AN ECONOMIC EVALUATION OF THE ROLE OF LAND AND LIVESTOCK DYNAMICS IN LIVELIHOOD DIVERSIFICATION IN BARINGO COUNTY, KENYA

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Declaration

I hereby declare that this thesis is my original work and has not been presented to any other university for any award.

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Dedication

To my daughter Natalie, may this always inspire you in the world of academia.

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Table of Contents

List of figures

List of tables

Abstract

Land in the rangelands of Kenya has been subdivided since 1968 following legislation for privatization with the aim of improving productivity, tenure security and reducing land degradation. This transformation has reduced transhumance among pastoralists who were previously nomadic. The change in land tenure institutions and property rights raises a critical concern on the future of the traditional pastoral system in Kenya. Pastoral communities continue to face a mixture of socio-economic and environmental challenges such as land degradation, climate change, land use change, urbanization, population increase and resource conflict. Climate variability comes with erratic rains, prolonged droughts and increased incidences of livestock diseases. These challenges undermine the sustainability of pastoralism as a main source of livelihood for households in the drylands. As a result, people in the drylands are slowly transforming to an agro-pastoral system. The government of Kenya and other stakeholders through the Kenya National Livestock Policy 2008 promised to support the pastoral economy to minimize vulnerability to droughts and conflicts. As a result, households through the help of non-governmental organizations, County and national government have embraced alternative income generating activities (IGAs). Livelihood diversification is not a new phenomenon in pastoral areas. Most livelihood enterprises have been in existence among pastoral communities. However, there are renewed efforts geared towards commercialization of fodder, honey, livestock and other enterprises. The calls for the adoption and intensification of these livelihood enterprises have been happening without empirical evidence on the influence of recent change in land ownership and livestock production systems on household choice of enterprises. This study was conducted to characterize the change in land tenure, size and livestock population and species, and pastoral livelihoods. It also analyzed the effect of land tenure and other socio-economic factors on the type of livelihood diversification. Further, the effect of

change in livestock population and species on the choice of livelihood enterprise was analyzed. Lastly, the economic returns of these enterprises were estimated. A household survey was conducted on 221 randomly selected pastoral and agro-pastoral households from two wards in Baringo County. Focus group discussion and household survey were used to obtain data. Descriptive statistics, binary logit and a multivariate probit were used to analyze data. It is evident that the land tenure is changing from communal ownership towards private ownership. However, land adjudication has not been completed; only 7% of the households had title deeds by the end of the year 2017. Households are stocking more goats than cattle, further there is a rise in the number of households pursuing poultry farming. Households depend on an average of three livelihood strategies up to a maximum of eight. Land tenure, land size, tropical livestock units, use of enclosures and practicing pastoralism have a positive influence on the choice of on-farm diversification strategies. The multivariate probit results showed that species diversity and decline in tropical livestock units had an implication on choice of fodder farming and waged labour. Additionally, the estimates from the gross margin analysis showed that bee keeping, livestock production, fodder and food crop farming are all viable enterprises. The study recommends linkage of dryland farmers to input and output markets to enable them to access drought tolerant crop varieties in order to reduce losses during drought and obtain better prices for their products. There is also need to settle land tenure issues to encourage farmers to invest in alternative on-farm enterprises and claim exclusive rights to economic returns from their enterprises. Further, upscaling extension services is important in improving the uptake of on-farm enterprises such as fodder farming and food crop production that require specialized technical skills.

Keywords: Land, livestock, livelihood enterprises, diversification.

List of abbreviations and acronyms

ASALs	Arid and Semi-Arid Lands
CIDP	County Integrated Development Plan
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
GM	Gross Margin
IGA	Income Generating Activity
KNBS	Kenya National Bureau of Statistics
MoALF	Ministry of Agriculture, Livestock and Fisheries
MVP	Multivariate Probit
OLS	Ordinary Least Squares
RAE	Rehabilitation of Arid Environments
SDGs	Sustainable Development Goals
SDI	Simpson Diversity Index
SID	Society for International Development
SSA	Sub-Saharan Africa
TLU	Tropical Livestock Units
TR	Total Revenue
TVC	Total Variable Costs
UNDP	United Nations Development Programme
VIF	Variance Inflation Factor
WISP	World Initiative for Sustainable Pastoralism

