Fodder Production as an Adaptation Strategy in the Drylands: A Case Study of Producer Groups in Baringo County, Kenya

BY

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A thesis submitted to the Board of Postgraduate Studies in partial fulfilment of the requirements for the degree of Master of Science in Range Management (Economics option) in the Department of Land Resource Management and Agricultural Technology, Faculty of Agriculture, University of Nairobi

DECLARATION

THIS THESIS IS MY ORIGINAL WORK AND HAS NOT BEEN PRESENTED FOR THE AWARD OF A DEGREE IN ANY OTHER UNIVERSITY.

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DEDICATION

To my parents, Godfrey and Martha Inimah; for their ceaseless support towards my education, may God bless you abundantly.

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ABBREVIATIONS AND ACRONYMS

ALRMP	Arid Lands Resource Management Programme
ASALs	Arid and Semi-Arid Lands
AWF	African Wildlife Foundation
CARE	Cooperative for Assistance and Relief Everywhere, Inc.
CNFA	Cultivating New Frontiers in Agriculture
ELMT	Enhanced Livelihood in the Mandera Triangle
FAO	United Nations Food and Agriculture Organization
HPG	Humanitarian Policy Group
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agricultural and Livestock Research Organization
KARI	Kenya Agricultural Research Institute
KCB	Kenya Commercial Bank
KEPHIS	Kenya Plant Health Inspectorate Service
KIRA	Kenya Interagency Rapid Assessment
KLMC	Kenya Livestock Marketing Council
KMT	Kenya Markets Trust
KRDP	Kenya Rural Development Programme
KSHS	Kenya shillings
KVDA	Kerio Valley Development Authority
MoL	Ministry of Livestock
NGOs	Non-Governmental Organizations

OFDA	Office of United States Foreign Disaster Assistance
RAE	Rehabilitation of Arid Environments Trust
RoK	Republic of Kenya
SNV	Netherlands Development Organization
SPSS	Statistical Package for the Social Sciences
STATA	Statistics and Data software
TLUs	Tropical Livestock Units
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USD	United States Dollars
USDA-SCS	United States Department of Agriculture-Soil Conservation Service
VIF	Variance Inflation Factor
VSF	Veterinaires Sans Frontiers

ABSTRACT

Pastoral communities in Kenya are faced with many challenges chief of them recurrent and prolonged droughts which has triggered a number of responses aimed at enhancing resilience of pastoral households against such shocks. Fodder production is increasingly gaining popularity as a source of both livestock feed and income for pastoral households. In Baringo County, fodder production groups drawing membership from the community have been established with the aim of improving household livelihoods. This has however, been going on in the absence of empirical evidence to guide out-scaling of such approach. This study was carried out in Marigat Sub-County of Baringo County to map the fodder and grass seed value chain, determine its profitability based on gross margin and contribution to household income as well as factors that influence households' participation in fodder production groups. Household interviews, focus group discussions and key informant interviews were used to gather data.

The results show that fodder producers were mainly composed of men, majority of whom had attained primary level education, and livestock keeping was their main occupation. *Cenchrus ciliaris* was the preferred grass species by the fodder producers due to its ability to easily establish, drought tolerance and it's viable and easy to harvest seeds. Those involved in bulking and processing of grass seeds were found to be the dominant actors in the value chain. Besides buying grass seeds from producers, these agents provided inputs and ploughing services, and trained farmers. The individuals produced 28.13 kgs of seeds/acre while the groups produced 9.35 kgs/acre. A kilogram of grass seed was sold at an average price of Kshs. 250 by the fodder producers at the farm gate. However, the price varied depending on the quantity of grass seed offered for sale by a producer, the market outlet and the price negotiation skills of the producer whenever that option was available.

Individual fodder producers made an average profit of Kshs. 1,088.60 per acre while the groups made a profit of Kshs. 474.48 per acre in the September to December fodder growing season of 2013. The leading sources of production costs were found to be ploughing and purchase of grass seed. Fodder production contributed about 5.71% of the monthly household income of individual producers compared to 0.42% for the group producers in the period under study (2013).

The results of the binary logit model show that households' access to communal drought grazing reserves and their past bad experience with drought positively influenced their participation in fodder groups. The number of livelihoods pursued by a household, its herd size and the age of the household head negatively influenced membership to fodder production groups. Drought occurrences and low prices offered for grass seeds as well as failure of the existing market outlets to purchase grass seeds at times were found to be some of the challenges facing the fodder producers in the value chain. However, the findings of this study indicate that fodder production has the potential to address cash needs for pastoral households. The study recommends the need to link the fodder producers to reliable markets to cushion them from low prices offered for produced grass seeds. Also important is access to more input and service providers in the fodder and grass seed value chain to help lower the high prices of inputs associated with the current monopolistic nature of input market. Moreover, the current communal drought grazing reserves in pastoral areas should be sustained and expanded to complement fodder production efforts by households through provision of forage to sustain their herds during prolonged dry seasons and drought.

Key words: Pastoral households, fodder and grass seed value chain, profitability of fodder production, collective action.

CHAPTER ONE

INTRODUCTION

1.1 Background

Drylands occupy 41% of the earth's land area and are a home to more than two billion people (Reynolds *et al.,* 2007; UNEP, 2007; MEA, 2005). In Africa, drylands make up 43% of the land surface and support 40% of the continent's population. Fifty million pastoralists and up to 200 million agro-pastoralists are estimated to live in drylands from West to East Africa (De Jode, 2009). In East Africa, drylands which are predominantly arid and semi-arid rangelands, comprise about 79% of the total land area (Nyariki *et al.,* 2005). In Kenya, the arid and semi-arid lands (ASALs) occupy 89% of the country and are a home to about fourteen million people and approximately 70% of the national livestock herd (RoK, 2012a).

The economy of arid areas is dominated by pastoralism characterized by extensive livestock production whereas agro-pastoralism, rain-fed and irrigated agriculture, bio-enterprise, and conservation or tourism-related activities exist in better-watered and serviced semi-arid areas (RoK, 2012a). The livestock sub-sector in Kenya's ASALs contributes 40% of the Agricultural Gross Domestic Product and 10% of the total Gross Domestic Product (KARI, 2004) and employs 90% of the ASAL population thereby contributing 95% of households' income in these areas (RoK, 2003). In the view of these contributions, the potential of the arid lands and livestock sub-sector are recognized by the Government of Kenya under the Vision 2030 as important drivers for economic growth for the country (RoK, 2008).

The productivity and therefore pastoral livelihoods have however been negatively impacted by several factors among them population pressure on resources, recurrent drought, changes in land

tenure, sedentarization of pastoral households and civil wars (Fratkin, 2001). As reported by Galvin (2009), the main social and environmental changes observed in pastoral areas of Kenya include changes in land tenure and land use, sedentarization, institutional changes and climate change.

The effects of climate change are manifested in the form of extreme weather events such as floods and recurrent droughts in the arid and semi-arid lands of Kenya (Olukoye *et al.,* 2007). These extreme climatic events usually result in a number of adverse impacts including loss of livestock, which is a major source of livelihood and food security among pastoral communities in the ASAL regions (Obando *et al.*, 2010). Changes in average rainfall remain uncertain but projections clearly indicate that the arid and semi-arid lands would experience decreases in precipitation, increasing their aridity. It is estimated that drought events, largely due to failed rainy seasons, will increase both in frequency and intensity with projected climate change (Osbahr and Viner, 2006).

Many interventions are usually undertaken to cushion pastoral communities from climatic risks such as droughts and they include food aid and non-food interventions (RoK, 2014). Some of these non-food interventions include provision of employment to pastoralists by the government through food for work initiatives, supplementary feeding of livestock, provision of water for livestock and selling part of the livestock (Mogotsi *et al.,* 2011). Sustenance of the livestock herds, especially the breeding stock during droughts is crucial in determining households' post drought recovery. Fodder production is another increasingly important non-food intervention, which is undertaken to increase household resilience to drought and rising food commodity prices (USAID, 2012).

1.2 Problem statement

Forage scarcity is a perennial problem that usually reduces the productivity of livestock and may also damage pastoral community relations by provoking conflict over grazing lands. Lack of livestock feed occasioned by drought is often a major cause of livestock mortality. For example, during the droughts of 2009-2011, many households in the arid and semi-arid areas of Kenya lost a lot of their animals resulting in increased levels of poverty and food insecurity among pastoral households (Joosten *et al.,* 2014). Forage deficiency is caused by a combination of factors that include limited and erratic rainfall, shrinking grazing lands due to competition for land for crops, and changing land use patterns that favour urbanization and settlement (Ayele *et al.,* 2012).

In Kenya, communities living in the drylands are now embracing fodder production to increase their household income and food security in the face of recurrent droughts (CNFA, 2013). In Baringo County, this practice has been mainly as a result of pastoralists' emulation of communal range rehabilitation enclosures set up by the Rehabilitation of Arid Environment (RAE) Trust, which has been practicing restoration of degraded range in collaboration with the communities since the 1980s (RAE, 2004). Various studies have been conducted on fodder production in Baringo County and other drylands in Kenya (Mureithi *et al.,* 2015; Wairore *et al.,* 2015; Kigomo and Moturi, 2013; Meyerhoff, 2012; Musimba *et al.,* 2004; RAE, 2004; Kitalyi *et al.,* 2002). The findings of these studies indicate that fodder production is mainly carried out through enclosures meant to exclude grazing animals to allow regeneration of degraded land from which households derive various benefits. However, none of these studies has analyzed the fodder value chain and collective action in fodder production in the drylands of Kenya.

1.3 Justification of the study

In addition to efforts by RAE, SNV and ILRI worked with existing groups to promote fodder production as a way of building households resilience against climate change. The project was funded by the International Livestock Research Institute (ILRI), Kenya Livestock Marketing Council (KLMC) and the Netherlands Development Organization (SNV) during September to December of 2013. The project specifically aimed at promoting livelihoods diversification, facilitating robust markets for livestock and livestock products and enhancing consolidation of knowledge base to enhance climate change adaptation and orientation. Part of the project's sustainability strategy was to establish and support the groups with the aim of making them viable micro-enterprises that will continue to sustain their businesses beyond the project period (Joosten *et al.,* 2014). Groups have been used for collective action to accomplish a range of activities for different socio-economic categories (Place and Kariuki, 2005). Crane *et al.,* (2011) noted that an analysis of people's performance of their technical practices and social lives is an important aspect of understanding adaptation processes.

Following the establishment of fodder production groups in Baringo County there was need to evaluate them so as to determine the achievements and challenges faced so far to guide decisions on sustainability strategies. This study was therefore conducted with the aim of generating information to guide development and scaling up of fodder production in groups in the arid and semi-arid areas of Kenya. Among the direct users expected to benefit from this information are groups and individuals involved in fodder production, non-governmental organizations, County governments and researchers.

1.4 Overall objective

To generate empirical evidence on fodder production and marketing in Marigat Sub-County of Baringo County so as to inform development, improvement and scaling up of the value chain in the drylands of Kenya.

1.5 Specific objectives

The specific objectives of this study were to:

1. Map the fodder and grass seed value chain in Marigat in terms of marketing channels, actors, volumes traded and prevailing prices.
2. Analyze the profitability of fodder production based on gross margin and its contribution to household income of both group and individual producers in the study area.
3. Determine the socio-economic and demographic factors influencing households' participation in fodder production groups in the study area.

1.6 Research questions

1. What are the marketing channels, prevailing prices and volumes traded by the actors involved in the fodder and grass seed value chain in Marigat Sub-County?
2. What is the profitability of fodder production based on gross margin and what is its contribution to household income of both group and individual producers in the study area?
3. What are the socio-economic and demographic factors influencing households' participation in fodder production groups?

1.7 Study limitations

This study only covered events in a single fodder growing season in 2013. A long term study would have been desirable, but it was not possible given the time frame of the M.Sc. programme.

1.8 Thesis organization

This thesis is organized into seven chapters. The first chapter provides background information of the study regarding the extent of rangelands, their importance and the challenges encountered by the pastoral communities in the face of climate variability and change. Chapter one also presents the problem statement, justification, objectives and limitations of the study. The second chapter presents literature review on fodder production and marketing, its contribution to household income and collective action in the drylands of Kenya. Chapter three comprises the study area and the study design. Chapter four presents the analysis of the grass seed value chain in the drylands of Baringo County, Kenya. The contribution of fodder production to households' income in the semi-arid Baringo County is presented in chapter five. Chapter six presents the determinants of households' participation in fodder production groups in the drylands of Baringo County, Kenya. Chapter seven summarizes the findings from chapter four to six and provides conclusions and recommendations. References and appendices are presented at the end of the thesis. The schematic organization of this thesis is shown in Figure 1.

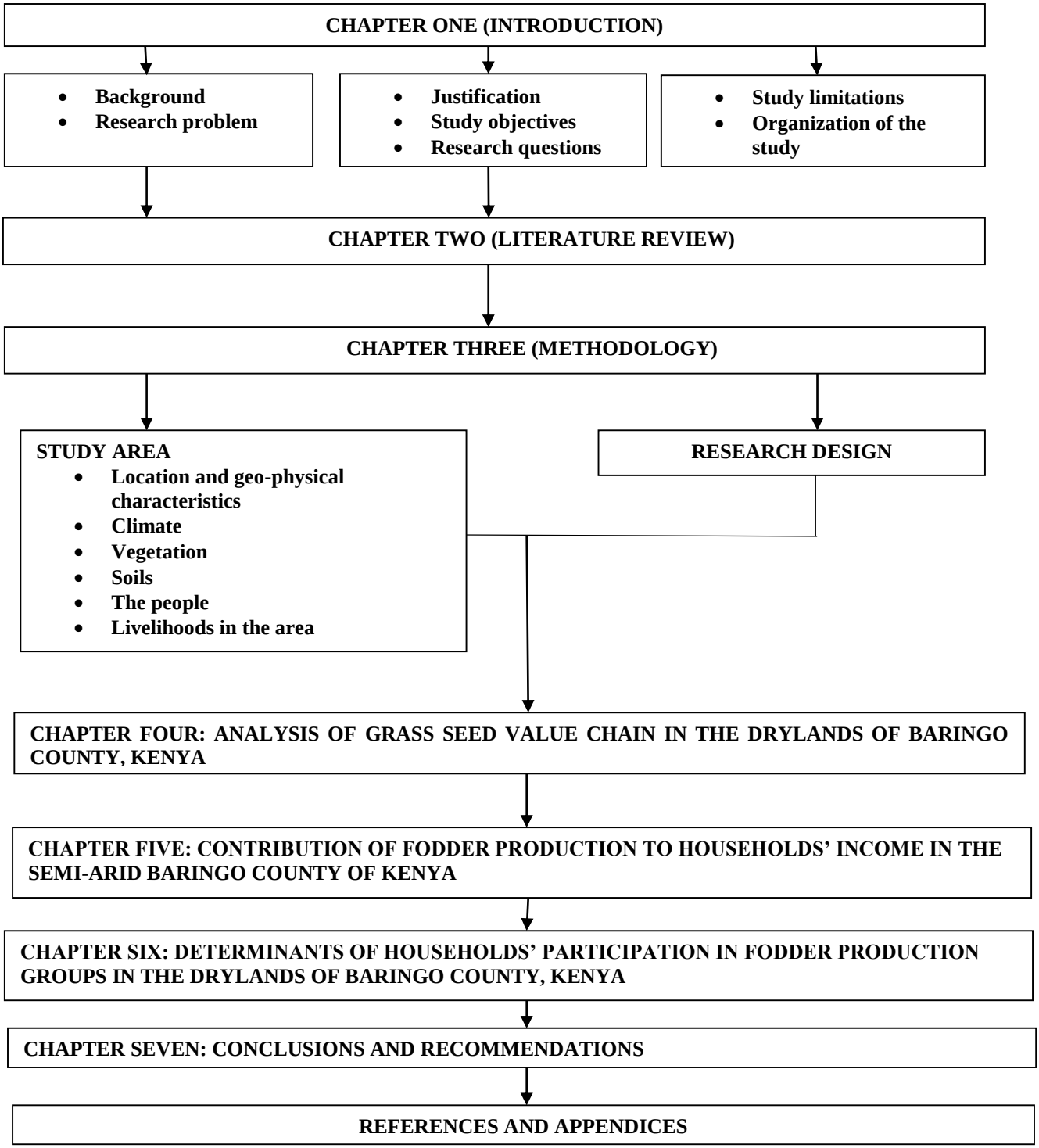

Figure 1: Thesis plan

CHAPTER TWO

LITERATURE REVIEW

2.1 Fodder production and marketing in the drylands of Kenya

Droughts have been increasing in frequency and severity over time, and over three million pastoralists in northern Kenya were affected by the severe drought of 2009 to 2011 (Huho *et al.*, 2011), which is considered the worst in the ASALs of Kenya since 1996. It led to massive livestock losses and pastoralists who once sold their cattle for as much as Kshs. 30,000 a head were forced to sell for as little as Kshs. 1,000 per animal in order to buy feed for the rest of their starving herds (Bevege, 2009). The loss to the livestock sector arising from the 2009-2011 drought was estimated at approximately USD 8 billion (RoK, 2012b). Over the years, pastoral communities in Kenya have developed various strategies to cope with droughts. In northern Kenya, among the Maasai pastoralists of Mukogodo Division the strategies include: grazing livestock early in the morning when pastures still have dew and this serves to reduce the livestock's water requirements, feeding livestock with browse, hiring of pasture and establishment of feed reserves to deal with feed deficits during the dry periods (Huho *et al.*, 2011).

Feed deficit caused by low and erratic rainfall is the chief challenge facing livestock production in the arid and semi-arid areas of Kenya (Smith *et al.*, 2003). In these areas many pasturelands are dominated by poor quality forage plant species for most part of the year and up to 60% of the pasturelands remain almost bare (Mnene, 2006). This trend has elicited response from the pastoral communities in form of fodder production through range enclosures for the main purposes of reversing land degradation and providing fodder to their herds, among other benefits (Kigomo and Moturi, 2013; Musimba *et al.*, 2004; RAE, 2004; Kitalyi *et al.*, 2002).

Currently, various stakeholders are promoting fodder production in the drylands of Kenya. In Mandera County, for example, the community has been sensitized on the importance of fodder production and conservation through the Enhanced Livelihoods in the Mandera Triangle (ELMT) project. Fodder groups have been provided with inputs such as grass seed, hay balers, hoes and spades, and trained on fodder production along rivers Juba, Daua and Bisan Adhi. The produced fodder is used to feed farmers' own livestock while the surplus is sold for cash to meet other household needs (VSF-Suisse, 2009). In their study on fodder production and marketing in the same county, Nyangaga *et al.,* (2013) found that Sudan grass (*Sorghum sudanese*) and Nappier grass (*Pennisetum purpureum*) are the grass species planted by the agro-pastoralists along river Daua. The households engaged in fodder production are mostly headed by men who own an average land size of 13 hectares. Family labour is used in production and the fodder farms have the potential to produce an average of 2 tonnes of fresh fodder per hectare. Most of the produced fodder is normally fed to households' herds with the surplus being sold for income. Other actors in the fodder value chain in the county include: the Ministry of Livestock Development, Arid Lands Resource Management Programme (ALRMP), local research stations and International NGOs such as VSF Suisse, Islamic Relief Foundation and Save the Children US. Fodder production in the County is being driven by several factors that include: availability of rivers that provide water for irrigation, high demand for fodder during droughts and a growing fodder market, improved household income from sale of surplus fodder, and the existence of extension services.

In Garissa County, small scale fodder farmers have been provided with grass seeds of Sudan grass (*Sorghum sudanese*) and Boma Rhodes (*Chloris gayana)*, and are trained on fodder production, conservation and marketing courtesy of the Office of the United States Foreign Disaster Assistance (OFDA) and United States Agency for International Development (CARE, 2013a). The

Agricultural Productivity and Climate Change in Arid and Semi-Arid Kenya project has initiated fodder production and storage for use during times of feed shortages in Ijara Sub-County of the same County. The grasses promoted are mainly the African fox tail grass (*Cenchrus ciliaris*) and Sudan grass (*Sorghum sudanese*). There has since been increased uptake of fodder production among target groups, as well the wider pastoral household in the County. The produced grass is largely sold within the community at Kshs. 300 per donkey cart (Kuria *et al.,* 2015).

The Kenya Drylands' Livestock Development Program (KDLDP) operating in Tana River County introduced farmers to irrigated fodder production and later commercial feed production for the market by using locally available materials (CNFA, 2013). This practice is carried out by various groups that grow various grass species such as Boma Rhodes (*Chloris gayana*), Sudan grass (*Sorghum sudanese*) and Napier grass (*Pennisetum purpureum*) using water from Tana River (CNFA, 2012). Communities engaged in fodder production in Makueni County of Kenya grow various grass species that include; African fox-tail grass (*Cenchrus ciliaris*), Horsetail grass (*Equisetum arvense*), Bush rye (*Enteropogon macrostachyus*), Maasai love grass (*Eragrostis superba*) and Rhodes grass (*Chloris gayana*) (Mutua, 2014). Seeds from some of these species have ready market both locally and internationally. Some of the buyers include- African Wildlife Foundation (AWF), World Vision, FAO-Kenya, FAO-Somalia, Care International and Germany Agro Action, which procure the seeds for range rehabilitation and fodder production in Kenya and Somalia.

