

**ANALYSIS OF FODDER PRODUCTION AND MARKETING IN THE
RANGELANDS OF SOUTHERN KENYA**

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the Award of the Degree of Master of Science in Range Management (Economics Option)
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(LARMAT), Faculty of Agriculture, University of Nairobi**

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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

I dedicate this thesis to my grandmother, Ondisore Nyabuodo and parents, Dickson Omollo and Jane A. Omollo. You have been a blessing throughout my academic journey. Thank you all.

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TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	ix
LIST OF ACRONYMS AND ABBREVIATIONS	x
ABSTRACT	xi
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background Information	1
1.2 Statement of the Problem	4
1.3 Justification of the study	4
1.4 Broad Objective.....	6
1.5 Specific Objectives.....	6
1.6 Research Questions	6
1.7 Thesis organization	6
CHAPTER TWO	9
LITERATURE REVIEW	9
2.1 Livestock Production and Pasture Scarcity in the Arid and Semi-Arid Lands of Kenya	9
2.2 Fodder Production and its Role in Pastoral and Agro-pastoral Livelihoods in the Drylands of Kenya	10
2.3 Fodder Marketing in Kenya	11
2.4 Factors Determining Households' Participation in Fodder Production	13
CHAPTER THREE	15
METHODOLOGY	15
3.1 Study Area.....	15
3.1.1 Location and Geo-physical Characteristics	15
3.1.2 Climate.....	15
3.1.3 Vegetation, Soils and Water Resources.....	16
3.1.4 The People, Land Use and Livelihoods.....	17

3.2 Research Design	18
CHAPTER FOUR.....	20
FODDER PRODUCTION PRACTICES IN THE DRYLANDS: A CHARACTERIZATION OF HAY AND GRASS SEED VALUE CHAIN IN SOUTHERN KENYA	20
ABSTRACT.....	20
4.1 Introduction	21
4.2 Sampling Procedure and Data Collection	24
4.3 Data Analysis	24
4.4 Results and Discussions	25
4.4.1 Socio-Demographic Characteristics of Fodder Producers and Production Practices...	25
4.4.2 Grass Species Grown and Sources of Seeds.....	31
4.4.3 Hay and Grass Seed Value Chain Map	32
4.5 Conclusions	35
CHAPTER FIVE	36
PROFITABILITY AND EFFICIENCY OF FODDER PRODUCTION AMONG AGRO- PASTORALIST AND PASTORALIST HOUSEHOLDS IN SOUTHERN KENYA	36
ABSTRACT.....	36
5.1 Introduction	37
5.2 Sampling Procedure and Data Collection	38
5.3 Data Analysis	39
5.4 Results and Discussions	41
5.4.1 Cost Benefit Analysis Results for Hay and Grass Seed Production.....	41
5.4.2 Marketing and Supply Chain of Hay and Grass Seeds.....	42
5.4.3 Grass Seed Market Performance and Efficiency	45
5.4.4 Constraints to Fodder Production and Marketing in Southern Kenya.....	47
5.5 Conclusions	49
CHAPTER SIX.....	50
DETERMINANTS OF PASTORAL AND AGRO-PASTORAL HOUSEHOLDS’ PARTICIPATION IN FODDER PRODUCTION IN MAKUENI AND KAJIADO COUNTIES, KENYA.....	50
ABSTRACT.....	50
6.1 Introduction	51

6.2 Sampling Procedure and Data Collection	53
6.3 Data Analysis	54
6.4 Description of the Dependent and Hypothesized Independent Variables.....	55
6.5 Specification of the Binary Logit Regression Model.....	59
6.6 Multicollinearity Statistical Test: Variance Inflation Factor.....	60
6.7 Results and Discussions	61
6.7.1 Results of Multicollinearity Test.....	61
6.7.2 Socio-Demographic Characteristics of the Sampled Households	61
6.7.3 Results of the Binary Logit Regression	62
6.8 Conclusions	65
CHAPTER SEVEN	66
SUMMARY CONCLUSIONS AND RECOMMENDATIONS	66
7.1 Conclusions	66
7.2 Recommendations	67
REFERENCES	69
APPENDICES	87
APPENDIX 1: QUESTIONNAIRE FOR FODDER PRODUCERS	87
APPENDIX 2: QUESTION GUIDE FOR FOCUS GROUP DISCUSSIONS	91
APPENDIX 3: QUESTION GUIDE FOR KEY INFORMANT INTERVIEWS	92

LIST OF TABLES

Table 4.1: Land under fodder production	25
Table 4.2: Pasture production technologies	277
Table 4.3: Land preparation methods	28
Table 4.4: Methods of pasture reseeding	300
Table 4.5: Grass seed production among the sampled households.....	311
Table 5.1: Gross margins per acre of fodder in Makueni and Kajiado Counties.....	42
Table 5.2: Efficiency of grass seed marketing channels.....	46
Table 6.1: The variables hypothesized to influence households' participation in fodder production.....	55
Table 6.2: Multicollinearity test for the explanatory variables included in the model.....	61
Table 6.3: Descriptive for the hypothesized variables used in the model	62
Table 6.4: Logit model estimates for the determinants of household's participation in fodder production.....	65

LIST OF FIGURES

Figure 1.1: Thesis map.....	8
Figure 3.1: Map of Makueni and Kajiado Counties	16
Figure 4.1: Grass species grown and (a) sources of grass seeds (b) in the study areas	32
Figure 4.2: Hay and grass seed value chain map for Makueni and Kajiado Counties	333
Figure 4.3: Hay and grass seed marketing channels and prices/kg along the chain	34
Figure 5.1: Major grass seed marketing.....	43
Figure 5.2: Grass seed marketing channels.....	44
Figure 5.3: Constraints of hay and grass seed production (a) and marketing (b)	49

LIST OF ACRONYMS AND ABBREVIATIONS

ADESO	African Development Solutions
AfDB	African Development Bank
ARLRI	Arid and Range Lands Research Institute
ARSP II	Agricultural Research Supports Program phase II
ASALs	Arid and Semi-Arid Lands
CARE	Cooperative for Assistance and Relief Everywhere
CBO	Community Based Organizations
CBS	Central Bureau of Statistics (Kenya)
CNFA	Cultivating New Frontiers in Agriculture
ELMT	Enhanced Livelihood in the Mandera Triangle
FAO	United Nations Food and Agriculture Organization
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
GoK	Government of Kenya
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agriculture and Livestock Research Organization
KEPHIS	Kenya Plant Health Inspectorate Service
KIIs	Key Informant Interviews
KVDA	Kerio Valley Development Authority
NGOs	Non-Governmental Organizations
ODI	Overseas Development Institute
OFDA	United States Foreign Disaster Assistance
RAE	Rehabilitation of Arid Environments Trust
SNV	Netherlands Development Organization
SPSS	Statistical Package for the Social Sciences
STATA	Statistics and Data software
TLUs	Tropical Livestock Units
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development

ABSTRACT

Pastoral and agro-pastoral communities in arid and semi-arid lands of Kenya have adopted fodder production to address the problem of livestock feed scarcity, as well as to diversify their household incomes from the sale of the produced hay and grass seed. However, there is limited information to guide targeting and prioritization of options for up-scaling fodder production for enhanced pastoral and agro-pastoral livelihoods. This study was conducted in Kajiado and Makueni Counties of southern Kenya to characterize hay and grass seed value chain, determine profitability of hay and grass seed and efficiency of their marketing channels; and assess factors that determine households' participation in fodder production. Data was collected through household interviews using semi-structured questionnaire, key informant interviews and focus group discussions.

Range pasture reseeding was found to be the most common production technology, practiced by 48% of the sampled producers. Analysis of the fodder value chain showed that key players at the production level were individual farmers and social groups who provided own labour for ploughing and sourced for own grass seeds. The Kenya Agricultural and Livestock Research Organization played key roles throughout the value chain, including provision of startup seeds, training producers on agronomic practices, and linking producers to the markets. Traders were found to dominate fodder markets; they bought grass seeds from the producers at low prices and sold mainly to international organizations. The main buyers of grass seeds in the study areas were United Nations Food and Agriculture Organization (FAO) and Red Cross Society of Kenya, which then distributed them to producers as free start-up seeds elsewhere in and outside the country. Hay and grass seed markets were found to be generally informal and unregulated.

The results showed that fodder production has a cost-benefit ratio of 1.73, which implies that it is a profitable venture for the pastoral and agro-pastoral households in the study areas. However,

market performance and efficiency analyses indicated that producers gain relatively less profits from the sale of their produce than traders. This was shown by the producers' lower share of the consumer prices especially in the marketing channels which offered the highest consumer prices. The results of the binary logit regression indicated that gender, membership to a producer group and access to extension services by the households had significant and positive influence on adoption of fodder production. Households' membership to a producer group was found to increase the probability of their participation in fodder production by 29%, while access to extension services was found to increase chances of fodder production adoption by 49%.

In view of these results, efforts aimed at enhancing households' participation in fodder production in the study areas should promote up take of range reseeding technology. This is likely to succeed in promoting participation as pasture reseeding is already preferred by the pastoral and agro-pastoral households in the study areas. Households should be supported to start and/or join existing groups through which extension and training services can be offered to enhance and promote fodder production in the drylands. Improving marketing and profitability of fodder products require structuring and formalization of the markets, as well as making the process of grass seed certification easy and cheap. This will help in facilitating commercialization and access to lucrative markets within and outside the country, thus increasing returns especially to the producers.

Keywords: Drylands of southern Kenya, fodder value chain, Kajiado, Makueni, pastoral and agro-pastoral households, profitability

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Livestock production plays an important role in Kenya's economic development. It contributes 40% of the agricultural Gross Domestic Product (GDP) and 10% of the total Gross Domestic Product (KARI, 2004). Most (70%) of the country's livestock population is found in arid and semi-arid lands (ASALs), which occupy above 89% of Kenyan landmass (GoK, 2015). Livestock production is the main and most reliable source of food, income and employment to households living in ASALs of Kenya (GoK, 2010). The dominant livestock holdings in such areas are cattle, goats, sheep, camels and donkeys (MacOpiyo *et al.*, 2013).

Over the years, pastoralism has remained the most practicable and resilient form of livestock production in ASALs. In a pastoral production system, livestock production relies mainly on strategic use of natural pasture and water resources which are unevenly distributed in space and time. Pastoralism has flourished under traditional management practices characterized by mobility under communal land tenure which facilitates periodic and seasonal movement of livestock by herders with respect to changes and availability of pasture and water (Sitters *et al.*, 2009; Kigumo and Muturi, 2013). Herd mobility and common access rights play an important role in enabling the livestock to utilize pastures at the peaks of their quantity and quality, and resting grazed areas to allow regeneration after use.

Although ASALs immensely contribute to the local and national economies, they experience uppermost incidences of poverty and least availability and access to essential social services and amenities such as infrastructure and education (FAO, 2005a; Fitzgibbon, 2012). Currently, most of them have been encroached by various land uses accompanied by injudicious rangeland

practices that have undermined the health and quality pastures (Wairore *et al.*, 2015). In addition to the collapse of customary resource management institutions, recurrent and severe droughts, increasing sedentarization due to subdivision of grazing lands as a result of population pressure and changes in social institutional milieu, and increase of crop cultivation have exacerbated the situation over time (Mnene *et al.*, 2004; Wasonga, 2009; Munyasi *et al.*, 2011; AfDB, 2010; FAO, 2011). Many grazing areas have remained either bare infested with undesirable and bushy invasive species (Kidake *et al.*, 2016). The result is low and poor pasture production which has been regarded as one of the most limiting factors to livestock production in ASALs of Kenya (GoK, 2011). The result of this situation is highly vulnerable pastoral environments and livelihoods. Violent conflicts over limited water and pasture resources have now been experienced more often than before among pastoral communities in Kenya, with greater adverse impacts on food security and general wellbeing of the communities (AfDB, 2010).

The increasing variability of climatic conditions has led to evolution of pastoral livelihoods aimed at adapting and coping with shocks of climate change (Notenbaert *et al.*, 2007; Thornton and Gerber, 2010; Opiyo *et al.*, 2015). Pastoralists are currently diversifying their sources of livelihood and reducing overdependence on livestock production as the main source of food and income. The most common complementary activities pursued by pastoral communities include engagement in small businesses and wage labour, as well as trading in wood, charcoal and non-timber products such as honey, gum and resins (Opiyo *et al.*, 2015).

Improvement of livestock production in the drylands of Kenya has been noted to have great potential to create opportunities, improve livelihoods and facilitate economic development among the poverty stricken livestock keepers (AfDB, 2010). So far, there is high demand for better quality pastures for increased livestock productivity (Gitunu *et al.*, 2003; Manyeki *et al.*,

2015), and this has been necessitated by the high and increasing market demand for livestock products. Fodder production and conservation has been regarded a lasting intervention for improving households' nutritional status through enhanced and subsidized livestock production (Catherine *et al.*, 2014). In view of this, the government of Kenya through Kenya Agricultural and Livestock Research Organization (KALRO) introduced a number of natural fodder improvement technologies (Dolan *et al.*, 2004; AfDB, 2010), which are increasingly being adopted by smallholder farmers in dry areas. Some of these technologies include natural pasture conservation and range pasture reseeding (Manyeki *et al.*, 2015; Kidake *et al.*, 2016). These technologies have been aimed at increasing livestock feed availability during the dry periods in addition to diversifying income through sale of hay and grass seeds (Manyeki *et al.*, 2015; Lugusa *et al.*, 2016). These interventions have been aimed at promoting growth and development for well-being of the people living in drylands. However, paucity of information on fodder value chain implies poor understanding of fodder production in terms of the existing production and marketing practices, and its contribution to households' income. In addition, adoption rate of fodder production is still comparatively low (Hall *et al.*, 2008), therefore limiting its potential in enhancing livelihoods of pastoral and agro-pastoral communities living in the drylands. This study was therefore aimed at analyzing fodder production as a livelihood strategy for enhancing resilience of households' livelihoods in the face of climatic extremes in the drylands of Kenya. Specifically, this study characterized fodder value chain, evaluated profitability of fodder production and its contribution to households' income, and assessed factors that determine households' participation in fodder production.

1.2 Statement of the Problem

Pasture scarcity has remained a major limiting factor to livestock production in the drylands of Kenya (GoK, 2015). Frequent occurrence of droughts is the main cause of pasture scarcity, a situation which has been exacerbated by increasing climate variability (IPCC, 2014). Decline in forage for livestock has not only resulted in low livestock production, but also huge livestock mortalities. For instance, the severe drought experienced in Kenya between 2009 and 2011 was a major drawback to pastoral livestock production in the drylands as it led to massive mortality of livestock populations. The main effect of such losses is impoverishment that leads to more vulnerable pastoral and agro-pastoral households (Joosten *et al.*, 2014). By undermining livestock production, which is the mainstay of pastoral and agro-pastoral economy, pasture scarcity negatively affects resilience of pastoral livelihoods.

Fodder production and conservation have been regarded as a crucial lasting intervention for augmenting households' nutritional and income sources through enhanced livestock production (Catherine *et al.*, 2014). Some of the fodder production technologies that have been introduced in the drylands include natural pasture conservation and management mainly through enclosures, and range pasture improvement through reseeding (Kidake *et al.*, 2016). A number of studies have been conducted on fodder production, especially through enclosures in West Pokot (Mureithi *et al.*, 2015; Wairore *et al.*, 2015), and Baringo County (Wasonga, 2009; Mureithi *et al.*, 2015). However, little has been done in the rangelands of southern Kenya, and specifically no study has been conducted to fully analyze fodder value chain in these areas.

1.3 Justification of the study

Fodder production has been widely promoted in the drylands of Kenya to address the problem of pasture scarcity and as a livelihood diversification strategy for agro-pastoral and pastoral

households to complement income from livestock production. Several studies have been done on fodder production in West Pokot (Mureithi *et al.*, 2015; Wairore *et al.*, 2015) and Baringo (Wasonga, 2009; Lugusa *et al.*, 2016) and Southern rangelands (Manyeki *et al.*, 2015; Kidake *et al.*, 2016). However, there are still knowledge gaps to be filled. For example, a study by Lugusa *et al.* (2016) focused on fodder value chain in Baringo County only focused on the contribution of fodder production to the households income with little attention given to other market players such as grass seeds and hay traders. There is therefore need to assess fodder production and marketing practices, as well as the profitability of the value chain, and contribution to incomes of the chain actors. Past studies (Irungu *et al.*, 1998, Lenne and Wood, 2004; Horne *et al.*, 2005) have reported that factors that determine participation in fodder farming vary from place to place and amongst producers, depending on socio-demographic aspects of the study population. Hence to appropriately guide fodder production in the drylands, it is necessary to generate location-specific information with regards to what influence pastoral and agro-pastoral households' participation in fodder production. This information would provide specific insights to policy and decision making aimed at enhancing adoption of fodder production among the pastoral and agro-pastoral households in the drylands of Kenya.

To fill the aforementioned knowledge gaps, the current study sort to map the fodder value chain; analyze profitability of fodder production, and its market efficiency; and determine factors that influence households' participation in fodder production in the rangelands of southern Kenya. The information generated from this study is expected to guide improvement and up-scaling of fodder production and marketing practices with a view to enhancing its profitability and sustainability among pastoral and agro-pastoral households in the drylands of Kenya.

1.4 Broad Objective

To analyze fodder production and marketing in the semi-arid rangelands of Makueni and Kajiado Counties in Southern Kenya for development and up-scaling of resilient livestock production and marketing among the pastoral and agro-pastoral communities.

1.5 Specific Objectives

The specific objectives of this study were to:

- i. Characterize fodder value chain in Makueni and Kajiado Counties in terms of production practices, marketing channels, actors and their roles, volumes traded and prices at various nodes.
- ii. Determine profitability and contribution of fodder production to the households' income in the study areas.
- iii. Assess the socio-economic factors that determine households' participation in fodder production in the study areas.

