of interest. Thus, the commonly encountered transaction costs by households involve time spent in information search about the different seed varieties, quality and prices mainly by making frequent physical visits to seed sellers, government agents, or neighbours and relatives. This study, therefore, focuses on information search costs.

Transaction costs exist in all economic exchanges along the products value chain. Along this value chain various stakeholders incur transaction costs. However, this study limited to smallholder maize producer– first seed source relations for maize seed segment of the value chain. Qualitative data collected on information search included; source of information on maize seed variety used; how to get this information for the first time; on obtaining the maize seeds and on improving information on the seeds, time spent in gathering this information as well as any incidental costs such as the costs of meals in the process. The estimated costs were calculated using the time allocated or used to perform such activities then multiplied by actual wage rate in the agricultural sector in the study area based on 8 hours a day plus incidental costs incurred by the farmer as shown in equation (9). The computed costs for different farmers and compared among the two major market channels

$$TC = (T_A * 1/8)\, W + C_I \qquad (9)$$

Where

TC=Transaction costs

T_A =Total sum of time in hours taken to perform activity

W =Wage rate

C_I =Incidental costs

4. Results and Discussions

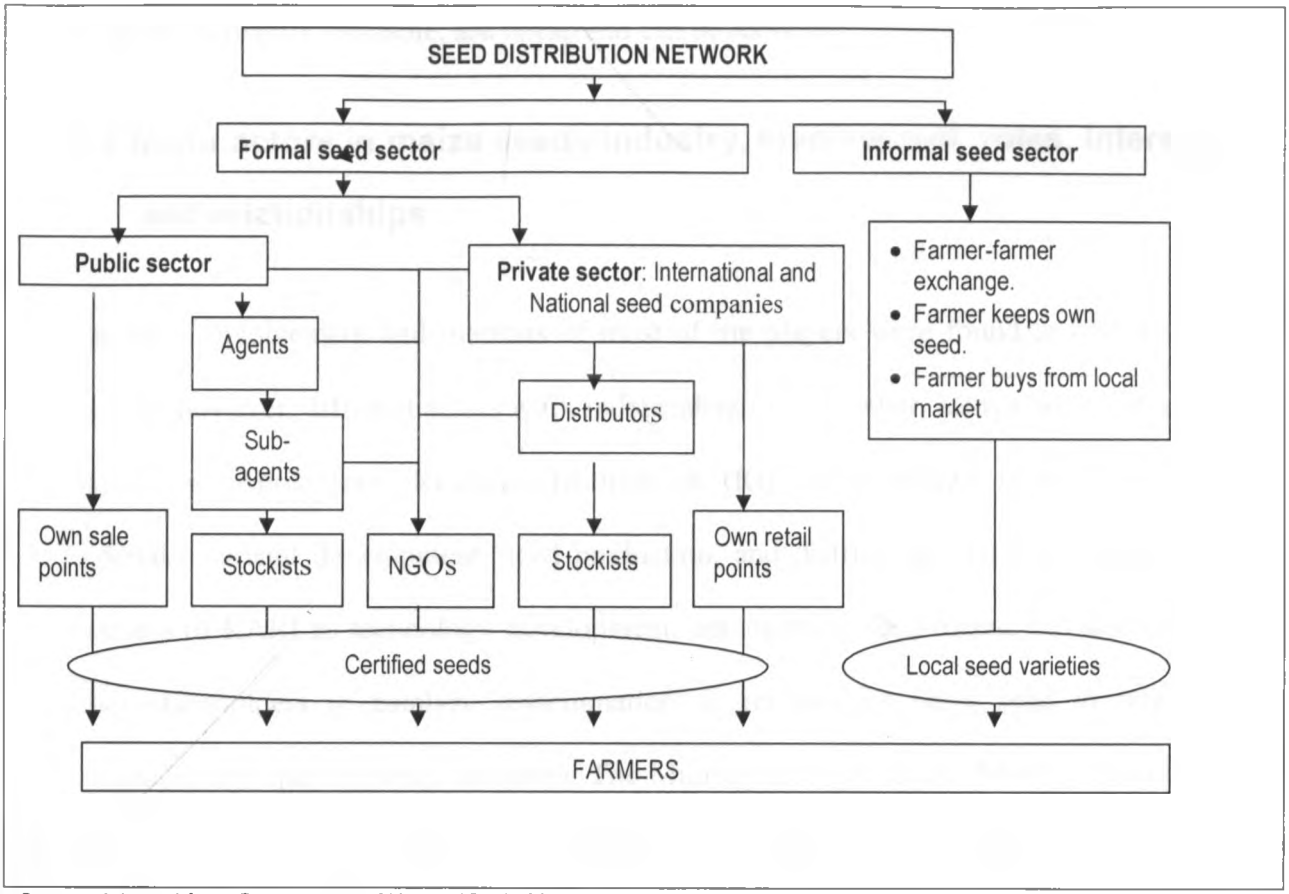
4.1 Maize seed market channel structure

In the study area, formal and informal maize seed channels can be distinguished (Figure 4). Informal seed chains deals with farmers' own local seeds such the indigenous local maize types (locally known as *Kikamba*,*Kienyeji* or *Kinyanya*). The study found that smallholders produce seeds as part of grain production rather than as separate activities. The seeds are obtained and distributed through informal networks: saved from farmers' own harvest, through trade among farmers (friends, neighbours and relatives), and through local grain markets or traders within and outside the study area. Formal seed chains, on the other hand, deal with improved maize seeds. Seeds move from researcher, over producer, seed seller and to the farmer through an established and legal process. Common improved seeds in use in the area include hybrids (Duma 43 and Duma 41, Pioneer Hybrid (PHB) 3253, DH02, DH04 Dekalb 8031), OPVs (Katumani (KCB), Makueni (DLC1)) and recycled hybrids.

The study further found that informal maize seed chains are made up of smallholders working within the community, local maize grain traders, local seed maize producers and farmers. Formal seed chains comprise both the public and private sector actors in the seed industry. The chains are organized into seed companies, agents and wholesalers, sub-agents, stockists (agro-vet businesses and farmers' unions) and farmers (see Figure 4). Focus group discussions and interviews with key informants identified a number of players and their roles in maize seed chains in the region. These include Kenya Agricultural Research Institute (KARI), Kenya Plant Health Inspectorate Services (KEPHIS), Ministry of Agriculture, Non Governmental Organisations (NGOs), Private and public companies, maize seed growers, stockists, small traders and farmers. Seed companies identified in this survey that deal with maize seeds in the

study area include: Monsanto, Western Seed Company, Kenya Seed Company and Oil Crops Development Company and KARI Seed Unit.

Figure 4: Seed maize seed distribution system chain



Source: Adopted from Government of Kenya (Gok), 2004.

The study area was found to be characterized by low coverage of formal seed sector leading to low access to improved maize seeds by many smallholders. According to majority of key informants in this study, informal maize seed chains handle the bulk of seed used in the arid and semi-arid region. Household survey results indicated that about 64 percent of smallholders use local maize seeds. Smallholder farmers use improved maize seeds as follows: 18 percent use OPVs, 11 percent use purchased hybrids and 4 percent use retained hybrids.

Discussions with key informants provided reasons for low access to improved seeds. These include low level of awareness on most improved varieties, unavailability of preferred varieties and high cost of improved seeds among others. However, according to the informants local seeds varieties are readily available, are cheap and can be recycled.