In Baringo County, fodder production is carried out by individual farmers as well as by groups. They plant mainly the African foxtail grass (*Cenchrus ciliaris*) in enclosures meant to keep off the grazing animals. The enclosures provide fodder banks for the owners' herds during the dry periods; feedlots for fattening livestock for sale; and fodder and grass seed for sale to other farmers for

income (Channer, 2013; Odunga, 2013; KRDP/ASAL DM, 2012; Meyerhoff, 2012). Under the enhanced community resilience to drought through innovative market based systems approaches project in Baringo County, fodder production groups were introduced to fodder production as a business venture (Joosten *et al.,* 2014). Communal pasture development has been embraced by pastoral communities in the same county with promising benefits. Households produce more milk leading to improved nutrition and food security among the households engaging in fodder production. Furthermore, fodder availability throughout the year even during drought periods has lessened conflicts over grazing that were previously rampant (Meyerhoff, 2012).

In an effort to combat land degradation and address their livelihood options, communities and individual farmers in the Baringo basin employ the use of enclosures to restore indigenous vegetation. As a consequence, they are able to earn income from the sales of grass seeds, hay and leasing out dry season grazing (Mureithi *et al.,* 2015). As reported by Kitalyi *et al.,* (2002) and RAE (2004); households that have access to communal enclosures enjoy improved livelihoods as a result of income generating activities that have enabled them to profit from the reclaimed land. In West Pokot County of Kenya, pastoralists practicing fodder production through enclosures benefit through selling cut grass, grass seeds and having contractual grazing arrangements. Access to dry-season grazing reserves, healthier livestock, improved livestock productivity and easier livestock management are among the benefits derived from fodder production using enclosures (Wairore *et al.,* 2015). The use of enclosures for pasture production leads to varied social and economic benefits.

Fodder production and marketing is characterized by both formal and informal sub-sectors in the arid and semi-arid areas of Kenya. The formal sub-sector is dominated by commercial fodder producers while the informal one includes trading amongst farmers in the same region. The large

scale commercial fodder producers specialize in the production of hay mainly from Boma Rhodes (*Chloris gayana*) and Lucerne as well as silage. Some of the farms involved in large scale fodder production include: Delamere, Morendat, and Marula farm in Naivasha County. Demand for these farms' produce outstrips supply particularly for Lucerne, which is produced at a small scale as compared to hay (SNV, 2013).

In the north Rift Valley regions of Kenya, fodder marketing is seasonal and mostly occurs during the dry periods accompanied with seasonal price variations. Local fodder markets are dominated by pastoralists selling surplus fodder and a few non-pastoralists who practice fodder production for income (Nangole *et al.,* 2013). In the southern rangelands of Kenya, pastoralists embrace community based forage seed system with the aim of multiplying grass seed for the improvement of livestock productivity and selling the surplus seed (Kimitei, *et al.,* 2011). However, the inadequate supply of quality seeds of high yielding rangeland grass species is the challenge to the adoption of reseeding technology.

Various challenges are experienced by pastoral communities in fodder production and marketing. In Baringo County, some of these challenges include: lack of hay and grass seed storage facilities, poor fencing systems on fodder farms, recurrent droughts which affect pasture establishment and growth, communal ownership of land (Joosten *et al.,* 2014) and lack of collateral for application of loans from lending institutions (KRDP/ASAL DM, 2012). In Mandera County, fodder farmers experience challenges in sourcing pasture seeds and seed banking facilities (VSF-Suisse, 2012). As reported by Manyeki *et al.,* (2015), the constraints in the southern rangelands of Kenya include high production costs arising from land preparation, grass seed purchases, weed management, and seed and hay harvesting. In north Rift Valley region of Kenya, Nangole *et al.,* (2013) reported constraints along the fodder value chain to include: poor seed quality, high input costs, and lack

of working capital, fodder price fluctuations, lack of markets, and lack of seed and fodder storage facilities. In Makueni County, recurrent drought, poor fencing on fodder farms and destructive termites that destroy dry standing pasture in fields are some of the challenges encountered by fodder farmers (Mutua, 2014). In Wajir County, the main challenge is that there is no formal fodder market and trading normally occur through informal channels. For those practicing irrigated pasture production high fuel costs associated with pumping water are incurred (Miano and Joosten, 2014).

2.2 Contribution of fodder production to household income in the drylands of Kenya

A project supported by CARE International has shown that fodder production has the potential of changing the lives of many pastoral communities (CARE, 2013b). CARE International is supporting groups of farmers in Garissa County through funding from the Office of United States Foreign Disaster Assistance (OFDA). CARE (2013b) has reported benefits arising from fodder production using an example from a group which was supplied with 25 kg of Sudan grass seeds (*Sorghum Sudanese*) and 5 kg of Boma Rhodes (*Chloris gayana*) and trained in fodder production. The group is reported to have earned Kshs. 25,000 from sale of grass seeds. The produced fodder was mainly fed to the group members' own herds, and the report shows that through fodder production, member households saved up to Kshs 1,400 per week, which could have been incurred in buying animal feeds.

In Baringo, Laikipia, Marsabit and other drylands in Kenya, 10 tonnes of indigenous perennial grass seeds are distributed and seeded annually. Pastoral groups are reported to generate income of about Kshs. 1.5 million per annum and some pastoral communities engaged in group fodder production take loans worth over Kshs. 750,000 using privately rehabilitated fields as collateral

(Meyerhoff, 2012). By processing commercial animal feeds from produced fodder, groups of farmers engaged in irrigated fodder production along river Tana have been able to increase their member households' income to Kshs. 200 per day (USAID, 2012).

Some of the benefits that households derive from fodder production in Baringo and West Pokot Counties include: income from the sale of grass seeds, hay and leasing out grazing. Other benefits derived from the enclosures include provision of grass for thatching, dry-season grazing reserves, healthier livestock and improved livestock productivity (Mureithi *et al.,* 2015; Wairore *et al.,* 2015).

In 2013, the "enhanced community resilience to drought through innovative market based systems approaches" project, supported Muungano Makaror farming group in Wajir County has expanded their fodder production from half an acre to six acres. The group earned Kshs. 17,500 from sale of some of the hay they produced (Miano and Joosten, 2014). Under the same project, Maiyani fodder group produced 190kgs and earned about Kshs. 30,000 from sale of 100 kgs of grass seeds.

2.3 Factors that influence households' participation in groups

Collective action brings together individuals who have common aspirations and problems. These individuals are often unable to realize certain goals effectively on their own and thus pool their labour and other resources so as to carry out profitable ventures (Ravnborg *et al.,* 2000). Formation of groups leads to building of social capital which may lead to positive impacts on human welfare, particularly as a result of income generation among the poor households (Grootaert, 2001). Groups coordinate and facilitate inter-organizational interactions and knowledge and information flows which allow the exploitation of complementary capabilities and open up opportunities for exploitation of concerted effort within networks (Howells and Edler, 2011).

When groups are formed, in effect a system is created and the capacity of such a system as indicated by Altenburg *et al.,* (2008) depends on the density and quality of relationship between the actors. Diversity amongst the actors shows an opportunity of combining complementary capabilities. Moreover, interaction and learning depends also on actors' proximity which includes the physical distance, the institutional environment shaping trust-based relationships, and actors' capacity to absorb new ideas (Clifton *et al.,* 2010).

In the arid and semi-arid areas of Kenya various fodder production groups have been formed (Miano and Joosten, 2014; Joosten *et al.,* 2014; Meyerhoff, 2012; CNFA, 2012; KRDP/ASAL DM, 2012) and several studies on factors influencing membership to development groups and societies have been carried out. A study conducted by Olila (2014) in Trans-Nzoia County of Kenya found that gender of the household head, households' income and their access to credit were the main factors that influenced participation in development groups. Elsewhere, Woldu *et al.,* (2013) studied the determinants of women membership in agricultural cooperatives in Ethiopia and reported that membership to cooperatives was determined by the gender and age of the household head, household size, the official position of an individual in the society and whether an individual's relative held position in a cooperative society. Adong *et al.,* (2013) studied factors affecting membership to farmer groups in Uganda, and found that the factors influencing participation in farmer groups were the level of education attained by an individual, distance to extension service and the quality of road infrastructure. In a study on the factors influencing membership in coffee cooperatives in Huye district of Rwanda, Mugabekazi (2014) reported age, household size, distance to washing station, experience of a farmer in growing coffee, access to credit and the quantity of coffee produced by a farmer to be the factors that influenced participation of farmers in coffee cooperatives.

CHAPTER THREE

METHODOLOGY

3.1 STUDY AREA

3.1.1 Location and geo-physical characteristics

Baringo County is located in the Northern part of the former Rift Valley Province of Kenya. The county borders Turkana to the North and North East, Samburu and Laikipia to the East, Nakuru to the South, Kericho and Uasin Gishu to the South West, Elgeyo Marakwet to the West, and West Pokot to the North West. The county is divided into six administrative units; East Pokot, Marigat, Baringo North, Baringo Central, Koibatek and Mogotio (RoK, 2012c). The exact study site was in Marigat Sub-County which falls in the Njemp Flats covering agro-climatic zones IV and V. Njemp Flats is located between latitude 00° 30'N and longitude 36° 00' E. The area is classified as Lower Midland (LM) Livestock-Millet Zone, which is best suited for livestock production (RoK, 2002; Herlocker *et al.*, 1994). This area covers the lowlands between Tugen Hills and the eastern Laikipia highlands that stretch northwards from Lake Bogoria to Kapedo. The study area map is shown in Figure 3.1.

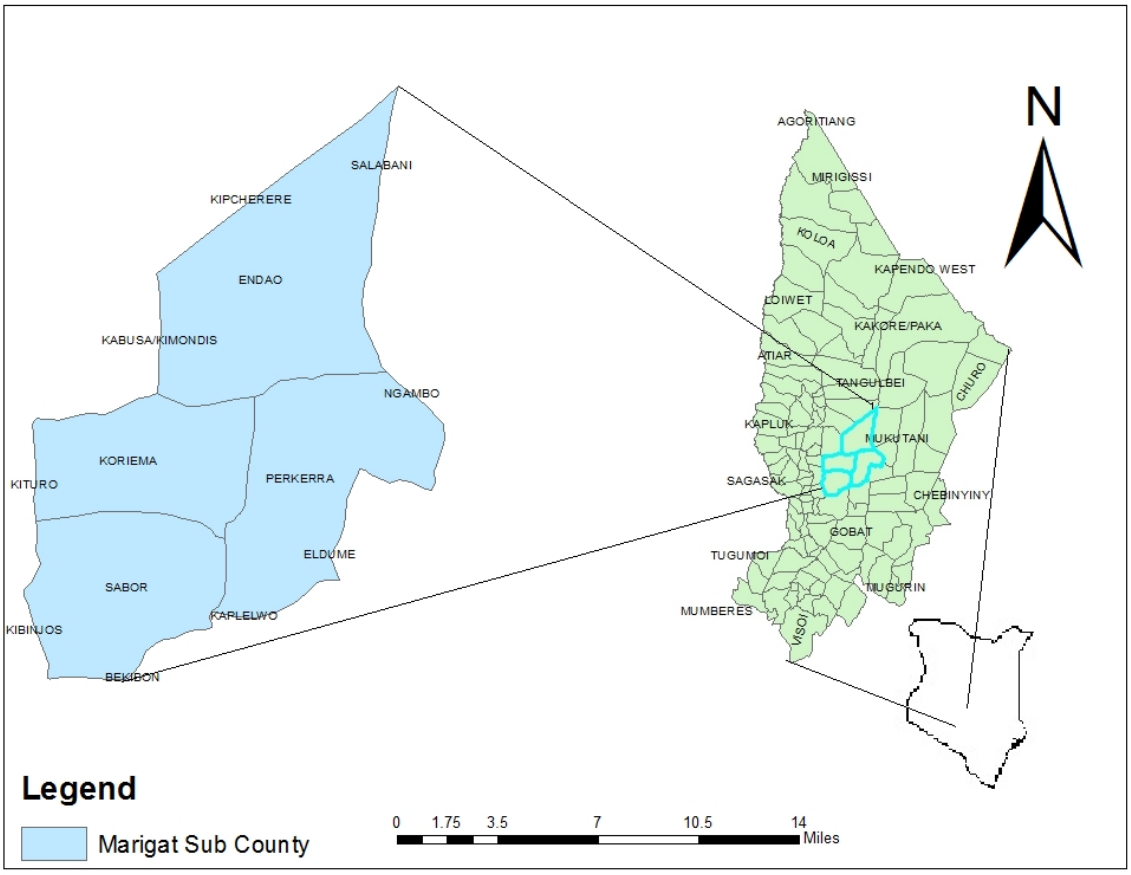

Figure 3. 1: The study area (Marigat Sub-County)

3.1.2 Climate

The study area has an altitude which ranges between 900 and 1200 metres above sea level and the climate is semi-arid (Owen *et al.,* 2004). The average minimum and maximum temperatures are 20°C and 30° C respectively and the area has two rainy seasons with an annual rainfall mean of 635 mm (Kassilly, 2002). The general annual rainfall variations in the Njemp Flats, follows the passage of the Inter-tropical Convergence Zone (ITCZ) and the changes in wind directions, which are accompanied by dramatic shifts in precipitation regimes between very dry and very rainy. The area has two rainy seasons with an annual mean of 635 mm (Kassilly, 2002). The area exhibits

bimodal rainfall pattern with the long rains occurring in March-June and the "short rains" in October-November. However, the local patterns are more complex because of the influence of the north-south trending mountain ranges and the Rift Valley (Davies *et al.,* 1995). Droughts are common in the area notably in 1996, 1973-1974, 1984-1985, 1992-1994, and 199-2000 (Johansson and Svensson, 2002).

3.1.3 Vegetation

The vegetation main vegetation types are *Acacia* woodland (80%), permanent swamp and seasonally flooded grassland (15%), and shrub grassland (5%) while ephemerals dominate the understorey and more so in the open and bare areas (Verdoodt *et al.,* 2010). The dominant land use is extensive livestock production complimented by crop farming around water sources and in the irrigation schemes managed by the National Irrigation Board. Due to land degradation, herbaceous vegetation especially grasses, are almost non-existent, except within the numerous enclosures which have been established to rehabilitate the degraded rangeland. In the early 1980s, the Fuelwood Afforestation Extension Project introduced *Prosopis juliflora* in the study area (Marangu *et al.,* 2008; Lenachuru, 2003). The invasive species has since spread to other parts of the area and is mainly problem in Marigat and Ng'ambo where it has formed dense thickets thereby inhibiting undergrowth. The invasion of *Prosopis juliflora,* however, seems higher in areas where no previous vegetation existed and in areas with high water table.

3.1.4 Soils

According to a reconnaissance soil survey conducted by the Government of Kenya in collaboration with the United States Department of Agriculture Soil Conservation Section (USDA-SCS) in 1978, the dominant soils in the Njemp Flats are well drained, silt loam to clay loam, Eutric and Calcaric

Fluvisols. They are developed on alluvium from various Tertiary and Quaternary volcanic rocks and on sediments from basic igneous rocks (FAO, 2006a, and b).

3.1.5 The people

Baringo County has a population of 555,561, with Marigat Sub-County having 73, 177 people (RoK, 2010). The semi-arid lowlands of Baringo County are inhabited by three principal ethnic groups namely: the Tugen (53%), Pokot (35%) and Njemps or Il Chamus (12%) (Sutherland *et al.,* 1991). The Tugen who live to the west of Lake Baringo are agro-pastoralists who cultivate crops and keep herds of cattle, sheep and goats. The Il Chamus are sedentary agro-pastoralists but were originally hunters and gatherers and they live to the southeast and southwest around Lake Baringo (De Groot *et al.,* 1992). The Pokot who like the Tugen belong to the Kalenjin ethnic group occupy the flatter region to the north and north east of the lake. They are nomadic to semi-nomadic pastoralists, herding large herds of cattle, sheep, goats and camels (Meyerhoff, 1991). Land is communally held under common property regime in the Njemps Flats. However, land privatization has been going on around some trading centres occupied by the agro-pastoral communities.

3.1.6 Livelihoods activities in the study area

The primary economic activity in the county is livestock keeping which contributes to the cash needs of the pastoralists and provides employment to 90% of the population (RoK, 2012c). Crop farming, mixed farming and sand harvesting are other economic activities in the County. According to the Republic of Kenya (2012c) the poverty level of Baringo County is estimated at 58.5% and is reported to be more pronounced in the rural areas especially the lower zones where income-earning activities are not diversified and 35% of the population are considered poor. The Republic of Kenya (2005) under the Baringo District Development Plan attributes poverty in the

area to inadequate infrastructure, low agricultural productivity, illiteracy, large family size and poor marketing systems. Most of the labour force in the county is unskilled and semi-skilled and the income is basically derived from the sales of livestock and agricultural products. Wage earnings are mainly from the formal sector such employment in the civil service and have been increasing over the years (RoK, 2005).

3.2 RESEARCH DESIGN

Non-probability sampling method that entailed the combination of snowballing and purposive sampling techniques was used in this study. Mugenda and Mugenda (1999) describes purposive sampling as a form of sampling where the researcher relies on his or her expert judgement to select units that are representative of the population. Five fodder production groups under the 'Enhanced Community Resilience to Drought through Innovative Market based Systems Approaches' project were purposively selected for this study. All members of the five fodder production groups were interviewed and a sample size of 78 was attained.

Under snowball sampling technique, initial subjects with desired characteristics are identified using purposeful sampling technique (Mugenda and Mugenda, 1999). The few identified subjects then name others they know who have the required characteristics until the researcher gets the number of cases required. This method is suitable when the population that possesses the characteristics under study is not well known and there is need to find subjects.

In snowball sampling, the exact selection probabilities are unknown for the samples and there exists no sampling frame but the subjects are connected by social relations (Shafie, 2010). Following Shafie (2010), let U be the total population of Marigat Sub-County with an unknown number of fodder producers N. Each fodder producer is characterized by y_i (attribute of being an

individual fodder producer) which is unknown but observable if a fodder producer *i* is sampled. An initial sample S_0 (five individual fodder producers) was questioned about y_i and asked to give names and addresses of other members of the population whom they know of. $Z_{ij} = 1$ if person *i* mentions person *j*. An assumption was made that the relation is symmetric, that is, $Z_{ij} = Z_{ji}$ implying that if person *i* mentions person *j*, then person *j* will also mention person *i*. The usual procedure was to stop sampling after a sample of sufficient size was reached. Therefore, interviews were conducted until a sample size of 47 individual fodder producers who did not belong to any fodder production group in Marigat Sub-County was attained. At the end, a semi-structured questionnaire was used to conduct a total of 125 individual interviews with the heads of the households practicing fodder production.

CHAPTER FOUR

ANALYSIS OF GRASS SEED VALUE CHAIN IN THE DRYLANDS OF BARINGO COUNTY, KENYA

ABSTRACT

Fodder production in the drylands is considered a pathway to pastoral household resilience in the face of climate variability and change. Understanding the grass seed value chain is a prerequisite for developing sustainable fodder production and guiding appropriate out-scaling in the drylands. This study mapped the grass seed value chain in Marigat Sub-County of Baringo County with the aim of characterizing the chain dynamics and documenting the challenges experienced. The results show that the fodder production groups marketed their seeds individually, and the dominant actors were the bulking and processing agents who provided inputs and were a source of grass seed market to the producers. Drought occurrence, inability of existing outlets to purchase grass seed at times and low prices offered to producers' grass seed were found to be among the challenges facing the producers. There is need to strengthen the fodder groups with a possibility of registering them as cooperatives for the purpose of collective bargain for better grass seed prices.

Key words: Fodder production, pastoral resilience, climate variability.

4.1 INTRODUCTION

Pastoral communities in Kenya are increasingly embracing fodder production as a way of enhancing their resilience against frequent droughts that negatively impact pastoral livelihoods. Most of the fodder production in the drylands has been reported in Turkana and Baringo Counties where enclosures have been used not only for fodder production but also as a means of

rehabilitating degraded areas through control of grazing (Musimba *et al.*, 2004; Kigomo and Muturi, 2013).