CHAPTER ONE

1.1 INTRODUCTION

1.1.1 Land in the context of pastoral livelihoods

Land is a vital resource for pastoralists who derive 50% of their income from pastoralism. In Africa, pastoralism is practiced in the arid and semi-arid land under traditional communal land ownership (Bromley, 2009). However, the customary land tenure systems are being converted into formal tenure systems worldwide (Fairhead et al., 2012). Privatization has been based on the argument that shared resources in rangelands do not have clear user rights for individual plots. In addition, communal land ownership does not promote long term investment in land, including sustainable practices (Burnsilver and Mwangi, 2007).

Land privatization in developing countries in Africa is a preferred development strategy. Privatization is centered on the theory of property rights, which postulates that private land ownership offers tenure security and is an incentive to farmers to invest in their land (Smith, 2005; Flitan, 2011). Prior to the colonial period, no formal policy regarding sustainable use of land existed in Kenya. Land was reserved for rotational use by agrarian and pastoral communities.

After independence, laws failed to provide adequate rights regarding access and use of common resource in rangelands. This saw the emergence of calls for privatization of commons. Privatization started with group ranches that were established through an Act of parliament in 1968 (Mwangi, 2007). Establishment of group ranches was a rejoinder of previous efforts aimed at controlling stock densities and improving livestock productivity in the rangelands. Recent studies in Kenyan rangelands have shown further subdivision of group ranches for individual ownership (Burnsilver and Mwangi, 2007).

A study by Saxer (2014) revealed a complex land tenure system in the rangelands. Land has been subdivided internally into private parcels with people engaging in informal contracts to secure tenure. Enclosures have been established in the commons to rehabilitate the degraded land, which further reduces the communal resources available. Nonetheless, the shift of land ownership from communal to private provides an opportunity for livelihood diversification since it creates new uses of land for instance one can rent out and sell land thus generating income (Lesogorol, 2008). However, the practice threatens welfare in cases where the entire parcel is sold and may lead to displacement of original inhabitants (Letai, 2014).

1.1.2 Trends in livestock production

Goats, cattle, and sheep are the common livestock species kept in pastoral areas in Kenya. The local breeds are mostly preferred and are kept for dual purposes. The local breeds are preferred due to their high tolerance to drought and the ability to walk long distances. They are also resistant to parasites and diseases, hence require low veterinary attention. Wasonga et al. (2011) observed a decline in herd size in Baringo, which was attributed to the frequent tribal conflicts and decline in grazing lands. The stock decline was also attributed to the sale of livestock to meet recurrent household expenses. Cattle and sheep population showed a decline, however goats and camels increased. This change was linked to the encroachment of bushes, which made the environment suitable for browsers as opposed to grazers.

Pastoralism enables people in the ASALs to meet their livelihood needs from livestock production (WISP, 2010). Despite being a cultural activity, it is an adaptive mechanism to the harsh environments that cannot support rain-fed agriculture (Barrow et. al., 2007). However, access to water, land and other natural resources is essential to sustainability of pastoralism. The trend towards privatization of communal land poses a great challenge to mobile pastoralism (Little and Mcpeak,

2014). The loss of grazing land affects pastoralists, particularly during droughts as it leads to death of livestock.

Though pastoralism remains a primary source of food and income for people in ASALs, they participate in other income generating activities such as fodder production, bee keeping, waged labour, buying/selling/leasing/renting of land and crop cultivation in areas that receive enough rainfall (Murethi et al., 2015; Grimm and Lesogorol, 2012). Diversification guarantees a regular source of income and minimizes risk associated with variable weather patterns, market failure, insecurity and animal disease (Little et al., 2001; Ellis, 2005).

For the purpose of this study, land dynamics refers to change in land tenure system, land size and the use of enclosures at household level. Additionally, livestock dynamics refer to the change in livestock population and species at household level.