4.2 Major actors in maize seeds industry, involvement, roles, interests and relationships

The roles, involvement and interests of most of the players were found to overlap to varying degrees, however, different actors work independent of each other. Kenya Seed Company (KSC) and Kenya Agricultural Research Institute (KARI) are dominant formal institutions that undertake varietal development, seed production, and distribution. Key informants cited core business of KARI as technology development, among them seed maize, but also partners with other stakeholders to catalyze dissemination. It releases its basic seed to interested seed companies who pay royalties in return. The Ministry of Agriculture (MoA) explained its major role in the seed sector, as creation of an enabling environment for the players in the seed industry and extension. The extension service of the Department of Agriculture undertakes dissemination of information about type, availability, handling, and planting procedures as well as creation of awareness for new seed varieties. The extension staff explained that the intention of the ministry is not only to increase uptake of improved seed but also ensure proper use to maximize yields. According to the extension agents, MoA is involved in seed development and distribution through KARI and KSC respectively. It facilitates development and adaptation of improved maize varieties through the established research institutions and owns shares in KSC. MoA occasionally give relief seeds to farmers especially in seasons immediately after severe droughts.

NGOs interviewed explained that they supplement the efforts of government through seed distribution and extension services. The most active ones in the study area are Catholic Relief Services, Inades Formation, and German Agro-Action (GAA). Agricultural Market Development Trust (AGMARK) had just introduced its activities in the area. KEPHIS is responsible for quality control and certification activities in collaboration with KARI, seed companies, and seed distribution agencies and seed traders (Ochuodho et al., 1999). According to KEPHIS staff, the agency is involved at every stage in the development, release and production of the seed and in licensing the distributors of the seed maize distributed through the formal seed maize chains. This ensures all seeds sold to farmers are genuine and of the highest quality.

A number of private seed companies were found to operate in the area. In discussions with company representatives, most of them said they undertake development and multiplication of new maize varieties, and some marketing and distribution of the seeds. According to these companies, their primary objective is to maximize commercial seed sales and company profitability through sustained volume sales. Reducing farmers' costs or maximizing farmer returns on investment on seeds did not appear to be one of their goals. This may explain why most companies are not willing to invest in OPVs, which farmers do recycle for a number of seasons. Failure by farmers to purchase new seeds every season or year lowers the companies' revenues. Private companies involved in maize seed distribution in the region include local companies such as Western Seed Company (WSC) Faida Seeds. Multinational firms such as Pannar, Syngenta, Pioneer and Monsanto import certified seed from other countries such as South Africa which they distribute through local companies or distributors who supply the same

to farmers through stockists. Local companies like multinationals can source germplasm from other countries and the importation is strictly regulated by KEPHIS.

Maize seed stockists, small traders and farmers were found to be major players in the study area. The seed stockists, agents and sub-agents said they are responsible for distributing seed to farmers and ensuring it is available when and where required. Wholesalers said they collect seeds from seed companies' stores, situated in major cities, and deliver to stockists. By so doing, these actors were found to contribute to efficiencies in the marketing channels to the benefit of both stockists and farmers. Like seed companies, wholesaler and stockists' motive is to maximize seed sales and profitability. A small number of trained stockists also provide advisory services to farmers as a means of attracting buyers. It was found that local maize grain traders select and sell part of commercial maize to farmers as seeds to fill the gap left by commercial seed sellers and to boost their revenues.

Maize farmers are at the end of the maize seed chains as ultimate consumers of maize seed as they purchase seeds and use it for production of commercial maize. Farmers aim to maximize maize yields while keeping the cost of production low. Thus they look for the highest yielding maize variety given their environment yet accessed at low costs.

4.3 The Common Maize Seed Varieties

The study found out that the common maize seeds used by smallholders in the study area are, in order of preference: indigenous local maize varieties, Katumani composite B (KCB), SCDUMA

Table 3: Main maize seed varieties observed in Yathui Division

Seed variety	Frequency	Percent
Formal markets sources		
Pioneer	6	4
DH 04	1	0.7
Katumani	25	16.7
Makueni	1	0.7
DK 8031	1	0.7
DH O2	1	0.7
SCDUMA	15	10
Informal market sources		
Indegenous/ local type	91	60.6
Kinyanya (local variety)	5	3.3
Others	4	2.6
Total	100	100

Source: Authors' computation from survey data

43, Pioneer, and Kinyanya. Other seed varieties include DH02, DH04, DK8031, and Makueni composite (DLC1). The proportion of farmers using each type of seed is indicated in Table 3.

This study estimated that about 250,000 kgs of maize seed were planted in the area over the 2007/2008 crop year. This amount was dominated, as already indicated, by local seed varieties 159,500 kgs (63.8%) (Table 4). The study results show that KSC varieties dominated the market for improved seed varieties holding 18% overall and 56% market share of the improved seed varieties. The other 3 seed companies hold 14% and 43 % overall and improved market share respectively. NGOs supplied a mere 1% of the improved of improved maize seeds.

Seed stockists surveyed in the area stocked on average 7 different varieties of seeds. Most stocked varieties in order of quantities were Duma 43 and Duma 41, Pioneer Hybrid (PHB) 3253, DH02, KCB, DH04 Dekalb 8031.

Table 4: Volume of seed maize sales: 2007/2008 crop year

Seed company	Seed variety	Volume of sales (Kgs)	Overall company share (%)	Market share of improved seed (%)
Syngenta	Duma 43	25,000	10	31
KSC	Hybrids	1,250	0.5	1.5
	Composites	44,500	17.8	55
Pioneer	Pioneer	9,000	3.6	11
Monsanto	DK 8031	1,250	0.5	1.5
Informal	Local varieties	15,9500	63.8	
	Others	8,500	3.4	

Source: Authors' computation from survey data

According to both stockists and key informants, farmers learn about these varieties mainly from agricultural extension service, neighbours, through the media, mainly radio, demonstrations and field-days. Stockists in the area indicated they only stocked the varieties that farmers frequently enquire about and that they would increase the varieties if farmers demand them. Given that seed purchases are seasonal the stockists were reluctant to stock varieties that are unpopular with farmers even though such varieties were most suited in the area.

4.4 Factors influencing Smallholders' choice of formal or improved: A qualitative analysis

This analysis is done using data obtained through participatory market chain analysis and key informants. It includes some factors in quantitative analysis as they were mentioned by farmers.

Extension service

According to key informants' interviews lack of information is a major constraint to smallholder access to improved maize seeds. Farmers get information from a variety of sources, extension agents, NGOs, personal visits to markets, neighbours, and seed stockists were the major maize seed information sources to farmers. MoA was said to provide 58 percent of extension service with NGOs providing 28%. The role of seed companies and stockists as a source of information on improved seed was small, as mentioned by less than 10 % of the households. Household survey results indicate that out of 150 farmers interviewed only 36 (24 %) had contact with extension service while 64 % did not. 19 (52 %) of farmers who had contact with extension service were using improved maize seeds compared to about 31 (27 %) of those without contact with extension service. Seed companies interviewed said they had not invested sufficiently in distribution and popularization of seed maize in arid and semi-arid areas due to increases in operational costs and low business in the area. The companies reported that they pass information on new seeds to stockists. 70% of the stockists, however, said that the information they receive from seed companies and the mode of giving such information does not adequately equip them to adequately give advice to farmers. The study found that the majority of the stockists do not have any basic training in agriculture and hence have their own limitations.