In the Lake Baringo Basin, pastoralists are using enclosures to rehabilitate the degraded land as well as to produce forage to meet livestock deficits during the dry seasons and droughts (RAE, 2004). It has been reported that such enclosures, where successful, ensure that pastoralists can provide for their own households and livestock, leading to independence from food aid (Makokha *et al.,* 1999). To counter the effects of land degradation in the same region, communities employ the use of enclosures to restore indigenous vegetation. In effect, the communities are able to get an income from the sale of grass seeds, hay and leasing out dry season grazing. Provision of grasses for thatching and livestock feed are among other benefits (Mureithi *et al.,* 2015). In West Pokot County of Kenya, pastoralists practicing fodder production through enclosures benefit through selling cut grass, grass seeds and having contractual grazing arrangements. Access to dry-season grazing reserves, healthier livestock, improved livestock productivity and easier livestock management are other benefits derived from fodder production (Wairore *et al.,* 2015).

The growing popularity of fodder production offers a possible pathway for adaptation to the increasing climate variability. However, for the purpose of developing sustainable value chain and out-scaling the practice, information on the performance, as well as understanding of the entire value chain is imperative. The purpose of this study was therefore to map the grass seed value chain in Baringo County in order to characterize the chain dynamics and to document the challenges encountered along the chain. This is expected to provide empirical evidence to guide development and out-scaling of the practice in other pastoral areas.

4.2 DATA COLLECTION AND ANALYSIS

Individual interviews were conducted as described in chapter three of this thesis. In addition, five focus group discussions of 8-12 participants comprising men and women were held with five fodder production groups. The interviews and focus group discussions were used to identify the sources of inputs, amount of grass seeds produced and sold and the available grass seed markets as well as the challenges encountered in the value chain. Key informant staff of – Kerio Valley Development Authority, Rehabilitation of Arid Environments Trust, Kenya Agricultural and Livestock Research Organization, World Vision Marigat Area Development Programme, and the Sub-County Livestock Production Office were interviewed as well as the independent grass seed traders. The key informant interviews were conducted so as to have in-depth understanding of the functions and activities of the various actors. The collected information was used to map the grass seed value chain in the study area.

Mapping is usually the first step in value chain analysis. A value chain map shows the actors involved in the chain, the relationships that exist among the identified actors and the economic activities that take place at each stage of the chain. In addition, it reveals the physical movement of the commodity and the changes in prices along the chain (Faße *et al.,* 2009). Mapping of a particular chain represents the functional and institutional analysis which is one of the approaches of mapping a value chain. In this process a preliminary map is constructed where the actors and the functions they perform in the chain represent institutional analysis and their interactions with one another represents the functional analysis. This preliminary map, which consists of agents and their main functions at each stage as well as the main products in the value chain can be presented in a flow chart or table (FAO, 2005 as cited in Faße *et al.,* 2009). Using the generated information

the grass seed value chain of the study area was developed that comprise five stages: input/service source, production, processing, marketing and consumption.

The quantitative data was analyzed using the Statistical Package for the Social Sciences (SPSS) to generate descriptive statistics such as percentages, frequencies, averages and standard deviations. Data from key informant interviews was synthesized and used to complement the information from individual interviews.

4.3 RESULTS AND DISCUSSIONS

4.3.1 Characteristics of sampled households

Table 4.1 shows that members of the fodder production groups were mainly younger, had lower monthly incomes, operated on a larger land scale and had smaller household herd sizes than the individual fodder producers. The majority of those interviewed were male, most of whom had primary level education and practiced livestock keeping as their main occupation. The average household size of eight persons reported in this study was more than the county's average of 5.02 persons (KIRA, 2014). Since labour for fodder production is mainly provided by the producers family, household size is critical in determining the level of production implying that all else held constant, larger households are likely to produce more compared to smaller ones. Elhadi (2014) noted that when considered together with other factors, household size determines the level of assets and food security and thus influences the ability of a household to cope with hazards in the drylands.

The majority of the households interviewed were male-headed. Men are primarily the key decision makers and owners of essential resources necessary for the pursuance of economic activities such as fodder production. Wasonga (2009) noted that female-headed households may be disadvantaged

when it comes to access to natural resources and important decisions necessary for undertaking of sustainable livelihoods

Table 4. 1: Social and demographic characteristics of sampled fodder producers

		Individual fodder producers (N=47)		Group fodder producers (N=78)	
Variable		Mean	Standard deviation	Mean	Standard deviation
Age of household head (years)		47	12	40	12
Household size (Persons)		8	3	8	5
Number of school-going children		3	2	3	2
Total monthly income (Kshs)		23,815	20,706	17,169	18,491
Land size under fodder production (acres)		5.3	4.7	9.6	3.5
Herd size of a household (TLUs)		24.7	26.8	10.7	14.4
Variable		Frequency	Percent	Frequency	Percent
Gender of household head	Male	44	93.6	74	94.9
	Female	3	6.4	4	5.1
Household head education level	None	8	17	10	12.8
	Primary	19	40.4	44	56.4
	Secondary	13	27.7	16	20.5
	Post-secondary	7	14.9	8	10.3
Main source of livelihood	Livestock keeping	16	34	41	52.6
	Crop cultivation	8	17	9	11.5
	Business	5	10.6	12	15.4
	Formal employment	18	38.3	16	20.5

The education level of the fodder producers is a reflection of Baringo County's education status where only 16% have secondary level education with majority (48%) having attained only primary education while the rest (36%) have no formal education (KIRA, 2014). As indicated by Wasonga

(2009), education provides opportunity for diversification of livelihood portfolios for pastoral households through employment as a source of wage and remittances. Since most of the fodder producers had attained primary level education, fodder production was an opportunity for livelihood diversification as most of the formal employment opportunities require high academic qualifications. This partly explains the low level of employment reported among the sampled population. Livestock keeping was the dominant source of livelihood for the majority of the fodder producer groups' members. The livestock species reared comprised cattle, sheep and goats but the respondents acknowledged that the number of cattle in their herds had decreased over time. This results concurs with Western (2002) who reported that sheep and goat numbers were increasing relative to cattle in many of the pastoral areas. Communities indulge in fodder production so as to attain pasture security for their herds. The fodder producers had multiple livelihood sources and as Barrett *et al.,* (2001) reported, pastoralists are increasingly diversifying their economic activities into agriculture, businesses and wage labour. In the study area, fodder production is a livelihood diversification option.

4.3.2 Functional analysis of the grass seed value chain actors

Figure 4.1 presents the grass seed value chain map showing the main stages that include production, processing, marketing and consumption. The map also shows the actors in the chain and their roles, and the resultant output at various nodes of the chain. The first stage comprise the input providers which include fodder farmers who provide own labour on their farms; ploughing services providers that comprised Kerio Valley Development Authority (KVDA) and, Rehabilitation of Arid Environments (RAE) Trust and famers who provide grass seed and ploughing services as well.

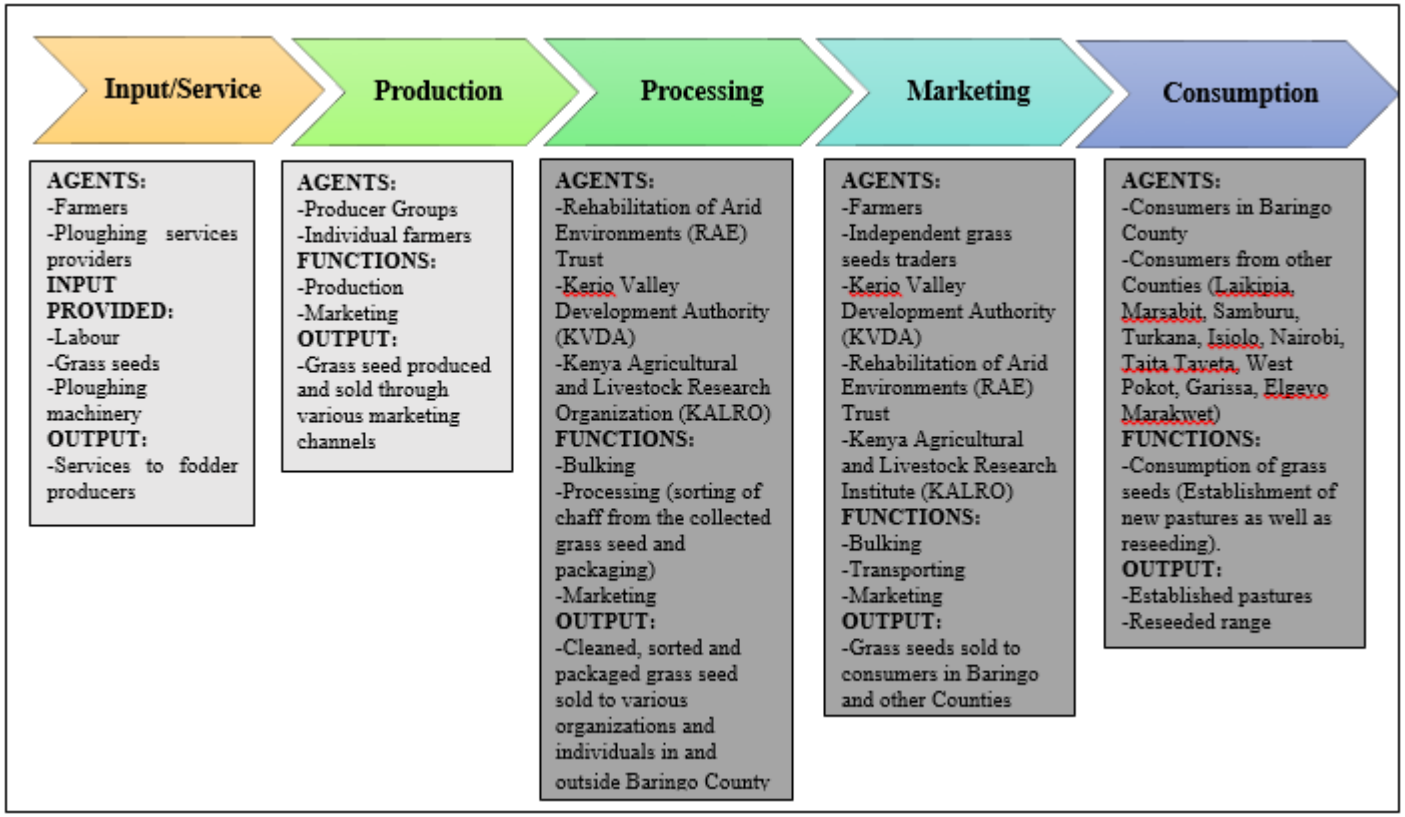

Figure 4. 1: Grass seed value chain map for Marigat Sub-County

At the second stage, there are group and individual fodder farmers who, produce and sell grass seed to various agents along the chain. Other actors involved in grass seed production included KVDA, RAE Trust and Kenya Agricultural and Livestock Research Organization (KALRO). The grass seed production activities of these organizations not only serve as demonstrations to the local community but also include sale of the produced grass seed for income. The agents involved in processing were found to be RAE Trust, KVDA and KALRO which bulk, process and market the grass seeds. The actors involved in marketing included farmers who sell their produce to other farmers, KVDA, RAE Trust and KALRO. In addition there are independent grass seed traders who buy the grass seed from the producers and sell to farmers and various non-governmental organizations. KVDA, KALRO and RAE Trust sell the grass seed to fodder farmers and various organizations in Baringo and other Counties such as Laikipia, West Pokot and Turkana. The consumers were found to be mainly the residents of Baringo and other Counties who buy grass seed for planting which entails the establishment of new pastures and reseeding that involves the establishment of pastures in fields previously with pastures.

4.3.3 Input supply for fodder production

Figure 4.2 shows that majority (55.3%) of the individual fodder producers bought their seeds from Rehabilitation of Arid Environments (RAE) Trust and obtained ploughing services from the same source. Three of the five groups whose farms were close to KVDA station obtained their seeds and ploughing services from KVDA through grass seed and ploughing services subsidies provided by the Netherlands Development Organization (SNV). Both RAE Trust and KVDA offered ploughing services to fodder producers on contractual terms. This finding is inconsistent with the findings of Nangole *et al.,* (2013) who reported that agrovets (shops selling agricultural inputs) and general retail shops are the only input suppliers in the existing fodder value chain in the Rift Valley region.

The main sources of inputs were found to be government departments, non-governmental organizations and the fodder farmers.

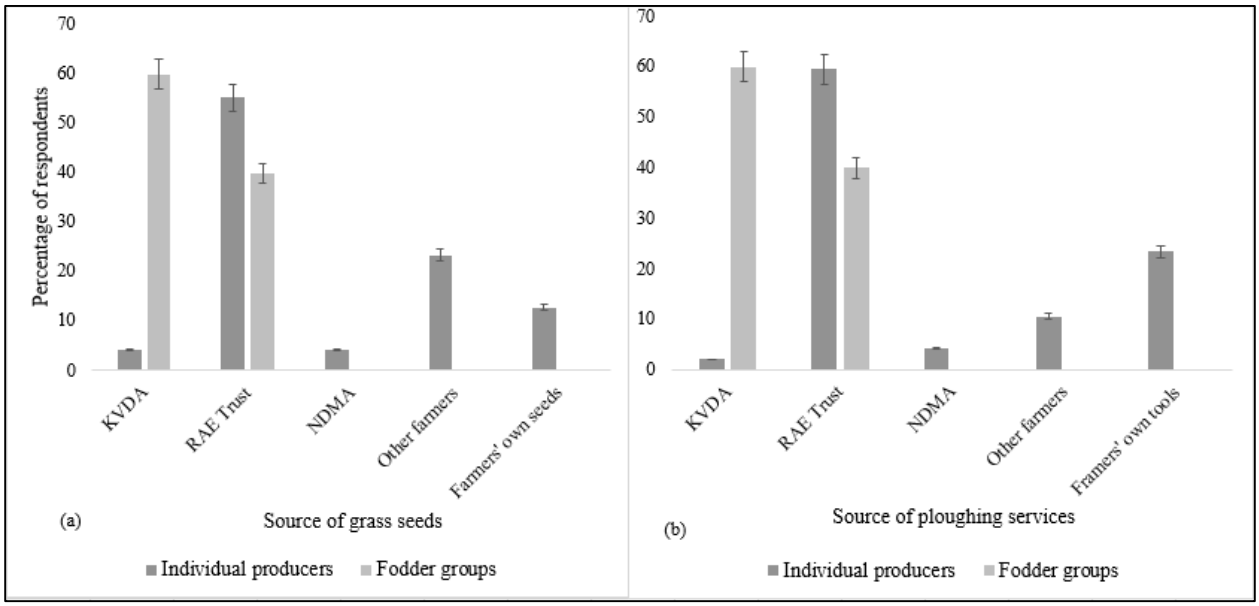

Figure 4. 2: Sources of inputs for fodder producers

The KVDA and RAE Trust are the two major organizations in the study area that offered ploughing services to the fodder producers. Kerio Valley Development Authority provided ploughing services to farmers based on agreement that the producers buy grass seed from them. They ploughed, contoured and harrowed the producers' farms at Kshs. 2,500 to 3,000 per acre depending on the distance of the farm from their station. Likewise, the Rehabilitation of Arid Environments Trust ploughed for the farmers on an agreement that, the farmer must sell the seeds back to them. RAE Trust provided ploughing services per acre for Kshs. 2,500 to 5,500 depending on the distance to the farm. The other farmers who provided ploughing services to fellow farmers charged Kshs. 1,000 to 2,500 per acre. The fodder producers in the study area preferred KVDA's mode of contract since it allows them to sell their harvested grass seed to markets of their choice. Although contracts compelled the farmers to sell the seeds back to the RAE Trust, they preferred to sell to

other markets, which offered better prices than RAE Trust. The KVDA bought the grass seed from producers at an average price of Kshs. 250 per kg, KALRO bought at an average price of Kshs. 250, independent grass seed traders an average price of Kshs. 275, RAE Trust bought a kg from the farmers at an average price of Kshs. 150 and other fodder producers bought a kilogram of grass seed from the producers at an average price of Kshs. 175.

4.3.4 Fodder production and processing in the study area

The only grass species that had been planted by all the fodder producers was *Cenchrus ciliaris*. This was attributed to easy establishment, drought tolerance, and ability to propagate itself and produce viable seeds which can be easily harvested (Herlocker, 1999; Mnene, 2006). The species is considered the best among local grass species in Makueni County and has been found to be highly adaptive to the ASAL climate, has high demand, and when fed to livestock it leads to high milk production in livestock (Machogu, 2013; Mutua, 2014).

The average farm size under fodder production in the study area varied between the fodder production groups and the individual producers. Farm sizes among the fodder groups ranged from a minimum of five acres to a maximum of sixteen acres while that of individual farmers ranged between half an acre and seventeen acres. The main fodder production practices in the study area included broadcasting as the main method of sowing grass. The farmers never irrigated nor did they apply fertilizer on the pastures. Weeding was done at four to six weeks after planting. The grass seeds were harvested using the stripping method when the seeds' colour changed from green to light brown. This method of harvesting is common among fodder farmers in the semi-arid rangelands of Kenya (Mnene, 2006). Individual fodder producers used both family and hired labour in their production, while the groups collectively provided labour and only hired labour

when the amount of work was overwhelming and needed to be accomplished quickly. Hired labour was mainly used in weed control and grass seed harvesting and cost Kshs. 100 per day per individual, while the wage for harvesting grass seed ranged between Kshs. 50 and Kshs. 150 per day.

In the wet season of September to December 2013, a total of 7.42 tonnes of grass seeds were produced by the interviewed groups and households and only 4.65 tonnes were sold. Only a total of 140 bales of hay was produced by the interviewed individual farmers, which formed only 4.26% of the producers. Three organizations, RAE Trust, KVDA and KALRO, were involved in the processing of grass seeds in the study area. Their functions entailed collection of grass seeds from the producers, sorting of the collected seeds from chaff and packaging the seeds for sale.

4.3.5 Marketing of hay and grass seed in the study area

A total of 140 bales of hay were sold to other fodder farmers within the sub-county at a price of Kshs. 150 per bale. Marketing channels for grass seeds are presented in Figure 4.3. The fodder producers sold to other farmers at a maximum price of Kshs. 200 per kilogram, this is a lower price than the maximum price of Kshs. 350 per kilogram offered when they sold to the independent seed traders, and processing and bulking agents. The fodder producers sold to other farmers at that price due to the social ties and kinship they have amongst themselves. The price received from processing and bulking agents as well as independent seed merchants was higher since the fodder producers expected these agents to further market the grass seeds. However, the prices in the study area are lower as compared to those in Makueni County where a kilogram of grass seed fetch Kshs. 1,000 while seeds of rare grasses species such as bush rye fetch as much as Kshs. 1,800 per kilogram (Mutua, 2014).

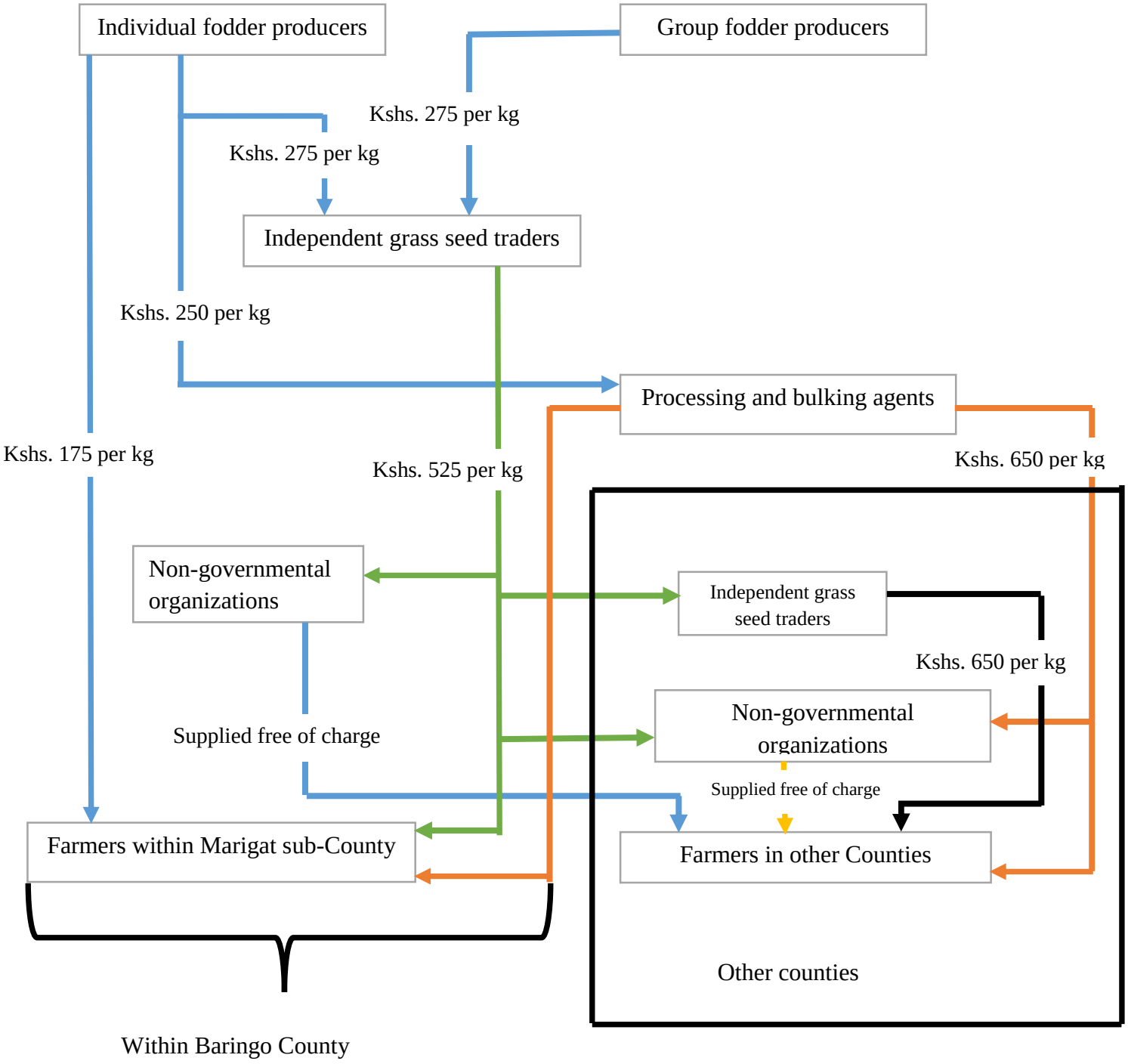

Figure 4. 3: Grass seed marketing channels and prevailing prices at various nodes

The first channel comprised producers selling to other farmers at a price of Kshs. 175/kg. Channel 2 comprised producers, independent grass seed traders and farmers within Baringo County. The independent grass seed traders bulked seeds bought from the producers at an average price of Kshs. 275/kg and in turn sold to farmers within the County at an average price of Kshs. 525 per kilogram. The third channel comprises producers, independent grass seed traders and non-governmental organizations within Baringo County. The independent traders bought the grass seed from producers at an average price of Kshs. 275 per kilogram and sold to NGOs such as World Vision at an average price of Kshs. 525 per kilogram. The NGOs in turn distributed the grass seed free of charge to farmers in the neighbouring Counties such as West Pokot.