1.2 Statement of the research problem

Subsistence pastoral economy has for a long time been the form of livelihood in the rangelands. Livestock forms an important source of livelihood, and plays a significant role in religious and cultural activities. To ensure sustainability in production, the pastoral communities keep diverse species in order to effectively utilize the scarce rangeland resources and have a social system in place to control resource sharing. Pastoralists rely on herd mobility to achieve maximum utilization of the scarce and fragile rangeland resources (Nori and Davies, 2007).

However, the change in land ownership from collective to individualized ownership has reduced transhumance (Wenersson, 2013). This has resulted in concentration of livestock around water points, which leads to increased degradation around these areas and conflicts over the limited water and pasture. The herd size has also reduced as the number of livestock kept is determined by the

size of one's parcel. This and other external factors including sedentarization and population growth have threatened the viability of pastoralism as a major source of livelihood. As a result, pastoralists pursue alternative livelihood strategies for food and income.

Privatization may have negative impacts on pastoral livelihoods such as increased vulnerability to drought and rise in poverty (Veit, 2011, Flintan, 2011). While some previous studies have addressed the effect of privatization on livestock production and pastoral livelihoods in the rangelands (Legosorol, 2008; Legosorol and Boone 2010) information on the role of tenure and changes in livestock production on household diversification decisions is scanty in literature. To broaden the discussion on diversification, this study includes the role of land privatization and the change livestock production system on the adoption of alternative livelihood enterprises.

Despite the potential benefits of livelihood diversification in pastoral areas, development indicators in these areas are still low. In Kenya, the poverty rate is higher in ASALs than the rest of the country (Republic of Kenya, 2017). Poverty incidence is approximated to be at 52% in Baringo County compared to 45% nationally (CIDP, 2019). While there is extensive literature on livelihood diversification in pastoral areas (Mureithi et al., 2015; Watete et al., 2016; Little, 2016), the economic returns obtained from the alternative enterprises are still unknown. These studies have broadly focused on outlining income sources of various pastoral groups and the determinants of livelihood diversification. Therefore, these studies cannot be used solely to give recommendations for enterprises that compliment pastoralism.

1.3 Objectives of the study

The overall objective of this study was to evaluate the role of land and livestock dynamics in livelihood diversification in Baringo County, Kenya. The specific objectives were to:

1. Characterize dynamics in land tenure and livestock population and species.
2. Assess the effect of land tenure on the type of livelihood diversification.
3. Analyze the effect of changes in livestock species and population on choice of livelihood enterprises.
4. Estimate determinants of economic returns from on-farm livelihood enterprises.

1.4 Research hypotheses

The following hypotheses were tested:

- There has been no significant change in land tenure, livestock species and population in pastoral households.
- Land tenure has no significant effect on the type of livelihood diversification adopted by different households.
- Change in livestock population and species do not have a significant effect on the choice of livelihood enterprises.
- Socioeconomic factors and external support factors do not influence the gross margins from on-farm enterprises.

1.5 Justification of the study

The sustainable development goal (SDG) number one and two of the United Nations Development Programme (UNDP) focus on ending poverty and hunger, respectively by 2030 (United Nations, 2015). Though diversification of livelihoods has not been stated as a means of achieving these

goals, the alternative enterprises are a vital source of food and income to the people living in the drylands. Conducting an analysis of the economic returns from the various enterprises is important for identifying the most profitable enterprises. Information on the profitability of enterprises will encourage farmers to diversify and hence obtain more income and improve food security. This will improve the living conditions for people in Baringo which exhibits features of rural areas trapped in chronic cycles of poverty and has often been a target for food aid (MoALF, 2019).

Assessing the choice of livelihood enterprises by households will help the government to prioritize on the agricultural enterprises to invest in, this will aid the achievement of the big four agenda, which aims to ensure that all Kenyans are food-secure by 2022 by expanding food production and supply (Republic of Kenya, 2018). With agriculture being a devolved function, the County government and their development partners will also use the findings of this study to deliberate on enterprises they will promote in order to attain the goal of food security. As stated in the county integrated development plan, the County government of Baringo aims to increase crop production and productivity for food security by the year 2022 (CIDP, 2019).