1.6 Research Questions

- i. What are the various types of fodder production and marketing practices among the pastoral and agro-pastoral communities in Makueni and Kajiado Counties?
- ii. Is fodder production profitable to households practicing it in the study areas?
- iii. What are the socio-economic factors that determine households' participation in fodder production in the study areas?

1.7 Thesis organization

This thesis has been organized into seven chapters (Figure 1.1). Chapter one comprises the general background information related to pasture production and marketing, the research

problem, rationale of the study, objectives and research questions. The second chapter presents literature review on livestock production in the ASALs of Kenya, fodder production and its role in pastoral and agro-pastoral households' wellbeing, fodder value chain and factors determining households' participation in fodder production in the drylands of Kenya. Chapter three contains the study areas and the research design. Chapter four presents the characterization of hay and grass seed value chain in southern Kenya. Profitability and efficiency of fodder production among pastoral and agro-pastoral households in southern Kenya is captured in Chapter five. Chapter six presents the determinants of pastoral and agro-pastoral households' participation in fodder production in Makueni and Kajiado Counties, Kenya. Chapter seven is a summary of conclusions and recommendations from the study.

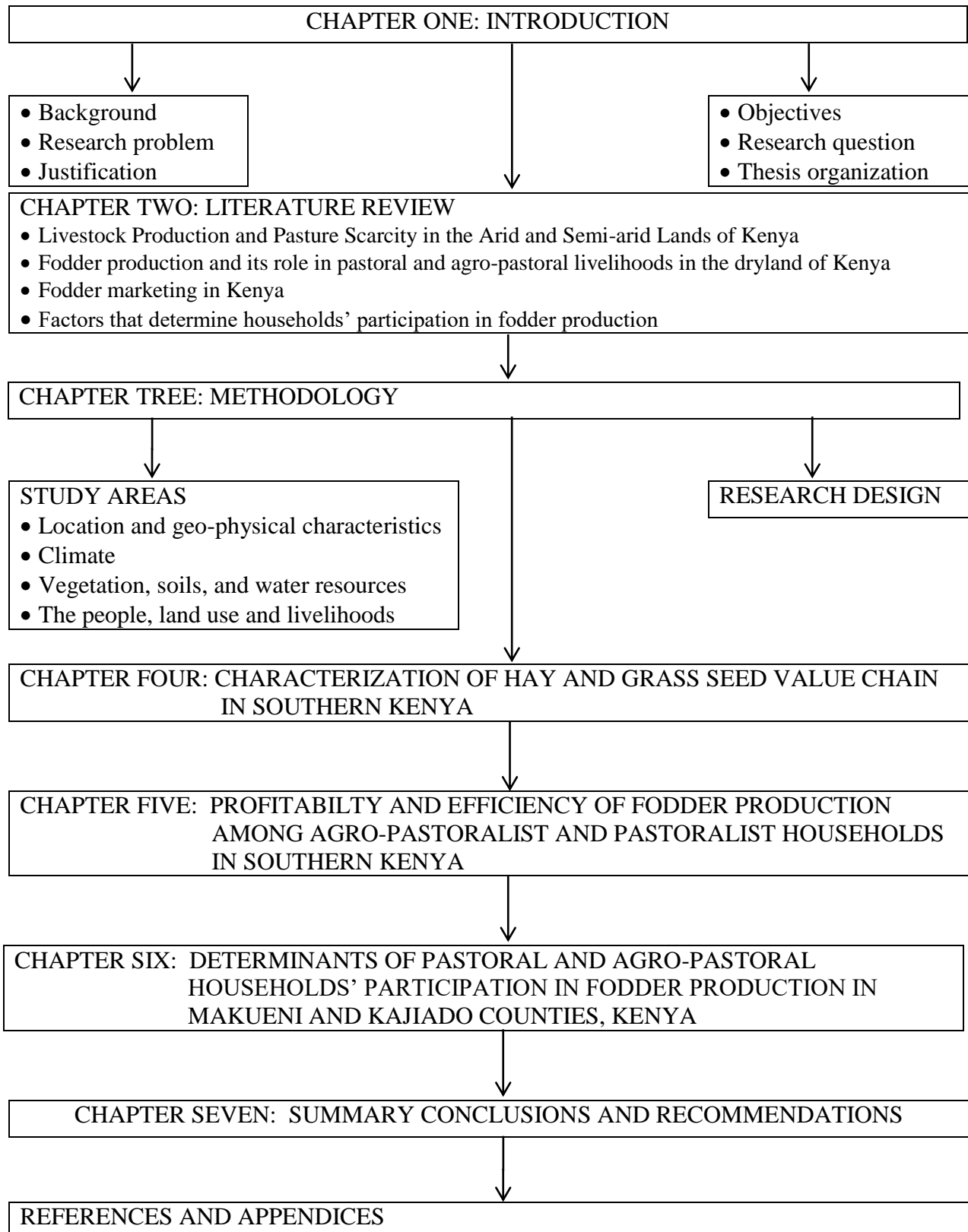


Figure 1.1: Thesis map

CHAPTER TWO

LITERATURE REVIEW

2.1 Livestock Production and Pasture Scarcity in the Arid and Semi-Arid Lands of Kenya

Livestock production is regarded as the most viable land use practice in the drylands of Africa, and has thus been embraced by communities living in such areas (Rich *et al.*, 2011; Ayele *et al.*, 2012). This is based on the fact that drylands experience low and erratic rainfall patterns (Fitzgibbon, 2012) rendering them unsuitable for crop cultivation. In the recent past, droughts have been experienced more often than before and tend to be more severe, making pasture scarcity and poor quality of pasture major constraints to livestock production in the ASALs of Kenya (Winrock, 1992; IPCC, 2014). This has been worsened by the increasing climate variability and unpredictable climatic events (IPCC, 2014).

In addition to climate variation, various socio-economic changes are taking place in pastoral societies and environments (AfDB, 2010) such as population growth, expansion of irrigated agriculture and sub-division of communal lands (Wasonga, 2009). These have led to associated high pressure on the dryland resources thus undermining their capacity to provide services such as water and pastures (Wairore *et al.*, 2015). Particularly, pastures have been characterized by poor yields and limited biomass production especially during dry seasons (AfDG, 2010). Pasture scarcity has not only led to poorer, malnourished pastoral households that are more vulnerable to the rising prices of food commodities (USAID, 2012), but has also often triggered conflicts due to competition over declining resources (Eriksen and Lind, 2009; Elhadi, 2014).

2.2 Fodder Production and its Role in Pastoral and Agro-pastoral Livelihoods in the Drylands of Kenya

Fodder production and conservation has been adopted in the drylands of Kenya to address the problem of pasture scarcity that undermines livestock production among the agro-pastoral and pastoral communities. It has the potential of increasing availability of high quality pasture, translating into high quality livestock and its products (MacOpiyo *et al.*, 2013) with the ultimate effect of improving pastoral livelihoods. Fodder production has been reported to have the capacity to augment households' nutritional status through enhancing stability of livestock production (Catherine *et al.*, 2014) and provision of surplus feeds to dairy animals (ADESO, 2012).

In Mandera County, the Enhanced Livelihoods in the Mandera Triangle (ELMT) project supported pastoral communities in enhancing livestock production through sensitizing and providing inputs for fodder farming. Increased fodder production has been reported in this area, most of which is used to feed livestock, while the surplus is sold to provide household income (VSF-Suisse, 2009). Significant benefits reported from fodder production in Baringo County have resulted in increased living standards, as well as reduced conflicts over grazing (Meyerhoff, 2012; Lugusa *et al.*, 2016). Fodder production has also been adopted in Kenya as a strategy to mitigate adverse effects of unsustainable grazing practices, as well as to rehabilitate degraded lands (Franka *et al.*, 2015). Empirical evidence shows that rehabilitation of rangelands using enclosures has significant impact in reducing soil erosion and improving water infiltration and internal drainage (Singh *et al.*, 2012). Communities around Lake Baringo basin have been able to benefit from sale of grass seeds, as well as hay from enclosures established to restore indigenous vegetation (Mureithi *et al.*, 2015). Range rehabilitation through enclosures in West Pokot County

has benefited pastoralists through the sale of grass and its seeds, as well as access to dry season grazing leading to improved livestock productivity (Wairore *et al.*, 2015). Like other communities living in the drylands, agro-pastoralists in Makueni County have embraced fodder production with the aim of increasing their livestock productivity, ensuring feed availability in the dry periods, and selling hay and grass seeds for income (Mutua, 2014). Past studies have also reported significant contribution of fodder production to households' income (USAID 2012; Meyerhoff, 2012). For instance, Meyerhoff, (2012) reported that out of 10 tonnes of indigenous perennial grass seed that is planted annually in Baringo, pastoral groups have been able to earn annual income of up to KSh1.5 million. Other benefits obtained by these households include increased and diversified livelihoods sources arising from increased livestock productivity and sale of hay and grass seed, and rehabilitation of degraded lands through pasture establishments and enclosures. However, fodder production in the drylands of Kenya has also been reported to face a number of constraints among them high costs of land preparation and grass seed, weed problems, poor seed quality, high input costs, lack of seed harvesting skills and lack of working capital (Nangole *et al.*, 2013; Manyeki *et al.*, 2015).

2.3 Fodder Marketing in Kenya

Fodder marketing in various parts of the Kenya's drylands has been documented by some of the past studies. For instance, a report by Nyanganga *et al.* (2009) on fodder marketing in Mandera indicated that fodder has been produced by pastoral households to feed own livestock, as well as for sale to other livestock keepers so as to earn extra income. The study noted that in the last five years, trading in fodder has been intensified, particularly from Mandera Kenya to Dollow in Ethiopia. This has been attributed to the increased drought frequency and severity which has pushed pastoralists to rely on purchased fodder as the main source of feed for their livestock

(Nyanganga *et al.*, 2009; Nangole *et al.* 2013). Fodder markets in these areas are supported by the active involvement of the village level traders who source for the feeds from producers and sell them to large scale traders or consumers. Performance analysis of these markets on the basis of marketing margins revealed that both producers and the traders realized high profits from fodder marketing (Nyanganga *et al.*, 2009). Agro-pastoral households in Mandera were found to sell up to 75% of the produced fodder, as the main driving factor behind fodder production was financial benefits. In addition to revenues earned from sale of fodder and livestock, and products such as milk, they utilize a portion of the produced fodder to feed own livestock, (Nyanganga *et al.*, 2009).

Currently, there are opportunities in commercial grass seed production in the drylands. However, this has not been exploited partly due to quality and standards regulations set by the Kenya Plant Health Inspectorate Station (KEPHIS). The regulations require that commercially marketed grass seeds must be certified, a process that is normally expensive to the producers (Lugusa, 2015). Despite this, fast increasing interest in fodder production in various parts of the drylands of Kenya, particularly Mandera, has motivated producers to do own seed multiplication for subsequent sowing (Nyanganga *et al.*, 2009).

A study by Nangole *et al.* (2013) on livestock feed production and marketing in Central and North Rift Valley regions of Kenya found that traders who operate as individuals or cooperative societies form a key link between fodder producers and the local and regional markets. The authors found that the traders buy fodder from the producers and sell to local or external consumers, making substantial profits. In these regions, fodder marketing has become a reliable and significant source of income to traders some of whom obtain up to 46% of their total income from it (Nangole *et al.*, 2013).

Hay and grass seed prices have been found to vary spatially and temporally, mainly due to the seasonal variations in rainfall that determine availability and supply of pastures, as well as lack of reliable and defined marketing channels (Nangole *et al.*, 2013; Lugusa, 2015). The maximum price of a kilogram of grass seed in Baringo County, for example, has been reported to be KSh. 350 (Nangole *et al.*, 2013). These prices are far much lower than in Makueni County where producers have been able to sell grass seeds at KSh. 1000 per kilogram, while rare grasses species such as rye have attracted prices as high as KSh. 1800 per kilogram (Lugusa *et al.*, 2016; Mutua, 2014). Generally, both livestock keepers and traders in Kenya have benefited from fodder marketing. However, fodder marketing in the drylands of Kenya is not without constraints. Some of the challenges facing fodder marketing include lack of working capital, fodder price fluctuations, lack of markets, and lack of seed and hay storage facilities (Nangole *et al.*, 2013). There is great variation in the prices of grass seed from place to place, which signifies that the markets are not streamlined and are largely unregulated.

2.4 Factors Determining Households' Participation in Fodder Production

Households' participation in fodder production is dependent on a number of factors (Muyekho *et al.*, 2016) which vary from region to region, as well as from farmer to farmer (Singh *et al.*, 2012). Different development agencies have employed different approaches in sensitizing and motivating communities to adopt fodder production. For instance, in Garissa County, Office of the United States Foreign Disaster Assistance (OFDA) and USAID provided grass seeds, trained fodder producers on fodder production practices, sustainable management of pasture farms and marketing (CARE, 2013a). Similar approach was used by Agricultural Productivity and Climate Change project in Ijara Sub-County of the Garissa County, where households were facilitated to produce two grass species; the African fox tail grass (*Cenchrus ciliaris*) and Sudan grass

(*Sorghum sudanese*) (Lugusa, 2015). The project further supported conservation and storage of harvested hay for use during the dry seasons when livestock feed is scarce. The project managed to increase adoption of fodder production not only among target groups but also the wider pastoral households in the County (Kuria *et al.*, 2015).

In their study on factors influencing adoption of fodders production among smallholder farmers in West Kenya, Muyekho *et al.* (2016) reported that adoption of fodder cropping was limited by lack of quality seed resources, input-output market problems, and lack of credit facilities, as well as limited extension services. Although a different study by Irungu *et al.* (1998) noted that adoption of Napier grass in Central Kenya was influenced by farmer education level, farm size, years of experience in farming and membership to cooperative group, they however observed that accessibility to credit facilities did not have any significant effect on adoption of the grass species. Another study by Lugusa (2015) assessed the factors that determine households' participation in fodder production groups in Baringo reported that livelihood options, herd size, past experience with drought, age of household head, and access to communal grazing reserves were the main factors that determine whether a household participates in fodder production group or not.

Past studies have reported that prior to adoption of new ideas, farmers learn a great deal on-farm about the performance and suitability of the technology to their farming systems and sustainability of input and product markets (Lenne and Wood, 2004). In so doing, they learn about the potential benefits and risks of the technology. It is therefore important to take into account socio-economic status of the target households when developing and introducing a new technology, particularly the fodder production technologies. This is because fodder production approaches attuned to farmers' local context are likely to be adopted.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

3.1.1 Location and Geo-physical Characteristics

The study was conducted in Makueni and Kajiado Counties located in the southern parts of Kenya (Figure 3.1) that are classified as arid and semi-arid lands (ASALs) (Amwata *et al.*, 2015). Makueni County lies between Latitude 1° 35' and 30° 00' S and Longitude 37° 10' and 38° 30' E, occupying an area of 7965.8km². It borders Kajiado County to the West; Taita Taveta County to the South; Kitui County to the East and Machakos County to the North (County Government of Makueni, 2013). Kajiado County covers an area of 21901km² and lies between longitudes 36° 5' and 37° 5' E and 1° 0' and 3° 0') (CBS, 1981). The County includes the Athi-Kaputiei ecosystem on the northern half bordering Makueni and Machakos Counties, the Greater Amboseli Ecosystem to the East bordering again Makueni and Taita Taveta Counties; and the Western Kajiado ecosystem to the West bordering Narok and Kiambu Counties (Ogutu *et al.*, 2014).

3.1.2 Climate

The study areas experience highly variable and unpredictable rainfall patterns, dry periods and long and frequent droughts typical of ASALs (Gikaba *et al.*, 2014; Amwata *et al.*, 2015). These areas are located a few degrees South of the equator and are thus exposed to strong seasonal and bimodal distribution of rainfall leading to high temporal and spatial variability between the seasons (Mganga *et al.*, 2013). The study areas experience long rains between March and May, and short rains between October and December (Gikaba *et al.*, 2014; Amwata *et al.*, 2015). They receive annual rainfall ranging from 300mm to 1250mm (Moss, 2001; County Government of Makueni, 2013). The temperatures range from 12°C to 35°C, depending on the time of day,

season and topography (Berger, 1993; County Government of Makueni, 2013; Gikaba *et al.*, 2014).

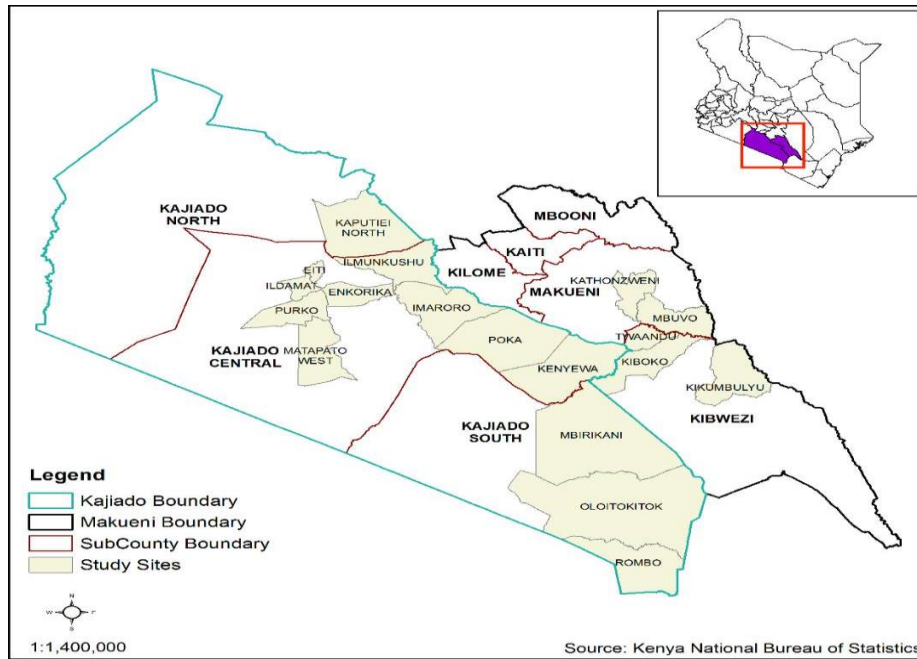


Figure 3.1: Map of Makueni and Kajiado Counties

3.1.3 Vegetation, Soils and Water Resources

There is a wide diversity of vegetation in the study areas, which arise from heterogeneity of soil types and rainfall patterns and amounts and other climatic factors (Kidake *et al.*, 2016). Larger part (80%) of Kajiado is an arid to semi-arid savanna with main habitats being open grass plains, acacia woodlands, rocky thorn bush lands, swamps and marshlands (Ogutu *et al.*, 2014). The main soil types in Kajiado County include poorly developed and shallow clayey soils in the floodplains; brown calcareous clay loams, sandy soils, ash and pumice soils in the higher elevations, as well as basement rock soils which dominate large areas of the County.