Access to credit

Credit was cited by many key informants to play an important role in smallholders' access to improved maize seeds. Credit here could be in terms of cash or kind (e.g. maize seeds). It was expected that farmers who get credit are likely to access and use improved maize seed varieties since their purchasing power is enhanced. Results from this study show that 69% of farmers in

the study area believe that credit is available and 58% of farmers interviewed had taken credit in the past, either in cash or in form of inputs. Majority (90 %) of farmers accessing credit used for agricultural production with 53 % purchasing improved maize seeds.

Membership in farmer groups

According to informants the easiest source of knowledge and information about maize seed is the people already known to the farmer. Seed acquired from people within the farmers' social net works is perceived to be better and more reliable than that from unknown people. In their view a member of a group who is looking for seed can easily be referred to a seed provider by group members. As such, most of the farmers who belong to farmer groups were using improved maize seeds. Results from household survey show that of the sampled farmers, 39% were members of agriculture based farmer groups, out these 64% were using improved maize seed varieties.

Farmers' past experience with improved seed varieties

Majority of key informants said that farmers prefer to observe how new varieties performed before trying them. This explains why many of the farmers using certified seeds indicated having had past experience with improved maize seeds. Results from farm household survey indicate that out of the farmers using improved maize seeds, over 50% had received information from NGOs and/or government programs dealing with improved seeds. More than 50% of farmers that had benefited from National Agricultural Accelerated Input Access Program (NAAIAP) said they were using improved seeds. NAAIAP is a government program promoting agricultural inputs through use of subsidy voucher system. 500 households in the study area receive each an input voucher worth 10 kgs of certified seeds and 50 kgs of fertilizer from the program for one season. After realizing increased yields, majority of the beneficiaries, procure improved maize

seeds on their own in the subsequent seasons. Similarly, a large proportion of those that had benefited from NGOs relief seed programs reported that they had adopted improved seeds.

Cost of seeds

One of the factors cited as limiting access to improved seeds is the seed cost. In the opinion of many key informants and sampled households certified seeds are very expensive in relation to cost of local seeds and the price of grain maize. The average price of improved seed is Ksh 160 (about 2.4USD) per 1 kg packet and Ksh 320 (4.8 USD) per 2kg packet. Of the sampled households, 90 % considered this price of certified seeds to be high. Farmers indicated they did not purchase certified seeds because of high seed cost (44.1%) and low purchasing power (26.6%). The study also found that although OPVs are lower yielding than hybrids, they are equally priced. The high price put certified seeds out of reach for most smallholder farmers. This high price often deters farmers from accessing seed from formal sources. Instead they opt to buy from informal sources (e.g. local market) where prices are low (about Ksh 35 = US$ 0.5). An average consumer price of grain maize in the study area was Ksh 20 (US$ 0.3) per kilogram during the time of the study.

Distance to output markets

According to key informants farmers who have no access to output markets are less likely to use improved maize seed. Key informants indicated that farmers travel an average of 4.1km to buy certified maize seeds. It was found that geographical isolation negatively influenced access to improved maize seeds. The further away from commodity markets the lesser the flow of information and the higher the transaction costs. Thus, key informants reported that long

distances from these markets coupled with poor roads discouraged use of improved seed. Distance to markets was mentioned by more than 50% as a hindrance to access to improved seeds. In their opinion, it does not make sense to invest in high costs seeds and complementary inputs if one has no market for the produce. Results from this study show that the average distance to markets in the study area is 4km and the nearest market for 48% of farmers in the area is 10 km away.

Transaction costs

To obtain maize seeds that meet their individual specific requirements, small-holder farmers have to find out who sells or grows what maize variety, characteristics and performance of the maize of interest. According to informants, many smallholder farmers are located in remote areas that lack stockists, have poor roads, lack of telephone services and lack of extension agents among others. These farmers incur costs mainly in terms of time, by making frequent physical visits to seed sellers or government agents in search of information on seed varieties, quality and prices. Informants explained that time, in hours, spent in these activities are time which could have been spent differently thereby representing an opportunity cost.

These findings were corroborated by results from the household survey. Although only about 26.7% of farmers accessed improved seed through formal market channels, 80% of these farmers incurred high transaction costs in information search compared to only 20% in informal channels. Over forty two (42.5%)of farmers in formal channels incurred transactions costs of seed search compared to 8.2 in informal channels while 92.5% of farmers in formal channels incurred transaction costs of changing seed varieties compared to only 36.4% in informal channels.

4.5 Determinants of improved maize seeds: A quantitative analysis

4.5.1 General characteristics of variable in the model

Table 5 shows the socio-economic characteristics for the farm household. . The average age of farm household head in formal maize seed marketing channel was 50.8 years while those in informal market channels was 52.3 years. On the other hand the average number of years in school for household head in formal maize seed marketing channel was significantly higher than those in informal channels. In addition extension contacts for households in formal channels was significantly higher than those in informal channels while distance to markets for households in formal channels was significantly shorter than for those in informal channels. Farm yields and transaction costs for households in formal channels were significantly higher than for those in informal channels. However from the data set there was no significant difference in household size and distance to motorable road for house in formal channels and those in informal channels.

Table 5: General characteristics of households accessing maize through formal and informal channels

Variable	Formal channel			Informal channel		
	N	Mean/%	Sd	N	Mean/%	Sd
Age	40	50.8	15.8	110	52.3	15.6
Years of schooling		8.7	4.9		6.4	4.6
Total land holdings		5.7	7.3		5.0	5.8
Proportion of males in farmer group		80*			25*	
Proportion of males accessing credit		90*			48*	
No. of extension contacts		2.25	6.1		.30	.90
Distance in kms to markets		1.8	1.6		4.4	3.0
Distance in kms to motorable road		.64	.62		.78	.83
Proportion of male headed HH		92.5*			78*	
Household size		6.1	2.1		5.65	2.6
Farm yield		567.7	558.9		403.5	319.9
Costs of information search		90.3	175.8		13.7	62.4
Costs of seed search		65.1	100.2		8.3	38.8
Costs of changing		142.3	366.7		35.2	94.5

Source: Authors' computation from survey data
Note* =Values in percentage

4.5.2 Regression results

Table 6 shows the logit regression results for maize seed market channel choice in Machakos District. Corroborating the qualitative and descriptive analysis, the regression showed that extension contacts, membership to farmer group, access to credit, distance to markets, distance to motorable road (infrastructure), maize yields and cost of information search (transaction cost) are important determinants in the choice of improved maize seeds.

Table 6: Logit model factors influencing choice of formal maize seed market channels

Variable	Coef.	Std.Err.	z	P>|z|
Total land holdings	-0.02998	0.076346	-0.39	0.695
Total no. extension contacts in the last year	1.002037	0.3369	2.97	0.003***
Membership to farmer group	3.872839	1.078672	3.59	0.000***
Access to credit	3.96697	1.235824	3.21	0.001***
Distance to markets	-0.70972	0.303493	-2.34	0.019**
Distance to motorable road	-1.40805	0.754462	-1.87	0.062*
Gender of the HH head	1.543534	1.688361	0.91	0.361
Age of the HH head in years	-0.01953	0.033436	-0.58	0.559
Years of schooling of the HH head	0.080045	0.109124	0.73	0.463
House hold size	-0.0111	0.238663	-0.05	0.963
Total maize harvest in kgs	0.002723	0.001199	2.27	0.023**
Costs of information on seed for the first time	0.008019	0.004229	1.9	0.058*
Costs of information when getting seed	0.007111	0.004917	1.45	0.148
Costs of inf. in improving knowledge on seed	0.004782	0.003375	1.42	0.156
	-6.12618	3.193822	-1.92	0.055

Log likelihood = -27.362468 Pseudo R2= 0.685 LR chi2 (15) = 119.25 Prob > chi2 = 0.0000
Number of obs = 150

Note* = Significant level at 10%, ** = Significant level at 5%, *** = Significant level at 1%.