The development partners and farmers will also use information from this study to understand the dynamics pertaining to land and livestock and how these changes inform the household diversification decisions. This is important for strengthening farmer participation in agricultural markets. It will also offer insights for designing appropriate and well-targeted strategies to cope with changes that undermine the sustainability of pastoral livelihoods. This will contribute to the achievement of the government strategy of "National Policy for the Sustainable Development of Northern Kenya and other Arid Lands" whose aim is to unlock the full potential of these areas by 2030 (Republic of Kenya, 2017).

1.6 Study area

Figure 1 is a map showing the livelihood zones of Baringo County. The county covers 11,015.3 km^2 and is inhabited by 555,561 people (KNBS, 2009). The rainfall received in the county varies from 600mm in the lowlands to a range of 1000mm to 1500mm in the highlands (CIDP, 2019). The sub-counties in Baringo are Baringo South, Baringo Central, Baringo North, Mogotio, Tiaty and Eldama Ravine. The study was conducted in Baringo South sub-county.

The study area was selected as part of the Paradox Project by The Triple L Initiative. The project aims to categorize and differentiate land tenure systems and their associated land use practices in pastoral areas in Kenya. Agriculture is the main source of livelihood in the county and provides employment to over 80% of the population (MoALF, 2017). In the past, the land use pattern in Baringo was characterized by cattle centred nomadic pastoralism. However, there has been a shift towards a sedentary lifestyle (Osterle, 2008). The County government has also promoted other enterprises such as bee keeping, fruit farming and fodder production. Though land is largely communally owned with no formal ownership, land is being fenced, privatized and traded (Greiner, 2013).

The county is susceptible to various climate risks including floods, landslides, drought and forest fires that pose a great challenge to agriculture. Water scarcity for domestic and agricultural use is also common. Drought and scarcity of resources including water and forages are perceived to be the major cause of inter-communal conflict, which result in huge losses (MoALF, 2017).