In Makueni County, the main soils include Ferrasols, Cambisols and Luvisols attributed to strong surface-sealing characteristics that lead to run-offs when heavy rains occur. The vegetation mainly comprise *Commiphora* and *Acacia* species and related genera notably of shrubby species,

with dominant grasses being *Cenchrus ciliaris*, *Eragrostis superba*, *Chloris roxburghiana* and *Enteropogon macrostachyus* (Mganga *et al.*, 2013).

Athi River, which is the main river in Makueni County, provides high potential for irrigated farming. In Kajiado County, there are permanent wetlands that occupy approximately 2% of the County (Gichuki *et al.* 2001). They are, in addition to seasonal rivers, such as River Namanga, artificial boreholes and water dams, the main sources of water for humans, livestock and wildlife use in the County (Ogutu *et al.*, 2014).

3.1.4 The People, Land Use and Livelihoods

Majority of the people living in Makueni County are agro-pastoralists belonging to the Akamba ethnic community, whereas Kajiado County is predominantly inhabited by the pastoral Maasai community (Gikaba *et al.*, 2014; Mganga *et al.*, 2013). Livestock production is the main source of livelihood in both Counties (Mganga *et al.*, 2013). Majority of the households in these Counties are small-holder subsistence farmers and/or livestock keepers who depend on rainfall for their livelihoods (Amwata *et al.*, 2015). Kajiado County has a population of 687,312 people by 2009 (CBS, 2009) with a growth rate of above 4%, surpassing the national average of 3.1% (Campbell *et al.*, 2003). This growth rate is associated with expansion of urban centers, infrastructure development, which is attracting greater human settlements in the County (Okello and Kioko, 2011). Land tenure and land use in Kajiado County have gradually changed over the years. Private land ownership is fast replacing the communal ownership system; subdivision and commercialization of communal rangelands to secure legal title to land have also become common. The economic liberalization and facilitated access to national and international markets in Kenya have led to the fast expanding irrigated horticultural production in riparian zones in

these areas. This is very common in most perennial swamps at the base of Mt. Kilimanjaro, woodlands and riverine areas (Kioko and Okello 2010).

Makueni County had a human population of 884,527 in the last national census conducted in 2009, with an annual growth rate of 2.8% (CBS, 2009; Mganga *et al.*, 2013). The County has potential in horticulture and dairy farming especially in the hilly regions. The lowlands are used for livestock production, cotton and fruit production, and the main fruits grown include mangoes, pawpaw and oranges. The main food crops produced in the County are maize, green grams, pigeon peas and sorghum (County Government of Makueni, 2013).

3.2 Research Design

Makueni and Kajiado Counties were purposively selected based on their active participation in the Agricultural Research Supports Program phase two (ARSP-II) that was initiated in 1998 by the Kenya Agricultural and Livestock Research Organization (KALRO) (Mnene *et al.*, 1999; Manyeki *et al.*, 2013). Three sub-counties were then selected from each County based on their adoption of various fodder production technologies that were generated and disseminated by KALRO under the ARSP-II program. In Makueni County, the selected sub-counties included Kathonzueni, Makindu and Kibwezi while in Kajiado County, Kajiado Central, Oloitoktok and Mashuru sub-counties were selected for the study. The target population for the study involved input suppliers, hay and grass seed producers, traders, County government officials, NGOs, as well as households that were not participating in fodder production in the two Counties.

Data was collected through household interviews using semi-structured questionnaire and was complemented by key informant interviews (KIIs) and focus group discussions (FGDs) between June and August 2016. KIIs and FGDs participants were purposively identified based on their key roles and involvement in the fodder value chain. A total of 11 FGDs of 10-12 participants

each and 38 KIIs were conducted in the two study areas. Systematic random sampling procedure as described by Mugenda and Mugenda (1999) was used in this study where 36 households were sampled in each of the 6 sub-county, resulting in selection of 216 households for interviews. The first household was randomly chosen and the subsequent respondents were systematically selected after every second household. The sample size for this study was determined using the probability proportional to size formula developed by Kothari (2004) as follows:

$$n = \frac{Z^2(1-p)p}{e^2} \dots\dots\dots 3.1$$

Where n is the sample size, Z is the desired Z-value yielding the desired degree of confidence, p is an estimate of the population proportion, and e is the absolute size of the error in estimating p that the researcher will be willing to permit. In this study p-value of 0.5 was used because a proportion of 0.5 gives a statistically adequate and reliable size particularly when the population proportion is not known as it was in this case. The study used 95% level of confidence. Using p-value the Z value was 1.96 (two tailed), with an allowable error of 0.0667. These values were substituted into the formula to calculate the sample size as follows;

$$n = \frac{1.96^2(0.5)0.5}{0.0667^2} = 216$$

CHAPTER FOUR

FODDER PRODUCTION PRACTICES IN THE DRYLANDS: A CHARACTERIZATION OF HAY AND GRASS SEED VALUE CHAIN IN SOUTHERN KENYA

ABSTRACT

Fodder production has been adopted by communities living in the drylands of southern Kenya in response to feed scarcity, as well as to diversify their sources of livelihood. However, there is no adequate empirical evidence to guide interventions aimed at strengthening production and marketing of fodder in drylands. This study was conducted to characterize fodder production and marketing practices in Makueni and Kajiado Counties. The results show that fodder production was dominated by males, representing 74% of the sampled producers. Most (91%) of them owned less than 10 acres of pastures. The common production practices reported by producers included land clearing and ploughing, as well as range reseeding. The choice of these practices was mainly influenced by gender, education and membership to social groups that produce fodder. The findings also reveal that Kenya Agricultural and Livestock Research Organization plays key roles in fodder value chain such as generation and dissemination of fodder production technologies and linking the producers to markets. Fodder production in the study areas remains low leaving a big demand gap, especially for the grass seed. Interventions targeting intensification and expansion of fodder production in the study areas should promote adoption of range reseeding technology. This is likely to enhance chances of success as range pasture reseeding is preferred and already being practiced by the pastoral and agro-pastoral communities in the study areas.

Keywords: Drylands, fodder value chain, Kajiado, Makueni, rangelands of southern Kenya

4.1 Introduction

Livestock production is the main economic activity among the pastoral and agro-pastoral communities living in the vast ASALs of Kenya (Macharia *et al.*, 2015; Kidake *et al.*, 2016). Over 14 million people and 70% of the country's total livestock population, mainly cattle, goats, sheep and camels are found in the drylands (McOpiyo *et al.*, 2013). The livestock sub-sector employs about 90% of the ASALs population which derive up to 95% of their households' income from livestock and their products (GoK, 2003, GoK, 2010).

Despite the contribution of livestock to both local and national economies, quick succession of droughts that leads to pasture scarcity has dealt a major set-back to livestock production in the drylands. In addition, population pressure and injudicious land use practices have accelerated natural pasture degradation (Alemu *et al.*, 2000; Mnene *et al.*, 2004; Wasonga, 2009; Munyasi *et al.*, 2011), leaving many grazing lands bare or infested with undesirable and invasive species (Kidake *et al.*, 2016). Pasture degradation has therefore been regarded as one of the most limiting factors to livestock production in the ASALs of Kenya (GoK, 2011). The situation has been exacerbated by increasing climate variability that is likely to be more unpredictable and destructive in the future (IPCC, 2014) thereby further undermining the resilience of pastoral environments and livelihoods.

Fodder production and conservation has been considered as a key intervention for improving households' nutritional status through enhanced livestock production (Mnene, 2006; Catherine *et al.*, 2014). Fodder farming has also been reported as a key source of alternative feeds for dairy farming which is fast expanding in peri-urban regions of Kenya. This is evident in Kajiado County where dairy production has been reported to be a profitable enterprise (MacOpiyo *et al.*, 2013). In response to high demand for quality pastures to enhance livestock productivity, various

fodder production technologies have been introduced and promoted in the drylands (Gitunu *et al.*, 2003; Manyeki *et al.*, 2015). Some of these technologies include enclosure of natural pastures to allow regeneration, and range reseeding through over sowing (Manyeki *et al.*, 2015; Kidake *et al.*, 2016).

In 1998, the government of Kenya in collaboration with other development agencies introduced several natural fodder improvement technologies in the dryland of Kenya (Mnene *et al.*, 1999; Dolan *et al.*, 2004). These technologies were aimed at increasing livestock feed availability during the dry periods in addition to diversifying income through the sale of hay and grass seed among communities living in the ASALs (Manyeki *et al.*, 2015; Lugusa *et al.*, 2016).

Various studies have been conducted in Kenya on fodder production, especially on range enclosure systems. These studies have reported that pastoral communities in Baringo and West Pokot Counties, for example, produce fodder with the aim of ensuring feed availability during dry seasons, as well as sale of surplus hay and grass seeds for income (Lugusa *et al.*, 2016; Mureithi *et al.*, 2015; Wairore *et al.*, 2015). Besides rehabilitation of degraded range, some of the benefits reported to result from range enclosures include availability of fodder in the dry periods, better management and use of pastures, improved livestock health and productivity, reduced conflicts over grazing, and improved living standards (Beyene, 2009; Meyerhoff 2012; Desta *et al.*, 2013; Wairore *et al.*, 2015). These findings have been consistent with those of Channer (2013) that the enclosures serve as natural fodder banks, preserved for use during the dry periods for communities in Baringo County. In addition, Makokha *et al.* (1999), Kitalyi *et al.* (2002), RAE (2004), and Lugusa *et al.* (2016) reported that enclosures are instrumental in enhancing income generation, improving living standards and reducing dependence on food aids in Kenya's drylands. The increasing trend of adoption of range reseeding using enclosures among the agro-

pastoralists around Lake Baringo, for example, has been attributed to its potential in securing livestock production and therefore pastoral livelihoods (Kitalyi *et al.*, 2002; Beyene, 2009), especially in the face of climate variability and change.

In Makueni and Kajiado Counties, fodder improvement practices have recorded successes among agro-pastoralist and pastoralist communities due to their successful trials for rehabilitation of degraded natural pastures in these areas (Mnene *et al.*, 1999). The success could also be attributed to use of local grass species that are adapted to the dry environments, and whose seeds are readily available from natural pastures (Mnene *et al.*, 1999). The common grasses in these areas include *Eragrostis superba*, *Cenchrus ciliaris*, *Chloris roxburghiana* and *Enteropogon macrostachyus*.

It is evident from the previous studies that fodder production contributes not only to reliable but also improved availability of feeds for livestock in the drylands. It has also offered an alternative source of livelihood, therefore reducing overdependence on livestock production among pastoral and agro-pastoral communities. Despite the reported benefits, a better understanding of the fodder value chain is still crucial in informing development and up-scaling of fodder production in the drylands.

A number of studies have been done in the southern Kenya rangelands to investigate mainly the productivity, nutritional quality and suitability of indigenous grass species for the drylands. However, none of the studies has attempted to analyze fodder and grass seed value chain in the area. This study was therefore conducted to characterize fodder value chain in Makueni and Kajiado Counties located in the drylands of southern Kenya with the aim of informing development and up-scaling of the fodder value chain in the drylands of Kenya.

4.2 Sampling Procedure and Data Collection

Purposive and systematic sampling approaches were used to select respondents for the study as described in chapter three of this thesis. In order to characterize hay and grass seed production and marketing practices in the two Counties, this study targeted individual households that have adopted various fodder production practices, commercial fodder producers, social groups, as well as other players including traders, and officials from government departments and NGOs that work with the communities in promoting fodder production.

A semi-structured questionnaire was administered to 131 households that were involved in hay and grass seed production to capture information on socio-economic and demographic characteristics of the respondents, and general production and marketing practices. Eleven focus group discussions (FGDs), each consisting of 10 –12 participants, were conducted with identified social groups that are producing fodder. In addition, 38 key informant interviews (KIIs) were conducted with selected farmers, service providers, private commercial producers, hay and grass seed traders, as well as relevant government and NGO officials. The key informants were interviewed on sources of inputs, amounts of hay and grass seeds produced and marketed, hay and grass seed marketing channels, and constraints encountered along the value chain. The FGDs and KIIs were mainly used to gain in-depth understanding of the key players, their roles, marketing channels, and hay and grass seed prices at various nodes of the fodder value chain.

4.3 Data Analysis

Information from key informant interviews and focus group discussions were collated and summarized to characterize hay and grass seed value chain, showing key players at various nodes, their roles as well as marketing channels and prices. Data from household interviews was analyzed using the Statistical Package for the Social Sciences (SPSS) version 22 to generate

descriptive statistics on the socio-demographic characteristics of the respondents and fodder production practices in the study areas. Chi-square test was used to determine if there were significant differences in production practices based on household characteristics of the respondents.

4.4 Results and Discussions

4.4.1 Socio-Demographic Characteristics of Fodder Producers and Production Practices

4.4.1.1 Size of land under fodder production in Makueni and Kajiado Counties

Table 4.1 indicates the size of land used for fodder production segregated by selected producer characteristics. Most farmers (91%) were mainly small-scale producers owning less than 10 acres of fodder especially those who practiced reseeding, majority (55%) of whom were found to be 31 to 50 years old and educated up to primary level (40%). The size of land under fodder was significantly ($p < 0.1$) different across gender of the producers.

Table 4.1: Land under fodder production

Household characteristics		Size of land under fodder production (acres)				Chi-square	p-value
		0.5 – 10	11 – 20	>20	Total		
Gender	Male	86 (65.6)	3 (2.3)	8 (6.1)	97 (74.0)	7.314***	0.063
	Female	34 (26.0)	0 (0.0)	0 (0.0)	34 (26.0)		
Age(years)	21 – 30	8 (6.1)	0 (0.0)	1 (0.8)	9 (6.9)	1.903	0.862
	31 – 40	23 (17.6)	3 (2.3)	2 (1.5)	28 (21.4)		
	41 – 50	41 (31.3)	1 (0.8)	3 (2.3)	44 (33.6)		
	51 – 60	17 (13.0)	0 (0.0)	0 (0.0)	17 (13.0)		
	61 – 70	24 (18.3)	1 (0.8)	0 (0.0)	25 (19.1)		
	> 70	7 (5.3)	0 (0.0)	1 (0.8)	8 (6.1)		
Education	None	17 (13.0)	2 (1.5)	3 (2.3)	22 (16.8)	9.455**	0.024
	Primary	46 (35.1)	3 (2.3)	2 (1.5)	51 (38.9)		
	Secondary	40 (30.5)	0 (0.0)	1 (0.8)	41 (31.3)		
	Tertiary	17 (13.0)	0 (0.0)	0 (0.0)	17 (13.0)		
Group membership	Yes	87 (66.4)	2 (1.5)	4 (3.1)	93 (71.0)	1.577	0.209
	No	33 (25.2)	0 (0.0)	5 (3.8)	38 (29.0)		

Source: Household interviews (N=131); * $p < 0.01$, ** $p < 0.05$, *** $p < 0.1$; Percentages are in parentheses

All producers who had more than 10 acres (8.4%) of fodder were males. Fodder farm sizes varied significantly ($p < 0.05$) with the level of education of the producers. Contrary to the expectations, it was found that the few fodder producers who had more than 10 acres of pasture were either not educated or only had primary education.

4.4.1.2 Fodder production technologies

The two main fodder production technologies embraced by pastoral and agro-pastoral communities include range reseeding and fencing of natural pastures to allow regeneration as shown in Table 4.2. Range reseeding was the most common approach, practiced by 48% of farmers. Thirty six percent of the farmers fenced natural pastures to allow rest and regeneration, while the rest (16%) combined both range reseeding and natural regeneration through enclosures but on separate plots. The adopted production technologies significantly varied with the age of the producers at $p < 0.01$. Whereas majority (33.6%) of fodder producers who had adopted range reseeding technologies were generally of middle age (31 to 50 years), the enclosure technology was widely adopted across the age categories, but mostly among older producers. Range reseeding has been regarded as a labour intensive approach (Manyeki *et al.*, 2015 and Mnene, 2006) and this could have been the reason why most producers who had adopted it were comparatively younger and therefore capable of providing the needed labour. In addition, the study areas are dominated by low income households which may not be able to afford hired labour for range reseeding. On the other hand, fencing of natural pastures to allow regeneration does not require much labour and this could explain why it was found to be more common among older producers.