According to the logit results indicated in Table 6, number of contacts with extension service positively and significantly influences the likelihood of choosing improved maize seeds at 1% level. Households with more frequent contacts with extension in the last one year have a 3% higher probability of choosing improved maize seeds than do those without. The importance of

access to extension service and credit in enhancing access to improved seeds has been demonstrated in a number of studies here in Kenya and elsewhere (de Groote et al., 2005, Langyintuo, 2005, de Groote et al., 2006).

Access to extension services provides greater access to information concerning hybrids and OPVs. Government extension services are the major source of farming technologies in Kenya. The government, however, seems not to be effective in promoting access to improved seeds by smallholders owing to insufficient extension officers and inadequate facilitation for promotional activities (MoA, 2004). Attempts by NGOs to supplement government efforts in providing the services have largely been unsuccessful owing to small numbers of staff, who also have little technical agricultural training (de Groote et al., 2005). For example, Agricultural Market Development Trust (AGMARK) which is involved in creation of awareness on the benefits of use of improved farm units among the small holder farmers and in input credit by enabling farmers to access credit through the innovative voucher schemes and microfinance institutions has a very thin presence in the study area. Thus, despite having many different varieties released by seed companies, access by smallholders has been less than expected.

Access to credit positively and significantly influence the likelihood of choosing improved maize seeds at 1% level. Those having access to credit have a 12% higher probability of choosing improved maize seeds than do those without access to credit. Farmers need cash to purchase the maize seed, which is more costly than the local ones, and complementary inputs such as fertilizer for optimal yields. Smallholder farmers in arid and semi-arid areas are usually resource poor and cash-trapped. Access to credit improves their purchasing power for agricultural inputs.

Agricultural Finance Corporation, a government body mandated to give credit to farmers at affordable interest rates, has concentrated almost exclusively on medium-to large-scale farmers in selected high potential areas (Argwings Kodhek et al., 1999). However, there have been some success cases of alternative source of credit to smallholders in Kenya. For example, financial self-help groups in Western Kenya, with support of AGMARK have been able to successfully tap meager resources and build funds that have availed credit among smallholders.

Membership to farmers' group positively and significantly influenced the likelihood of choosing improved maize seeds at 1% level. Households who were members of farmers' group in 2007 had a 21% higher probability of choosing improved maize seeds than those who were not. Membership to a farmers' group may accord households access to social networks that may diminish the effects of transactions costs, e.g. by reducing costs of information search on seeds, or by facilitating group-buying of seeds in order to reduce costs of travel. Social networks might also allow greater access to finance by way of credits. Social interactions in farmer groups have been demonstrated to be important in information sharing, hence enhancing technology adoption (Jackson and Watts, 2002).

Distance to markets negatively and significantly influenced the choice of improved maize seeds at 5% level. Long distances increase transaction costs thereby reducing the benefits of improved maize seeds (Renkow et al., 2004). Households far from markets also lack market information necessary for decision making on the use of the seeds. A study by Karugia (2003) found a positive relationship between distance to market and technology adoption of hybrid seeds and fertilizer in Central and Western Kenya. This could probably be explained by results of a study

by Ayieko and Tschirley, (2006) which showed that whereas a stockist may be located near a farmer, the farmer could still travel long distances to buy inputs if convinced of making a saving.

The findings by Karugia (2003) may be true for central and western Kenya where populations were higher and the distance between the stockists and farmers tend to be shorter. However, markets in arid areas are sparsely located and seeds are not available in most of the nearest permanent markets. Alternatively, seeds arrive too late in relation to the cropping season or the type of seed available is not the desired one. Unsure of getting the preferred variety at the onset of rains, many farmers residing far from markets rely on the local seed.

Maize yields positively and significantly influences the likelihood of farmers choosing improved maize seeds at 5% level. These approve the hypothesis that maize yields will positively influence the choice of improved maize seeds. The results suggest that smallholder farmers have incentive to purchase certified seeds using the money they obtain from sales of grain maize. Higher yields would therefore increase smallholders' use of improved maize varieties. However, due to risks of poor rains, farmers believe they cannot achieve good yields.

Positive coefficients on transaction cost factors support the hypothesis that the choice of improved technology is associated with high transaction costs. In this case they indicate high transaction costs are associated with the use of improved maize seeds. In other words, in order to choose improved maize seeds one must be prepared to incur higher transaction costs. The cost of search of information for the first time showed significant influence on the choice of improved seeds. This indicates poor access to information on improved maize seeds in the study area.

As already indicated earlier, the results show that 80% of farmers in formal maize seed channels incurred high transaction costs of information on seed for the first time compared to only 20% in informal channels. Further, 42.5% of farmers in formal channels incurred transactions costs of information on getting the seed compared to 8.2 in informal channels while 92.5% of farmers in formal channels incurred transaction costs of improving information on seed compared to only 36.4% in informal channels (Table7).

The relationship between transaction costs and input markets can be deduced from other studies. Nelson and Temu (2005) found that transaction costs in input markets influence input use in Tanzanian coffee farmers. Using remoteness and input distance as proxies for transaction costs, their study showed that high transaction costs reduced access and utilization of fertilizer by coffee farmers. Rankow et al (2003) used distance to markets as proxy for transaction costs and showed that, long distances increase transaction costs thereby reducing the benefits of improved maize seeds. Households far from markets also lack market information necessary for decision making on the use of the seeds. Transaction costs lower market participation among smallholder maize farmers in Kenya. A study by Omano (1998) on the effect of transaction costs on crop marketing and specialization showed that farmers will specialize if the benefits out weigh the increase in transaction cost. Smallholder farmers are rational in their decisions to invest in a particular technology as they weigh the costs and benefits. In this case, for farmers to participate in formal maize seeds channels despite facing higher transactions, it implies that the benefits that they receive from use of certified seeds out weighs increases in transaction costs. Only farmers willing to incur high transaction costs accessed seeds through the formal seed channels.

Table 7: Comparing transaction costs between formal and informal channels

Transaction cost category	Formal			Informal		
	No. of respondents	% response	TC Ksh	No. of respondents	% response	TC Ksh
Costs of information on seed for the first time	32	80	3610.97	22	20	1505.97
Costs of information when getting seeds	17	42.5	2603.72	9	8.2	917.65
Costs of improving information on seeds	37	92.5	3676.86	40	36.4	3875.55

Source: Authors' computation from survey data

4. 6 Hypotheses testing

Three hypotheses were tested for this study. Hypotheses 1 and 2 were evaluated on the basis of t statistic at 5 percent level of significant.

Hypothesis one: Farm and farmers' socio economic characteristics do not influence farmer's choice of improved maize seeds.

The null hypothesis 1 stated that farm and farmers' socio economic characteristics do not influence farmer's choice of improved maize seeds. Most of farm and farmers' socio economic characteristics were found to influence farmer's choice of improved maize seeds. However, the most important is farmers' level of education in acquiring and processing important information on improved maize seeds. We therefore tested the variable level of education. Thus the null hypothesis states that level of education does not influence the choice of improved maize seeds. In other words, the coefficient on this particular variable is not significantly different from zero. In light of regression results, we fail to reject the null hypothesis because the coefficient estimate

is not statistically significant at both 5 and 10% levels (Pr (|T| > |t|)) = 0.463). One would expect that higher level of education increases farmers' ability to acquire and process information on new technologies and to modernize farm operations and make sound production decisions including use of improved maize seeds accessed via formal maize seed channels. Such farmers were expected to better deal with transaction costs of information search. These findings can be interpreted to mean that improved maize seeds and information on improved maize seed is not readily available at the farm level.