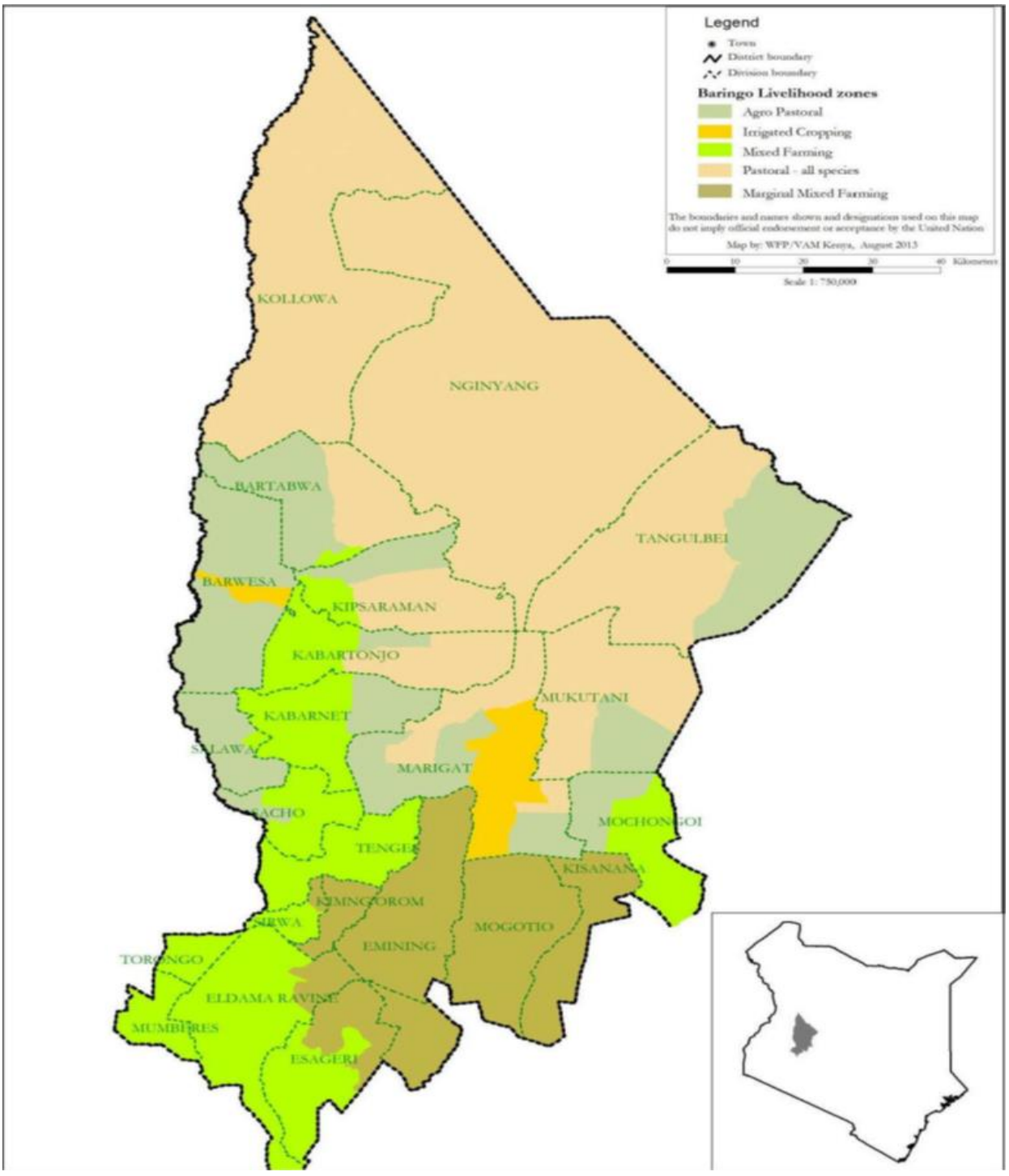


Figure 1: Baringo County livelihood zones

Source: National Drought Management Authority (2014).

1.7 Organization of the thesis

This thesis is organized into seven chapters. In chapter one is the general overview of land tenure system and livestock production and pastoral livelihoods. The problem investigated and the research objectives are also discussed here. Chapter two contains the literature review on trends in land tenure, livestock population and species, knowledge gaps, review of methods used to measure land livestock dynamics, conceptual and theoretical framework. Chapter three, four, five and six are presented in paper format each containing the methods used in analysis of each objective and results obtained. Finally, chapter seven provides a summary of the study, conclusions, implications to policy, and suggestions for further research.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 A review of land tenure dynamics in Kenya

Since the colonial period, there have been various legal frameworks to support land ownership in Kenya. The partitioning of Africa into colonies in 1885 saw the establishment of arbitrary boundaries. Land was allocated to white settlers under the crown lands ordinance of 1902 and 1915 (Letai, 2014; Markakis, 2004; Ndungu, 2006). White settlers were allocated land under leasehold and freehold title areas. Africans on the other hand occupied trust lands, this was land that had not been consolidated, registered or adjudicated.

Trust land was neither registered in the name of individuals or groups nor taken over by government. In 1963 after Kenya attained independence, land consolidation was amongst the government's top priorities. The aim was to support agricultural production, settle the landless and to bring political stability in rural areas (Nangulu, 2001). This saw the establishment of a commission of inquiry into land registration and consolidation in 1965. It is the findings of the commission that formed the official basis for group ranch establishment (Veit, 2011). The commission concluded that group registration was more relevant in the rangelands compared to individual land registration. The argument was that land rights in rangelands were collective, and that appointment of group representatives would grant private land rights to the group.

The group representative Act of 1968 passed by parliament saw the establishment of group ranches in former trust lands. The household head was registered in the group ranch title deed and the group ranch committees were the legal trustees (Veit, 2011). Group ranches were established by government mainly to preserve biodiversity and to enable flexible regulation of wildlife and easy

access to watering points (Lengoiboni et al., 2010). Pastoral communities embraced the group ranch concept to acquire legal tenure hence qualify for loans that would see them build cattle dips and bore holes (Fratkin, 2001).

In the1960s and 1970s development agencies in East Africa initiated programs to improve livestock production and integration of pastoralists into markets. The guiding principle of these programs was "the tragedy of commons" (Fratkin, 2001). The theory considered traditional pastoralism on communally shared pastures to be wasteful and result in degradation. The local governments were urged to restrict pastoral livestock production in communal land and encourage private ranching for beef and dairy production. This saw the rise in private ranches and conservancies in pastoral areas. Private land owners were thought to use rangeland resources sustainably. In the1980s with the help of the World Bank through the structural adjustment programs, land in the ASALs was further subdivided for individual ownership (Fratkin, 2001). Privatization of land resulted in a permanent loss of grazing commons through sale of land to private developers for other non-pastoral ventures.