Table 4.2: Pasture production technologies practiced by producers

Household characteristics	Pasture production technology					Chi-square	p-value
	Range reseeded	Fencing of natural pasture	Reseeding & fencing	Total			
Gender	Male	45 (34.4)	37 (28.2)	15 (11.5)	97 (74.0)	0.835	0.659
	Female	18 (13.7)	10 (7.6)	6 (4.6)	34 (26.0)		
Age(years)	21 – 30	5 (3.8)	1 (0.8)	3 (2.3)	9 (6.9)	24.367*	0.007
	31 – 40	17 (13.0)	10 (7.6)	1 (0.8)	28 (21.4)		
	41 – 50	27 (20.6)	11 (8.4)	6 (4.6)	44 (33.6)		
	51 – 60	7 (5.3)	9 (6.9)	1 (0.8)	17 (13.0)		
	61 – 70	6 (4.6)	11 (8.4)	8 (6.1)	25 (19.1)		
	> 70	1 (0.8)	5 (3.8)	2 (1.5)	8 (6.1)		
Education	None	3 (2.3)	18 (13.7)	1 (0.8)	22 (16.8)	29.338*	0.000
	Primary	24 (18.3)	19 (14.5)	8 (6.1)	51 (38.9)		
	Secondary	25 (19.1)	8 (6.1)	8 (6.1)	41 (31.3)		
	Tertiary	11 (8.4)	2 (1.5)	4 (3.1)	17 (13.0)		
Group membership	Yes	52 (39.7)	27 (20.6)	14 (10.7)	93 (71.0)	8.458**	0.015
	No	11 (8.4)	20 (15.3)	7 (5.3)	38 (29.0)		

Source: Household interviews (N=131); *p < 0.01, **p < 0.05, ***p < 0.1; Percentages are in parentheses

The adopted production technologies varied significantly ($p < 0.01$) among the producers with different education levels. Most (28.2%) producers who had adopted enclosure system were mainly those who were either not educated or had only primary education, while majority (27.5%) of the producers who practiced pasture reseeded had attained either secondary or tertiary education. This finding could be attributed to the fact that educated producers are likely to have more understanding and therefore easily appreciate use of various technologies such as range pasture reseeded.

Majority (39.7%) of producers who have adopted range reseeded technology in fodder production were found to be members of specific fodder producing social groups. On the other hand, those who produced pastures through fencing to allow regeneration were dominated by individuals who did not participate in any fodder producing social groups. Participation in such groups was found to be significantly ($p < 0.05$) higher among producers who had adopted range

reseeded than producers who had enclosures. These findings are similar to those of Manyeki et al. (2013) that age, land ownership, education level and participation in groups are the most important factors affecting households' adoption of fodder production practices among communities living in arid and semi-arid areas of Kenya.

4.4.1.3 Methods of land preparation

The three most common land preparation practices reported in the study areas included clearing and ploughing of the land, clearing without ploughing, as well as use of range pits for planting grass. Table 4.3 indicates that among those who had adopted range reseeding practices, land clearing and ploughing was the dominant method with 72.6% of farmers practicing it. Only 6% of the sampled producers practiced land clearing without ploughing, while 21.5% were found to make use of range pits.

Table 4.3: Land preparation methods

Household characteristics		Methods of land preparation			Total	Chi-square	p-value
		Clearing & ploughing	Clearing	Range pits			
Gender	Male	41 (48.8)	4 (4.8)	15 (17.9)	60 (71.4)	1.961	0.375
	Female	20 (23.8)	1 (1.2)	3 (3.6)	24 (28.6)		
Age(years)	21 – 30	3 (3.6)	1 (1.2)	4 (4.8)	8 (9.5)	11.301	0.335
	31 – 40	15 (17.9)	1 (1.2)	2 (2.4)	18 (21.4)		
	41 – 50	24 (28.6)	2 (2.4)	7 (8.3)	33 (39.3)		
	51 – 60	7 (8.3)	0 (0.0)	1 (1.2)	8 (9.5)		
	61 – 70	11 (13.1)	1 (1.2)	2 (2.4)	14 (16.7)		
	> 70	1 (1.2)	0 (0.0)	2 (2.4)	3 (3.6)		
Education	None	1 (1.2)	3 (3.6)	0 (0.0)	4 (4.8)	12.652*	0.049
	Primary	25 (29.8)	7 (8.3)	0 (0.0)	32 (38.1)		
	Secondary	25 (29.8)	4 (4.8)	4 (4.8)	33 (39.3)		
	Tertiary	10 (11.9)	4 (4.8)	1 (1.2)	15 (17.9)		
Group membership	Yes	51 (60.7)	4 (4.8)	11 (13.1)	66 (78.6)	4.184	0.123
	No	10 (11.9)	1 (1.2)	7 (8.3)	18 (21.4)		

Source: Household interviews (N=84); *p < 0.01, **p < 0.05, ***p < 0.1; Percentages are in parentheses

Education level was higher among producers who had embraced land clearing and ploughing than those who did not plough their land in preparation for planting. The results in Table 4.3

show that producers practicing clearing and ploughing were mostly those with secondary and tertiary education (41.7%). On the other hand, the largest proportion (8.3%) of producers who did not plough their farms had only primary education. Generally, the education level of producers who cleared and ploughed their farms during preparation were significantly ($p < 0.05$) higher than those who did not, while gender, age and group membership showed no significant influence on the method of land preparation used by the producers.

4.4.1.4 Methods of pasture reseeding

Table 4.4 shows the various methods of pasture reseeding, which include broadcasting on ploughed land, planting in lines either as pure or mixed stands on ploughed land and over-sowing on unploughed land. These methods were used by 48%, 38% and 14% of the sampled producers respectively. This finding is consistent with that of Lugusa *et al.* (2016) who found broadcasting to be the most practiced seed sowing method among fodder producers in Baringo County. Sowing method varied significantly ($p < 0.01$) among the producers participating in social groups and those who did not participate in such groups. About 40.5% of those who adopted broadcasting and 33.3% of those who planted grass seeds in lines were members of fodder producing social groups. This could be attributed to the tendency of many organizations such as Red Cross Society of Kenya, FAO and extension agents to disseminate fodder production technologies through existing groups in the study areas. Also, the producers in the study area have been actively involved through such groups, in demonstrations, farmer field days and other important platforms for learning and sharing fodder production technologies. Gender, age and education of the producers did not have any significant influence on the pasture reseeding methods adopted by the producers.

Table 4.4: Methods of pasture reseeding

Household characteristics		Pasture reseeding methods			Total	Chi-square	p-value
		Broadcast on ploughed land	Plant in lines on ploughed land	Oversow on unploughed land			
Gender	Male	28 (33.3)	22 (26.2)	10 (11.9)	60 (71.4)	0.986	0.611
	Female	12 (14.3)	10 (11.9)	2 (2.4)	24 (28.6)		
Age (years)	21 – 30	2 (2.4)	2 (2.4)	4 (4.8)	8 (9.5)	13.925	0.176
	31 – 40	7 (8.3)	9 (10.7)	2 (2.4)	18 (21.4)		
	41 – 50	18 (21.4)	11 (13.1)	4 (4.8)	33 (39.3)		
	51 – 60	3 (3.6)	5 (6.0)	0 (0.0)	8 (9.5)		
	61 – 70	8 (9.5)	4 (4.8)	2 (2.4)	14 (16.7)		
	> 70	2 (2.4)	1 (1.2)	0 (0.0)	3 (3.6)		
Education	None	2 (2.4)	1 (1.2)	1 (1.2)	4 (4.8)	1.638	0.950
	Primary	16 (19.0)	13 (15.5)	3 (3.6)	32 (38.1)		
	Secondary	15 (17.9)	13 (15.5)	5 (6.0)	33 (39.3)		
	Tertiary	7 (8.3)	5 (6.0)	3 (3.6)	15 (17.9)		
Group membership	Yes	34 (40.5)	28 (33.3)	4 (4.8)	66 (78.6)	17.083*	0.000
	No	6 (7.1)	4 (4.8)	8 (9.7)	18 (21.4)		

Source: Household interviews (N=84); *p < 0.01, **p < 0.05, ***p < 0.1; Percentages are in parentheses

4.4.1.5 Grass seed production

Grass seed production was found to be very low in the study area with only 32% of the 131 fodder producers practicing it, all being small scale producers (Table 4.5). Lack of knowledge and high labour requirements of grass seed production were reported to be the most limiting factors to the practice. This finding is consistent with that reported by Ndathi (2013) and Kidake et al. (2016) that lack of seed production and handling skills is a major constraint to grass seed production in Makueni County. High labour requirement especially during harvesting and other post-harvest handling of seed was particularly mentioned as a deterrent to the practice. The respondents reported having been faced with a tough decision on either to go for high quality pasture, which means harvesting grass before seed maturity or harvesting at a later stage in order to obtain high quality seeds as well. Given that most farmers were interested in feeding their livestock, they mainly harvested hay just after flowering and before seed maturity.

Table 4.5 shows that adoption of grass seed production by fodder producers is influenced by various socio-demographic characteristics of the households. Specifically, seed production varied significantly with gender ($p < 0.1$), age ($p < 0.01$), education ($p < 0.01$) and membership to social group ($p < 0.1$). Grass seed production was dominated by males (26.7%) in the age bracket of 31–50 (22.1%) most of whom were members of fodder groups (26%) and had secondary and tertiary education (22.9%).

Table 4.5: Grass seed production among the sampled households

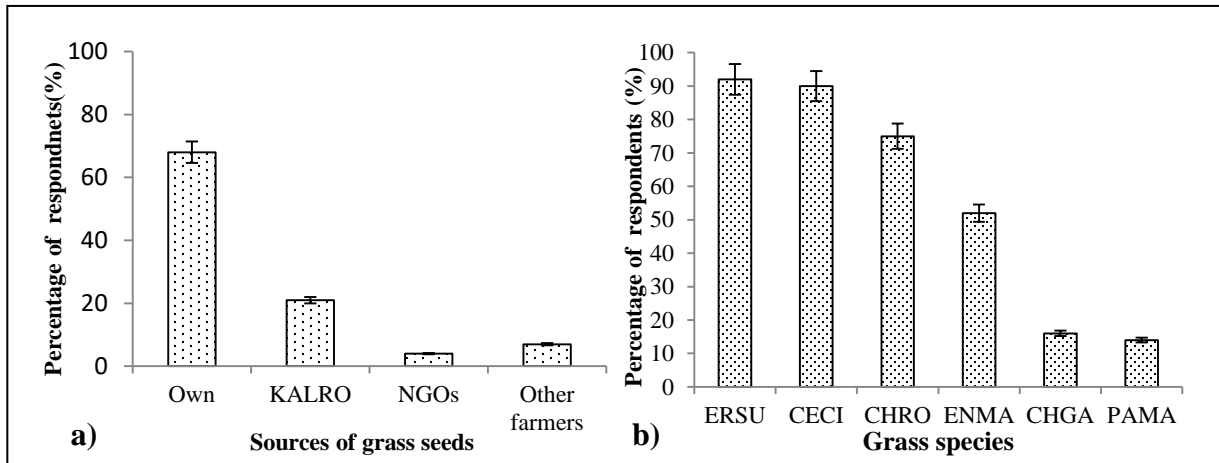
Household characteristics		Proportion of Respondents Producing grass seed			Chi-square	p-value
		Yes	No	Total		
Gender	Male	35 (26.7)	62 (47.3)	62 (74.0)	2.775***	0.096
	Female	7 (5.3)	27 (20.6)	34 (26.0)		
Age (years)	21 – 30	6 (4.6)	3 (2.3)	9 (6.9)	15.860*	0.007
	31 – 40	11 (8.4)	17 (13.0)	28 (21.4)		
	41 – 50	18 (13.7)	26 (19.8)	44 (33.6)		
	51 – 60	2 (1.5)	15 (11.5)	17 (13.0)		
	61 – 70	5 (3.8)	20 (15.3)	25 (19.1)		
	> 70	0 (0.0)	8 (6.1)	8 (6.1)		
Education	None	1 (0.8)	21 (16.0)	22 (16.8)	124.449*	0.000
	Primary	11 (8.4)	40 (30.5)	51 (38.9)		
	Secondary	18 (13.7)	23 (17.6)	41 (31.3)		
	Tertiary	12 (9.2)	5 (3.8)	17 (13.0)		
Group membership	Yes	34 (26.0)	59 (45.0)	93 (71.0)	2.9778***	0.084
	No	8 (6.1)	30 (22.9)	38 (29.0)		

Source: Household interviews (N=131); * $p < 0.01$, ** $p < 0.05$, *** $p < 0.1$; Percentages are in parentheses

4.4.2 Grass Species Grown and Sources of Seeds

Harvesting of grass seeds from the naturally growing pastures was the dominant source of startup seeds for reseeded (68%) for producers besides donation from KALRO (21%) (Figure 4.1b). The main grass species grown in the study areas were found to be *Eragrostis superba* (ERSU), *Cenchrus ciliaris* (CECI), *Chloris roxburgiana* (CHRO) and *Enteropogon macrostachyus* (ENMA) (Figure 4.1a). As reported in earlier studies (Mganga, 2013; Mwaura, 2015; Manyeki *et al.*, 2015; Kidake *et al.*, 2016), they were preferred because of their adaptation to the local environments, palatability to livestock and high biomass production. Other species included

Panicum maximum (PAMA) and *Choris gayana* (CHGA), the latter which was mainly grown due to availability of its seed in the formal market (MacOpiyo *et al.*, 2013). In a study conducted in Tana River County by Koech (2014) CECI and CHGA were found to have the highest biomass and crude protein compared to *Chloris roxburghiana*, *Eragrostis superb*, *Enteropogon macrostachyus*, and *Sorghum sudanense*. All these grass species have however been found to have high water use efficiency making them suitable for fodder improvement in regions receiving limited rainfall (Mwaura, 2015). Drought tolerance, quick response to rains as well as high palatability of these grasses have led to their wide acceptance among communities living in the drylands (Marshall *et al.*, 2012).



Source: Household interviews (N=131)

Figure 4.1: Grass species grown (a) and sources of grass seeds (b) in the study areas

4.4.3 Hay and Grass Seed Value Chain Map

Figure 4.2 shows fodder value chain map for the study sites; the various stages of the chain, activities undertaken, support services and the main actors at various nodes of the chain. Those involved in fodder production were mainly farmers (agro-pastoralists and pastoralists) and Community Based Organizations (CBOs) who provided own labour for ploughing and sourced for startup seeds mainly from the natural pastures. Organizations such as FAO and Red Cross Society of Kenya, as well as government institutions such as KALRO provided free startup grass

seeds to some producers. Fodder was produced by various parties including farmers who mainly produced for own use, a few commercial producers, CBOs and KALRO which did not only produce for sale but also used their farms for research, training and demonstration purposes. Extension agents were also found to be important actors at the production level because of their role in training farmers on new fodder production technologies. Baling of hay and seed harvesting and drying, bulking and packaging, were mostly done manually given that most producers were small scale farmers that could hardly afford mechanized systems. Interviews with key informants revealed that there is a growing demand for mechanized land preparation and grass harvesting, which has led to the entry of private harvesting and post-harvesting service providers. KALRO was reported to train farmers on harvesting and post-harvest handling of hay and grass seed for quality assurance. Hay was mainly sold to neighboring livestock keepers, while grass seed was mostly sold to the service providers, particularly NGOs, KALRO and local bulkers (Figure 4.2).

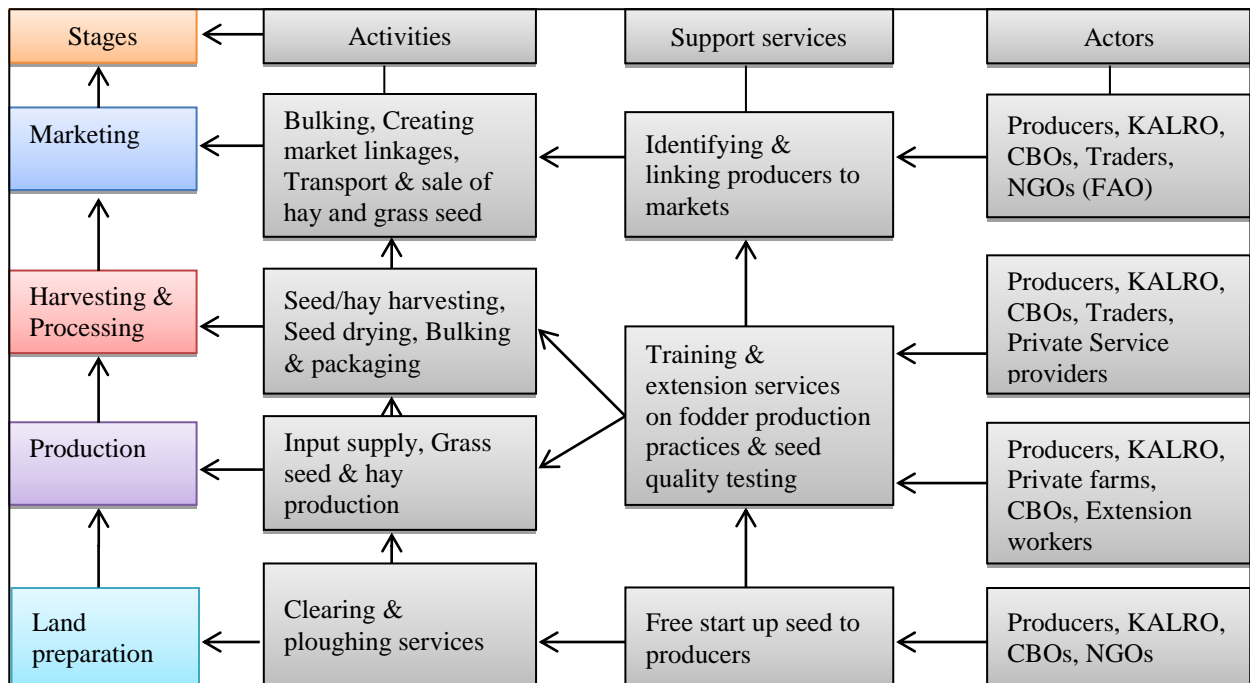


Figure 4.2: Hay and grass seed value chain map for Makueni and Kajiado Counties
Source: Focus group Discussions (N=11) and Key Informant Interviews (N=38)

Producers sold their seeds to organizations such as Food and Agriculture Organization of the United Nations (FAO) and KALRO through traders/bulkers or their various CBOs. Seeds bought by these organizations were then sold or given for free to farmers for start-up either within Makueni and Kajiado Counties or elsewhere to promote adoption of fodder production.