Hypothesis two: contacts with extension service providers does not influence farmer's choice of improved maize seeds

The coefficient estimate on this variable is statistically significant at 1% level (Pr (|T| > |t|)) = 0.003) and therefore the null hypothesis that contacts with extension service providers does not influence farmer's choice of maize seed market channel is rejected.

Hypothesis three: there are no differences in transaction costs between formal and informal maize seed marketing channels

The null hypothesis 3 stated that there are no differences in transaction costs between the formal and informal seed maize marketing channels. In light of results in table 8 below, we reject the null hypothesis because the coefficient estimate is statistically significant at both 5 %levels (Pr (|T| > |t|)) = 0.000).

Table 8: Channel Comparison of Transaction costs

Channel	Mean values for transaction costs categories			One -sample t test for mean transaction cost between channels
	Information search	Seed search	Changing variety	Mean
Formal	90.27	65.09	93.48	248.84
Informal	13.69	8.34	35.23	57.26
			t = -14,2545	*P*-value (|T| > |t|) = 0.000

Source: Authors' computation from survey data

5 Conclusions and policy implications

This study was undertaken to understand how the seed maize market channels are structured, the bottlenecks to them operating more efficiently, effectively and equitably, and to identify the factors influencing the choice of smallholder farmers. The study results showed that informal maize seed chain handle 64% of seed used in Yathui Division. The study also found out that there were significant costs attached to information search and hence transaction costs associated with acquisition and use of maize seeds. Access to improved maize seed was likely to increase with increase in information flow, more contacts between smallholders and extension agents who are a major source of information to farmers, better access to credit, improved agricultural technology, and greater group buying. On the other hand, high cost of certified seeds, long distances to input and output markets and high transaction costs present large obstacles for access and use of improved seeds by smallholders.

Increasing maize production to achieve self sufficiency and enhance the achievement one of the millennium development goals (MDG 1) of eradicating extreme poverty and hunger by reducing by half the proportion of people who suffer from hunger by 2015 and vision 2030 has been an important objective of the Kenya government in its national policy on food and nutrition. This study has generated factors that will shed light on relationships between socio economic factors, transaction costs and maize output.

This study has shown that low coverage and lean presence of maize sellers and poor coordination among different actors lead to low use of improved seeds. There is need for harmonization of activities and strengthening of relationships among actors in maize seed marketing channels to

enhance efficiency and effectiveness of the channels in delivery of seeds and flow of important information on seeds from the source to consumers. It will also be important for policy makers in the seed industry to provide a clear policy direction in regard to improved seed and how public sector resources could be engaged towards creating awareness amongst smallholders who do not purchase improved seeds. The government could also give incentives that will encourage seed companies to invest in seed distribution and in raising the level of awareness among smallholder farmers in arid and semi-arid areas. These incentives may be inform of tax rebates or working in collaboration/partnerships with such seed companies through friendly credit schemes.

The study found that contacts with farmers yield a positive influence on use of improved seeds. Increased use of improved seeds and higher maize yields may be achieved through intensification of extension service provision. Thus, there is need for institutional support to extension services. It is recommended that the government improves its own extension services through increased funding to improve staff mobility and capacity. It should also encourage other players outside government to participate in provision of extension services.

The study shows that access to credit leads to increased use of improved seeds. There is therefore need for both the government and private sector to shift to avenues that make credit more accessible to especially smallholder maize farmers. One option may be to support the development of credit schemes such as micro-finance to facilitate seasonal financing smallholder farmers and seed traders.

The study showed that groups favour choice of improved maize seeds. It will therefore be important for actors in the sector to provide training and capacity building on farmer group formation and empowerment to increase use of improved seeds.

Efforts should be made to organize farmers into producer organisations to enhance access to social networks and their capacity to collective action. Efforts should be made by farmer's organizations such as KNFAP, Kenya National Farmers Association of Producers and other farmer groups to encourage their membership and other farmers to use improved maize seeds.

Transaction costs were shown to have a negative influence on the choice of improved seeds. Policy makers in the seed industry need to consider mechanisms for reducing transaction costs in formal seed marketing channels. Investment in physical infrastructure and information and communication technology (ICT) will be necessary if choice of improved seeds via formal channels is to be increased. Various programs in print and electronic media that target farmers will enhance access to information. Proper distribution systems, adequate infrastructure, deeper penetration of stockists into the villages and as well as greater farmer groups' participation need to be in place in order to reduce transaction costs and hence the cost of marketing by seed sellers.

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Appendix: Questionnaire

University of Nairobi/CIMMYT

Developing and disseminating stress tolerant maize for sustainable food security in East and Central Africa

Household Survey 2008

HH Name _____ Household No. **HHID** _____

Respondent(s) _____ **MEM** _____

Date:(dd/mm/yy) **SURDATE** _____

(Instruction: Record the member number of the Respondent from the Demography table on page 10 after the survey is completed.)

Start time _____ **End** _____

Identifying Variables:

Supervisor: _____ **SNUM**_____

Enumerator: _____ **ENUM**_____

Province: _____ **PROV**_____

District: _____ **DIST** _____

Division: _____ **DIV** _____

Location: _____ **LOC** _____

Sub-Location: _____ **SUBLOC**_____

Village: _____ **VIL** _____

GPS coordinates : **HH1 :** _____ (1=North 2=South) (_____° **DEG1**_____`` **MIN1**_____ **SEC1)**

HH2 : __East__ (_____° **DEG2**_____`` **MIN2**____ **SEC2)**

HH3 : Altitude MT. a.s.l **MASL** (_____)

SECTION 1

CROP ENTERPRISE ANALYSIS

The relative importance of crop enterprises as ranked by the farmer

What are the five (5) most important crop enterprises to you as farmer according to their contribution to the household welfare for the last 12 months?		*Enumerator*: Then determine which of the remaining activities was the most important, second, etc.		What is the major use /importance for this crop? 1=for food consumption at home 2=for sale(edibles crops only) 3=fodder 4=industrial /cash crop 5=other specify?
	cropname	Cropcode	croprank	Importance
1				
2				
3				
4				
5				

SECTION 1: QUESTIONS IN THIS SECTION REFER TO THE MAIN CROP SEASON 2007/08*(Embu; NOV/DEC 2007 Machakos Jan-Mar)*

Q1.1. How many **acres** in **total land holdings** did the household **own last year (2007)**? **TACRES**_____

Q1.2.a. Did this household have any cropping activity during the **MAIN CROP Season 2007**(1 = Yes, 2 = No) **MAINCROP**_____

(Embu; NOV/DEC 2007 Machakos Jan-Mar)

Q1.2.b. If **Q 1.2 a. =Yes (1), go to table below. (Enum make sure you get all details for fields with maize; for all other crops stop at tenure)**