The constitution of Kenya promulgated in 2010 classifies land as private, public or communal (Republic of Kenya 2010). This recognizes communal land ownership as a distinct tenure regime. The old constitution of Kenya did not adequately support communal land ownership. Customary tenure was seen as a transitory tenure that was subjet to conversion to stable regimes such as private tenure (Ogolla and Mugabe 1996). Further, the communal land Act 2016 recognizes, protects and provides for the registration of communal land. It also outlines the role of the county government in governing unregistered community land. Under the Act, the County government holds in trust communal land that has not been registered on behalf of the community. It also holds any money payable to the community should compulsory acquisition occur on unregistered community land.

The Act also prohibits the county government from selling or transferring unregistered community land for private purposes. It further establishes a land management committee tasked with the responsibility of managing and coordinating land use plans (K'Onyango, 2017).

2.2 Emerging trends in livestock population and species

Pastoralists depend on livestock for economic survival and it forms an essential part of their identity and socio-cultural existence (Lesogorol, 2008; Mureithi and Opiyo, 2010). Cows are the most popular livestock species in rangelands. However, the livestock population varies for each household and among species (Engström, 2016). Additionally, the importance of small stock and camels has increased overtime. Pastoralists have shown a tendency of rearing more small stock as a form of adaptation to the increased risk of drought and environmental changes. Abebe (2016) noticed a significant upward trend between 1977-2011 in the proportion of small stock among the Borana in their herds.

Further, pastoral communities are incorporating camels in their herds. Kagunyu and Wanjohi (2015) noted that pastoral communities in northern Kenya incorporated camels in their herds due to their adaptability to harsh environments. Camels report fewer deaths during drought compared to cattle. Camels are browsers and can rely on shrubs for feed during drought. A household survey by Abebe (2016), found that in the year 1977-1984 and 2009-2016 there was a rise in the number of Borana households that owned camels. In the Borana culture camels were often used as pack animals used to carry loads and for water hauling. Further, their findings showed that more than 50% of the households surveyed owned chicken. Poultry is not considered as wealth among pastoral communities. However, it is an indicator of sedentarization of pastoral communities and recognition of its value for household income.

The decline in livestock population has largely been attributed to subdivision and establishment of enclosures in communal land. However, the introduction of invasive plant species also explains the downward trend in livestock population. *Propospis juliflora* was introduced in the arid areas in the 1980s. In 2005, Mwangi and Swallow (2005) reported a decrease in grazing and farming land in Baringo. This was associated with the spread of *Prosopis juliflora* species, which was also thought to cause deterioration in animal health and sometimes death especially among goats.

2.3 Review of knowledge gaps in land tenure changes, livestock species and population

Various studies have documented land tenure dynamics and livelihoods in different contexts. Literature shows that changes in demographics, market, technological and political factors have resulted to a change in land use and livelihoods in pastoral areas (CAPRi, 2005). The land tenure regime is shifting from communal to private ownership. On the other hand, nomadic pastoralism is shifting towards sedentary agro-pastoralism.

A study by Saxer (2014) showed that pastoralists are concerned about the shrinking land sizes due to the rising population and privatization. Establishment of enclosures on commons limit the mobility of livestock. Wennersson (2013) asserts that as land diminishes, pastoralists have felt the need to demarcate and privatize their land to more individual plots. Today pastoral communities are more static and depend on their enclosures for grazing resources. Flintan (2011) focused on the causes and impact of land fragmentation in Kenya, Uganda and Ethiopia. Results of the study showed that despite the improvement in livestock production, livestock holdings have significantly declined. Veit (2011) emphasizes that land ownership under more secure tenure is an important means of achieving food security in agrarian communities. Privatization presents opportunities for diversification such as cultivation and land markets. The studies on privatization have demonstrated the effect of change in land tenure and livestock production on livelihoods. However, they

do not show how these changes influence a household to participate in a particular enterprise either on-farm or off-farm.