The fourth channel was composed of producers who sold grass seed at an average price of Kshs. 275 per kilogram, independent grass seed traders within Marigat Sub-County who sold at an average price of Kshs. 525 per kilogram; and independent grass seed traders outside the County who sold the grass seed to farmers at an average price of Kshs. 650 per kilogram. Channel five included producers, independent seed traders and non-governmental organizations within the Sub-County who supplied the seeds to farmers outside the County. The sixth channel comprised producers who sold one kilogram of grass seed at an average price of Kshs. 225, processing and bulking agents and farmers in the County. Channel seven was composed of producers, bulking and processing agents who sold a kilogram of grass seed to farmers outside the County at an average price of Kshs. 650. The eighth channel included producers, processing and bulking agents who sold one kilogram of seed at an average price of Kshs. 625 to the NGOs outside the County who in turn distributed the grass seeds to farmers free of charge.

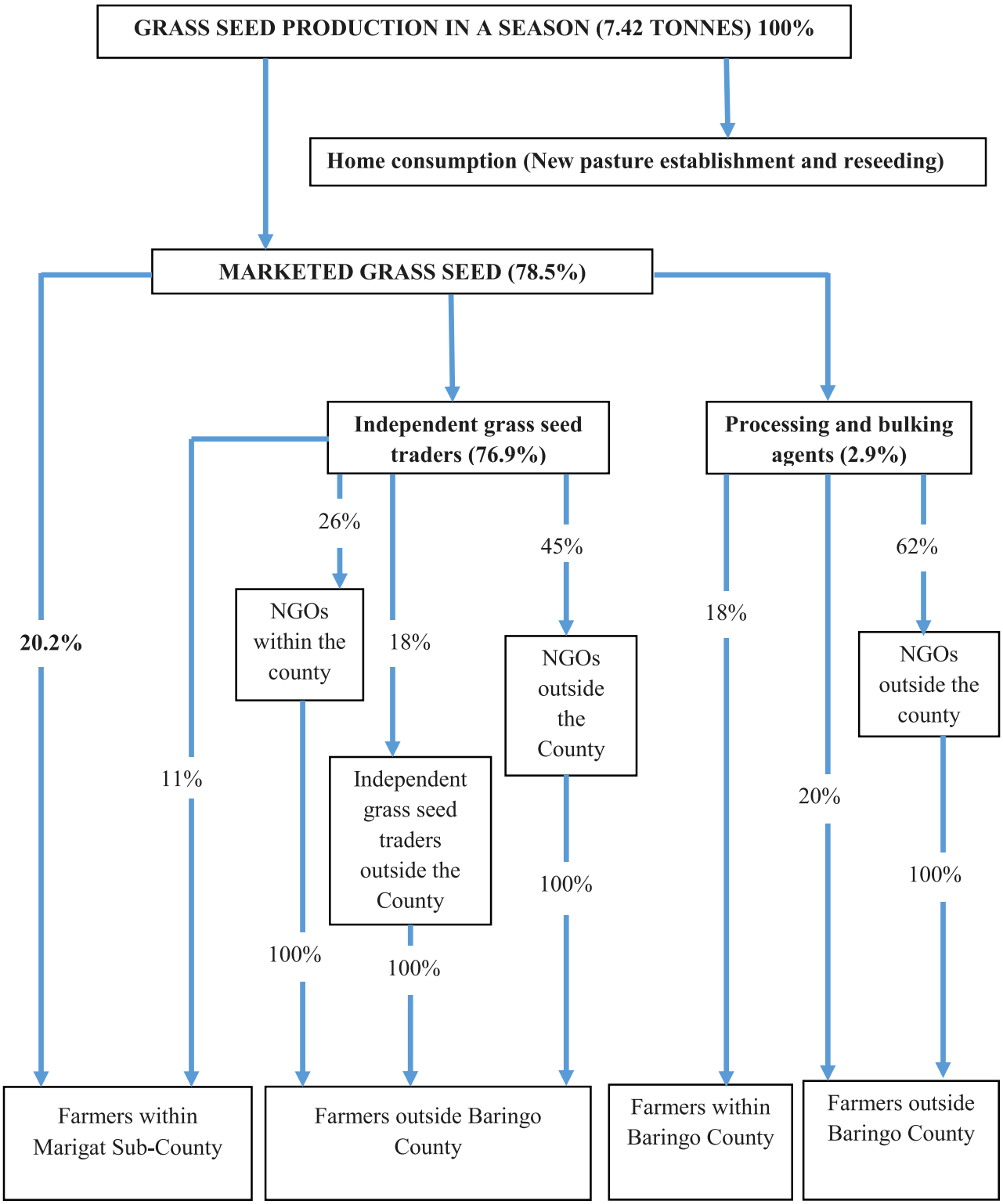

Figure 4. 4: Grass seed marketing channels showing volumes traded in the study area

Volumes of grass seed handled in the various marketing channels are shown in Figure 4.4. About 20.2% (940kg) of the marketed seeds were bought by other farmers directly from the producers' farms. Channels 2, 3, 4, and 5, which entailed the producers selling their seed to independent grass traders at the first point of sale, handled most of the grass seed produced in that season as compared to the quantities handled by channels 6, 7 and 8 in which the processing and bulking agents were the first point of sale. The producers mentioned the low prices for the produced grass seed and at times the unwillingness of the processing and bulking agents to buy from them as some of the reasons why they preferred to sell to the independent grass seed traders. Furthermore, only 8.1 % of the fodder producers interviewed honoured their contract to sell their produce to RAE Trust. The other contracted producers preferred to sell their grass seeds to other available outlets such as KVDA and independent grass seed traders, who offered better prices than RAE Trust and gave room for price negotiations.

4.3.6 Supporting services to the fodder producers in the grass seed value chain

Extension services provided by non-governmental organizations (NGOs) and government institutions include information dissemination and training in new technology. Individuals who receive such training are able to plan their activities accordingly, consequently making appropriate and timely decisions thus reducing uncertainties and risks associated with production (Elhadi *et al.,* 2012). In this regard, only 64% of the fodder producers interviewed had received training on fodder production practices. As shown in Figure 4.5(a), most of the producers (51.6%) received training from the Ministry of Livestock, while 25% were trained by the RAE Trust, 12.5% by KVDA, 9.4% by KALRO, and 1.6% FAO.

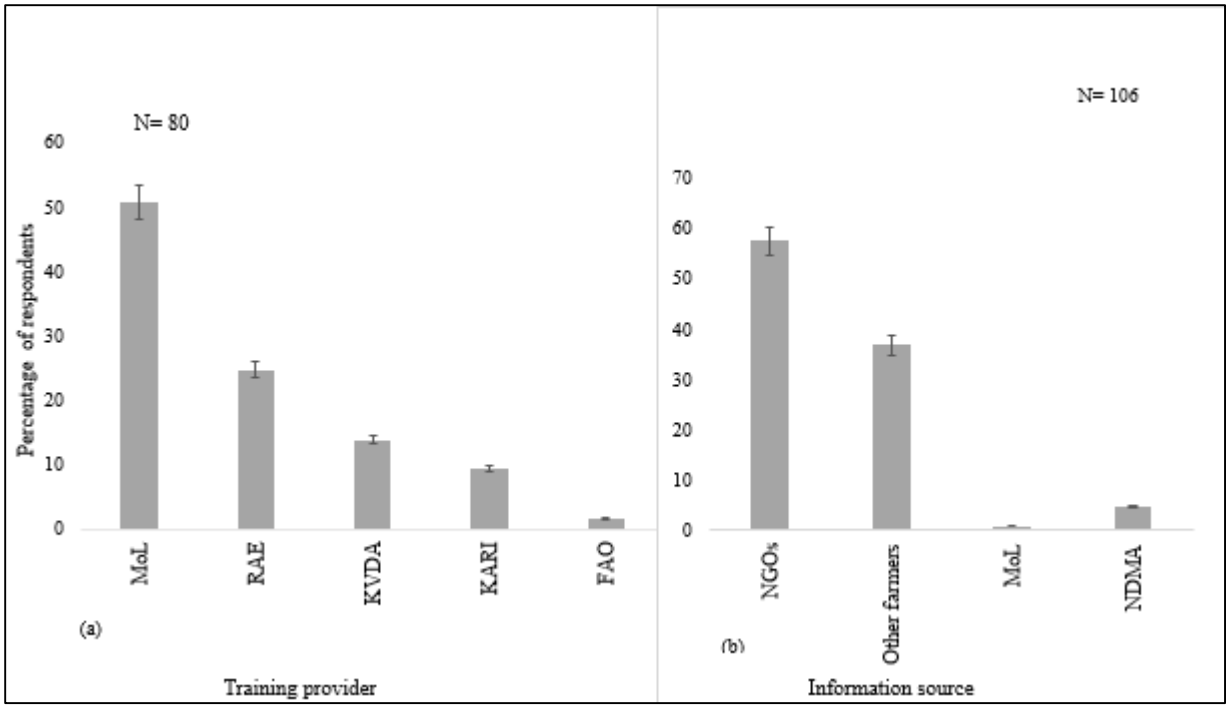

Figure 4. 5: Training and information providers to fodder farmers in Marigat Sub-County

Figure 4.5(b) shows that majority of the fodder producers had access to information on fodder production. Majority (57.5%) of them received the information from non-governmental organizations, 36.8% from other fodder producers, and 0.9% from the Ministry of Livestock (MoL). Extension workers were the main information delivery channel to 60.4% of the fodder producers, while 38.7% of the producers received information through fellow producers. The KVDA, RAE Trust and the Sub-County livestock production office all have extension workers who visit fodder producers in the study area. This explains the dominance of extension workers as the information delivery channel.

As shown in Figure 4.6, currently there is little interest in accessing credit for fodder production by the producers in the study area. Access to such facilities would however enable them to invest in irrigation practices thereby sustaining their grass seed production during drought periods.

Majority of the fodder producers did not make any effort to seek for financial credit to enhance their fodder production activities due to lack of collateral. However, as reported in the Baringo County Integrated Development Plan of 2013-2017, the county has limited access to financial credit services (RoK, 2012c). Whereas various financial institutions such as Kenya Commercial Bank and BORESHA SACCO exist in Marigat Sub-county, most of the pastoralists lack collateral to secure such services due to the communal ownership of land (KRDP/ASAL DM, 2012).

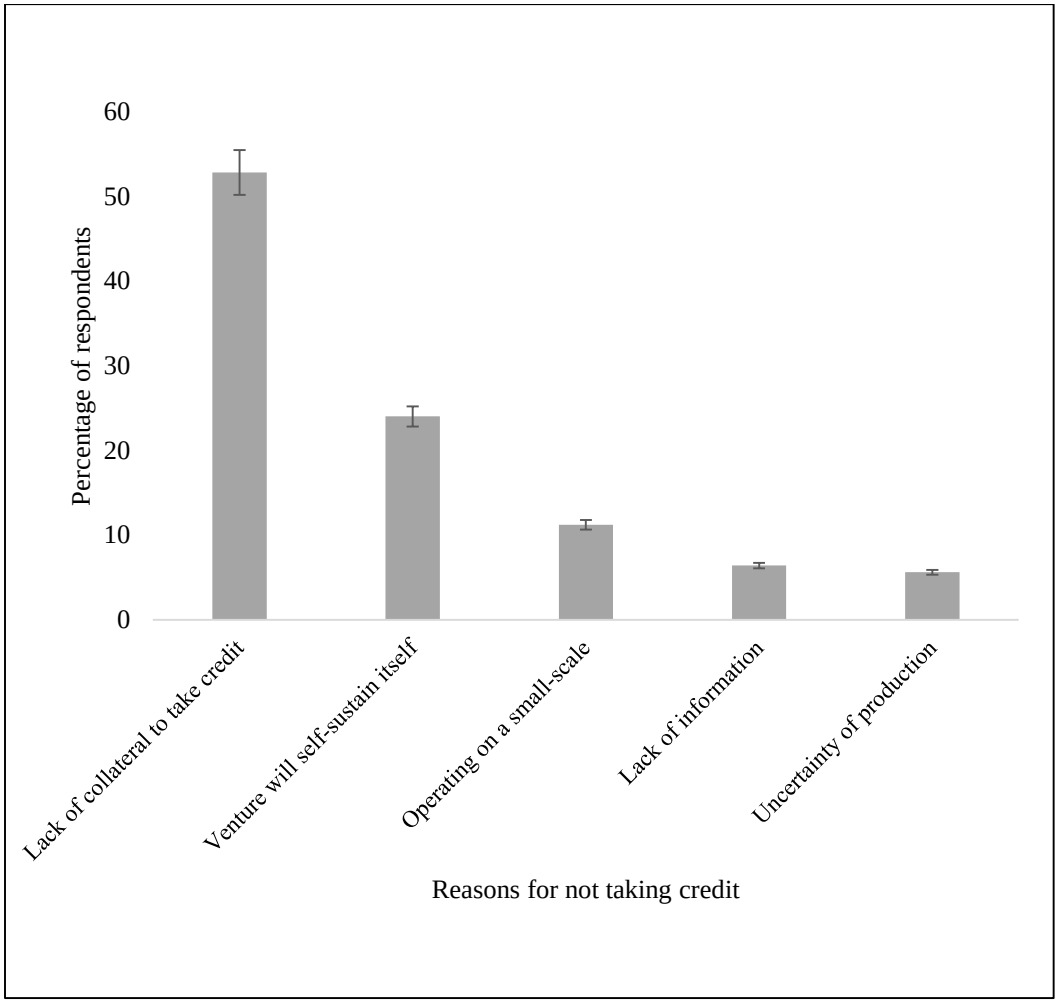

Figure 4. 6: Fodder producers' reasons for not taking credit for fodder production

4.3.7 Challenges facing the grass seed value chain in Marigat Sub-County

The fodder producers cited the shortage of planting labour as a challenge. This was attributed to the high demand for labour for other economic activities that usually make hired labour expensive. In addition to the scattered small fodder farms that made ploughing uneconomical venture for the service providers, poor bush clearing by the fodder farmers meant regular break down of ploughs therefore making it costly for the service providers to repair and maintain the equipment.

Figure 4.7 shows major challenges facing fodder production in the study area. Frequent droughts and intrusion of goats into fodder farms due to poor fencing were the challenges reported by most of the fodder producers. The problems faced were found to be similar to those faced by fodder farmers in Makueni County where continuous droughts and poor fencing of the fodder farms were some of the major problems (Mutua, 2014). In a study conducted in Southern Kenya to determine the financial returns of three range grasses, Ogillo (2010) reported droughts, termite problems and seed loss to be the challenges faced in fodder production. Furthermore, Mnene (2006) while studying the strategies to increase success rates in natural pasture improvement through reseeding degraded semi-arid rangelands of Kenya, reported drought, poor establishment and lack of or poor grass seeds to be some of the challenges facing fodder production.

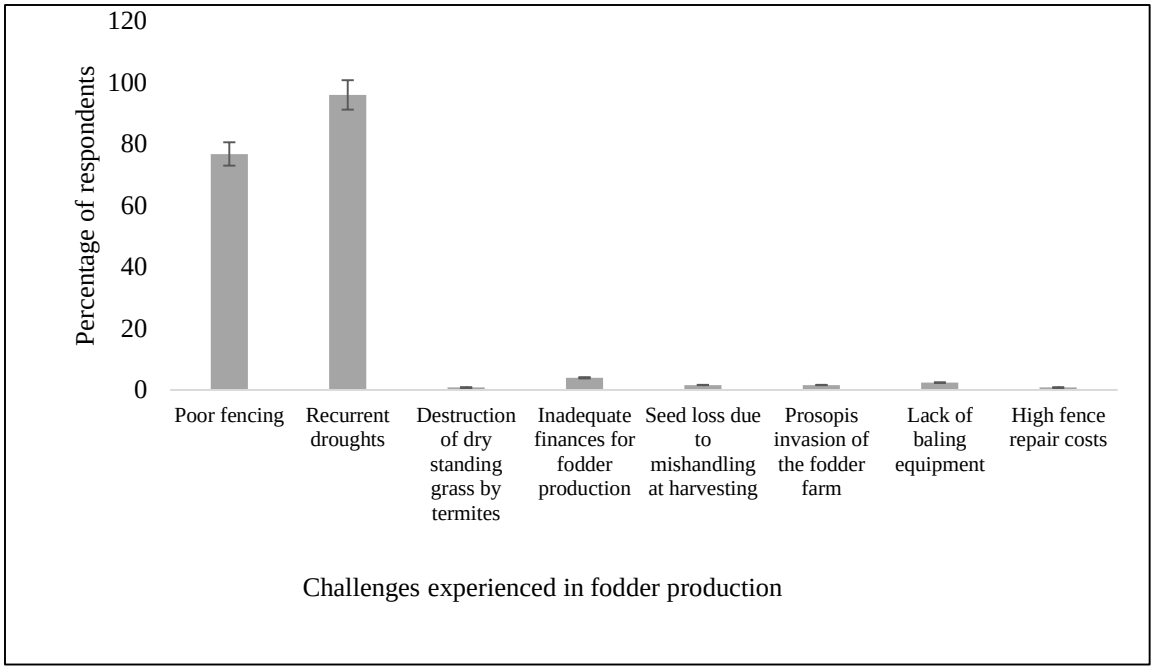

Figure 4. 7: Challenges facing fodder production in the study area

The fodder producers cited the inability of market outlets to buy grass seed at times and low prices offered for grass seed as their main challenges in the marketing of their produce. Independent grass seed traders and the bulking and processing agents mainly faced the challenges of poor quality of seeds due to improper post-harvest handling by producers. Such included inadequate drying, immature seeds and seeds mixed with chaff. The independent grass seed traders experienced delay in payment when organizations bought grass seeds on contractual terms. The high cost of an independent grass seed trader certificate which is issued by the Kenya Plant Health Inspectorate Service (KEPHIS) was also cited as a challenge.

Kerio Valley Development Authority cited the following: the difficulty in predicting the grass seed harvest time as this is not usually indicated by the fodder producers. The harvest time is crucial to KVDA for the purpose of advising the seed buyers on the storage time needed to break seed dormancy before planting. Unscrupulous behaviour of mixing the grass seeds with stones by some

of the fodder producers to increase the weight with the view of fetching more money was reported by KVDA as a challenge. In general, the various challenges faced by actors along the chain are consistent with findings of Nangole *et al.*, (2013) who found out lack of capital, seed quality issues, lack of consistent markets and lack of storage space to be some of the challenges faced by actors in the fodder value chain in the Rift Valley region of Kenya.

4.4 CONCLUSIONS

The grass seed value chain in Marigat Sub-County is dominated by the bulking and processing agents who provide input and ploughing services to farmers. They also provide training for farmers and market for the produced grass seed. The fodder production groups marketed their grass seeds individually but were faced by unreliable markets and low prices. Sometimes they failed to get buyers and whenever they did, low prices were offered. Therefore, there is need to strengthen the fodder producer groups with a possibility of registering them as cooperatives for the purpose of collective bargain for better grass seed prices.