Crop08.sav *Key Variables: hhid, harvest, field, crop:*

Crop code	Field No.	Acres	Is this field 1=owned w/ deed 2=owned w/o deed 3=rented 4=owned by parent/ relative 5=government/communal/ co-operative	Was this maize an intercrop or mono crop? 1=Yes 2=No	Hired land prep cost (Ksh)	Planting/ Seed Type 1=Purch /New Hybrid 2=Retained Hybrid 3=OPV 4=local var 7=hybrid& local var 8=hybrid purc+retained	Quantity of seed used & cost, if purchased this season				1st Fertilizer used			2nd Fertilizer used			3rd Fertilizer used			Harvest -777=not yet harvested		Sales		Price received on **largest** sale trans-action Use sale unit code	Distance to point of sale kms	Buyer type (**largest** sale): 1=small trader 2=large trader 5=NCPB 6=miller 7=other coop 8=NGO 9=consumer 10=Exporter
							Qty	Unit	Cost p unit	Source of funds 1=group credit (AFC) 2=other group credit 3=ROSCAS 4=own cash 5=other individual credit	Type	Qty	Unit	Type	Qty	Unit	Type	Qty	Unit	Qty	Unit	Qty	Unit			
Crop	**field**	**acres**	**tenure**	**microp**	**lpcost**	**Sdtype**	**sqt**	**sunit**	**scost**	**sors**	**ft1**	**fq1**	**fu1**	**ft2**	**fq2**	**fu2**	**ft3**	**fq3**	**fu3**	**hvt**	**hunit**	**sold**	**slunit**	**Price**	**Dist**	**Buyer**

Unit codes: 1=90 kg bag 11=50 kg bag 2=kgs 3=litre 4=crates	5=numbers 6=bunches 7=25kg bag 8=10kg Bag 9=gorogoro 10=tonnes 12=debe	13=grams 14=wheelbarrow 15=cart 16=canter 17=pickup 18=2kg packet(seed)	Fertilizer codes: 0=None 1=DAP 2=MAP 3=TSP 4=SSP	5=NPK (20:20:0) 6=NPK (17:17:0) 7=NPK (25:5:+5S) 8=CAN (26:0:0) 9=ASN (26:0:0) 10=UREA (46:0:0)	11=SA (21:0:0) 12=Other (specify)___ 13=manure 14=Foliar feeds 15=NPK (23:23:23) 16=NPK (20:10:10)	17=DAP + CAN 18=compost 19=magmax lime 20=DSP 21=NPK(23:23:0) 22=NPK(17:17:17) 23=NPK(18:14:12) 24=NPK(15:15:15)	25=Mavuno-basal 26=Kero green 27=Rock-phosphate 28=NPK 14:14:20 29=Mijingu 1100 30=UREA+CAN 31=Mavuno-top dress.

Q1.3 SHORT CROP 2007/2008 (Eastern Kenya refers to Jul-Sept 2007 harvest, Embu refers to Nov 2006-Jan 2007)

crop07.sav *Key variables: hhid,harvest,field, crop.* *Harvest=2*

Crop code	Field No.	Acres	Is this field 1=owned w/ deed 2=owned w/o deed 3=rented 4=owned by parent/ relative 5=government/communal/ co-operative	Was this maize an intercrop or mono crop? 1=Yes 2=No	Hired land prep cost (Ksh)	Planting/ Seed Type 1=Purch /New Hybrid 2=Retained Hybrid 3=OPV 4=local var 7=hybrid& local var 8=hybrid purc+retained	Quantity of seed used & cost, if purchased this season				1st Fertilizer used			2nd Fertilizer used			3rd Fertilizer used			Harvest -777=not yet harvested		Sales		Price received on largest sale trans-action Use sale unit code	Distance to point of sale kms	Buyer type (largest sale) 1=small trader 2=large trader 5=NCPB 6=miller 7=other coop 8=NGO 9=consumer 10=Exporter
							Qty	Unit	Cost p unit	Source of funds 1=group credit (AFC) 2=other group credit 3=ROSCAS 4=own cash 5=other individual credit	Type	Qty	Unit	Type	Qty	Unit	Type	Qty	Unit	Qty	Unit	Qty	Unit			
Crop	**field**	**acres**	**tenure**	**Microp**	**lpcost**	**sdtype**	**sqt**	**sunit**	**scost**	**sors**	**ft1**	**fq1**	**fu1**	**ft2**	**fq2**	**fu2**	**ft3**	**fq3**	**fu3**	**hvt**	**hunit**	**sold**	**slunit**	**Price**	**Dist**	**Buyer**

Unit codes:			Fertilizer codes:				
1=90 kg bag	5=numbers	13=grams	0=None	5=NPK (20:20:0)	11=SA (21:0:0)	17=DAP + CAN	25=Mavuno-basal
11=50 kg bag	6=bunches	14=wheelbarrow	1=DAP	6=NPK (17:17:0)	12=Other (specify)___	18=compost	26=Kero green
2=kgs	7=25kg bag	15=cart	2=MAP	7=NPK (25:5:+5S)	13=manure	19=magmax lime	27=Rock-phosphate
3=litre	8=10kg Bag	16=canter	3=TSP	8=CAN (26:0:0)	14=Foliar feeds	20=DSP	28=NPK 14:14:20
4=crates	9=gorogoro	17=pickup	4=SSP	9=ASN (26:0:0)	15=NPK (23:23:23)	21=NPK(23:23:0)	29=Mijingu 1100
	10=tonnes	18=2kg packet(seed)		10=UREA (46:0:0)	16=NPK (20:10:10)	22=NPK(17:17:17)	30=UREA+CAN
	12=debe					23=NPK(18:14 12)	31=Mavuno-top dress.
						24=NPK(15:15:15)	

USE OF SEED

Q 2 . Indicate the types of maize seed planted in the main and short seasons: (Instructions: Refer back to the crop table and copy the field numbers and seasons, where maize was planted, to this table. Then ask the questions.)

Seed08.sav *(Key variables: field, season, sdvar)*

Field No.	Season 1=Main 2=Short	Crop 1=Maize 2=Green Maize	Seed **varieties** planted Use code below.	**Seed Type** 1=Purchased/New hybrid 2=Retained hybrid 3=Purchased OPV 4=Retained OPV 5=Purchased local variety 6=Retained local variety	**Source type codes:** 1=small trader 2= stockist/agent 3=large company 4=NGO /CBO 5=KFA 6=Cooperative 7=Own seed 8=Farmer /Neighbour 9=General market 10=GoK 11=Farmer group 12= Other, specify___ Source type	**Kms** from point of purchase to farm	How much did you incur in transporting the seed?	How did you **obtain this seed**? 1=Cash purchase 2=Credit 3=Exchange 4=Free 5=Retained seed	Reason for **Maize seed variety** selection (Use codes below) **(Maize Only)**
field	**season**	**crop**	**sdvar**	**sdtype**	**source**	**kms**	**transport**	**sdobtain**	**Rseed**