Grass seed prices varied between KSh150 and KSh800 per kg, while a bale of hay was sold for KSh100 – KSh300 (Figure 4.3). The price variations were influenced by various factors including seed quality, season and species. Individual seed bulkers were reported to buy at relatively low prices (KSh200 per kg) from farmers and selling to NGOs at KSh800 per kg, indicating low comparative gains to the producers. The informal nature of the market, seed quality control and standardization undermines marketability of the seeds (Lugusa *et al.*, 2016). These markets therefore need to be formalized with proper structure and policies that do not only open them up but also encourage private investment in providing lacking services as mechanized harvesting.

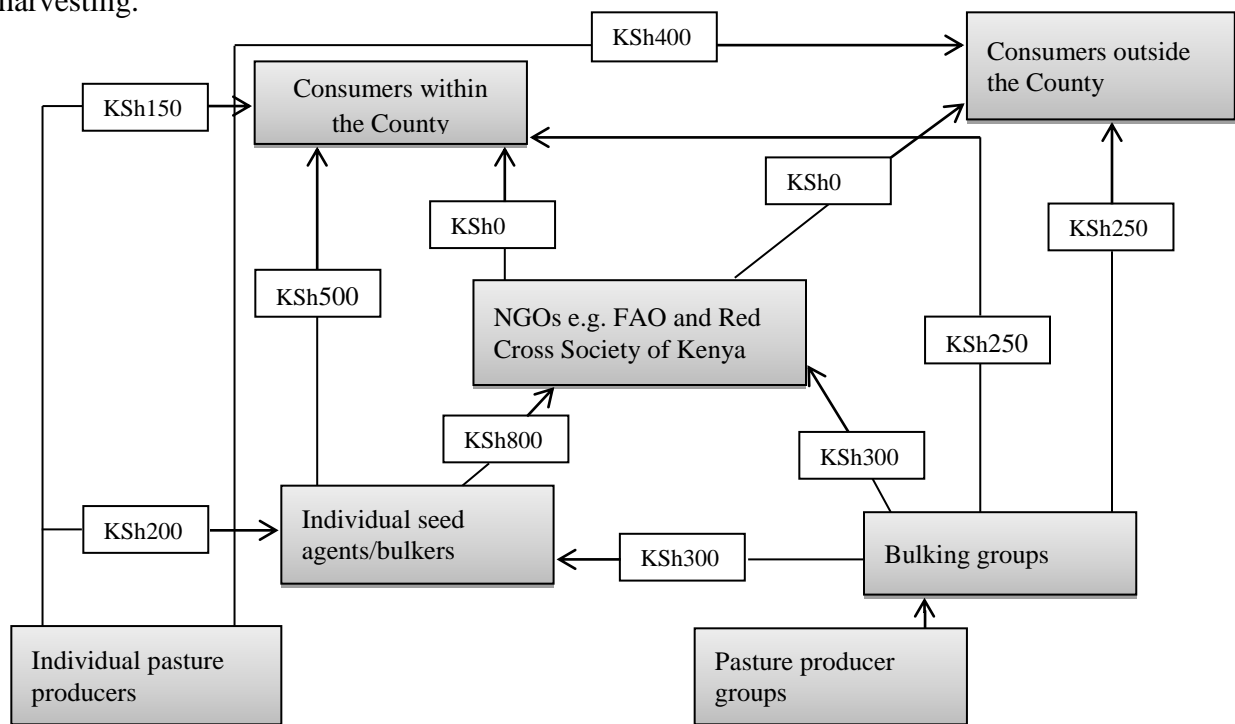


Figure 4.3: Hay and grass seed marketing channels and prices/kg along the chain

4.5 Conclusions

- The results of this study reveal that fodder producers in Makueni and Kajiado Counties prefer range reseeding to enclosing natural pastures for regeneration as the former allows them to faster improve production of specific grass species of their choice.
- Service providers such as Kenya Agricultural Livestock Research Organization play important roles in the fodder value chain ranging from generation and dissemination of fodder production technologies, as well as linking fodder producers to hay and grass seed markets.
- Although households in the study areas have embraced various fodder production practices, production levels are still low especially for the grass seed, leaving a demand gap. Increasing adoption of fodder technologies and intensifying productivity would be achieved through promotion of range reseeding technology. This intervention is likely to succeed due to the fact that range pasture reseeding is preferred and already being practiced by the pastoral and agro-pastoral communities.

CHAPTER FIVE

PROFITABILITY AND EFFICIENCY OF FODDER PRODUCTION AMONG AGRO-PASTORALIST AND PASTORALIST HOUSEHOLDS IN SOUTHERN KENYA

ABSTRACT

Pastoral and agro-pastoral communities inhabiting the arid and semi-arid lands of Kenya are increasingly embracing fodder production not only in response to pasture scarcity, mainly occasioned by frequent droughts, but also to complement income from livestock production. This study was conducted to analyze profitability and efficiency of hay and grass seed value chain in order to inform efforts aimed at increasing benefits from fodder production for improved household livelihoods in the rangelands of southern Kenya. Data was collected through household interviews, key informant interviews and focus groups discussions. The findings indicate that hay and grass seed production is a profitable venture in the study areas. However, the producers generally gained less from the sale of their produce compared to other actors in the market, particularly the traders. This could be attributed to the informal and unregulated nature of the fodder market which gives the traders undue advantage over the producers. It is therefore necessary that fodder markets are formalized and appropriate strategies put in place to facilitate producers' direct access to external markets that offer better prices. In addition, research aimed at understanding the dynamics of fodder markets with respect to supply, demand and prices under different market conditions will be key in guiding up-scaling of fodder technologies, and improvement of market organization and efficiency.

Keywords: Cost-benefit analysis, gross margin, hay and grass seed value chain, rate of return to investment, southern Kenya

5.1 Introduction

Drylands cover approximately 41% of the total global land mass (MA, 2005) and are inhabited by over two billion people (Reynolds *et al.*, 2007), most of whom are found in the developing countries (UNEP, 2007). These areas are characterized by low and highly variable rainfall, frequent droughts as well as fragile and infertile soils, making them unsuitable for crop production (Irungu *et al.*, 2014; Gikaba *et al.*, 2014). However, these conditions have set them uniquely appropriate for livestock production particularly through pastoral production systems (Rass, 2006). In Kenya, the drylands occupy over 82% of the total land area (Herlocker, 1999; Nyariki *et al.*, 2005) and support over 70% of the total country's livestock population (Omiti *et al.*, 2002; McOpiyo *et al.*, 2013). Some of the major constraints facing livestock production in Kenya include pressure on grazing resources, changes in land tenure, sedentization of pastoral households, disease outbreaks and recurrent droughts (Fratkin, 2001; UNEP, 2000). Amongst these, pastures inadequacy, both in quality and quantity, has been regarded as a major and perennial constraint to livestock production (FAO, 2005a) leading to massive livestock mortalities, mainly experienced during the dry periods. These constraints have been compounded by climate change and variability, which have led to more frequent and severe droughts with far reaching effects on livestock production (Olukoye *et al.*, 2007). This has consequently led to increased food insecurity and poverty levels among the pastoral and agro-pastoral communities (Mureithi, *et al.*, 2015).

Fodder production is increasingly being adopted by agro-pastoral and pastoral communities in response to perennial pasture scarcity occasioned by frequent droughts in the Horn of Africa (Ndathi *et al.*, 2011; Koech *et al.*, 2016; Lugusa *et al.*, 2016). In the Kenya's arid and semi-arid lands, fodder production has been regarded as a potential strategy to address the problem of

pasture scarcity (Koech *et al.*, 2016); households have embraced it with the aim of diversifying their livelihood options, as well as increasing their food security thus enhancing their resilience to droughts (USAID, 2012; CNFA, 2013; Lugusa *et al.*, 2016).

In Makueni and Kajiado Counties, many pastoral and agro-pastoral households have adopted various fodder production technologies developed and disseminated by Kenya Agricultural and Livestock Research Organization (KALRO) and other partners under that Agricultural Research Supports Program phase two (ARSP-II) (Manyeki *et al.*, 2015). Previous studies have shown an increasing trend of acceptance and adoption of these practices among the households in these areas (Manyeki *et al.*, 2015). This study built on the previous research work to examine profitability and efficiency of fodder production and marketing in Makueni and Kajiado Counties with the aim of guiding intervention measures on fodder production, as well as informing formulation of appropriate policies to ensure sustainable fodder value chain in the drylands of Kenya. In addition, the results are expected to inform up-scaling of fodder production for enhanced pastoral and agro-pastoral livelihoods in Kenya.

5.2 Sampling Procedure and Data Collection

This study used purposive and systematic sampling techniques to select the respondents. Three sub-counties were selected from each of the two Counties considering their active participation in fodder production practices that were introduced by KALRO under the Agricultural Research Supports Program phase II (ARSP-II). Kathonzueni, Makindu and Kibwezi sub-counties were selected in Makueni County, while in Kajiado County the selected sub-counties included Kajiado Central, Oloitoktok and Mashuru. The sample population for the study included individual small-scale fodder producers, commercial producers, farmer groups, traders, national and county

government officials and NGOs which are involved in production and supporting of hay and grass seed value chain in the study areas.

A systematic sampling approach was used to select the sample population among the households that were involved in fodder production. In each of the 6 sub-counties, 22 fodder producers were systematically selected using a list of fodder producers obtained from KALRO-Kiboko and extension officers in respective sub-counties. A total of 131 producers were interviewed using semi-structured questionnaire. The information collected included socio-economic and demographic characteristics of the fodder producing households, and their marketing practices. Eleven focus group discussions, each consisting of 10–12 participants, were conducted, one with each of the 11 fodder producing groups identified in the study areas. In addition, 38 key informant interviews were conducted with individual actors who were knowledgeable on fodder production and marketing, identified with the help of extension agents. The information gathered from the interviews included fodder production inputs and their costs, amounts of hay and grass seeds produced and marketed, selling and buying prices at various nodes of the chains, and channels and constraints encountered along the value chain.

5.3 Data Analysis

This study used gross margin analysis method, similar to Manyeki *et al.* (2015) to compute the costs and benefits of fodder production and profitability. Marketing efficiency is known to cause direct relation with the costs incurred and quantity of services offered as a commodity moves through the chain to the ultimate consumer. It plays a central role in determining the producer's share in the consumer's price. A market can be considered efficient when the costs incurred in offering a given service in the market are comparatively less than the service offered, thus the cheaper the services, the more efficient a market is (Islam *et al.*, 2014). In this study, efficiency

was measured based on four indicators including quantity of hay and grass seed handled, rate of return to investment, market margins and producer's share in the price of the commodity at consumer' level. After calculating and ranking these indicators, the total and mean scores for the ranks in each channel were determined. The channel with the smallest mean score was ranked most efficient and vice versa (Thamizhselvan and Murugan, 2012; Islam *et al.*, 2014). The Eq. (5.1) was used to determine the mean efficiency for each channel:

$$R_j = \frac{R_i}{N_i} \dots \dots \dots \text{Eq. (5.1)}$$

Where R_j = mean rank of a channel for all indicators; R_i = total value of ranks of indicators; N_i = number of indicators.

The grass seed marketing margin was calculated by subtracting producer price from consumer price, while gross marketing margin (GMM) of the market players was determined using Eq. (5.2):

$$\text{GMM} = \left[\frac{\text{Consumer price} - \text{marketing cost}}{\text{Consumer price}} \right] \times 100 \% \dots \dots \dots \text{Eq. (5.2)}$$

Marketing cost includes cost of transport, storage, labour and other activities associated with moving the product to the consumer, and was calculated using Eq. (5.3):

$$TC = CP + \sum MC_i \dots \dots \dots \text{Eq. (5.3)}$$

Where TC = Total cost of marketing; CP = Producer cost of marketing; MC_i = Marketing cost by the i th trader, $i = 1$

The quantity of hay (bales) and grass seed (kg) handled was based on the information collected during the survey, while rate of return was calculated using Eq. (5.4):

$$\text{Rate of return} = \frac{NM}{MC} \dots \dots \dots \text{Eq. (5.4)}$$

Where NM = net marketing margin, and MC = total marketing cost

The producer's share in the price of commodity at consumers' level was calculated using Eq. (5.5), and the channel that had the biggest producer's share was ranked 1:

$$\text{Percentage of producer's share} = \frac{PP}{RP} \times 100 \dots\dots\dots \text{Eq. (5.5)}$$

Where PP = producer's price, and RP= average retail price

5.4 Results and Discussions

5.4.1 Cost Benefit Analysis Results for Hay and Grass Seed Production

Costs incurred and benefits accrued from one acre of established pasture were determined based on two seasons of harvesting in 2015. Hay and grass seed harvesting were the most expensive production activities, taking up to 63% of the total production costs (KSh11775), followed by land preparation and ploughing costs (KSh3800) (Table 5.1). These findings corroborates those of Mnene (2006) and Manyeki *et al.* (2015) that labour requirements for land preparation, ploughing, weeding and harvesting are the most expensive production activities in range pasture reseeding. These activities are tedious and labour intensive, making them very expensive especially when hired. Although mechanized harvesting is time and labour saving, it was hardly used as it was comparatively more expensive than manual harvesting especially given that seed and hay production were still done on a small scale by most producers.

Sale of hay and grass seed, as well as pasture leasing were the three ways through which income were generated, giving average profit of KSh1350 per acre to the producers. The sale of grass seeds had the highest contribution to the households' income, while pasture leasing had the least contribution mainly due to its low preference among fodder producers. This confirms the findings by Manyeki *et al.*, 2015 who in their economic analysis of natural pasture rehabilitation through reseeding in the southern rangelands of Kenya, found that grass seed production was more profitable than hay production, and Lugusa (2015) who found that sale of grass seed

contributed more to the households' income than sale of hay in Baringo County of Kenya. The main reason for low fodder leasing among the producers was fear of destruction of pasture as a result of poor grazing.

Gross margin (GM) and cost benefit ratio (CBR) were positive with a CBR greater than one (1.73), implying that range reseeding for pasture improvement is a profitable venture as producers are able to cover all their production costs, and even make profits.

Table 5.1: Gross margins per acre of fodder in Makueni and Kajiado Counties

Source of Costs and Income	Value (KSh)	
Expenditure	Land preparation	1800
	Ploughing and planting	2000
	Grass seeds	1575
	Weed control	1000
	Grass seed harvesting	7275
	Harvesting of hay	4500
	Sisal twines	300
	Gunny bags	100
	Total cost (a)	18550
Revenue	Sale of grass seeds	14550
	Sale of hay	13500
	Leasing of grazing	4000
	Total revenue (b)	32050
	Gross margin (c) = (b – a)	13500
	CBR (d) = (b/a)	1.73

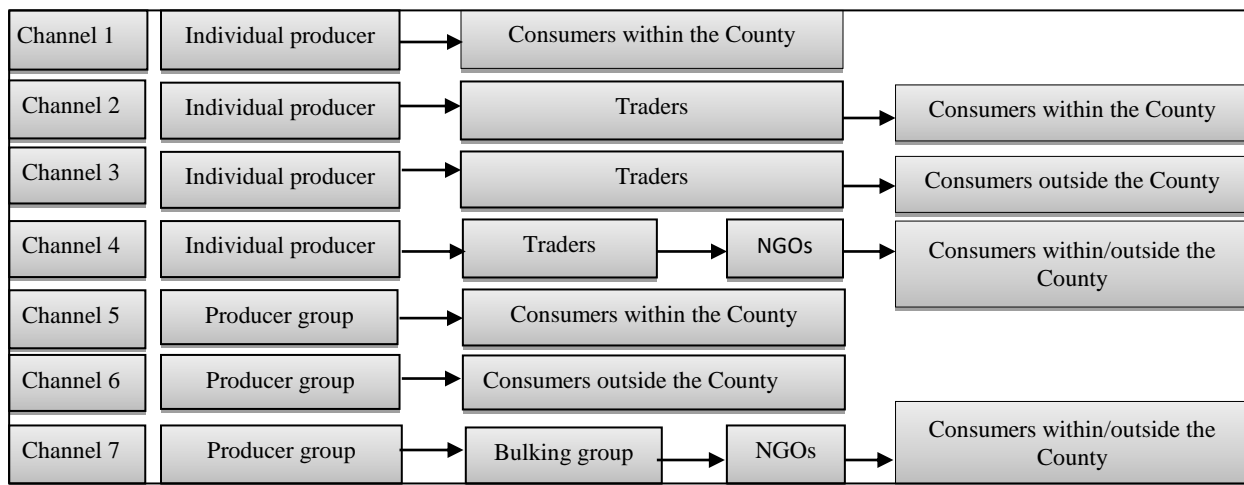
Source: Household interviews (N= 131)

5.4.2 Marketing and Supply Chain of Hay and Grass Seeds

About 37.5% of the bales of hay produced by the sampled households was sold to other livestock producers within their localities at an average price of KSh180 per bale, while the rest was retained for domestic consumption.

Unlike hay which was only sold directly to the consumers by producers, grass seed moved through various channels to reach the final consumer. The major grass seed marketing channels in the study areas are shown in Figure 5.1. Channels 1, 5 and 6 were found to be the shortest as

they involved direct selling to the consumers mainly within the Counties. Channels 2, 3 and 4 involved traders as key players in the chain. The traders (seed bulkers) were found to collect small quantities of grass seeds from the individual producers and upon bulking sold to local consumers and preferably NGOs such as FAO Kenya and Red Cross Society of Kenya. These organizations mainly donate seeds for free to the producers for startup not only within Makueni and Kajiado Counties, but also elsewhere within and outside the country. Channel 7 indicates individual producers working as a group, who bulk grass seeds prior to selling to various organizations and government departments.