CHAPTER FIVE

CONTRIBUTION OF FODDER PRODUCTION TO HOUSEHOLDS' INCOME IN THE SEMI-ARID BARINGO COUNTY

ABSTRACT

Fodder production is increasingly gaining popularity as a source of both households' livestock feed and income. However, this has been going on with little documented information on its profitability and contribution to household income. This study was conducted in Marigat Sub-County with the aim of determining the contribution of fodder production to household income. Gross margin analysis results show that the individual fodder producers made a profit of Kshs. 1,088.60 per acre while fodder production groups made a profit of Kshs.474.48 per acre. Expenditures on grass seed and ploughing were found to contribute the largest portion of production costs to the producers due high prices charged by the limited variety of input and ploughing services providers. The contribution of fodder production to the individual producers' household income was found to be about 5.71% compared to 0.42% for those participating in groups. The study recommends the promotion of public-private partnership to encourage the entry of more input providers. This may help reduce the high prices associated with the current monopolistic nature of the input market.

Key words: Gross margin analysis, household income, Marigat Sub-County.

5.1 INTRODUCTION

Drylands are characterized by low and variable rainfall coupled with frequent droughts. They however support millions of inhabitants, mostly pastoralists who primarily depend on livestock

for their livelihoods (Rass, 2006). Depending on the cultural values attached to specific livestock species coupled with the prevailing climatic conditions, the species kept vary from one ethnic community to the other (Huho *et al.,* 2009; Huho *et al.,* 2011).

Pastoral production systems face many challenges among them high livestock mortalities associated with frequent droughts. The situation is likely to worsen due to climate variability, which may further render most of the traditional pastoral coping strategies ineffective, consequently leading to insecure pastoral livelihoods (Elhadi, 2014). Galvin (2009) reported some of the main challenges in pastoral social and environmental systems to be sedentarization, changes in land tenure, human population growth, human-wildlife conflicts and climate change. Other challenges include food insecurity, human population increase and degraded ecosystems as indicated in the sessional paper on National Policy for the Sustainable Development of Northern Kenya and other Arid Lands (RoK, 2012a). Increasing frequency and severity of droughts in pastoral areas leads to; increased likelihood of crop failure, increased livestock mortality and diseases, sale of livestock at low prices, increased livelihood insecurity which results in out-migration of pastoral communities to areas with pasture and water resources for their herds and dependency on food aid. This consequently leads to a downward spiral on human development indicators such as health and education (Easterling *et al.,* 2007).

In the face of climate change, agro-pastoral communities in Kenya have developed key adaptation strategies which include increased livestock offtake in anticipation of droughts, diversifying animal species, mixing crop and livestock production, diversifying livestock feeds and her mobility (Silvestri *et al.,* 2012). Other strategies employed include keeping female dominated herds, hiring pasture, increasing number of goats and sheep in the herds as they have low dietary requirements and they mature quickly and thus can easily be sold, formation of alliances with

neighbours, keeping of indigenous breeds that are adapted to the harsh climatic conditions in the drylands and establishment of feed reserves (Huho *et al.,* 2011). In addition to pastoralists own initiatives, different institutions and agencies are promoting fodder production in the arid and semi-arid areas of Kenya with the aim of enhancing resilience of pastoral systems (CNFA, 2013; VSF-Suisse, 2009).

Pastoral communities in Kenya have practiced pasture production through the use enclosures for various social and economic reasons. In Baringo County, such enclosures are used for fattening of livestock, as fodder banks for the dry periods, for leasing out grazing, and for production of hay and grass seed for sale to generate income (Channer, 2013; Odunga, 2013; KRDP/ASAL DM, 2012). Fodder production has been reported to occur in groups in the drylands of Baringo county (Joosten *et al.,* 2014; Meyerhoff, 2012) and the formation of such groups leads to the building of social capital which may lead to positive impacts particularly as a result of income generation among the poor households (Grootaert, 2001). Various benefits have been reported to accrue from fodder production in the drylands (Mureithi *et al.,* 2015; Wairore *et al.,* 2015). This study was therefore conducted with the aim of determining the profitability of fodder production to the groups and individual producers, as well as contribution to income of households involved in the production.

5.2 DATA COLLECTION AND ANALYSIS

A semi-structured questionnaire was used to collect data as described in chapter three. The questionnaire was designed to elicit information on the costs of inputs, labour, taxes, and any other investment and income from the sales of hay and grass seed, as well as income from leasing out grazing and how much fodder production contributes to households' income. The Statistical

Package for the Social Sciences (SPSS) was used in the analysis of the collected data to determine profitability by computing the total costs incurred and income accrued per acre of land by the individual producers and the fodder production groups.

Several methods can be used to determine profitability of fodder production. According to Emmerson (1999), the use of financial ratios is a time-tested method of analyzing a business venture. Gross profit as well as net profit margin and operating profit margin are some of the profitability ratios that are commonly used. In their study on economic analysis of natural pasture rehabilitation through reseeding in the southern rangelands of Kenya, Manyeki *et al.*, (2015) used gross margin as one of the parameters to evaluate the costs and benefits of fodder production. They estimated profit margin as a measure of the control the fodder producers exerted over their operating costs, while profit accruing to them was the difference between total revenue from leasing out dry season grazing, sales of hay and grass seed and total costs incurred in production.

Gross profit is arrived at by subtracting the cost of goods sold from the net sales. Operating profit is gross margin less administrative and selling expenses. Net profit is arrived at by subtracting taxes and additional expenses from operating profit. All the three ways can be used in constructing profitability ratios where each item is divided by net sales and expressed as a percentage (Emmerson, 1999). The percent contribution of fodder production to household income was calculated as shown below:

$$\text{Monthly contribution to household income in a season} = \frac{\text{Profit made in a season (Ksh)}}{\text{The number of months in a fodder growing season}}$$

$$\%\ \text{Monthly contribution to household income} = \frac{\text{Monthly income from fodder production (Ksh)}}{\text{Total monthly income (Ksh)}} * 100$$

In calculating the total costs incurred and income accrued, each fodder production group was treated as a single entity for the ease of computation of costs incurred and income accrued and the method of valuing the inputs and outputs in fodder production are as shown in Table 5.1. Furthermore, an assumption made was that the profit earned by the fodder production groups was not was invested in group activities but was equally shared among the interviewed group members.

Table 5. 1: Units of measurement used to value inputs and outputs for fodder production

Activity	Valuation technique
Grass seed purchases	Selling price from institution/source
Planting	Wage rate of hired labour (Kshs. 100/person/day)
Grass seed harvesting	Wage rate of hired labour (Kshs. 100/kg)
Grass seed sales	Average market price of grass seed sold by farmers (Kshs. 250/kg)

Adopted from Manyeki *et al.,* (2015)

Table 5.2 presents the scenario when the fodder production groups had their ploughing and grass seed costs subsidized by SNV, while Table 5.3 presents the situation without the subsidies. The results are derived from data for September to December, 2013. An independent samples t-test was used to test if there was significant difference in profit per acre between the individual producers and the groups when their grass and ploughing costs were fully subsidized.

5.3 RESULTS AND DISCUSSIONS

5.3.1 Characteristics of fodder groups

5.3.1.1 Formation and governance of fodder groups

As shown in Figure 5.1 all the fodder production groups were formed on initiative of members and functioned without external influence of organizations with interests in the operations of the

groups. The groups formed in a period ranging from 2010 to 2013 and started fodder production in August 2013. The main objective of the groups was to improve the well-being of the members by undertaking multiple income-generating ventures. Whereas the groups formation was own initiative of the fodder producers, Place *et al.*, (2004) and Coppock *et al.*, (2006) in their studies reported strong influence from external agencies in formation of development groups in central and northern Kenya respectively.

The management structure of the fodder groups consists of a chairperson, vice chairperson, secretary, vice secretary and a treasurer who are entrusted with various duties. The chairpersons of the fodder groups preside over meetings, sign documents on behalf of the groups and coordinate group activities. In the absence of chairpersons, vice-chairpersons perform their duties. The treasurers of the groups keep records of their respective group funds, and offer advice on financial matters to the group officials.

5.3.1.2 Rules construction by the fodder groups

The sampled fodder groups had been registered by the Ministry of Gender, Children and Social Services of the Government of Kenya, and are governed by own by-laws and constitutions. The groups' by-laws stipulate that any person above 18 years is eligible for membership but subject to approval by the respective group's committee. A non-refundable membership fee that ranges between Kshs. 150 and Kshs. 200 has to be paid for an individual to be registered. Moreover, an amount of Kshs. 500 has to be paid as shares to the group by the individual being registered. The groups' by-laws require that every member must respect and adhere to the rules. Members who attend monthly meetings late, don't attend general meetings without apologies and who don't pay their monthly contributions on time are issued with warning letters. If such individuals fail to

change their conduct, committee meetings are called and a verdict is given on the action to be taken. Members wishing to leave their groups, are required to do so in writing indicating to the other group members through the respective group's committee the reason behind their intentions. A general meeting is normally called following a member's request to quit in order to discuss and make a decision on the matter.

The fodder groups' constitutions can only be amended in the presence of all members for the respective groups. For an amendment to be passed, it must have the consent of at least two-thirds of the members present during the meeting for each group. The amendments to the respective groups' constitution can only be implemented after consent from the Sub-County Social Development Officer who must have received prior notification from the respective groups. All the fodder groups' by-laws stipulate that the groups' accounts be audited at the end of every year by an auditor from a recognized institution who has competence in accounts auditing. If a member of a particular fodder group passes on, the family of the late member is called upon by the group to appoint someone to replace the deceased as a new member in the group.

5.3.1.3 Fodder groups' meetings

Each fodder group holds monthly committee meetings to discuss and plan for the activities to be implemented. Other meetings include monthly general meetings which usually occur on the first Saturday or Sunday of the month, where group members are given reports on the matters discussed in the committee meetings for approval and implementation. Special meetings are normally meant for urgent matters, while annual general meetings are used to discuss and evaluate activities carried out during the year and decide on the way forward. During the general meetings, members report on the conditions of their respective fodder farms which then form the main agenda for the

meetings. Other issues discussed during such meetings pertain to the wellbeing of the members and execution of other group activities such as merry-go-round contributions.

The members of the fodder production groups made monthly contributions part of which was offered as loans to the group members. The monthly contribution by members varied amongst the groups, ranging from Kshs. 100 to 200. Place and Kariuki (2005); Place *et al.,* (2004); and Coppock *et al.,* (2006) reported similar findings in central and northern Kenya where the groups were based on some form of savings scheme sustained through monthly contributions.

5.3.1.4 Labour organization and benefit-sharing mechanisms by the fodder groups

Group labour was mainly mobilized for land clearing, sowing, weed control and harvesting of grass seeds. In all the groups, members who were unable to avail themselves for group activities usually paid some fees equivalent of hired labour. Benefits accruing to the groups were equally shared among the members. Profits from the sale of grass seeds in all the groups were equally shared amongst the members. Before selling the grass seeds, the seeds were usually stored by one of the member households. Normally such members usually had leased the fodder farm to the group and would be holding an executive position in the group.

5.3.1.5 Future plans of the groups

The future plans for all the groups were similar and were all centered on the livestock production and related activities. The groups aim to expand the acreage of their respective fodder farms, engage in food crop cultivation (water melon, sorghum, maize and millet) and upscale their livestock fattening enterprises by purchasing livestock species, fatten them and sell unlike the current state where each member contributes an animal to the group for fattening and then selling.

The study by Coppock *et al.*, (2006) found that the future plans of the groups studied involved an interplay between livestock production and non-livestock related activities.

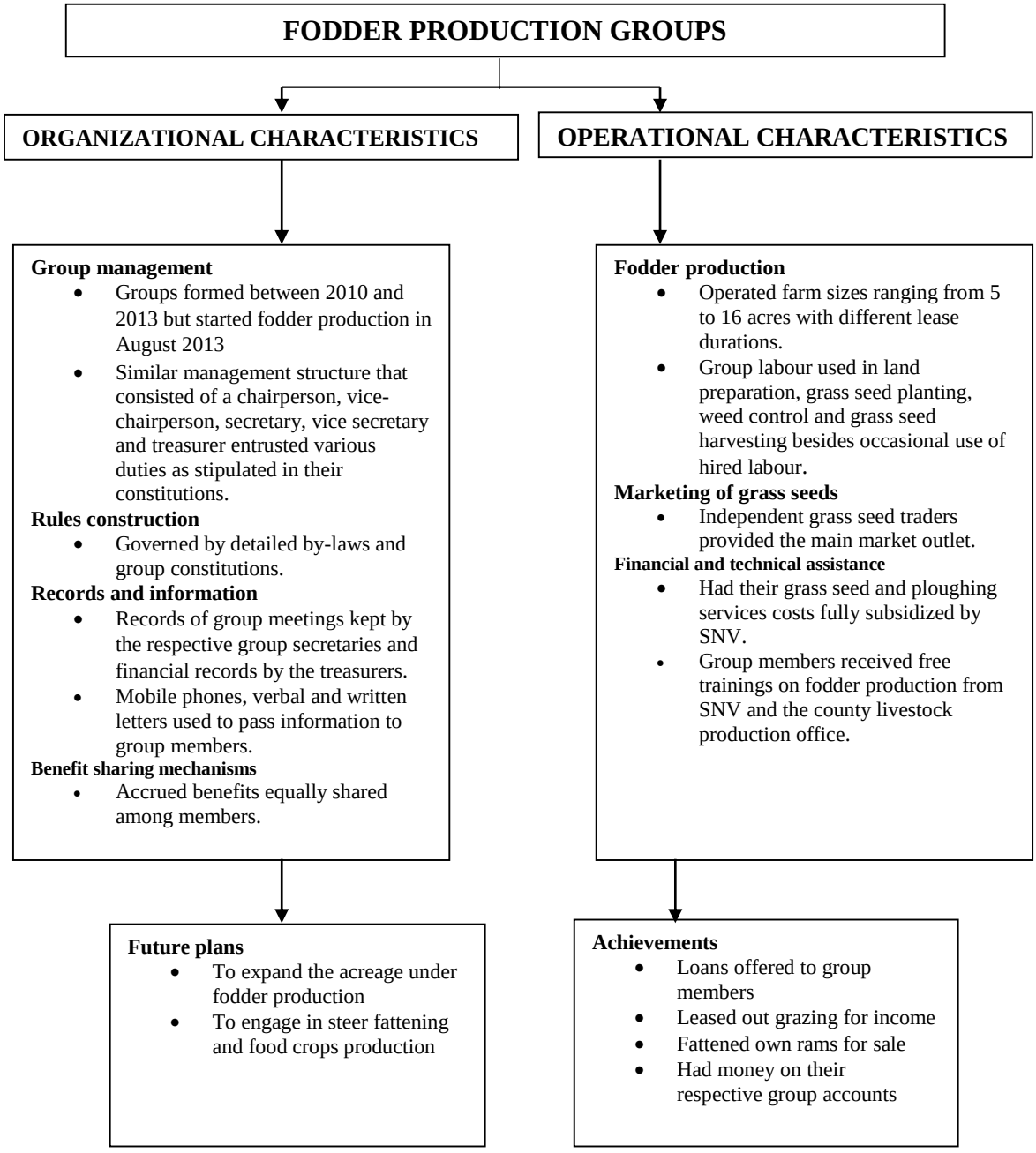

Figure 5. 1: Organizational and operational characteristics of the fodder groups in Marigat Sub-County

5.3.2 Profitability of fodder production based on gross margin analysis

Expenditures on grass seed, ploughing, seed harvesting and land preparation contributed the highest proportion (%) of the total costs incurred by the fodder producers (Table 5.2). The fodder producers generated income from the sale of grass seed, hay and leasing out grazing. Grass seed sales contributed the most percentage to the total income of the producers. Individual fodder producers made a profit of Kshs. 1,088.60 per acre whereas the groups made a profit of Kshs. 474.48 per acre. However, fodder production groups had a higher profit margin per acre (17.20%) than the individual producers' (14.33%).

The higher cost of land clearing for groups than the individual producers depicted in Table 5.2 can be associated with the high costs arising from land clearing and planting for the groups, which were engaging in fodder production for the first time as opposed to the individual producers. Similarly, the higher costs of weeding for the groups than the individual producers can be explained by smaller farms owned by the individual producers as compared to relatively larger ones operated by the groups. Furthermore, the group farms were new and needed more frequent weeds control than the individual ones thereby raising the costs associated with weeding.

Grass seed harvesting was found to be costly and this finding concurs with that of Mnene (2006) who in his study in the southern rangelands of Kenya found that high labour costs was one of the main constraints of communities' participation in range reseeding. Costs related to grass seed purchases, ploughing services, land clearing and grass seed harvesting contributed the largest proportion of the expenditure of the producers. This finding corroborates that of Manyeki *et al.,* (2015) who found land preparation, purchase of grass seed, seed and hay harvesting, and weed

management to be the largest contributors to fodder production costs in the Southern rangelands of Kenya.

The individual fodder producers generated income from the sale of grass seed, hay and leasing out grazing, whereas, the fodder production groups generated income from the sale of grass seed and leasing out grazing. This difference was expected to make the individual producers have an edge over the groups in the profit made per acre. In the Southern rangelands of Kenya, Ogillo (2010) reported leasing of pasture, sale of hay and grass seed as some of the benefits from range reseeding. Grass seed sales had the highest contribution to the households' total income from fodder production but the individual producers sold more quantities thus generating higher income than the fodder groups. This is in line with a study by Manyeki *et al.,* (2015) which found that grass seed sales had a higher revenue as compared to revenue generated from hay.

Table 5. 2: Gross margin of fodder production with ploughing and grass seed subsidy

	Production (tons/acre) (September-December, 2013)	
Source of Cost	Individual Producers (N=47)	Producer groups (N=5)
Land hiring	0	1380
Grass seed purchase	6,452	0
Ploughing services	9,248	0
Land clearing	2,568	8400
Planting	780	1,100
Pasture security	391	1,000
Weed control	400	1,080
Seed harvesting	14, 566	8,960
Hay harvesting	85	0
Total cost incurred ***(a)***	34,490	21,920
Average land size under fodder production (acres) ***(b)***	5.3	9.6
Source of income		
Grass seed sales	38,493.62	22,400
Hay sales	457	0
Leasing out grazing	1,309	4075
Total income accrued ***(c)***	40,259.62	26,475
Total cost per acre ***(d) = (a/b)***	6,507.55	2,283.33
Total income per acre ***(e) = (c/b)***	7,596.15	2,757.81
Gross profit per acre ***(f) = (e-d)***	1,088.60	474.48
Gross margin per acre %, ***g = (f/e)*100***	14.33	17.20
Gross profit per season ***(f*b)***	5,769.58	4,555

The individual fodder producers had a higher mean profit per acre (Kshs. 1,088.60±6,091.97) than the fodder groups (Kshs. 474.48 ±1,388.03) as shown in Table 5.3. The assumption of homogeneity of variances (no differences in the variances of the individual and group producers) was tested using Levene's *F* test, *F* (50) =3.370, *P* = 0.72. The results of Levene's test show that the individual producers and groups were sampled from the same population justifying the comparison between the individual and group producers. The independent samples t-test showed a statistically insignificant effect (*t* (50) =0.223, *P*= 0.825) between the mean profits per acre of the individual and group producers. Thus, the individual fodder producers had an insignificantly higher mean profit per acre (*P*> 0.05) than the fodder production groups.

Table 5. 3: Mean profits per acre accruing to the fodder groups and the individual producers

Parameter	Individual fodder producers (N=47)	Fodder production groups (N=5)	Levene's Test for equality of variances	t-test for equality of means
Mean profit (Kshs.)	1,088.60	474.48	*F* = 3.370	*t*= .223
Standard deviation	6,091.97	1,388.03	*P*= 0.72	*P*= .825
Standard Error Mean	888.61	620.75		

If there were no subsidies, the fodder production groups would have made a loss of Kshs. 6,711.88 per acre (Table 5.4). In absence of subsidies, grass seed and ploughing costs contributed the largest portion of the total production cost of the groups, indicating the high startup costs associated with fodder production. In a study conducted in the rangelands of southern Kenya to document the

financial returns on three range grasses, Ogillo (2010) underscores the high cost of reseeding and attributes this to the costs of inputs. The high costs incurred in grass seed purchases and payment for ploughing services in the current study can be attributed to high charges from input and services providers (KVDA and RAE). The differences in the profit margins shown in Table 5.2 (17.20% per acre) and Table 5.3 (-243.28% per acre) for the fodder production groups shows that the subsidy of ploughing and grass seed costs had a positive influence on the profit made by the groups.