Maize Seed Codes:
1=KS 614
2=KS 611
3=KS 622
4=KS 623
5=KS 625
6=KS 627
7=*KS* 628
8=KS 511
9=KS 512
10=KS 513
11=Pioneer
12=CG 4141
13=CG 5051
14=CG 5252,
15=Pan 5195
16=Pan 5355
17=Pan 5243
18=Pan 99
19=Maseno DC
20=DLC
21=DH1
22=DH2
23=DH3
24=DH4
25=Katumani
26=PH1
27=PH2
28=Coast Composite
29=Indigenous/Local type
31=Don't know
32=KS 514
33=KS 613
34=KS 626
35=KS 636
36=KS 9401
37=Kinyanya
38=Makueni
39=PH4
42=KS 612
43=Pan67
44=Monsanto
45=WS 501
46=Faida Seed 650
48=Rwanda
49=Pan 691
50=PH 1033
51=DK 8071
83=DK 3081
52=KS 629
53=KS 621
55=KS 515
56=DH 02
57=SCDUMA43
58=KH500-21A
59=KS 6213
60=KS 9201
61=WS 404
62=KS 615
63=KS 616
64=KS6 210
65=Resistant Maize (IR)/ua kayongo
66=Kakamega Synthetic
67=KSTP 94
68= Pan 612
69=Sadvil A
70=Sadvil B
71=Sadvil Composite
72=Simba
74= WS 402
75= WS 505
76= WS 403
77= WS 503
78= WS 504
79= WS 905
80= WS 909
81= WS 205
82= WS 500
40=WS 699
41=WS 904
54=WS 502
84=WS105
30=other , specify__

Reason codes
1 high yielding
2 cheaper
3 pest/disease resistant
4 freely available/own
5 Drought resistant
6 Seed promotion/donation
7 only available in the market at the time
8 Early maturing
9 No lodging/rotting
10 Striga weed resistant
11 Good for sale
12 Good for home consumption
13 On trial
14 heavy grains
15 Other specify__

TRANSACTION COSTS OF OBTAINING MAIZE SEED:

2.1 Ask the following questions for the **main seed variety** grown by the farmer.

Q 2.2a. What **MAIN** maize variety did you grow (***main season***) **MAIZVAR** _____

Q 2.2b. Do you grow improved maize?(**If the answer in Q2a is a local seed)** **Yes**_____**No**_____

If the answer is yes, what is the main improved maize variety do you grow? **IMPMAIZVAR**_____

Q 2.3a From whom did you first learn about this seed variety?. **WHFIRST**_____

1=Public Extension Agent 2= NGO agent 3=neighbour/farmer 4=market 5=traders/input dealers 6=radio /television
7=family/friend 8=newspaper/magazines 9=Farmer Organizations/cooperatives 10=field days/demonstrations 11=ASK Shows
12= Mobile phone 13=private(company agent) 14=other (specify)_____

TCTABLES

Ask the following questions for the main seed variety specified here; fill in the table below each question

Q 2.3b What did you do to get this information or how did you get this information?.

Kms from point of activity to farm

Activity date and venue	Time spent travelling to the meeting(hrs)	Cost of transport for the return journey(ksh)	Time spent in the meeting/activity (hrs	Cost of meals and incidental costs relating specifically to this activity(ksh)

Q 2.4a. From whom did you get the seed?. **HOWGET**_____

1=Small trader 2= stockist/agent 3=large company 4=NGO /CBO 5=KFA 6=Cooperative 7=Own seed 8=Farmer /Neighbor 9=General market 10=GoK 11=Farmer group

12= Other, specify_____

If not own seed, ask the following questions for main/improved varieties

Q 2.4b Did you spend any money other that the cost of seeds?.

Activity date and venue	Kms from the farm to the source of seeds	Time spent travelling to the source(hrs)	Cost of transport for the return journey(ksh)	Time spent in the activity (hrs)	Cost of meals and incidental costs relating specifically to this activity(ksh)

Q 2.5. Did you ever improve your knowledge on the use of seeds? Yes _____No_____if yes
What do you do when you want to improve your knowledge on the use of seeds? (Attend demonstration, field day etc)_____

Activity date and venue	Time spent travelling to the meeting(hrs)	Kms from point of activity to farm	Cost of transport for the return journey(ksh)	Time spent in the meeting/activity (hrs)	Cost of meals and incidental costs relating specifically to this activity(ksh)

Q 2.6. Did you ever change from use of one type of seed to another? Yes _____No_____ if yes
What do you do when you want to change from use of one type of seeds to another? _____

Activity	Time spent travelling to the meeting(hrs)	Kms from point of activity to farm	Cost of transport for the return journey(ksh)	Time spent in the meeting/activity (hrs)	Cost of meals and incidental costs relating specifically to this activity(ksh)

MAIZE VARIETY CHOICE:

Q3.Questions on the main **MAIN** maize variety grown (***main season***)_____(**Maizvar). Q 2.2 above**

List the criteria for choosing maize variety to grow? (***Reminder to enumerator:*** **prompt** the respondent with the **type** but ***do not read*** *the options* ***under criterion****, just tick the "mentioned" column, (After the farmer mentions ask the three most important properties to the by farmer)*

Type	Criterion	mentioned	Three most important? 1=Yes, (Leave blank for No)
1=General	1=Early maturity		
	2=High yield		
2=Tolerance	3=Drought tolerance		
	4=Tolerance to Stemborer		
	5=Tolerance to other field pests		
	6=Tolerance to storage pests		
	7=Tolerance to diseases		
	8=Tolerance to Striga		
	9=lodging		
	10=Low external input demand		
	11=Rotting		
	12=tolerance to Low soil fertility		
3=Storage	13=rotting of cobs in storage		
4=Plant	14=Vigour		
	15=Height		
5=Seed	16=seed, low price		
	17=availability of seed		
	18=Seed size		
	19=Quality		

Type	Criterion	mentioned	Three most important? 1=Yes, (Leave blank for No)
6=Cob aspects	20=cobs, number per plant		
	21=number of rows per cob (high or fixed)		
	22=cob size		
	23=cobs well filled		
	24=husk cover good		
7=Grain aspects	25=grain, large size		
	26=grain colour		
8=Processing, cooking	27=Compact grain/high flour density		
	28=taste		
	29=Easy threshing		
	30=Flint		
	31=processing qualities		
	32=tolerance to weeds		
	33=Drying period		
	34=Familiarity		
10=Other(Specify)			

Farming practices/ training/ - MAIN CROP Season 2007/08

Q4a. What seed type did you plant on the largest maize field in during **main crop season** of **2006/07** **MSEASON06**_____

1=New hybrid_ 2=Retained hybrid 3=Purchased OPV 4=Retained OPV 5=Purchased local variety 6=Retained local variety

Q4b. Which **year** did you **first** plant **purchased hybrid maize**? (0=Never planted) **YHMZ**_____

Q4c. Have you ever had an **experience with Bad/adulterated** Purchased maize seed? (0=Never planted) **(1 = Yes, 2 = No)BADEXP**_____

Q4d. **If yes to Q4c,** What was the problem? **(PROBPMZ)**_____

Q4e. If you **didn't purchase hybrid maize**, in the MAIN CROP Season 2007/08 why not? **NFERMZ**_____

0=did not plant maize 1=not profitable 2=lack of information 3=seed not available 4=not enough cash 5=too expensive
6=maize price too low 7=no money for other inputs 8= no need to use 10=other, specify_____

Q4f. If you **didn't use chemical fertilizer on maize**, why not? **NFERMZ**_____

0=did not plant maize 1=not profitable 2=low response rate 3=couldn't obtain credit 4=not enough cash 5=too expensive
6=maize price too low 7=no cash when needed 8= fertilizer not available 9= no need to use 10=other, specify_____

Q4g. **Who** makes decisions on use of farm inputs (e.g. seed & fertilizers)?**NAMED**_____**MEM2**_____(*fill later*)

Q4h. Did this household purchase dry maize for home consumption in the last 12 moths? **(1 = Yes, 2 = No) MCONSUME**_____

Q5a. Has anyone in this household attended farmer field days or farmer training school on Maize production in the last 3 years? **TRAINING** - (1=yes, 2=no)