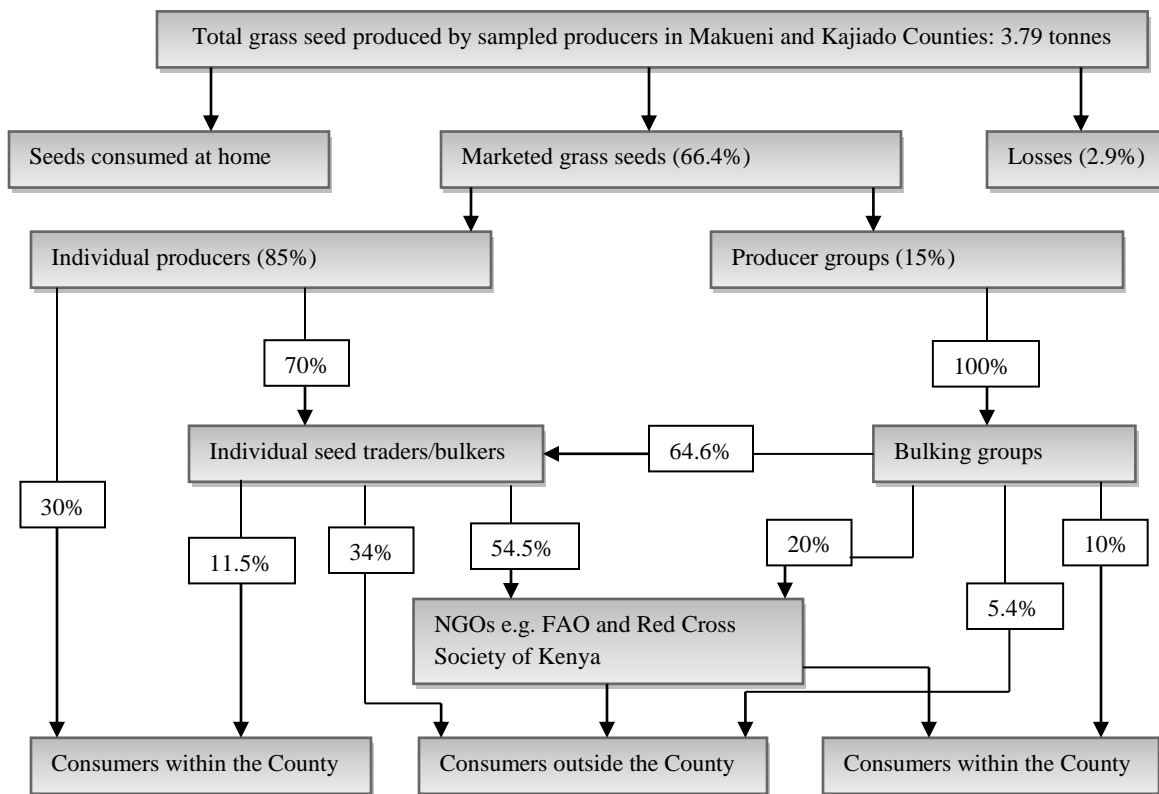


Source: Household interviews (N=131)

Figure 5.1: Major grass seed marketing channels and actors

Figure 5.2 shows the distribution and supply chain system of grass seed produced and marketed in the study areas. A total of 3.79 tonnes of grass seeds was produced by the sampled households in two harvesting seasons in the year 2016 in the study areas, of which 30.7% was consumed at home, 66.4% sold, and 2.9% lost mainly due to poor storage and pests. A large proportion (85%) of the marketed grass seed came from individual small scale producers who were the majority, while the rest (15%) was produced by producer groups. Individual small scale producers sold 24% and 76% of their produce to consumers within their respective counties and traders

respectively. Individual producers who operated under the organized groups submitted all their produce to their groups for bulking and marketing. Through these groups, they sold 10% directly to consumers within their respective Counties, 5.4% to consumers outside their Counties, 20% to NGOs and the biggest portion (64.6%) to traders. On the other hand, seed bulkers who are the major grass seed collectors in the study areas sold to NGOs (54.5%), consumers outside their Counties (34%) and consumers within their Counties of operation (11.5%). This finding corroborates those of Kidake et al. (2016) that a large percentage of the grass seeds produced by farmers in the ASALs of Kenya are sold to government departments and NGOs for distribution to farmers for reseeded.



Source: Household interviews (N=131)

Figure 5.2: Volumes of grass seeds sold through different channels

5.4.3 Grass Seed Market Performance and Efficiency

Table 5.2 represents a summary of channels ranks with respect to each indicator, and the overall ranking of the channels. About 948.21kg of seed, accounting for 38% of the total amount produced was sold through channel 4, making it the most efficient channel. Channel 1 was the second most efficient, moving up to 25.5% of all marketed grass seed. On the other hand, marketing efficiency was least in channel 6, through which only 0.8% of the total marketed grass seeds in the study areas was sold. Preference for channel 4 by the producers could be explained by the fact that it involved both individual seed bulkers who have the strongest market networks in the area and NGOs which offered the highest prices for the seeds, giving it an advantage over other channels. On the other hand, preference for channel 1 could be associated with its simplicity, ready market in the neighborhoods, in addition to low or no marketing cost incurred by the producers. While grass seed sold through channel 1 was locally consumed, NGOs, who were the final buyers in channel 6, donate these seeds for start up to producers within the study areas, other parts of Kenya and outside the country.

With respect to gross marketing margin, channel 1, was the most efficient having 100% gross marketing margin followed by channel 4 (88.1%), channel 7 (87%), channel 3 (78.2%) and channel 2 (78%) and channel 5 (78%) in descending order of efficiency. Channel 6 was the least efficient, with 70.8% gross marketing margin. Measurement of efficiency based on producer's share of the consumer's price revealed that channel 1, channel 5, channel 6 and channel 7 were the most efficient channels with the producers selling through these channels gaining up to 100% of the consumers' price. They were followed by channel 2 (40%), channel 3 (33.3%) in descending order of efficiency. Channel 4 was the least efficient channel with producers getting only 25% share of the consumer's price of the grass seeds. It was interesting to note that producer's share on the consumer's price was comparatively higher in the shortest channels

involving direct selling of the seeds by producers to consumers, which had registered the least amount of grass seeds traded. Channel 4 which was found to be least efficient in this regard, had the largest number of actors involved in marketing grass seeds. In addition, analysis of rate of return on marketing activities revealed that channel 7 was the most efficient having a rate of return of KSh7.69 per kg of grass seeds. The second most efficient was channel 4 with KSh6.32 per kg of grass seeds, while channel 1 was the least efficient channel with zero rate of return to investment.

Table 5.2: Efficiency of grass seed marketing channels

Parameter	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Channel 7
Quantity handled (kg)	641.21	200.08	591.54	948.21	37.74	20.38	75.48
Rank by quantity	2	4	3	1	6	7	5
Total marketing margin Producers							
Price (KSh/kg)	150	200	200	200	250	250	300
Marketing cost (KSh/kg)	0	46	46	46	55	73	39
Seed traders							
Price (KSh/kg)	-	500	600	800	-	-	-
Marketing cost (KSh/kg)	-	64	85	49	-	-	-
Consumer price (KSh/kg)	150	500	600	800	250	250	300
Total marketing margin (KSh/kg)	0	110	131	95	55	73	39
Total marketing margin	150	300	400	600	250	250	300
Gross marketing margin %	100	78	78	88	78	71	871
Rank by GMM	1	5	4	2	5	6	3
Producer's share (PS) %	100	40	33	25	100	100	100
Rank by PS	1	2	3	4	1	1	1
Rate of Return (RR) (RR = margin/cost)	0	2.73	3.05	6.32	4.55	3.42	7.69
Rank by RR	7	6	5	2	3	4	1
Average ranks	2.75	4.25	3.75	2.25	3.75	4.5	2.5
Overall rank	3	5	4	1	4	6	2

Source: Household interviews (N=131)

Overall evaluation of the channels ranked channel 4 as the most efficient channel, thus the most sustainable channel in the study areas. This can be explained by the fact that the largest amount of grass seeds, the highest consumer price (KSh800/kg), and the second highest rate of return were recorded in this channel. The highest price offered in channel 4 could be attributed to

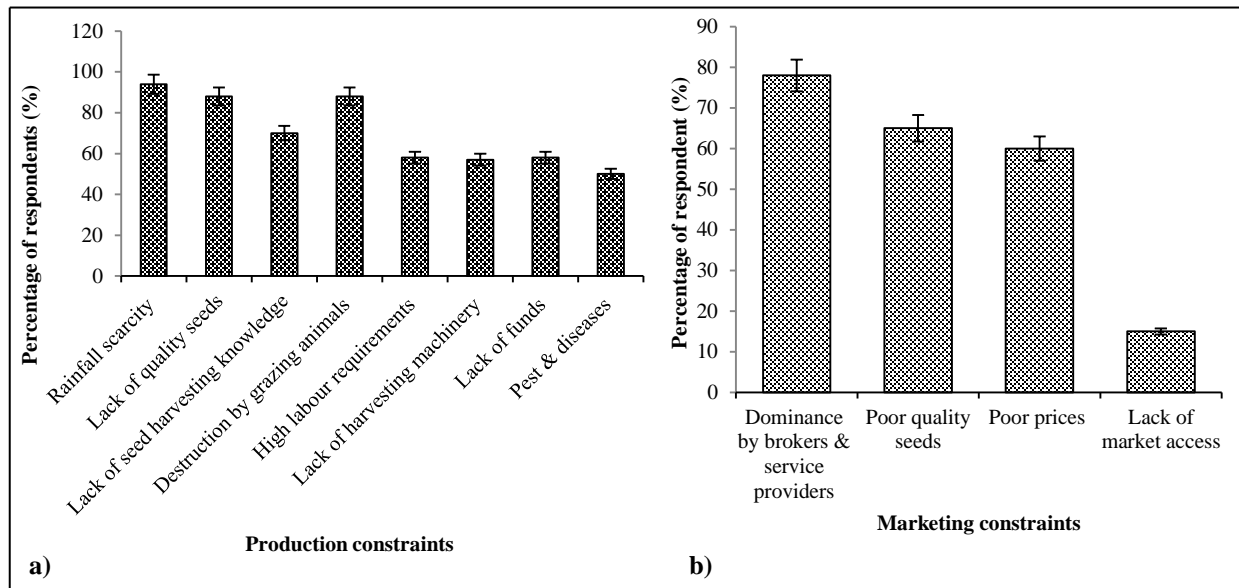
NGOs which offer good prices for certified seeds, unlike other buyers who may not pay attention to quality. Channel 7 was the second most efficient in overall ranking. The high efficiency of this channel could be explained by the fact that it is a short channel, involving only producers selling to consumers through their groups, which helps them to get better prices as well as reduce marketing costs. This channel had higher price (KSh300) than other channels where producers bypassed traders and sold directly to consumers. Though channel 1 was the simplest and shortest channel with producers retaining 100% of the consumer price and 100% gross marketing margin, this channel was ranked third most efficient mainly due to its zero rate of return on marketing activities. Channel 6 was the least efficient, and its poor performance was attributed to the high marketing costs incurred in selling grass seed to consumers outside the County of production. In addition, access to external markets is greatly challenged by inability of most of the producers/bulking groups to obtain certification for their produce from the Kenya Plant Health Inspectorate Services (KEPHIS).

5.4.4 Constraints to Fodder Production and Marketing in Southern Kenya

Figure 5.3 presents the constraints that undermine fodder production in the study areas. Rainfall variability and scarcity, poor seed quality, lack of seed harvesting skills, fodder destruction by stray grazing animals and birds, and high labour requirements were mentioned as the main constraints by the respondents. Other constraints cited were lack of proper tools, financial limitations and lack of land arising from competition with crop production, especially in agro-pastoral systems (Figure 5.3a). Mutua (2014) reported similar challenges among fodder producers in Makueni County. While studying fodder production in Baringo County, Joosten *et al.* (2014) found that lack of storage facilities, destruction of pasture by grazing animals due to poor fencing of fodder farms, recurrent droughts which affect fodder establishment were the

main challenges facing fodder production in the area. Lugusa *et al.* (2016) also reported frequent droughts and poor fencing as the greatest challenges facing fodder production in Marigat, Baringo County where fodder farms were invaded by grazing livestock and wildlife.

The reported hay and grass seed marketing constraints were poor seed quality that attract low prices, market dominance by key service providers and traders, as well as limited access to external markets that offer better prices (Figure 5.3b). Poor quality of the grass seeds (low germination rates) was mainly attributed to lack of adequate knowledge and skills on seed production, harvesting and post-harvest handling. The latter arises because many untrained individuals opportunistically get into the production and marketing of seeds to make quick money. The main grass seed buyers, which were found to be international NGOs, were only buying seeds in bulks. However, because most farmers were mainly small scale producers without direct access to these buyers, they could only sell to traders at lower price than those offered by the NGOs. Fodder markets were therefore mainly controlled by the main service provider such as KALRO, which has the capacity to produce large quantities of high quality seeds, as well as the independent traders who buy the small quantities from the farmers for bulking before selling to the NGOs. Direct access to external markets requires one to meet quality standards, and thus needs to be a certified seed trader. However, the certificate which is issued by KEPHIS is not affordable to majority of the producers. As reported by Lugusa *et al.* (2016), similar market challenges are faced by grass seed producers in Baringo County. These constraints undermine the efficiency of production and marketing and therefore a step-by-step evaluation and solution to constraints will be important in improving value chain performance thus leading to sustainable development.



Source: Household interviews (N=131)

Figure 5.3: Constraints of hay and grass seed production (a) and marketing (b)

5.5 Conclusions

- The results of this study demonstrate that fodder production in southern Kenya is a profitable venture. However, the markets are largely informal and unregulated leading to exploitation of the producers by the middlemen in the hay and grass seed market. This is evident in the producers' small share of the consumers' price depicted in this study.
- The main challenges facing fodder production in the study areas are rainfall scarcity, poor seed quality, and destruction of fodder farms by grazing animals and wildlife.
- Interventions to enhance fodder production in the study areas should focus on improving producers' share of consumers' price through institutionalizing and formalizing fodder markets, and enhancing access to external markets that offer better prices.
- Market research to understand the dynamics of fodder markets with respect to demand, supply and prices will be key in guiding up-scaling of fodder production and improvement of market organization and efficiency.

CHAPTER SIX

DETERMINANTS OF PASTORAL AND AGRO-PASTORAL HOUSEHOLDS' PARTICIPATION IN FODDER PRODUCTION IN MAKUENI AND KAJIADO COUNTIES, KENYA

ABSTRACT

Fodder production has been regarded as one of the suitable strategies for increasing feed availability for enhanced livestock production among pastoral and agro-pastoral communities in the drylands of Kenya. Previous studies indicate that factors determining adoption of these practices vary from time to time, as well as from one location to another. This study was therefore conducted to assess the socio-economic and demographic factors influencing households' participation in fodder production in Makueni and Kajiado Counties. Data was collected from 216 households through interviews using semi-structured questionnaire. Results indicate that gender of household head, education, social/development group membership and access to extension services were the most important factors influencing households' participation in fodder production. There is need for technical support to the pastoral and agro-pastoral households towards starting and/or joining existing social groups, through which extension and training services aimed at enhancing fodder production in the arid and semi-arid lands of Kenya can be offered.

Keywords: Drylands of southern Kenya, fodder production, pastoral and agro-pastoral households

6.1 Introduction

Livestock production in Kenya contributes up to 40% of the agricultural GDP and 12% overall GDP (Irungu *et al.*, 2014). It is the main economic activity in the ASALs of Kenya (Macharia *et al.*, 2015; Kidake *et al.*, 2016), which supports over 14 million people and 70% of the total country's livestock population (McOpiyo *et al.*, 2013).

A common characteristic of the ASALs is low and erratic precipitation associated with recurrent droughts (Irungu *et al.*, 2014; Gikaba *et al.*, 2014), leading to poor quality pasture, which is a major constraint to livestock production in these areas (FAO, 2005a). More recently, frequent droughts resulting from climate change and variability, fast population increase, as well as poor land use practices have significantly contributed to degradation and loss of natural pastures (Mnene *et al.*, 2004; Orindi *et al.*, 2007; Wasonga, 2009; Munyasi *et al.*, 2011; Ndathi *et al.*, 2011; Koech, 2014). The frequent droughts have contributed to collapse of traditional land management practices (Kassahun, 2008) hence high pressure on the few remaining livestock feed resources (Zemmelink *et al.*, 1999), and consequently, a lot of grazing lands have become degraded (Kidake *et al.*, 2016). Natural pasture degradation has been pointed out as the most limiting factor for livestock production in the ASALs of Kenya (GoK, 2011). Reduced livestock productivity and increased mortality are the main effects arising from lack of livestock feed. The far reaching effects of this are low production of milk and meat (Mapiye *et al.*, 2006; Chinogaramombe *et al.*, 2008), thus increased vulnerability of pastoral livelihoods and high poverty levels among the pastoral communities (Joosten *et al.*, 2014).

Regardless of all the challenges, livestock production still has the potential to alleviate poverty among ASAL populations, and this can be best achieved through transformation of natural feed resources into greatly rewarding products for domestic consumption and sale (GoK, 2005;

Irungu *et al.*, 2014). Being the most important requirement for livestock production, availability of high quality fodder directly reflects success in livestock production (McOpiyo *et al.*, 2013) and therefore pastoral livelihoods. The need to increase livestock productivity in the ASALs has led to high demand for not only adequate but also better quality fodder thus calling for improved fodder production practices (Gitunu *et al.*, 2003; Manyeki *et al.*, 2015).