Table 5. 4: Gross margin of fodder production without ploughing and grass seed subsidy

	Production (tons/acre) (September-December, 2013)	
Source of Cost	Individual Producers (N=47)	Producer Groups (N=5)
Land hiring	0	1,380
Grass seed purchase	6,452	46,000
Ploughing services	9,248	22,989
Land clearing	2,568	8,400
Planting	780	1,100
Pasture security	391	1,000
Weed control	400	1,080
Seed harvesting	14, 566	8,960
Fodder (hay) harvesting	85	0
Total cost incurred ***(a)***	34,490	90,909
Average land size under fodder production (acres) ***(b)***	5.3	9.6
Sources of Income		
Grass seed sales	38,493.62	22,400
Hay sales	457	0
Leasing out grazing	1,309	4,075
Total income accrued ***(c)***	40,259.62	26,475
Total cost per acre ***(d) = (a/b)***	6,507.55	9,469.69
Total income per acre ***(e) = (c/b)***	7,596.15	2,757.81
Gross profit per acre ***(f) = (e-d)***	1,088.60	-6,711.88
Gross profit margin per acre %, ***g = (f/e)***	14.33	-243.38
Gross profit in a season ***(f*b)***	5,769.58	-64,434.05

Crop cultivation made the highest contribution to the household income of the individual and group fodder producers (Table 5.5). The main crop grown by the farmers was water melons, which matured within two months and had ready market. Crop cultivation was practiced through production of water melons which had a ready market and fetched higher prices after only two months. Formal employment was the second contributor to household income followed by livestock keeping, businesses, charcoal and fodder production in that order. Fodder production made a monthly contribution of Kshs. 1,442.40 to households' income as compared to Kshs. 73 for households participating in the groups. The contribution made by fodder production was considered low by the producers and was attributed to the drought that prevailed in the study area in late 2013. It affected pasture production and consequently lead to low fodder and grass seed production. Moreover, the profit made by the fodder producer groups and consequently the contribution of fodder production to household income of the group members shows that the fodder producer groups are yet to attain a sustainable operating level as they are still unable to cover the costs of production and make profits without being provided with input subsidies. This may partly be due to the fact that the groups were partaking fodder production for the first time and the seeded pasture had not been properly established.

Table 5. 5: Monthly contribution of fodder production to household income in Marigat Sub-County

	Individual fodder producers (N=47)			Group fodder producers (N=78)		
Source of income	Total (Kshs.)	Mean (Kshs.)	Percent contribution	Total (Kshs.)	Mean (Kshs.)	Percent contribution
Formal employment	275,700	5865.96	23.22	329,850	4228.85	24.53
Livestock keeping	188,050	4001.06	15.84	217,150	2783.97	16.15
Businesses	115,000	2446.81	9.69	142,700	1829.49	10.61
Charcoal production	73,800	1570.21	6.22	135,800	1741.03	10.10
Beekeeping	30,000	638.30	2.53	6,000	76.92	0.45
Fishing	10,000	212.77	0.84	500	6.41	0.04
Crop cultivation	426,750	9079.79	35.95	507,150	6501.92	37.71
Fodder production	67,793	1442.40	5.71	5,694	73	0.42
Total	1,187,093	25,257.30	100	1,344,844	17,241.59	100

5.4 CONCLUSIONS

The results of this study show that fodder production can be a profitable venture although the drought experienced in the study area undoubtedly had adverse impact on the production. In order to cope with the recurrent droughts, fodder production groups should diversify their activities into non-farm ventures. Moreover, adherence to groups' activities such as loaning schemes and monthly contributions may help keep the groups functioning together as a unit during drought periods, and therefore further provide the social capital that is crucial during such times. The high expenditure on grass seeds and ploughing lowered the profit earned by farmers. To enhance farmers' profit, they should be cushioned from high price tendencies associated with monopolistic input market by exposing them to more input and service providers.

CHAPTER SIX

DETERMINANTS OF HOUSEHOLDS' PARTICIPATION IN FODDER PRODUCTION GROUPS IN THE DRYLANDS OF BARINGO COUNTY, KENYA

ABSTRACT

Collective action through fodder groups has been going on in the drylands of Baringo County for close to three decades. However, this has continued in the absence of empirical evidence on the factors influencing households' decisions to engage in these groups. This study was carried out in Marigat Sub-County with the aim of assessing the socio-economic and demographic factors that determine participation of households in fodder production groups. The results of the binary logit model show that the number of livelihood options in a household, its herd size and the age of the household head negatively influenced participation in fodder production groups. Past experience with drought and access to communal grazing reserves were positively related to participation in the groups. The positive relationship between participation in fodder production groups and access to communal grazing reserves, shows that resource-poor households who have experienced the benefits of drought grazing reserves are likely to join fodder groups to cushion them from the adverse effects of drought. The strategy of setting aside drought grazing reserves is akin, as well as complementary to collective fodder production and therefore provides a basis for modelling sustainable fodder production groups in pastoral areas.

Key words: Collective action, pastoral communities, binary logit model, livelihood options.

6.1 INTRODUCTION

Groups bring together individuals with common problems and aspirations which they are unable to effectively address individually. The collective action therefore involves pooling of social capital and labour resources to achieve common goals. The groups are crucial in mobilizing material resources to help produce more, organize labour resources for production, improve access, secure sustainability in natural resource use, provide a framework for joint effort and action as well as cement social relationships (Ravnborg *et al.,* 2000; Scoones and Thompson, 1994).

Pastoral communities face various challenges that undermine their capacity to adapt to changes from external sources. Some of these challenges include climate variability and change that results in severe droughts leading to loss of pasture, and livestock as well as the spread of livestock diseases. Pastoralists' political and economic marginalization adds another layer of problem that may lead to poor ability to defend their land rights and advocate for better provision of basic services. Inappropriate development policies often encourage sedentarization and as a result lead to the diminishing dry and wet season grazing areas, as well as restricted herd mobility. Another challenge is the increasing competition for resources due to population increase that puts pressure on pastoralists grazing lands and water resources (Kirkbride and Grahn, 2008).

The challenges faced prompt pastoral communities to work together to tackle their problems and improve their well-being. The traditional pastoral institutions, existence of alliances and social kinships among the pastoral communities enable them to cooperate and work together to uplift their standards of living (Huho *et al.,* 2011; HPG, 2009). The groups may serve the same purpose as the customary social networks. However, factors such as gender (Ireri, 2010), age, marital status, asset endowment of a household, education level, religious affiliation and ethnicity may

limit participation of individuals in these groups (Baden, 2013). Income to the group members, employment, improved social welfare, property ownership and food security are some of the benefits that accrue to individuals that belong to a group (Kilavuka, 2003).

In Baringo, Laikipia and Marsabit Counties of Kenya, women groups own over 50 community pasture fields from which they derive several benefits (Meyerhoff, 2012). Men and women engage in similar group activities but the motivation for joining and extent of participation differ with gender. While social insurance and access to markets are the main motivation for men, women normally join groups for building household assets as well (Place and Kariuki, 2005).

Collective action is widely practiced by communities and one of the forms in which it is manifested in the arid and semi-arid lands of Kenya is through the creation of fodder production groups. However, no study exists on socio-economic and demographic factors that influence households' participation in these groups. Such information is crucial in forming establishment and up-scaling fodder production of such groups. This study was therefore carried out to determine the factors that influence households' participation in fodder production groups in Marigat Sub-County of Baringo County.

6.2 DATA COLLECTION AND ANALYSIS

A semi-structured questionnaire was used to gather data from households as described in chapter three. Household heads were interviewed on their socio-economic and demographic characteristics hypothesized to influence their participation in fodder production groups. These included, among others, age, education, employment, number of livelihood options pursued, income earned, access to communal drought grazing reserves, herd size and past bad experience with drought. The Statistical Package for the Social Sciences (SPSS) was used to analyze the data to generate

descriptive statistics such as percentages, frequencies, averages and standard deviations. STATA software was used to compute the marginal effects and to carry out multicolinearity test. Binary logit regression was performed to determine the factors that influenced participation in fodder groups. Marginal effects was used to determine the change in the dependent variable in the Logit model for every unit change in the independent variables in the model, while multicollinearity test was undertaken to determine if there was a correlation in the independent variables in the model.

6.3 RESULTS AND DISCUSSIONS

6.3.1 Description of the hypothesized explanatory variables

It was hypothesized that participation of individuals in fodder production groups is a function of the household demographic characteristics that determine access to factors of production and assets. The independent variables hypothesized in this study were: the number of livelihood options, household's past experience with drought, access to communal grazing reserves, household herd size, age of household head, and formal employment status of the household head, per capita daily income, and education of the household head. The variables are described in details in Table 6.1.

Table 6. 1: Variable description and their expected influence on the regressand in the Logit model

Variable	Description	Measurement	*A priori* influence on dependent variable
LLHNUM	Number of livelihood options	Counts	+
PASTEXP	Past bad experience with drought	[1=Yes, 0=No]	+
GRSVACC	Access to communal grazing reserves	[1=Yes, 0=No]	-
TLU	Herd size of a household	Tropical livestock units (TLUs)	+
AGEHH	Age of a household head	Years	-
EMPHH	Employment status of the household head	[1=Yes, 0=No]	-
PDINCM	Per capita daily income of a household	Kenya shillings (Kshs)	-
EDUCHH	Education of household head	Years of education	-

i. Number of livelihood options

Pastoral production systems in Kenya are characterized by high risk and uncertainty and pastoralists have normally relied on fallback livelihoods besides livestock production to cushion them from natural shocks such as droughts (Herlocker, 1999). Expanding livelihood portfolios in ways that encourage local growth linkages is usually meant to augment subsistence from livestock (Wasonga, 2009). Thus, households that were pursuing multiple sources of income were hypothesized to already be aware of the benefits of diversification and therefore were expected to be more receptive to collective action.

ii. Past bad experience with drought

Droughts usually lead to the loss of livestock and conflicts over pasture resources in pastoral areas (Ouma, 2012). Therefore, those households that had such experiences before were expected to join fodder production groups especially if they had no capacity to invest in their own pasture production activities. Past bad experience with drought was a dummy variable where a value of 1

was assigned to those households that had past bad experiences with drought, and 0 to those without such experiences.

iii. Access to communal drought grazing reserves

This study hypothesized that a household which had access to communal grazing reserves during drought periods and had the capacity to produce fodder on its own was less likely to join fodder producer groups. Access to grazing was a dummy variable where those households that had access to communal grazing reserves during droughts were assigned a value of 1 and 0 to those households that did not have such access.

iv. Herd size

In most pastoral communities, wealth and wellbeing are usually measured in terms of the number of livestock owned (Wasonga, 2009). This study hypothesized that the decision as to whether a household joined a group for fodder production was a function of its herd size, among other variables. Those households with large herd sizes were hypothesized to likely join fodder production groups. Because larger herds would mean higher forage demand than smaller herds. Herd size was measured in terms of Tropical Livestock Units (TLUs) per household, where one TLU was taken as an equivalent of a mature live animal weighing 250 kgs as defined by KARI/ODA (1996). In this study, a bull was equated to 1.29 TLU, a cow = 1 TLU, a calf = 0.4 TLU and a sheep or goat = 0.11 TLU, adopted from Wasonga (2009). Conversion of livestock numbers into TLU equivalent was necessary for the purpose of standardizing different animal kinds and classes into a universal unit to allow comparisons between households.

v. Age of household head

The age of a household head is expected to determine a household's access to livelihood assets and means of production (Wasonga, 2009). This in effect determines the amount of wealth created and which is at the disposal of the family and consequently the decision as to whether one joins a group for fodder production or not. Younger household heads are expected to have less wealth created thus are more likely to join a fodder production group with the aim of diversifying their livelihood options and generating income. Age in this study was treated as a continuous variable and it was categorized as follows: below 24 years, 25 to 40 years, 41 to 56 years, and 57 years and above.

vi. Employment status of the household head

Formal employment is a source of cash income that supplements subsistence from livestock (Campbell, 1999). Those household heads that were employed were hypothesized to have the capacity to invest in their own fodder production and hence were less likely to participate in fodder groups. Employed household heads were assigned a value of 1 and 0 to those that were unemployed.

vii. Per *capita* daily income

The per *capita* daily income measures the average income earned per person per day in a given area. The households with low *per capita* daily income are hypothesized to be less endowed with resources necessary to undertake own fodder production, and therefore are more likely to participate in collective fodder production than their well off counterparts.

viii. Education level of household head

Education provides an opportunity for livelihood diversification for pastoral households through employment as a source of wage and remittances (Wasonga, 2009). According to Krishna *et al.,* (2004), educated household heads have a higher income earning potential and more income earning alternatives. Thus, the education level attained by the head of a household was expected to influence decision making, income earned and livelihood security of a household. Educated household heads were therefore less likely to participate in fodder groups as these heads were hypothesized to; have a higher income earning potential, make timely and right decisions in their households and consequently already pursuing more or less secure livelihood. The education level of a household head was assigned the value of 0 if not educated, 1 if attained primary education, 2 if secondary education was attained and 3 for post-secondary education.

6.3.2 Specification of the Logit Model

The dependent variable, membership to a fodder group was considered discrete in nature and thus it is a binary variable. This variable took the value of 1 if a household belonged to a fodder production group and 0 if otherwise. Since the dependent variable in this model is not continuous, ordinary least square (OLS) regression was unsuitable since it could lead to wrong conclusions based on the parameter estimates due to the problem of heteroscedasticity, which arises due to the assumption that the variance of the error term is not constant for all observations in the model (Salvatore and Reagle, 2002).

The suitable method for analyzing discrete binary data in which the dependent variables evokes a yes or no response is binary regression. Logit and Probit models are appropriate when the dependent variable is discrete usually taking two values, 0 or 1 (Maddala, 2001). The logistic and normal distributions associated with these two models are similar and using either basically

produces similar results (Maddala, 1983; Salvatore and Reagle, 2002). However, in discrete choice modelling, the logit is commonly used and this model assumes that all alternatives have the same variance and that the unobserved factors are not correlated over alternatives. Despite this assumption being limiting, it provides a very suitable form for the choice probability since the formula for the choice probabilities is readily interpretable and takes a closed form. The use of maximum likelihood estimation in this model assumes standard logistic distribution of errors, which implies that the errors are independently normal (Train, 2009).

This study assumed a logistic distribution and the probability that a household belongs to a fodder producer group can be specified as follows (Pindyck and Rubinfeld, 1991):

$$P_1 = F\,(\alpha + \beta X_i) = \frac{1}{1+e^{-(\alpha+\beta x\mathrm{i})}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

Where $P1$ is the probability that the *i*th household will belong to a fodder producer group given Xi, where X is a vector of explanatory variables and *e* is the error term powered by the negative function in hand. Equation (1) can be re-written as:

$$P_1 = [1 + e^{-(\alpha+\beta xi)}] = 1$$

Where $\alpha+\beta x_i$ = log [$\frac{P1}{1-P1}$] and $\frac{P1}{1-P1}$ is the likelihood ratio, whose log gives the odds that a household belongs to a fodder group.

The model can be written as following:

$$\mathrm{Log}\left[\frac{P1}{1-P1}\right] = \alpha + \beta_0 LLHNUM_i + \beta_1 PASTEXP_i + \beta_2 GRSVACC_i + \beta_3 TLU_i + \beta_4 AGEHH_i + \beta_5 EMP_i + \beta_6 PDINCM_i + \beta_7 EDUCHH_i$$

Where *i* denotes *i*th household (1……125), LLHNUM is the number of livelihood options in a household; PASTEXP is past bad experiences with drought; GRSVACC is access to communal grazing reserves; TLU is the household herd size; AGEHH is the age of a household head; EMP is employment status of the household head; PDINCM is the per *capita* daily income for a household; EDUCHH is the education level of the household head, α is the constant term and β_0,…….. β_k are coefficients representing parameter estimators of the variables in the model.

A series of binary logistic regressions were conducted using membership to a fodder group as the regressand until the best fit of the model was attained. The criteria for determining the variables that best defined the estimated model was based on the coefficient of determination (R^2); adjusted R^2, chi-square value, the sign or direction of influence of the independent variables, and the number of significant variables in the model.

In order to ensure that the explanatory variables included in the model were not in any way correlated with each other, a multicolinearity test was done through a variance inflating factor computation. This was necessary because if two or more expounding variables in a regression model are highly correlated, it would be impossible to isolate their effects on the dependent variable (Salvatore and Reagle, 2002). If a predictor variable in a model has its variance overestimated by the occurrence of multicolinearity, variance inflation factor (VIF) is able to show this (Gujarati, 2004). The VIF is calculated as shown below:

$$VIF = \frac{1}{1-\mathrm{R}i^2} \quad \text{..... (1)}$$

Where $\mathrm{R}i^2$ is the $R^2$of the regression with the i^{th} independent variable as a dependent variable. The VIF range for the explanatory variables is from 1.10 to 1.79 as shown in Table 6.2. Since the VIF's

for the independent variables are less than five (<5), the variables are justified to be included in the Logit model (Maddala, 2001).

Table 6. 2: Results of multicolinearity test on the independent variables

Variable	VIF	1/VIF
Number of livelihood options	1.10	0.91
Past bad experience with drought	1.43	0.70
Access to grazing reserves	1.36	0.74
Herd size of a household	1.55	0.65
Household head's age	1.79	0.56
Employment as main livelihood source	1.34	0.75
Per capita daily income	1.48	0.68
Household head's total years of education	1.43	0.70
Mean VIF	1.43	

6.3.3 Descriptives of variables in the Logit model

Individual fodder producers had more livelihood options, herd size, per *capita* daily income and were older than the group fodder producers as shown in Table 6.3. This implies that those who are considered well off were unlikely to join fodder production groups since they are already endowed with resources required to practice fodder production individually. It can be argued that those who joined groups opted to do so in order to expand their livelihood portfolios through collective action to consequently increase their incomes.

Table 6. 3: Descriptive results of independent variables used in the Logit model

Variable	Individual fodder producers (N=47)		Group fodder producers (N=78)	
	Mean	Standard Deviation	Mean	Standard Deviation
Education of household head	8	5	8	4
Number of livelihood options of a household	3	1	2	1
Household herd size	24.7	26.8	10.7	14.4
Per capita daily income	118.2	137.3	105.7	183.5
Age of household head	47	12	40	12
	Frequency	Percent	Frequency	Percent
Past bad experience with drought	31	66.0	50	64.1
Access to communal grazing reserves	18	38.3	34	43.6
Formal employment as the main source of livelihood	18	38.3	18	23.1

6.3.4 Factors that influence participation in fodder producer groups

Table 6.4 shows the results of the binary logit regression. The number of livelihood options of a household showed a negative but significant ($P<0.01$) influence on membership to a fodder production group, while past bad experience with drought had a positive and significant ($P<0.05$) influence on the participation of a household in a fodder production group. Access to communal drought grazing reserves was positively and significantly ($P<0.01$) related to households' participation in fodder groups. The households' herd size and age of households' head negatively influenced their participation in a fodder group.

Table 6. 4: Results of the binary Logit regression

Variable	B	S.E.	Wald	Exp(B)
Number of livelihood options	-1.087	.376	8.358*	.337
Past bad experience with drought	1.440	.654	4.839**	4.219
Access to grazing reserves	1.738	.631	7.578*	5.686
Household herd size	-.046	.017	7.659*	.955
Age of household head	-4.028	1.229	10.736*	.018
Employment as main source of livelihood	-.464	.587	.626	.629
Per capita daily income	-.403	.273	2.179	.669
Education of household head	.016	.063	.061	1.016
Constant	19.206	4.928	15.191	219398871.955

Statistical significance levels: *1% and **5%; Chi-square=52.682; -2log likelihood= 112.890; Cox and Snell R Square=41.3; Nagelkerke R Square=56.3

The results show that individuals with fewer livelihood options were likely to join fodder production groups than their counterparts with multiple livelihood options. Watson and Binsbergen (2008) observed that some individuals join groups to explore alternative livelihood options. This explains in part why households with multiple livelihood options were less likely to join fodder production groups in the current study.

Households that had experienced drought events in the past were found to be more likely to join fodder groups with the aim of undertaking multiple ventures to cushion them against such climatic risks in the future. Mutua (2014) reported similar results in Makueni County of Kenya, where Kavatini Pasture and Livestock Improvement (KaPaLi) Group was formed in 2004 after a severe drought resulted in mass deaths of livestock due forage scarcity. This would be the case if a

household lacks the resources and capacity to carry out its own fodder production and therefore has to seek for collective action.

In many pastoral communities, dry season grazing reserves serve as an important part of traditional land management systems and they provide grass bank for periods of scarcity (Nelson, 2012). Hence the positive relationship between access to communal grazing reserves and participation in fodder production groups shows that resource-poor households which have already experienced the benefits of having forage reserves are likely to embrace collective fodder production.