Q5b. If yes, Number of days in the last 3 years: **TRAINDAYS**_____

Q5c. Total number extension contacts in the last year: **CONTACT**_____

Q5d. Do you **ACTIVELY listen to <u>Agricultural Programs On Radio</u>? (1=Yes 2=No)** **:LISTEN** _____

Q5e. What was the average **daily wage rate** for **general farm labour** in this area in the 2007 season? (Ksh per day):**WAGERA07** _

Q5f. For this wage, what was the **typical number** of hours **worked per day**? (Hours): **HOURS07**_____

Q5g. Over the past year (2007/ 2008 season), would you consider your agricultural production system to be reflective of a normal production year, a good production year, or a poor production year? **YR07/08**_____

1=normal year 2=good year 3=poor year

Q5h. How many months in a year is work available for you? **YRMONTHS**_____

Q6a. Did any member of this household belong to a farming group/CIG during the last one year?(1 = Yes, 2 = N**FRMGRP07**_____

Q6b. Did any member of this household **belong** to a **farmer cooperative or institution** dealing in **maize inputs or maize marketing**? **INSTMZ07**_____

(1 = Yes, 2 = No)

Q6c **If Q6a is No** what kind of group did the household belong to? **OTHGRP06**_____

1. None 2. Church group 3. Rotating savings group (ROSCA) 4. Other (specify)

CREDIT

Q7a. Did any household member **TRY to get any credit during** the 2007/08 crop year? (See the sources in **Q7d).** (1=Yes) (2=No **go to Q8**)
CASHCRD _____

Q7b. (If Yes) Did you receive the **credit** that **you tried to obtain**? (1= Yes) (2=No **go to Q7f**) **CASHRD**_____

Q7c. (If yes) How **much credit** did you receive (ksh) **CASH** _____

Q7d. For the **two** main sources of credit, what was the **source** and the **amount** that you received from each? **CSRC1** ____**CAMT1** _____
CSRC2 ____ **CAMT2** _____

(1= neighbor 2=farmer group 3=SACCO 4=commercial bank, specify _____ 5=relative/friend
6=NGO/MFI, specify_____ 7=AFC 8= group (ROSCA) 9=Village bank 10=Shopkeeper 11=other, specify _____)

Q7e. How was the **cash credit** used (1=Agricultural purposes 2=Non agricultural purposes 3=Both) **MAINPUR** _____

Q7f. If you tried to get **cash credit but did not get** what was the reason for not getting? **NCASH** _____
(1=no collateral 2=Had outstanding loan 3= Don't Know 4= Other, specify_____)

Q7g. If the loan in Q7e was used for agricultural purposes, was it maize related? Yes _____**No**_____

Q8 Infrastructure

Infrast07.sav

Infrastructure (Distance should be recorded in kilometers, Km)	
Q 8. Distances from your homestead	**April 2007 to March 2008**
a. What is the distance from your homestead to where you bought **hybrid maize seed**?	**SEEDSKM2** _____
b. What is the distance from your homestead to the nearest **hybrid maize seed seller**?	**NEARSEEDKM** _____
c. What is the distance from your homestead to where you bought **fertilizer**?	**FERTKM2** _____
d. What is the distance from your homestead to where the nearest fertilizer **seller**?	**NEARFERTKm**_____
e. What is the distance from your homestead to **extension advice**?	**DEXTN2** _____
f. What is the distance from your homestead to the nearest **market place** for **farm produce**?	**MKTKM2**_____
g. What is the **type of the road** from your homestead to the **farm produce market**?	**ROADTYP2**_____
h. What is the distance from your homestead to a **motorable road**?	**DTMR0D2** _____
i. What is the distance from your homestead to a **tarmac road**?	**CTMR0D2** _____

Codes for type of Road: 1=tarmac, 2=murrum/all weather, 3=dry weather, 4=foot path, -7=services not available

Q9. DEMOGRAPHIC CHARACTERISTICS OF HOUSEHOLD MEMBERS

Demog07/08.sav *(Key variables: hhid, mem)* **Reference Period: The Past 18 months -Jan 2007to June 2008**

ID	Name	In which **year** was this person born?	What is the **sex** of this person? *1=male 2=female*	**Relation-ship** to **current** head *See code below*	Is this person **Currently** enrolled in formal schooling? *1 = Yes 2 = No*	What is the **highest** level of education completed? *See codes below*	Did this person receive cash from **informal /business activity?** Include **farm kibarua, dividends** between **march 2007 & march 2008?** *1=Yes 2=No*	Did this person receive income from salaried employment between **march 2007 & march 2008?** *1=Yes 2=No*
MEM	**NAME**	**yborn**	**gender**	**rshead**	**cursch**	**heduc**	**Istinf**	**Curinf**
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

rshead

1= head	6= brother /sister	11=unrelated
2= spouse	7= nephew /niece	12=brother /sister-in-law
3= own child	8= son/daughter-in-law	13=parent-in-law
4= step child	9= grandchild	14=worker

Education levels

-9=None	0=pre school	9= form 1	10 = form 2	17= college 3	18= college 4
1=std 1	2=std 2	11=form 3	12=form 4	19=univ 1	20=univ 2
3=std 3	4=std 4	13=form 5 14=form 6		21=univ 3	22=univ 4
5=std 5	6=std 6	15= college 1		23=univ 5 & above	

Q10. IMPORTANCE OF INCOME SOURCES

Economic Activity		Please indicate the order of importance of each of these activities in the household's total income during the past 12 months -9=activity could not be ranked 0=did not give any income though produced 1=this activity gave the highest income 2=this activity gave the second highest income ... ...all the way to the least income -1=the household did not engage in this activity *Enumerator*: First place a -1 for all activities that the household did not engage in. Then determine which of the remaining activities was the most important, second, etc.
ECONACT		**ORDER**
Crop production and sales (all crops)	1	
Livestock production and sales	2	
Farm kibarua	3	
Salaried labor	5	
Business activities	6	
Remittance	7	

Q11. Household Assets (PROMPT for each item AS LISTED BELOW)
AT PRESENT, how much/many of the following does this household own that are usable/repairable? (**Instructions**: Ask for the resale price for each asset or the current market value of the asset as it is and then add up to get total value for the asset category.) **Asset07/08.sav** *Key Variables. hhid, item*

Asset	Current Quantity (2008)	Total Value (2008)	Asset	Current Quantity (2008)	Current Total Value (2008)
ITEM	QTY1	TOTVAL	ITEM	QTY1	TOTVAL
1=houses			27=posho mill		
2=stores			28=weighing machine		
3=water tanks			29=grinder		
4=radio			30=cattle dip		
5=TV			31=power saw		
6=telephone/mobile			32=spray pump		
7=solar panels			33=irrigation equipment		
8=battery			34=water pump		
9=gas cooker			35=cart		
10=bicycle			36=animal traction plough		
11=wheel barrow			37=donkey		
13=sewing/knitting machine			38=motorcycle		
14=milking equipment/shed			39=car		
15=zero-grazing units			40=truck		
16=chaff cutter			41=trailer		
17=water trough			42=tractor		
18=poultry houses			43=harrow/tiller		
19=piggery houses			44=ploughs for tractor		
21=borehole			45=planter		
22=well			46=sheller		
23=dam			47=ridger/weeder		
24=jaggery unit			48=generator		
25=cane crusher			49=boom sprayer		
26=pestle and mortar			50=Furniture (totval)		
51=Boat (rowing)			12=Beehives		
52=Motor boat/engine					

Thank you