To address the problem of pasture scarcity, a number of fodder production technologies have been introduced by the government of Kenya mainly in the ASALs (Dolan *et al.*, 2004). However, uptake of these technologies by farmers has been found to dependent on various factors (Muyekho *et al.*, 2016), which vary from region to region as well as from farmer to farmer (Singh *et al.*, 2012). In attempt to increase fodder production in ASALs, different development agencies have been using various approaches to sensitize and motivate communities to adopt these technologies. For instance, in Garissa County, Office of the United States Foreign Disaster Assistance (OFDA) and United States Agency for International Development (USAID) provided various services to producers including, grass seeds and trainings on fodder production practices, sustainable management and marketing (CARE, 2013a). A closely related approach was taken by Agricultural Productivity and Climate Change project to promote fodder production in Ijara sub-county of the Garissa County. This project supported fodder production and storage for use during dry seasons when livestock feed is normally scarce (Lugusa, 2015). As a result of this intervention, increased adoption of fodder production has been achieved in the County, not only among target groups but also among the wider pastoral households (Kuria *et al.*, 2015).

In their study on factors influencing adoption of fodder production among smallholder farmers in western Kenya, Muyekho *et al.* (2016) reported that adoption of fodder and fodder cropping was limited by lack of quality seed resources, input-output market problems, lack of credit facilities,

as well as limited extension services. In a study conducted in the highlands of Kenya, Irungu et al. (1998) reported that adoption of Napier grass was influenced by farmer education level, farm size, years of experience in farming and membership to a cooperative group. However, they noticed that accessibility to credit facilities did not have any significant effect on adoption of this particular grass species.

In a broader perspective, past studies have reported that prior to adoption of a new idea, farmers learn a great deal on-farm about the performance and suitability of fodder technologies to their farming systems, livestock production practices and sustainability of input and product markets (Lenne and Wood, 2004). In so doing, they learn about the potential benefits and risks that come with the technologies and therefore, fodder options attuned to farmers' local context are likely to be adopted. Past studies in Kenya's ASALs (Koech, 2014; Mureithi *et al.*, 2015; Wairore *et al.*, 2015) have focused mainly on the qualitative and quantitative benefits of fodder production, leaving grey areas on factors determining adoption of fodder production technologies. It is against this background that the current study was conducted to assess factors influencing adoption of fodder production practices among pastoral and agro-pastoral households in the drylands of Makueni and Kajiado Counties. The results of this study are expected to inform decisions aimed at enhancing adoption of fodder production technologies through identification of areas that need interventions, and thus enhancing livestock production for improved food and livelihood security in the ASALs of Kenya.

6.2 Sampling Procedure and Data Collection

Three sub-counties were purposively selected from Makueni and Kajiado Counties based on their active adoption of various fodder production technologies that had been introduced under the ARSP-II program. In Makueni County, the selected sub-counties included Kathonzueni,

Makindu and Kibwezi, while in Kajiado County; Kajiado Central, Oloitoktok and Mashuru sub-counties were selected for the study. In each of the 6 sub-counties, 36 households were sampled using systematic random sampling, resulting in selection of 216 households for the interviews. The first household was randomly chosen and the subsequent respondents were systematically selected after every second household.

The study was preceded by an exploratory survey in each of the six sub-counties under the guidance of the local extension workers with the view of understanding the context to guide the design of the study approach and development of data collection tools. A pre-tested questionnaire was administered to the selected households through face-to-face interviews to capture information on socio-economic and demographic characteristics of the respondents. This was done with the help of 12 enumerators who had been selected and adequately trained to give them full understanding of the questionnaire and the objectives of the study. In addition, eleven focus group discussions each comprising 10-12 participants, and 38 key informant interviews were conducted in the study areas in order to get clarification and better understanding of the information gathered from household interviews (Bryman, 2008; Ngenga *et al.*, 2016). FGD participants were knowledgeable people drawn from individuals and groups that were producing fodder within the six sub-counties in the study areas. The key informants included selected individuals producing fodder, extension service providers, hay and grass seed traders, as well as the main service providers drawn from government institutions and non-governmental organizations.

6.3 Data Analysis

Descriptive and inferential statistical analyses were done using Statistical Package for Social Science (SPSS) version 22, and STATA version 14. Descriptive statistics including means,

standard deviation (SD), frequencies and percentages were generated for the selected socio-demographic characteristics of the sampled households. Binary logistic regression was done to determine factors that influence participation in fodder production.

6.4 Description of the Dependent and Hypothesized Independent Variables

The dependent variable used in the logit regression model was participation in fodder production. The sample was classified into fodder producers and non-producers based on the question whether the respondent was producing fodder or not. The value of “1” was assigned to fodder producing respondent, while “0” was assigned to a non-producing respondent.

Table 6.1: Variables hypothesized to influence households’ participation in fodder production

Variable	Description	Expected influence on adoption of fodder production
AGH	Age of household head (Number of years)	–
GEH	Gender of the household head (Male=1, Female=2)	±
EDH	Education level of the household head (0=No education, 1=Primary, 2=Secondary, 3=Tertiary)	+
SZL	Household land size (Number of acres)	+
GRPM	Membership to fodder producing group (1= Yes, 0=No)	+
SZHRD	Household herd size (Total TLU)	+
ACEXTN	Access to extension services (1=Yes, 0=No)	+

The independent variables in Table 6.1, age, gender and education of household head, size of land owned of household, herd size owned by the household, access to extension services, and membership to fodder producing group, were hypothesized to influence household’s participation in fodder production.

6.4.1 Age of household head

Age of household head is a key factor that is expected to directly influence availability and access to production and livelihood resources (Wasonga, 2009; Lugusa, 2015). Access to these

resources is an important factor for wealth creation and accumulation thus determining their availability for use by households. Studies measuring experience have demonstrated that square of age is negatively associated with uptake of new technologies (Doss and Morris, 2001), implying that capacity of a household to adopt new technology is likely to decline after a certain age. This is partly because younger farmers or household heads are more risk takers and willing to improve their farming practices by adopting new technologies in order to diversify their livelihoods and increase their income sources than their older counterparts. This study therefore hypothesized that age has a negative relationship with adoption of fodder production. The age of the household head was a continuous variable which was categorized and assigned the value of 1 if 30 years or less, 2 if 31 – 40 years, 3 for 41 – 50 years, 4 if aged between 51 and 60 year, 5 for 60 – 70 years and 6 if above 70 years.

6.4.2 Gender of household head

Gender determines access to resources and assets particularly in the rural African context. In the sub-Saharan Africa, female headed households have more limited access to productive resources such as livestock, land and finances compared to the male headed households (Adesina *et al.*, 2000). With respect to this, women headed households are constrained by limited access to natural resources (Wasonga, 2009). This study therefore hypothesized that male headed households are more likely to adopt fodder production technologies due to their higher access to key production resources than their female headed counterparts. Gender of household head was a dummy variable where a value of 1 was assigned to male headed households and 0 to female headed households.

6.4.3 Education level of household head

Education level of household heads was measured in terms of the number of years spent by respondent in school. The level of education is known to influence major household decisions. Education creates an opportunity for pastoral and agro-pastoral households to diversify their livelihood sources (Muyanga, 2008; Wasonga, 2009). More educated household heads are therefore expected to have better understanding and deeper insight enabling them to easily perceive the benefits of new technologies than their less educated counterparts (Okello *et al.*, 2009). Education level was therefore expected to have a positive influence on adoption of fodder production technologies. The education level of a household head was assigned the value of 0 if not educated, 1 if attained primary education, 2 for secondary education and 3 for household heads with tertiary education.

6.4.4 Household land size

Total land size owned by households determines the availability and amount of land that a household can devote to fodder production. Households with larger parcels of land are more likely to set aside some portions for fodder production, leading to the hypothesis that land size has a positive relationship with participation in fodder production. The size of land owned was a categorical variable and was assigned a value of 1 if 10 acres or less, 2 for 11 – 20 acres, and 3 if greater than 20 acres.

6.4.5 Membership to fodder producing group

Group membership provides social capital and it helps farmers to pool resources for collective action. It also increases the capacity of group members to access services such as credits, extension and information. Participation in such groups is believed to strongly facilitate adoption of new technologies (Salasya *et al.*, 1996). This study hypothesized that membership to a

social/development group has a positive influence on adoption of fodder production practices by households. Membership to a fodder producer group was a dummy variable where the value 1 was assigned to the households that are members to such groups, while 0 was assigned to households which are not members of a group.

6.4.6 Household herd size

The herd size of a household is a symbol of wealth status in a pastoral community (Wasonga, 2009). This study hypothesized that participation in fodder production is dependent on number of livestock a household owns, and that there is a positive relationship between the two. Herd size was measured in terms of the total number of livestock owned by a household converted into Tropical Livestock Units (TLUs), where 1TLU was equated to 250kgs mature live animal (KARI/ODA, 1996). In this study, one bull was equivalent to 1.29TLU, a cow = 1TLU, a calf = 0.4 TLU and a sheep or goat = 0.11 TLU. Conversion of livestock numbers into TLU equivalent enables standardization of different animal kinds and classes into a universal unit thus aiding comparisons between household herds (Wasonga, 2009).

6.4.7 Access to extension services

Provision of extension services to farmers is presumed to capacitate households to adopt new technologies by offering them basic and technical skills and knowledge on various production technologies. The current study hypothesized that access to extension services on fodder production together with sensitization on the importance of the practice positively relates to adoption of fodder production. Access to extension services was a dummy variable where a value of 1 was allocated to household heads with access to extension services and 0 to household heads with no access to such services.

6.5 Specification of the Binary Logit Regression Model

The model choice for a study is based on the nature of the dependent variable and the objective of the study. The dependent variable in this study was binary that assumed two values; 1 if the respondent was producing fodder and 0 if otherwise. This kind of variable is normally estimated using logit or probit models, both of which estimate parameters using maximum likelihood approach. While probit model assumes normal distribution error term, the logit model takes a logistic distribution of the error term. This study used the binary logit model due to consistency of parameter estimation associated with the assumption that error term in the equation has a logistic distribution (Baker, 2000; Ravallion, 2001).

The behavioral model described in the equations (Amemiya 1994; Gujarati, 1995) below was used to evaluate factors that influence participation in fodder production.

$$Y_i = f(t_i) \dots \dots \dots (6.1)$$

This means that there is a functional relationship (f) between the survey observation (Y_i) and the stimuli t_i , where,

$$t = b_0 + \sum b_i X \dots \dots \dots (6.2)$$

Y is the response for the i^{th} observation with binary variable 1 = producers and 0 = non-producers. t_i is the stimulus index for the i^{th} observation. It is presumed that there is a threshold index for each household, t_i^* such that if $t_i^* > t_i$ the household is observed as a participant in fodder production and if $t_i^* < t_i$ then, the household is a non-participant. The probability of such a household participating in fodder farming was computed using equation 6.3:

$$\{P_i = (e^{t_i}) / (1 + e^{t_i})\} \dots \dots \dots (6.3)$$

The model for the factors hypothesized to influence households' decision whether to participate in fodder production or not was then re-written as:

$$Y = \ln\{P(X_i) / (1-(P(X_i)))\} = \beta_i X_i + \varepsilon_i \dots\dots\dots (6.4)$$

Where Y = the natural log of the probability of participating in fodder production (P), divided by the probability of not participating (1-P).

β_i = coefficient of factors influencing participation in fodder production

X_i = factors that are hypothesized to influence participation in fodder production

ε_i = error term

The linear regression model for this study was specified as shown in the equation 6.5.

$$Y = \beta_0 - \beta_1 AGH \pm \beta_2 GEH + \beta_3 EDH + \beta_4 SZL + \beta_5 GRPM + \beta_6 SZHRD + \beta_7 AGEXTN + \varepsilon_i \dots\dots (6.5)$$

Several binary logistic regressions were conducted with participation in fodder production as the regressand until the best fit of the model was obtained. The variables that best defined the estimated model was determined based on the coefficient of determination (R^2); adjusted R^2 , chi-square value, the direction of influence of the independent variables, as well as the number of significant variables in the model.

6.6 Multicollinearity Statistical Test: Variance Inflation Factor

It was important ensure that the explanatory variables used in the binary logit model do not correlate with one another, a situation known as multicolliniarity, which occurs when two or more independent variables are linearly related. Multicolliniarity usually occurs in all sample data necessitating the need to test the level of its severity in the exogenous explanatory variables (Koustoyiannis, 1973). This was done through the test of the Variance Inflation Factor (VIF). Multicolliniarity was then eliminated through excluding or merging some variables during analysis so as to obtain a thrifty model. Long (1997) expression for empirical estimation of VIF was followed:

$$VIF = \frac{1}{1-R_i^2} \dots\dots\dots (6.6)$$

Where R_i^2 is the R^2 of the artificial regression with the i^{th} independent variable as the dependent variable.

6.7 Results and Discussions

6.7.1 Results of Multicollinearity Test

The VIF of the explanatory variables were found to range from 1.051 to 1.886 with a mean of 1.381 as shown in the Table 6.2. The fact that the VIF's for the independent variables were less than five (<5) provided satisfactory justification for their inclusion in the logit model (Maddala, 2001) as there was no serious problem of multicollinearity.

Table 6.2: Multicollinearity test for the explanatory variables included in the model

Variable	Tolerance (1/VIF)	VIF
Age	0.776	1.288
Gender	0.951	1.051
Education	0.706	1.416
Household land size	0.530	1.886
Group membership	0.797	1.254
Household herd size	0.724	1.381
Access to extension services	0.718	1.392
Mean VIF		1.381

6.7.2 Socio-Demographic Characteristics of the Sampled Households

Table 6.3 and table 6.4 show descriptive statistics of the explanatory variables included in the model. While there was no difference in mean age between fodder producers (50.47 ± 10.28 years) and non-producers (50.94 ± 11.94 years) the results showed that fodder producers were significantly ($p < 0.01$) more educated with mean of 9.14 ± 3.99 years of education than non-producers whose mean age was 5.80 ± 4.13 . Households that adopted fodder production had significantly ($p < 0.01$) smaller average land sizes (33.93 ± 41.54) acres but larger herds sizes

(19.97 ± 29.75 TLU) than non-producers who had averagely larger land sizes on average (48.72 ± 57.54 acres) and smaller herds (17.47 ± 25.79 TLU).

Table 6.3: Descriptive statistics for the hypothesized variables used in the model

Variable	Producers (N=131)		Non-producers (N=85)	
	Mean	Mean	Chi-square	p-value
Mean age of the household head in years	50.47±10.28	50.94±11.94	47.684	0.526
Years of education	9.14±3.99	5.80±4.13	53.699*	0.000
Household land size (acres)	33.93±41.54	48.72±57.54	96.620*	0.007
Household herd size (TLU)	19.97±29.75	17.47±25.79	53.373	0.421
	Frequency (%)	Frequency (%)		
Gender of households head	Male	97 (74.0)	47 (55.3)	8.157* 0.004
	Female	34 (26.0)	38 (44.7)	
Group membership	Yes	97 (74.0)	20 (23.5)	52.989* 0.000
	No	34 (26.0)	65 (76.5)	
Access to extension services	Yes	103 (78.6)	16 (18.8)	74.518* 0.000
	No	28 (21.4)	69 (81.2)	

Most (74%) of fodder producer households were male headed compared to 55.3% for non-producers. In addition, most (74%) of the fodder producers were members of certain social groups compared to only 23.5% of the non-producing households (Table 6.3). More (78.6%) fodder producers had access to extension services than non-producing households (18.8%). These results indicate that gender, education level, size of land owned, group membership and access to agricultural extension services important factors that may influence participation in fodder production among the pastoral and agro-pastoral communities. These findings corroborate those of Irungu et al. (1998) and Kaliba et al. (1998) who reported similar factors amongst others to be primarily important in influencing adoption of agricultural technology.

6.7.3 Results of the Binary Logit Regression

Table 6.4 shows the results of the binary logit regression model. Seven variables were tested of which five were found to significantly influence fodder production uptake by households. The

independent variables were found to explain 57% ($R^2 = 0.57$) of the variation in households' participation in fodder production in the study areas. Gender of the household heads had a positive and significant ($p < 0.05$) influence on households' participation in fodder production, implying that the male headed households were more likely to participate in fodder production than those headed by females. This could be explained by the fact that men have better access and control over important resources such as livestock, land and financial capital than women (Saito and Spurling, 1992; Olila, 2013). In addition, this finding could be associated with the high labour requirements of the practice and the domestic responsibilities of women in the societies which limit time, their access to agricultural information, trainings and extension services (MacOpiyo, *et al.*, 2013; GoK, 2015; Kidake *et al.*, 2016). The marginal effects show that facilitating both gender participation would increase chances of adopting fodder production technologies by 20%.

Education level of the household heads showed a positively significant ($p < 0.05$) influence on the possibility of a household participating in fodder production, suggesting that household heads with higher education levels have higher chances of undertaking fodder production, unlike their counterparts with no or less education. Manyeki *et al.* (2013) reported higher adoption of natural pasture improvement technologies in Makueni and Narok Counties where household heads were more educated than in Mashuru where household heads were comparatively less educated. As observed by Okello *et al.* (2009), Oladeebo and Masuku (2013) and Khalid *et al.*, (2013), higher education enhances understanding of the value of agricultural technologies and innovations and therefore their adoption.

Participation in a group and access to extension services showed positively significant ($p < 0.01$) influence on households' participation in fodder production. This implies that household heads

who participate in groups and with better access to agricultural and extension services were more likely to adopt fodder production. Specifically, the marginal effects explain that group membership of an individual increases their probability of adopting fodder production technologies by 29%, while a unit increase in access to extension services increases adoption of fodder production chances by 49%. This could be linked to the fact that working in organized farmer groups has many benefits such as easier and enhanced access to financial and extension services (de Haan, 2001; Olila, 2013), as well as free or subsidized inputs such as startup grass seeds. Government institutions, as well as NGOs have successfully implemented many agricultural development programs through working with farmer groups (Katinka and Johanness, 2001). Fodder producing social groups in Baringo County for example, have successfully established pasture and rehabilitated degraded lands mainly through the support offered to them by various NGOs and development agencies such as the Netherlands Development Organization (SNV), Rehabilitation of Arid Environments (RAE) Trust and Kerio Valley Development Authority (KVDA) (Lugusa *et al.*, 2016).