In the arid and semi-arid lands of Kenya, pastoral communities depend on livestock for their livelihoods (Kaimba *et al.,* 2011) and wealth for these communities is usually measured in terms of number of livestock owned (Wasonga, 2009). This study reveals that those households that had larger herd sizes were less likely to join fodder production groups. This is contrary to the *a prior* expectation that households with larger herds might join fodder groups so as to be able to support their animals during bad times. This may be explained by the fact that those who had larger herds were better off and independent and therefore could afford to engage in fodder production individually.

Household heads that were above 40 years were found to be unlikely to join fodder producer groups as compared to youth headed households. It can be argued that the youth joined fodder production groups with the aim of diversifying their livelihood portfolios. In studies conducted in Ethiopia and Rwanda Woldu *et al.,* (2013) and Mugabekazi (2014) respectively, age was found to positively influence membership to formal groups. Studies on women collective action conducted by Baden (2013) in Ethiopia, Mali and Tanzania, found that age positively influenced participation in groups.

The results in Table 6.5 show that for a unit increase in the number of livelihood options in a household, the chance of that household joining a fodder production group is decreased by 24%. A household's exposure to a bad experience from a drought event, either through the loss of livestock, crop failure or conflicts over grazing resources, leads to a 33% increase in the likelihood of such a household joining a fodder producer group. If there is a unit increase in access to community grazing reserves for a household, that household will have its odds of joining a fodder group increased by 35%. If the herd size of a household increases by one livestock unit, the possibility of that household joining a fodder group is decreased by 1%. A unit increase in the age of a household head who is 40 years decreases the probability of household joining a fodder group by 89%.

Table 6. 5: Results of marginal effects of Binary Logit model after Logit regression

Variable	dy/dx
Number of livelihood options	-0.2395
Past bad experience with drought	0.3264
Access to communal grazing reserves	0.3511
Household herd size	-0.0101
Age of household head	-0.8878
Employment status of household head	-0.1053
Per capita daily income	-0.0887
Education of household head	0.0034

(*) dy/dx is for a discrete change in the dependent variable following a unit change in the independent variable

The results show that a unit change in age leads to the highest influence on the decision of households to join fodder production groups. This implies that youth are more likely to form fodder

production groups in the arid and semi-arid areas of Kenya. In order to cushion their herds from losses associated with pasture scarcity during droughts, more households in the drylands of Kenya are more likely to engage in group fodder production with a view of attaining pasture security for their herds.

6.4 CONCLUSIONS

The findings show that the number of livelihood options, herd size, past experience with drought, age of household head, and access to communal grazing reserves are the key factors that influence households' participation in fodder production groups. Households with diversified livelihood options, large herd sizes and those with older heads are less likely to be involved in fodder production groups. Diversification of livelihood options makes households better off in terms of income and this reduces the need of households to seek collective action by joining fodder groups. The recurrent droughts as well as high demand for drought grazing reserves are likely to lead to participation of more resource-poor individuals in collective fodder production. The sustenance and expansion of the current communal grazing reserves in the pastoral areas therefore plays a complementary role to fodder production in the drylands.

CHAPTER SEVEN

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

- The bulking and processing agents dominate the grass seed value chain in Marigat Sub-County with the producers being faced by relatively low prices offered for the produced grass seed. Whereas using the producer groups as a platform for collective bargaining for better prices may help improve the situation, the unreliable markets given the seasonality in grass seed production would still remain a challenge to the producers.
- Grass seed and ploughing costs subsidies proved critical to the fodder producer groups, without which they would have incurred losses given the high charges by the current providers of these services. That notwithstanding, the results of this study show that fodder production can be a profitable venture and thus can address cash needs of pastoral households.
- The number of livelihood options pursued by a household, its herd size, past bad experience with drought, household head's age, and its access to communal drought grazing reserves were found to be the key determinants of households' participation in fodder production groups. The results show that the youth and households less endowed with resources are more likely to participate in fodder production groups.
- Drought featured as one of the key challenges facing fodder production in the study area; it disrupted the normal operations of the groups most likely because they never had alternative sources of livelihoods to complement fodder production.

7.2 Recommendations

The following recommendations arise from the key results of this study:

- While subsidies had positive impact on fodder production by the groups, more support to the producers is necessary to ensure their produce fetch better prices. The problem of poor prices and unreliable markets could be addressed by fostering linkages between producers and reliable grass seed markets to cushion them from price fluctuations.
- Promotion of Public-Private partnerships would help encourage entry of more input and service providers in the grass seed value chain that may help reduce the high prices of inputs associated with the current monopolistic nature of the market in Marigat Sub-County.
- Given the positive relationship between participation in fodder production groups and access to communal drought grazing reserves, the current communal grazing resources in the pastoral areas should be sustained if not expanded to complement fodder production in order to cushion the pastoral households from livestock losses associated with droughts.
- Since younger household heads are likely to join fodder production groups, this offers an opportunity for engaging the youth to address the widespread unemployment amongst the youth in the pastoral areas. Targeting the youth in promotion of fodder production groups has the potential of enhancing sustainability and may help make fodder production a more viable source of alternative income. Therefore, interventions aimed at promoting fodder production in the drylands should target both the youth and poor households.
- Key to the sustainability of fodder production groups during drought periods is the commitment to group activities such as monthly contributions and holding of regular

group meetings. Also, diversification into off-farm activities may help serve keep the groups functioning as a unit and enjoy more benefits from their collective action.

- There is need to strengthen the groups to enable them collectively bargain for better prices for their produce. This could be done by formally registering the groups as cooperatives, which can then also be legible to secure loans for their operations.
- This study only focused on the contribution of fodder production to household income in a single growing season, it is important to study this over consecutive fodder growing seasons in order to have a better picture of viability of fodder production in the drylands.
- The focus of this study was on mapping the grass seed value chain. However, it is important to document the benefits accruing to each actor along the chain for the purposes of better understanding of the value chain.

REFERENCES

Adong, A., Mwaura, F., and Okoboi, G. (2013). What factors determine membership to farmer groups in Uganda? Evidence from the Uganda Census of Agriculture 2008/09. Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammamet, Tunisia.

Altenburg, T., Schmitz, H., and Stamm, A. (2008). Breakthrough? China's and India's transition from production to innovation. *World development*, *36*(2), 325-344.

Assessment, M. E. (2005). *Ecosystems and human well-being: desertification synthesis*. World Resources Institute. Washington, DC. Island Press.

Ayele, S., Duncan, A., Larbi, A., and Khanh, T. T. (2012). Enhancing innovation in livestock value chains through networks: Lessons from fodder innovation case studies in developing countries. *Science and public policy*, *39*(3), 333-346.

Baden, S. (2013). *Women's Collective Action: Unlocking the potential of agricultural markets*. Oxfam.

Barrett, C. B., Reardon, T., and Webb P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics and policy implications. *Food Policy 26*(4), 315–331.

Bevege, A. (2009). Drought in Kenya ravages Maasai cattle. Available at http://www.reuters.com/article/2009/03/26/kenya-drought-idAFLQ61702920090326 accessed on 8/7/2014.

Campbell, D. J. (1999). Response to drought among farmers and herders in southern Kajiado District, Kenya: A comparison of 1972-1976 and 1994-1995.*Human Ecology*, 27(3), 377-416.

Channer, A. (2013). Tackling a great menace. Article available at http://www.iofc.org/initiative land-lives-and-peace-Baringo-county-Kenya accessed on 16/05/2015.

Clifton, N., Keast, R., Pickernell, D., and Senior, M. (2010). Network structure, knowledge governance, and firm performance: evidence from innovation networks and SMEs in the UK. *Growth and Change*, *41*(3), 337-373.

Cooperation for Assistance and Relief Everywhere. (2013a). Embracing fodder farming in northern Kenya. Article available at: http://care.or.ke/index.php/2013-01-31-07-20-51/stories-from-the-field/2-uncategorised/184-embracing-fodder-farming-in-northern-kenya accessed on 22/9/2015.

Cooperation for Assistance and Relief Everywhere. (2013b): Discovering the benefits of green fodder. Article available at: http://www.care.or.ke/index.php/2013-01-31-07-00-31/women-and-girls-empowerment/19-newsroom?start=25 accessed on 23/10/2013.

Coppock, D. L., Desta, S., Wako, A., Aden, I., Gebru, G., Tezera, S., and Tedecha, C. (2006). Women's groups in arid northern Kenya: Origins, governance and roles in poverty reduction. In *Invited paper presented at A Policy Research Conference on Pastoralism and Poverty Reduction in East Africa, held* (Vol. 27, p. 28).

Crane, T. A., Roncoli, C., and Hoogenboom, G. (2011). Adaptation to climate change and climate variability: The importance of understanding agriculture as performance. *NJAS Wageningen Journal of Life Sciences, 57*(3), 179-185.

Cultivating New Frontiers in Agriculture. (2012): Fodder farming Increases Household's Income through USAID/KDLDP Initiatives. Article available at http://www.cnfa.org/resource/fodder-farming-increases-households-income-through-usaidkdldp-initiatives/ accessed on 16/05/2015.

Cultivating New Frontiers in Agriculture. (2013): Fodder Fortification Improves Lives for Farmers and Livestock Keepers in Kenya's Tana River County. Article available at: http://www.cnfa.org/resource/fodder-fortification-improves-lives-for-farmers-and-livestock-keepers-in-kenyas-tana-river-county accessed on 15/7/2014.

Davies, T. D., Vincent, C. E., and Beresford, A. K. C. (1995). July-August Rainfall in West central Kenya. *Journal of Climatology*, *5*, 17 -33.

De Groot, P., Field-Juma, A., and Hall, D. O. (1992). Reclaiming the land: Revegetation in Semi-arid Kenya. *African Center for Technology Studies (ACTS) Press, Nairobi and Biomass Users Network, Harare.*

De Jode, H. (2009**).** Modern and mobile. *The future of livestock production in Africa's drylands*. IIED and SOS Sahel UK.ISBN 978-1-84369-752-7.

Easterling, W. E., Aggarwal, P. K., Batima, P., Brander, K. M., Erda, L., Howden, S. M., Kirilenko, A., Morton, J., Soussana, J. F., Schmidhuber, J., and Tubiello, F. N. **(**2007). Food, fibre and forest products. p. 273-313. *In* M. L. Parry, O. F. Canziani, J. P. Palutikof,

P. J van der Linden and C. E. Hanson (Eds.). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.

Elhadi, A. M. Y. (2014). *The contribution of camel milk production as a livelihood strategy for building pastoral resilience in the dry lands of Kenya* (Doctoral dissertation, University of Nairobi).

Elhadi, A. Y., Nyariki, D. M., Wasonga, V. O., and Ekaya, W. N. (2012). Factors influencing transient poverty among agro-pastoralists in semi-arid areas of Kenya. *African Crop Science Journal, 20*(1).

Emmerson, P. (1999). Business builder modules 7, 8, and 9. Intermediate Teacher's Resource Series. Macmillan publishers.

Faße, A., Grote, U., and Winter, E. (2009). *Value chain analysis methodologies in the context of environment and trade research* (No. 429). Discussion papers//School of Economics and Management of the Hanover Leibniz University.

Food and Agriculture Organization (2005): EASYPol. On-line resource materials for policy making. Analytical tools. Module 043. Commodity Chain Analysis. Constructing the Commodity Chain, Functional Analysis and Flow Charts in Faße, A., Grote, U., and Winter, E. (2009). *Value chain analysis methodologies in the context of environment and trade research* (No. 429). Discussion papers//School of Economics and Management of the Hanover Leibniz University.

Food and Agriculture Organization. (2006a). FAO World Reference Base for Soil Resources, Food and Agriculture Organization of the United Nations, Rome (2006) 128pp.

Food and Agriculture Organization. (2006b). FAO Guidelines for Soil Description (Fourth edition). Food and Agriculture Organization of the United Nations, Rome (2006) 97pp.

Fratkin, E. (2001). East African pastoralism in transition: Maasai, Boran, and Rendille cases. *African Studies Review*, *44*(03), 1-25.

Galvin, K. A. (2009). Transitions: pastoralists living with change. *Annual Review of Anthropology*, *38*, 185-198.

Grootaert, C. (2001). Does social capital help the poor? A synthesis of findings from the local level institutions studies in Bolivia, Burkina Faso, and Indonesia. *World Bank Local Level Institutions Working Paper No. 10*. Washington, DC. World Bank.

Gujarati, D. N. (2004). Economics Basic Econometrics. McGraw-Hill Companies.

Herlocker, D. (1999). *Rangeland resources in eastern Africa: their ecology and development*. GTZ, German Technical Cooperation, Nairobi, Kenya.

Herlocker, D., Shaabani, S. B., and Wilkes, S. (1994). *Range Management Handbook of Kenya*, Ministry of Agriculture, Livestock Development and Marketing, Range Management Division, republic of Kenya.

Howells, J., and Edler, J. (2011). Structural innovations: towards a unified perspective?. *Science and Public Policy*, *38*(2), 157-167.

Huho, J. M., Ngaira, J. K., and Ogindo, H. O. (2009). Climate change and pastoral economy in Kenya: a blinking future. *Acta Geologica Sinica (English Edition)*, *83*(5), 1017-1023.

Huho, J. M., Ngaira, J. K., and Ogindo, H. O. (2011). Living with drought: the case of the Maasai pastoralists of northern Kenya. *Educational Research, 2*(1), 779-789.

Humanitarian Policy Group. (2009). Synthesis Paper: Pastoralism, policies and practice in the Horn of East Africa. A review of current trends. Article available at: www.odi.org/resources/docs/4315.pdf accessed on 9/7/2015.

Inter-governmental Panel on Climate Change. (2007): Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri, and A. Reisinger (eds.)]. *IPCC, Geneva, Switzerland, 104 pp.*

Ireri, J. N. (2010). *Masculinities and Young Men's participation in self-help groups: The case of poverty eradication interventions in Mwingi District of Rural Kenya*. Erasmus University.

Joosten, K., Ekodere P., and Miano, G. (2014). Best Practice Brief- Fodder production in Baringo County available at: http://asals-markets.wikispaces.com/file/view/Best+practice+brief++Mayiani+fodder+group+(2).pdf accessed on 15/08/2014.

Kaimba, G. K., Njehia, B. K., and Guliye, A. Y. (2011). Effects of cattle rustling and household characteristics on migration decisions and herd size amongst pastoralists in Baringo District, Kenya. *Pastoralism, 1*(1), 1-16.

Kassilly, F. N. (2002). Forage quality and camel feeding patterns in Central Baringo, Kenya. *Livestock Production Science, 78*(2), 175-182.

Kenya Agricultural Research Institute. (2004). Transformation of Agricultural Research in Africa: Lessons from Kenya. Ndiritu, C. G., Lynam, J. K., and Mbabu, A. N. (eds). Michigan State University Press. Michigan, USA.

Kenya Agricultural Research Institute/ODA. (1996). *Manual of livestock production systems in Kenya*. Livestock socio economics and epidemiology project. National veterinary research Centre, Kikuyu, Kenya.

Kenya Interagency Rapid Assessment. (2014). Baringo County Baseline Analysis. Available at www.humanitarianresponse.info/system/files/documents/files/Baringo%20Secondary%20Data%20Review_20141112.pdf accessed on 3/03/2015.

Kenya Markets Trust. (2013). KMT impact stories. Smallholder dairy farmers benefit from quality hay Available at http://www.kenyamarkets.org/news/41/57/Smallholder-Dairy-Farmers-benefit-from-Quality-Hay accessed on 22/09/2015.

Kenya Rural Development Programme/Arid and Semi-Arid Lands Drought Management. (2012). Pastoral farmers fattening wallets from nutritious grass available at: http://www.dmikenya.or.ke/drr-activities/item/2-pastoral-farmers-fattening-wallets-from-nutritious-grass.html accessed on 13/03/2015.

Kigomo, J. N., and Muturi, G. M. (2013). Impacts of enclosures in rehabilitation of degraded rangelands of Turkana County, Kenya. *Journal of Ecology and the Natural Environment*, *5*(7), 165-171.

Kilavuka, J. M. (2003). A comparative study of the socio-economic implications of rural women, men, and mixed self-help groups: A case of Kakamega District. Africabib.org.

Kimitei, R., Kirwa, E., Kidake, B., Kubasu, D., Manyeki, J., and Mnene, W. N. (2011). Community based forage seed system approaches in southern Kenya rangelands. In *Kenya Arid and Semi-Arid Lands Research Programme (KASAL) End of Programme Conference held on 9 th to 11 th august 2011 at KARI Headquaters conference Hall, Kenya*.

Kirkbride, M., and Grahn, R. (2008). Survival of the fittest: pastoralism and climate change in East Africa. Oxfam Briefing Paper 116, August. Oxfam International.

Kitalyi, A., Musili, A., Suazo, J., and Ogutu, F. (2002). Enclosures to protect and conserve. *For better livelihood of the West Pokot community. Technical Pamphlet, (2).*

Krishna, A., Kristjanson, P., Radeny, M., and Nindo, W. (2004). Escaping poverty and becoming poor in 20 Kenyan villages. *Journal of Human Development*, *5*(2), 211-226.

Kuria, S. G., Mwaura, J. M., Kinyua, M. G., Nduma, B., Okoti, M., Wamuongo, J. W., and Ofwona, E. (2015). Adapting dryland livestock production to meet climate change challenges in Kenya. Article available at: idl bnc.idrc.ca/dspace/bitstream/10625/54167/1/IDL-54167.pd accessed on 16/7/2015.

Lenachuru, C. I. (2003). Impacts of Prosopis species in Baringo District. In *Proceedings of workshop on integrated management of Prosopis species in Kenya, Workshop held at Soi Safari Club, Lake Baringo* (pp. 1-2).

Machogu, C. (2013). *A comparative study of the productivity of Brachiaria hybrid cv. Mulato II and native pasture species in semi-arid rangelands of Kenya* (Masters Dissertation, University of Nairobi).

Maddala, G. S. (1983). Limited-Dependent and Qualitative Variables in Econometrics. Cambridge Univ. *Press, Cambridge*.

Maddala, G. S. (2001). Introduction to Econometric, 3rd edition. Wiley and Sons Inc, 32.

Makokha, W., Lonyakou, S., Nyang, M., Kareko, K. K., Holding, C., Njoka, J. T., and Kitalyi, A. (1999). *We work together–Land rehabilitation and household dynamics in Chepareria Division, West Pokot District*. Kenya. Issue 22 of Technical report (Sweden. Regional Land Management Unit). Volume 22 of Relma Technical Handbook Series.

Manyeki, J. K., Kirwa, E. C., Ogillo, P. B., Mnene, W. N., Kimitei, R., Mosu, A., and Ngetich., R**.** (2015): Economic analysis of natural pasture rehabilitation through reseeding in the southern rangelands of Kenya. *Livestock Research for Rural Development. Volume 27, Article #49.* Retrieved March 20, 2015, from http://www.lrrd.org/lrrd27/3/many27049.html.

Marangu, D. K., Kimani, J. N., Msafiri, F., and Roimen, H. P. (2008). *Mapping of prosopis species in Baringo District.* Department of Resources Survey and Remote Sensing (DRSRS) Technical Report No. 173.DRSRS. Ministry of Environment and Natural Resources, Republic of Kenya.

Meyerhoff, E. (1991).Taking Stock: Changing Livelihoods in Agro-pastoral Community. *African Center for Technology Studies (ACTS) Press, Nairobi and Biomass Users Network, Harare.*

Meyerhoff, E. (2012). Pasture development for land rehabilitation in Baringo. Article available at http://www.agriculturesnetwork.org/magazines/east-africa/desertification/pasture-development-for-land-rehabilitation-in-baringo accessed on 7/11/2014.

Miano, G., and Joosten, K. (2014). Briefing Paper. Best Practice: Fodder Production in Wajir County. Article available at: www.snvworld.org/.../**fodde**.. Accessed on 22/9/2015.

Mnene, W. N. (2006). *Strategies to increase success rates in natural pasture development through reseeding degraded rangelands of Kenya* (Doctoral dissertation, Ph. D. Thesis, University of Nairobi, Nairobi, Kenya).

Mogotsi, K., Nyangito, M. M., and Nyariki, D. M. (2011). Drought management strategies among agro-pastoral communities in non-equilibrium Kalahari ecosystems. *Environmental Research Journal*, *5*(4), 156-162.

Mugabekazi, D. (2014). *Evaluation of factors influencing membership in coffee Cooperatives in Huye District, Rwanda* (Doctoral dissertation, University of Nairobi).

Mugenda, O. M., and Mugenda, A. G. Research Methods: Quantitative & Qualitative Approaches, (1999). *African Centre of Technology Studies, Nairobi, Kenya*.

Mureithi, S. M., Verdoodt, A., Njoka, J. T., Gachene, C. K., and Van Ranst, E. (2015). Benefits Derived from Rehabilitating A Degraded Semi-Arid Rangeland in Communal Enclosures, Kenya. *Land Degradation & Development*.

Musimba, N. K. R., Nyariki, D. M., Ikutwa, C. N., and Teka, T. (2004). *Dryland Husbandry for sustainable development in the southern rangelands of Kenya*. OSSREA, Addis Ababa, 2004.

Mutua, C. (2014). Grass farmers earning millions, making a difference in the ASALs. Available at http://nairobidigest.blogspot.com/2014/08/grass-farmers-earning-millions-making.html accessed on 14/03/2015.

Nangole, E., Lukuyu, B. A., Franzel, S., Kinuthia, E., Baltenweck, I., and Kirui, J. (2013). Livestock feed production and marketing in Central and North Rift Valley Regions of Kenya. Article available at: https://cgspace.cgiar.org/bitstream/handle/10568/34450/Livestock%20feed%20production%20and%20marketing%20in%20Kenya.pdf?sequence=1 accessed on 3/5/2014.

Nelson, F. (2012). Natural conservationists? Evaluating the impact of pastoralist land use practices on Tanzania's wildlife economy. *Pastoralism*, *2*(1), 1-19.

Nyangaga, J., Ounga, T., Gebremedhin, B., Baker, D., Lukuyu B., and Randolph, T. (2009). Market survey supporting peri-urban livestock in Mandera. Article available at: edu.care.org/.../Market%20Survey%20of%20**Fodder**%20supporting%20... accessed on 30/10/2015.

Nyariki, D. M., Kitalyi, A., Wasonga, V. O., Isae, I. M., Kyagaba, E., and Lugenja, M. (2005). *Indigenous techniques for assessing and monitoring range resources in East Africa*. World Agroforestry Centre, Nairobi.

Obando, J., Ogindo, H., Otieno, W., Macharia, A., Ensor, J., Tumuising, W., Kisiangani, E., Muchiri, L., and Amollo, N. (2010). Reducing vulnerability of Pastoralists communities to climate change and variability in Northern Kenya. Available at: www.dewpoint.org.uk/.../ICID18/18-obando_et_al_ICID+18.pdf accessed on 5/2/2014.

Odunga, D. (2013): Baringo chief leads the way in Farming. Article available at http://www.nafis.go.ke/2013/10/baringo-chief-leads-the-way-in-farming accessed on 16/05/2015.

Ogillo, B. P., Nyangito, M. M., Nyariki, D. M., and Kubasu, D. O. (2010). *A comparison of two micro-catchment technologies on aboveground biomass production and financial returns of three range grasses in southern Kenya.* (Masters dissertation, University of Nairobi, College of Agriculture and Veterinary Sciences).

Olila, D. O. (2014). Economic evaluation of factors affecting farmer participation in development groups: A case of Trans-Nzoia County, Kenya. *Journal of Agricultural Economics, Extension and Rural Development*: ISSN-2360-798X: Vol. 2(6): pp 074-081, June, 2014. Copyright © 2014 Spring Journals.

Olukoye, G. A., Wakhungu, J. W., Wamicha, W. N., Kinyamario, J. J., and Mwanje, I. (2007). Livestock versus Wildlife Ranching in Kenyan Rangelands: A Case Study of Laikipia District Ranches. *Kenya Veterinarian*, *27*(1), 24-30.

Osbahr, H., and Viner, D. (2006): Linking Climate Change Adaptation and Disaster Risk Management for Sustainable Poverty Reduction. *Kenya Country Study. A study carried out for the Vulnerability and Adaptation Resource Group (VARG) with support from the European Commission.*

Ouma, C. O. (2011). *Assessment of the post drought recovery strategies among pastoralists in Turkana Central District* (Doctoral dissertation, School of Environmental Studies, Kenyatta University).

Owen, R. B., Renaut, R. W., Hover, V. C., Ashley, G. M., and Muasya, A. M. (2004). Swamps, springs and diatoms: wetlands of the semi-arid Bogoria-Baringo Rift, Kenya. *Hydrobiologia*, 518(1-3), 59-78.

Pindyck, R. S., and Rubinfeld, D. L. (1991). Models of Qualitative Choice. *Econometric Models, Economic Forecasts*, 273-315.

Place, F., and Kariuki, G. (2005). *Initiatives for rural development through collective action: The case of household participation in group activities in the highlands of Central Kenya*. CGIAR Systemwide Program on Collective Action and Property Rights. Article available at: http://core.ac.uk/download/pdf/6242728.pdf accessed on 7/8/2014.

Place, F., Kariuki, G., Wangila, J., Kristjanson, P., Makauki, A., and Ndubi, J. (2004). Assessing the factors underlying differences in achievements of farmer groups: methodological issues and empirical findings from the highlands of Central Kenya. *Agricultural Systems*, *82*(3), 257-272.

Rass, N. (2006). Policies and strategies to address the vulnerability of pastoralists in sub-Saharan Africa. *Rome: FAO, Pro-poor Livestock Policy Initiative (PPLPI) Working Paper Series, 37.*

Ravnborg, H. M., Cruz, A. M., de la, M., Guerrero, and Westermann, O. (2000). *Collective action in ant control.* CAPRi Working Paper No. 7. Washington, D.C.: International Food Policy Research Institute.

Rehabilitation of Arid Environments. (2004). Factsheet. Kampi ya samaki, Marigat Kenya.

Republic of Kenya. (2000). *Poverty in Kenya, Vol. I*, Incidence and depth of poverty. Central Bureau of Statistics and Human and social Resources Department, Ministry of Finance and Planning, Government of Kenya.

Republic of Kenya. (2002). *National Action Programme. A framework for combating desertification in Kenya*. Ministry of Environment and Natural resources, Government of Kenya.

Republic of Kenya. (2003). Economic Recovery Strategy for Wealth and Employment Creation 2003-2007. Ministry of National Planning and Development. Nairobi, Kenya. 92pp.

Republic of Kenya. (2005). Baringo District Strategic Plan 2005-2010 for the Implementation of the National Population Policy for Sustainable Development. National Coordination Agency for Population and Development Ministry of Planning and National Development, Republic of Kenya.

Republic of Kenya. (2008). Kenya Vision 2030: First Medium Term Plan (2008-2012). Ministry of State for Planning, National Development and Vision 2030, Government of the Republic of Kenya.

Republic of Kenya. (2010a). Kenya Population and Housing Census, 2009. Kenya National Bureau of Statistics, Nairobi, Kenya, 2010.

Republic of Kenya. (2012a). Sessional paper No. 8 of 2012 on National Policy for the Sustainable Development of Northern Kenya and other Arid Lands available at: www.hsnp.or.ke/index.php/component/.../1-user-downloads?download accessed on 10/08/2014.

Republic of Kenya. (2012b). 'Kenya Post-Disaster Needs Assessment for the 2008-2011 Drought'. Article available at: http://www.recoveryplatform.org/assets/publication/PDNA/Kenya_PDNA_Final.pdf accessed on 6/7/2014.

Republic of Kenya. (2012c). Baringo County Development Plan 2012. Baringo County economic planning unit, Baringo, Kenya.

Republic of Kenya. (2014). National Drought Management Authority. Baringo County Drought Monitoring and Early Warning Bulletin- May 2014. Article available at: http://reliefweb.int/report/kenya/baringo-county-drought-monitoring-and-early-warning-bulletin-may-2014 accessed on 15/08/2015.

Reynolds, J. F., Maestre, F. T., Kemp, P. R., Stafford-Smith, D. M., and Lambin, E. (2007). Natural and human dimensions of land degradation in drylands: causes and consequences. In *Terrestrial ecosystems in a changing world* (pp. 247-257). Springer Berlin Heidelberg.

Salvatore, D., and Reagle, D. (2002). Shaum's outline of statistics and econometrics, the McGraw-Hill Companies, Inc. USA.

Scoones, I., Thompson, J., Niño de Zepeda, A., Di Silvestre, F., Maino, M., Escobar, G. B., and Rodríguez, V. (1994). *Beyond farmer first: rural people's knowledge, agricultural research and extension practice* (No. GTZ-1551). IIED, Londres (RU).

Sethi, N. (2014). India's poor may shrink 75% by new World Bank formula. Purchasing power parity revision set to alter poverty estimation; fall won't be so steep once the global poverty line is revised too. Article available at: http://www.business-

standard.com/article/economy-policy/india-s-poor-may-shrink-75-by-new-world-bank-formula-114080400161_1.html accessed on 3/2/2015.

Shafie, T. (2010). Design-based estimators for snowball sampling. *Available at SSRN 2471006*. Accessed on 10/11/2015.

Silvestri, S., Bryan, E., Ringler, C., Herrero, M., and Okoba, B. (2012). Climate change perception and adaptation of agro-pastoral communities in Kenya. *Regional Environmental Change, 12*(4), 791-802.

Smith, T., Jayasuriya, N., Mlambo, V., Lekule, F., Thoma, D., Owen, E., Pearson, A., and Titterton, M. (2003). Feeds and Feeding to Improve Productivity and Survival. In Owen, E., Kitalyi, and Jayasuriya, N. (Eds.), *Livestock and Wealth Creation. Improving the Husbandry of Animal Kept by Resource Poor People in Developing Countries*. Nottingham University Press, pp. 191-213.

SNV. (2013). Study on the Kenyan Animal Feed and Fodder Sub-sectors. Trends in the Kenyan Fodder Sub-Sector (Sub-report VI) available at: www.snvworld.org/.../blgg_... accessed on 22/9/2015.

Sutherland, R.A., Bryan, R.B., and Wijendes, D.O. (1991). Analysis of the monthly and annual rainfall climate in a semi-arid environment, Kenya. *Journal of Arid Environments*, 20(3), 257 ─ 275.

Train, K. E. (2009). *Discrete choice methods with simulation*. Cambridge university press.

United Nations Environmental Programme. (2007). The Global Environment Outlook 4. Environment for Development. UNEP. Nairobi.

United States Agency for International Development. (2012): Mother of Five Invests in Fodder Production in Kenya's Arid Lands, article available at http://www.feedthefuture.gov/article/mother-five-invests-fodder-production-kenya%E2%80%99s-arid-lands accessed on 21/07/2014.

United States Department of Agriculture-Soil Conservation Service/GoK. (1978). Reconnaissance soil Survey. Lake Baringo-Kerio Valley area: Government of Kenya, Ministry of Agriculture Project Evaluation and Management Division, Nairobi.

Verdoodt, A., Mureithi, S. M., and Van Ranst, E. (2010). Impacts of management and enclosure age on recovery of the herbaceous rangeland vegetation in semi-arid Kenya. *Journal of Arid Environments, 74*(9), 1066-1073.

VSF-Suisse. (2009): ELMT technical brief; FODDER PRODUCTION: Experiences and Lessons Learnt. Article available at: www.elmt-relpa.org/.../ELMT%20TECHNICAL%20BRIEF_fodder%20production accessed on 16/05/2015.

Wairore, J. N., Mureithi, S. M., Wasonga, O. V., and Nyberg, G. (2015). Benefits Derived from Rehabilitating a Degraded Semi-Arid Rangeland in Private Enclosures in West Pokot County, Kenya. *Land Degradation & Development*.

Wasonga, V. O. (2009). *Linkages between land-use, land degradation and poverty in semi-arid rangelands of Kenya: The case of Baringo district* (Doctoral dissertation, University of Nairobi, Department of agriculture).

Watson, D. J., and van Binsbergen, J. (2008). *Livelihood diversification opportunities for pastoralists in Turkana, Kenya* (Vol. 5). ILRI (aka ILCA and ILRAD).

Western, D. (2002). *In the Dust of Kilimanjaro*. Washington, DC: Island.

Woldu, T., Tadesse, F., and Waller, M. K. (2013). *Women's Participation in Agricultural Cooperatives in Ethiopia* (No. 57). International Food Policy Research Institute (IFPRI).

APPENDICES

APPENDIX I: FODDER AND GRASS SEED PRODUCTION QUESTIONNAIRE

1. General information **QUESTIONNAIRE NO:----------**

1.1 Date of interview……../…..…/……... Name of enumerator……...
1.2 Name of respondent…….…..Sex: 1) Male…..…… 2) Female……..
1.3 County……. Sub-County…….. Division……..……. Location……..… Village……..……..
1.4 GPS Reading: Latitude……..... Longitude……...
1.5 Phone number of respondent…….…….

2. Household head's information

2.1 Name…… (OPTIONAL)
2.2 Gender: 1) Male…….…… 2) Female…….
2.3 Age……
2.4 Education: 0) None…..…1) Primary…… 2) Secondary…...…3) Post-Secondary…….
2.5 Household Size…… No. of males…… No. of females……
2.6 What is the number of children attending school from your household? ……
2.7 MAIN source of livelihood: 1) Livestock keeping……. 2) Crop cultivation…….. 3) Business….. 4) Bee-keeping…….. 5) Formal employment…….. 6) Other (Specify)…….
2.8 Do you receive remittances from any of your relatives who are employed elsewhere? 1) Yes…… 0) No……..
2.9 What is the average monthly income amount from all your income generating activities during the wet and dry seasons? Please fill in the table below:

Source of income	**Wet season (Kshs.)**	**Dry season (Kshs.)**

2.10 What is the total number of livestock you own? Please fill in the table below:

Species	**Number**
Cattle	
Sheep	
Goats	
Donkeys	
Camels	
Total	

2.11 Have you had any past bad experience with droughts? 1) Yes…… 0) No……..
2.12 Do you have access to communal grazing reserves during drought period? 1) Yes…… 0) No……
2.13 Does your neighbour(s) practice fodder production? 1) Yes…….. 0) No…….

3 Fodder and grass seed production

3.1 Where do you grow your fodder? Please fill in the table below:

Land ownership	**Acreage**	**Hiring price (Kshs./season)**
Own land		
Rented land		
Communal land		
Government land		
Other (Specify)……		

3.2 Where did you acquire the inputs that you used in production last season from? Please fill in the table below:

Input	**Source of input**	**Quantity of purchased input**	**Quantity hired**	**Number of days input hired**	**Price per unit**	**Total cost**
Grass seeds						
Fertilizer						
Ploughing tools						
Fencing materials						
Harvesting tools						
Baling equipment						

3.3 What quantities of fodder and grass seeds did you produce last season from the fodder species you grow? Please fill in the table below:

Species grown	**Area (Acres)**	**Fodder (Bales)**				**Seeds (Kgs)**			
		Produced	**Consumed**	**Sold**	**Price/bale**	**Produced**	**Used**	**Sold**	**Price/kg**

3.4 How much did you spend on labour in the following activities during your fodder and grass seed production last season? Please fill in table below:

Activities	**Family labour (No.)**	**Hired labour (No.)**	**Group members labour (No.)**	**Total days taken**	**Cash payment/unit/day**	**Total amount paid**
Land preparation						
Planting						
Weed management						
Pasture security						
Seed harvesting						
Fodder harvesting						
Bailing						
Storage						
Marketing						
Selling						

3.5 Did you fatten any livestock species on the planted fodder last season? 1) Yes…… 0) No…….
IF YES, please fill in the table below:

Type of animal	**Number of animals grazing**	**Acreage grazed**	**Source of animal [1=own, 2=purchased]**	**Animal purchasing price**	**Animal selling price after fattening**
Cattle					
Sheep					
Goats					

3.6 Do you irrigate your fodder? 1) Yes…… 0) No…….
3.7 IF YES, how much water did you use last season? …….. Litres
3.8 Do you pay for the irrigation water? 1) Yes…….. 0) No…….
3.9 IF YES, how much do you pay per litre of irrigation water in Kshs? ……..
3.10 IF NO, why don't you irrigate your fodder? …….
……
3.11 Do you fertilize your fodder? 1) Yes…….. 0) No……
3.12 IF YES, how much fertilizer did you use on fodder last season? ……. Kgs
3.13 How much did you buy a kilo of fertilizer last season in Kshs? ……
3.14 IF NO, why don't you fertilize your fodder? ……...
3.15 What are the major problems that you faced in your fodder and grass seed production last season? Please list them: ……
……
……
3.16 Do you belong to a fodder group? 1) Yes……..…….. 0) No……
IF NO proceed to Question 4.1
3.17 What is the name of your group? ……
3.18 Which year was the group formed? …….
3.19 What is the total number of members in the group? ..... 1) Adult males…… 2) Adult females……. 3) Male youth…….. 4) Female youth……..
3.20 What is the reason(s) that motivated you to join the group? ……...
……
……
3.21 What are the benefits of belonging to the group? Please list and rank them in the table below:

Benefits	**Rank (1=Most important, 2, 3……)**

3.22 Were you producing fodder before joining this group? 1) Yes…….. 0) No…….

4 Fodder and grass seed marketing

4.1 Do you sell grass seeds? 1) Yes……. 0) No…….
4.2 Do you sell fodder? 1) Yes……. 0) No…….
4.3 IF YES, what are the selling arrangements? 1) Contract…….. 2) Freelance…… 3) Both……
4.4 How do you market your fodder and grass seeds? 1) Consumers come to buy on farm….

2) I take the fodder and grass seeds to the market for selling…. 3) I sell to brokers whom come to buy from the farm …….. 4) I am a member of a fodder group which sells on behalf of producers……. 5) Other (Specify)…….

4.5 What quantities of grass seeds and fodder did you produce last season and how much did you sell? Please fill in the table below:

	Amount produced	**Area harvested (Acres)**	**Amount sold**	**Main market**	**Distance from homestead (Km)**	**Unit price (Kshs.)**	**Total amount (Kshs.)**
Seeds (kgs)							
Fodder (bales)							

4.6 How did you determine the price of: Grass seeds you sold? ……..……. Hay you sold……

4.7 How much did you spend last season on the following activities in Kshs?

Cost	**Harvesting**	**Baling**	**Transport**	**Airtime**	**Tax**	**Other investments**
Seeds						
Fodder						

4.8 Do you lease out grazing? 1) Yes…….. 0) No….. IF YES, what acreage did you lease out last season? Please fill in the table below:

Acreage leased	**Type of animal**	**No. of animals grazing**	**Duration of leasing (Months)**	**Leasing price/animal/month**	**Total amount (Kshs.)**
	Cattle				
	Sheep				
	Goats				

4.9 What major problems did you face in your fodder and grass seed marketing last season? Please list them……...
……
……

4.10 Do you keep records on fodder and grass seed production and marketing? 1) Yes…… 0) No……. IF NO, why not? ……

5. Institutional and capacity building:

5.1 Do you ever get any information on fodder? 1) Yes…… 0) No…….

5.2 IF YES, what kind of information and from which sources? Please fill in the table below:

Type of information	**Main source** *[1=NGOs, 2=Other farmers, 3=Ministry of agriculture, 4=other……..]*	**Information delivery channel** *[1=Radio, 2=Extension workers, 3=Newspaper, 4= TV, 5=Other farmer, 6=Other----------]*
Fodder &seed prices		
Fodder husbandry practices		
Market demand		
Other inputs, eg. Machinery…….		
Other (Specify)--------		

5.3 How do you use this information? ……

5.4 Do you get any support to improve your fodder business? 1) Yes……. 0) No……..
5.5 IF YES, please provide the following information:

Type of support	Source of support	Frequency	Service delivery

Codes for service delivery: 1) very poor 2) poor 3) good 4) very good.

5.6 Did you get any kind of training to improve your fodder business? 1) Yes…….. 0) No……..
5.7 IF YES, please provide the following information:

Type of training	When?	Provider of training	Amount paid

5.8 Do you have access to credit for fodder production? 1) Yes……. 0) No…….
5.9 IF NO, why not? ……
5.10 IF YES, please provide the following information:

Source of credit	Amount borrowed

THANK YOU FOR YOUR TIME

APPENDIX II: CHECKLIST FOR FOCUS GROUP DISCUSSIONS AND KEY INFORMANT INTERVIEWS ON THE PRACTICE OF FODDER PRODUCTION AS AN EMERGING ADAPTATION TO CLIMATE VARIABILITY IN BARINGO COUNTY

1. **MAPPING THE FODDER AND GRASS SEED VALUE CHAIN**
    a) **Input suppliers**
        i. Source of inputs sold to farmers and the prices
        ii. Volumes sold and the behavior of demand
        iii. The distribution practice
        iv. Challenges experienced in offering services to fodder farmers
    b) **The fodder and grass seed buyers and brokers**
        i. Volumes bought, frequency of purchasing and prices
        ii. The market outlet/ source
        iii. The usage of the purchases
        iv. Challenges faced
    c) **Technical advisors**
        i. The practices on which advice is offered and the type of advice
        ii. The charges and frequency of offering advice
        iii. Challenges faced
2. **ASSESSING THE ORGANIZATIONAL AND OPERATIONAL CHARACTERISTICS OF FODDER PRODUCTION IN GROUPS**
    a) **Organizational characteristics**
        i. Group management
        ii. Rules construction
        iii. Records and information sharing
        iv. Benefit sharing mechanisms
    b) **Operational characteristics**
        i. Production aspects
        ii. Marketing aspects
        iii. Financial and technical assistance
        i. Risks and their management strategies