Household herd size was found to have a positive and significant ($p < 0.05$) relationship with adoption of fodder production, indicating that households with large herds have higher probability of adopting fodder production than those with smaller herds. This is because, under the current situation where there is decline in natural pastures due to climate variability and change, sustaining large herds call for strategies to avail extra feed resources, and therefore making adoption of various production technologies necessary.

Traditionally, pastoralist households with large herds tend to remain mobile especially in the dry seasons when pasture is scarce. However, the challenge of diminishing communal grazing fields due to changing land use and tenure have restricted mobility as a coping strategy (AfDB, 2010).

This situation could be regarded as a catalyst to establishment of fodder farms by livestock keepers with larger herds.

Table 6.4: Logit model estimates for the determinants of household's participation in fodder production

Variable	β	Wald	Exp (β)	Marginal effect	p-value
Age	-0.034 (0.021)	2.688	0.966	0.008 (0.005)	0.104
Gender	0.878** (0.420)	4.367	2.407	0.200 (0.976)	0.040
Education	0.141* (0.052)	7.326	1.151	0.003 (0.115)	0.007
Household land size	-0.007 (0.005)	1.537	0.993	-0.001 (0.001)	0.217
Household herd size	0.015** (0.008)	2.988	1.015	0.003 (0.002)	0.085
Group membership	1.318* (0.403)	10.699	3.736	0.289 (0.085)	0.001
Access to extension service	2.333* (0.414)	31.706	10.306	0.492 (0.074)	0.000
Constant	-1.235 (1.340)	0.850	0.291	–	–

Statistical significance level: *1%, **5% and ***10%; Chi-square (df=7) = 117.99 (p<0.001); -2log likelihood=171.577; Cox and Snell R² = 0.421; Nagelkerke R² = 0.570; N=216; Standard error in parentheses

6.8 Conclusions

- The results of this study indicate that gender, group membership and access to extension services are the most important factors determine households' participation in fodder production in the study areas.
- Household heads that have access to extension services and are also members of social groups have the highest chances of adopting fodder production. This is due to the fact that extension workers and other supporting organization prefer to reach out to the producers through organized groups.
- On the basis of the results of this study, interventions aimed at facilitating households' participation in fodder production should support formation and strengthening of fodder producing groups as way of enhancing information sharing, as well as increasing producers' access to agricultural information and extension services.

CHAPTER SEVEN

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

- Pastoral and agro-pastoral households in Makueni and Kajiado Counties were found to prefer range reseeding to enclosing natural pastures for regeneration, as the former allows for faster improvement of production of specific grass species of their choice. The key production practices adopted by fodder producers in the study areas include ploughing during land preparation and broadcasting as the major method of seed sowing.
- Kenya Agricultural and Livestock Research Organization is a key actor in fodder production in the ASALs as it offers technical support throughout the value chain. The institution is involved in development and dissemination of fodder production technologies, and promotion of fodder production among the pastoral and agro-pastoral communities in the study areas.
- In addition to increased availability of feed for their livestock, households that participate in fodder production make profits from the sales of hay and grass seed thus providing additional income to what they earn from livestock and other livelihood activities. However, the producers tend to benefit relatively less than traders, who dominate the hay and grass seed markets. The main market for grass is found among international organizations such as the United Nation Food and Agriculture Organization and the Red Cross Society of Kenya, which donate them to producers to promote fodder production in the drylands.
- Participation in social groups and access to extension services are the major factors that determine participation in fodder production by the households in the study areas. Household heads who have access to extension services and are also members of social groups have the highest chances of adopting fodder production.

- Fodder markets in the study areas are informal and unregulated and the seeds offered for sale are largely uncertified and therefore of poor quality. The poor market linkages and seed quality deny the producers, and traders access to external and better markets which are keen on quality and phytosanitary standards.
- The main constraints in fodder production in the study areas are rainfall scarcity, poor seed quality, lack of seed harvesting skills, fodder destruction by grazing animals, and high labour requirements.

7.2 Recommendations

The following recommendations were arrived at based on the key findings of the study:

- Strategies and efforts aimed at enhancing pastoral and agro-pastoral households' participation in fodder production should promote up take of the range reseeding technologies. This is likely to be successful as most producers preferred and are already practicing range reseeding.
- To increase adoption of fodder production in Makueni and Kajiado Counties, more service providers, particularly the County governments and development agencies should partner with KALRO in providing technical support and capacity building on fodder production. This will go a long way in enhancing adoption of fodder production thus spreading the benefits to a wider population not only in the study areas, but also in other drylands of Kenya. Increased fodder production would have the ultimate benefit of improved livestock production, as well as household incomes in the ASALs thus enhanced pastoral and agro-pastoral livelihoods.
- Improving marketing and profitability of fodder products require formalization of hay and grass seed markets, as well as making the process of grass seed certification affordable and easy for producers. This will help in facilitating commercialization and access to the external markets thus increasing profitability especially to the producers. In addition, the producers

need to be supported by the national and County governments to set up bulking centres for their produce, as well as to form marketing groups to allow them collectively bargain for better prices.

- Efforts towards out-scaling fodder production should target access to extension services and support households to start and (or) join existing groups, which are known to be avenues for accessing extension services with the ultimate goal of ensuring sustainable and efficient fodder production in the drylands.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE FOR FODDER PRODUCERS

Section 1: General information

Questionnaire No:.....

- 1.1 Date of interview:...../...../..... Name of enumerator:
- 1.2 County Sub-County Division
- 1.3 Location Ward..... Village.....
- 1.4 GPS: Latitude Longitude
- 1.5 Name of respondent (optional)..... Gender: 1) Male.....2) Female....
- 1.6 Relationship of respondent to the fodder producer: 1) Self.....2) Spouse.....3) Son.....
4) Daughter.....5) Relative.....
- 1.7 Age..... Phone No

Section 2: Fodder Producer Information

- 2.1 NameAge (years).....
- 2.2 Gender: 1) Male.....2) Female
- 2.3 Education level:1) None..... 2) Primary.....3) Secondary..... 4) Tertiary.....
- 2.4 Years of education.....
- 2.5 What livelihood options do you have? 1) Livestock.....2) Crop production.....3) Trade
(specify).....4) Formal employment.....5) Casual labour.....6) Others (specify).....
- 2.6 Which one of the above is your MAIN source of livelihood?.....
- 2.7 How many are you in the family?.....No of Males.....No of Females.....
- 2.8 What is the total size of the land you own?.....acres
- 2.9 Do you own livestock? 1) Yes.....0) No.....
- 2.10 If Yes, What livestock species do you own? Please fill in the table below:

Livestock species	Number of mature	Number of young	Purpose of keeping
Cattle			
Sheep			
Goats			
Donkey			
Camels			
Total			

- 2.11 Do you have any past encounters with drought? 1) Yes.....0) No.....
- 2.12 If Yes, please list the adverse effects?
- 2.13 Do you have access to communal grazing reserves during drought periods?1)Yes....0)
No.....

Section 3: Fodder and grass seed production

- 3.1 Do you produce fodder 1) Yes..... 0) No.....
- 3.2 If No, why?.....
- 3.3 Do you produce grass seeds 1) Yes.....0) No.....
- 3.4 If No, why?.....
- 3.5 If Yes, what is the MAIN objective of producing fodder? 1) To feed my livestock.....
2) For sale..... 3) Leasing out for income.....

- 3.6 Where did you learn about fodder production? 1) KALRO.....2) African wildlife services.....3) Neighbouring farmers.....4) Farmer groups.....5) Others (specify).....
- 3.7 Do you belong to any fodder/seed producer/marketing group? 1) Yes.....0) No.
- 3.8 If Yes, name the group..... and year of formation.....
- 3.9 What are the benefits of belonging to the group?1)2)3).....4)

3.10 What fodder species do you grow and which ones do you get from the wild?

Reseeded/grown	Yes/No	Collected from the wild	Yes/No
i <i>Eragrostis superba</i>		i <i>Eragrostis superba</i>	
ii <i>Cenchrus ciliaris</i>		ii <i>Cenchrus ciliaris</i>	
iii <i>Chloris roxburghiana</i>		iii <i>Chloris roxburghiana</i>	
iv <i>Enteropogon macrostachyus</i>		iv <i>Enteropogon macrostachyus</i>	
v Others (specify)		v Others (specify)	

3.11 What factors influence the choice of fodder species that you grow? 1) Preference by livestock.....2) Availability of seeds3) Cost of production4) Marketability.....5) Short production period.....6) Adaptability to the area.....7) Others (specify)

3.12 Which agronomic practices do you apply in your fodder / seed production?

Land preparation		Reseeding	Weeding	Type of planting	
Clear land & plough		Broadcast on prepared land (drilling)	Do not weed	Pure stand	
Clear land but do not plough		Plant in lines on prepared land	Uproot weeds rarely	Mixed stand	
		Oversow on unprepared land	Frequently uproot weeds		
		Enclose land to allow natural regeneration			

3.13 How do you procure inputs used in your fodder production? How much did they cost you in the last one year? Please fill in the table below:

Inputs	Sources	Quantity used in the last one year	Unit cost (KSh)	Total cost
Land (acres)				
Land preparation				
Fencing				
Grass seeds				
Fertilizer/Manure				
Ploughing				
Labour				
Farm tools				
Planting				
Water/irrigation				
Weeding				
Harvesting				
Transportation of				

hay/seed				
Training				
Others (specify)				

(Land 1=Owned, 2=Hired, 3=Communal, 4=Government, 5=Others (specify))

3.14 How did you do the following activities in the last one year and what costs did you incur?
(Indicate **NIL** if you don't do)

Activity	Hay		Grass seeds	
	Method	Costs(KSh)	Method	Costs(KSh)
Harvesting				
Baling				
Value addition				
Transportation				
Storage				

3.15 What quantity of hay and seed did you produce during the last one year?

Variable	Amount produced	Amount consumed	Amount sold
Hay (bales)			
Grass seed (Kg)			

3.16 What major constraints do you face in fodder production and how can they be resolved?

Constraints	Suggested solutions
1	
2	
3	
4	

Section 4: Fodder/Seed Marketing

4.1 Do you sell fodder? 1) Yes.....0) No.....

4.2 If No, why?.....

4.3 Do you sell grass seeds? 1) Yes.....0) No.....

4.4 If No, why?.....

4.5 If Yes, to whom do you sell your fodder and seed? 1) Local consumers 2) I take to

market..... 3) Traders 4) I sell through my group 5)KALRO.....

6) FAO.....7) NGOs (name them).....8) Other (specify).....

4.6 How do you choose these outlets?.....

4.7 What are the selling arrangements? 1) Contract.....2) Freelance..... 3) Both.....

4.8 How much do you sell one bale of hay and 1Kg of seed? 1Bale.....1Kg.....

4.9 How do you determine the selling price of fodder/seed? 1) Fixed price.....2) Haggling.....

4.10 What costs (KSh) did you incur in marketing your fodder/seed last year?(1) transport
.....(2) local taxes.....(3) Labour.....4)Others (specify),.....

4.11 Did the quantity of fodder/seed you sold meet the market demand? 1)Yes....0)No.....

4.12 Do you lease out grazing? 1) Yes..... 0) No.....

4.13 If Yes, why do you prefer leasing?.....

4.14 What acreage did you lease out last year? Please fill in the table below:

Acreage leased	Type of animal	No. of animals grazing	Duration of leasing in months	Leasing price /animal/month	Total amount (KSh)

	Cattle				
	Goats				
	Sheep				
	Others				

4.15 What are the major constraints you face in fodder marketing and what can be done to address these problems?

Fodder marketing constraints	Suggested solution
1.	
2.	
3.	

Section 5: Institutional and capacity building:

5.1 Do you ever get any extension/ information services on fodder farming? 1) Yes.... 0) No ...

5.2 If Yes, what kind of extension/ information and from which sources and at what frequency?

Type of information/ extension	Information source <i>1= KALRO 2=NGOs 3= Other farmers 4= Extn. Officers 5=Mnstry of Lvsck</i>	Frequency of obtaining information <i>1=Very frequently 2=Frequently 3=Not frequently</i>	Information delivery channel <i>1=Radio/ TV 2=Extension workers 3=Buyers 4=Agrochemical Co. 5=Other farmers</i>
Agronomic practices			
Seed Prices & source			
Other inputs			
Market demand & price			

5.3 How is this information important to you?.....

5.4 Have you attended any agronomic training on fodder production 1) Yes.....0) No.....

5.5 If Yes, what were you trained on? 1) Land preparation.....2) Planting3) Weed management.....4) Harvesting.....5) Storage.....6)Others (specify).....

5.6 Do you have access to credit for fodder production? 1) Yes..... 0) No.....

5.7 If No, why not?

5.8 If Yes, provide the following information:

Source of credit	Amount obtained last time	No of borrowings per year	Purpose of borrowing	Loan conditions	Did you pay on time? <i>1=yes,0=no</i>

5.9 If you didn't repay the loan on time, why?

THANK YOU FOR YOUR TIME

APPENDIX 2: QUESTION GUIDE FOR FOCUS GROUP DISCUSSIONS

General Information

1. When did the group start fodder/seed production?
2. Is the group formally registered? If No, why?
3. What is your main objective of producing fodder/seed?
4. What is the role of this group in pasture production and improvement?
5. Main source of livelihood for majority of the residents in this area?

Fodder Production and marketing

1. What fodder species are commonly grown and livestock species kept in the area(*table*)
2. What factors determine the choice of these fodder species?
3. What production practices do you use in your fodder/ seed production?
4. What factors determine the choice of production practices?
5. What costs do you incur in carrying out these activities?
6. What technologies do you implement in addition to the above practices?
7. As a group from where do you get your inputs and how much do they cost you?
8. What amount of fodder/seed did this group produce in the last one year and what amount of it did you sell?
9. Where do you sell and at what prices per bale/Kg?
10. What selling arrangements do you have with your buyers? (*freelance, contracts, both*)
11. What costs do you incur in marketing your fodder/seed?
12. What are other chain actors and what are their roles on fodder/seed production & marketing?
13. What are the various fodder/seed marketing channels in this County?
14. Do you do any value addition before selling your fodder/seed?
15. Are there any fodder/seed cooperatives or marketing groups in this area?
16. Do you collaborate with them if any?
17. Do you get any support from the County to promote you fodder production and marketing?
18. That constraints do you face as a group in producing and marketing your fodder/seed?

APPENDIX 3: QUESTION GUIDE FOR KEY INFORMANT INTERVIEWS

1. Producers

1. General information of the respondent (*probe: age, gender, education level, household size*)
2. Which year did you start fodder production and where did you learn about it?
3. Which livelihood options do you have and which one of them is the main one?
4. What is your MAIN objective of fodder/ seed production? (*for own use, sale*)
5. What fodder species do you grow and which ones do you get from the wild?
6. What factors determine the preference of fodder species that you grow?
7. Do you produce grass seeds?
8. What production practices/technologies do you use?
9. What is the land size that you used for fodder production in the last one year?
10. What costs did you incur in producing fodder in the last one year?
11. What amount of hay and seeds did you harvest during the last one year?
12. Amount consumed at home and that sold?
13. How did you do the following activities in the last one year and what are the costs incurred? (harvesting, baling, value addition, transportation, storage)
14. What are other uses of hay apart from the MAIN one? (*control erosion, thatching, etc*)

Marketing

1. Do you sell hay/ grass seed?
2. If Yes, where do you sell and how do you choose buyers?
3. What amount did you sell during the last one year, and at what prices per bale/Kg?
4. How are the selling prices determined?
5. Do you lease out grazing land? If yes, what is the arrangement?
6. Are there any fodder cooperative or marketing groups in this County?
7. What are the various fodder marketing channels in this County?
8. Who are the main actors and their roles?
9. What challenges do you encounter in producing and marketing fodder/ seeds?
10. Do you ever work with any institutions, NGOs or government agency in the fodder production and marketing (list and indicate their roles)
11. Have you received any support from the County government in fodder production?

Fodder/ Grass seed Traders

1. What motivated you to start fodder/seed business?
2. Where do you buy fodder and seed and at what price per bale/Kg?
3. To whom do you sell fodder/seed and at what price per bale/Kg?
4. What amount of fodder/ seed did you buy and sell in the last one year?
5. How did you arrive at the buying and selling prices?
6. What costs did you incur in marketing fodder/ seed?
7. Who are other chain actors and what are their roles?
8. What are the various fodder /seed marketing channels in this County?
9. Do you do any value addition before selling fodder/seed?
10. Do you collaborate in anyway with other fodder/seed retailers in the county?
11. Have you ever received training concerning fodder/seed handling?
12. What challenges do you face in your operations? What are possible solutions?
13. Ministry of Livestock/Extension Officers/KALRO/ NGOs
14. What is your role in fodder production and marketing in this County?

15. What fodder species are grown & collected from the wild?
16. Who are involved in fodder growing in the County & what determine their participation?
17. What are the main fodder/seed production practices in this County?
18. What is the source of inputs e.g. seeds, fertilizers, tools if any etc?
19. What costs are involved in procurement and use of the inputs?
20. Are there any training, extension and information services provided to the fodder farmers?
21. What are the various fodder/seed marketing channels in this County?
22. Who are the main actors in fodder/seed marketing and what are their roles?
23. What are the fodder/seed buying and selling prices at various nodes of the chain?
24. What costs are incurred in marketing fodder/seed?
25. How can fodder production and marketing be strengthened in the county?
26. What challenges are there in fodder production and marketing?
27. What do you think should be done to mitigate the challenges?
28. What are the county plans on fodder/seed production?
29. Any support from the County to fodder/seed farmers and traders?

THANK YOU FOR YOUR TIME