The causes of diversification among pastoralists are multi-faceted and differ based on economic, ecological and cultural differences. Little (2001) points out climate, wealth, distance to market towns and education as some of the causes of variations in diversification patterns among pastoralists in East Africa. Livelihood assets, activities and income also change within pastoral communities over time (Burnsilver, 2009). Diversification patterns vary ranging from partial or complete transformation into non-pastoral ventures to adaptation to socio-economic and environmental changes (Little, 2016).

It is evident that herd diversification and control of household stock levels is a strategy used by pastoralist to effectively utilize rangeland resources (Abebe, 2016, Adriansen, 2006, Wasonga et al., 2011). The studies found that pastoralists were increasing the proportion of small stock and camels as they have relative advantage of surviving during drought. However, these studies have not shown how these changes may affect participation in other livelihood activities. For example, the Maasai pastoralists in Kajiado Kenya diversify into wage labour, business and agriculture (Burnsilver, 2009). Incorporating crop farming can lead to competition for grazing land as well as herding labour, which undermines pastoralism. This study fills the gap in knowledge by analyzing the effect of change in species and population on diversification.

Research has shown that subdivision of communal land has led to the decline in land holdings, increased cultivation and land sales. The parcel sizes have become too small to support traditional livestock production both ecologically and economically (Veit 2011). Beyond the effects of land privatization on productivity of agricultural land, there is still much to learn on how privatization affects pastoral livelihoods. While the question of the effects of privatization on livestock

production and livelihoods has been addressed in literature (Gebre, 2009; Kisamba-Mugerwa et al., 2006; Legosoral, 2008), little is still known on the effect land and livestock dynamics on household diversification decisions. There exists a strong relationship between pastoralists and their rangelands and it is often hard to study them independently (Herrera et al., 2014). Land, livestock and people form the foundation of pastoralism. This study focuses on how the change in tenure and livestock production influences diversification into on-farm and off-farm enterprises.

2.4 Review of approaches in measuring land and livestock dynamics

Grimm and Lesogorol (2012) studied the impact of privatization on labour cooperation. The results showed that people who own land under private ownership were less likely to be involved in cooperative labour groups. The use of cross-sectional data to predict relationship between land ownership and labour cooperation was one of the limitations of the study. Though the current study also used cross-sectional data, it characterizes land tenure at the household level for a period of 30 years. Analysis of diversification pathways requires an understanding of the way a system behaved historically and how it influences the choice of a livelihood strategy.

Data on land tenure and livestock changes were obtained using the recall method. Though information obtained from each individual may not be accurate when this method is used, it provides data to satisfactorily identify trends (Abebe, 2016). This study used recall to elicit the respondent's memory of livestock production and land ownership. Researchers have questioned the reliability of data obtained through the recall method, which relies on the respondent's capability to remember crucial events (Howard, 2011). This limitation was addressed by asking questions in the context of significant events that act as pointers and facilitate recall (McCabe et al., 2010).

Kgosikoma and Batisani (2014) used livestock population changes of two dominant species to illustrate the adaptation of local communities to rainfall variability. The study demonstrated the effect of rainfall variability on goats and cattle. One shortcoming of the study is that it used only the dominant species to analyze livestock dynamics. The current study includes other species; poultry and sheep. There has been an increase of these species in the drylands and they form a vital source of food and income to the households (Nyberg, 2015; Engstrom, 2016).

Mureithi et al. (2015) studied the benefits of establishing group enclosures in Baringo. The study used panel data and observed that income earned from enterprises in enclosures increased over time. Further, the study computed the profit margins for the enterprises. However, operational costs such as veterinary costs were not considered. This study takes into consideration the variable costs of each enterprise in calculating the gross margins of the enterprises. Taking into account variable costs generates a comparatively precise indicator of performance of an enterprise. The economic returns of an enterprise tend to be overestimated if the variable costs are not taken into consideration.

2.5 Key drivers of livelihood diversification

Livelihood diversification is used to refer to dependence on a number of remunerative enterprises (Ellis, 2000). In the case of rural households, this may include pursuing non-farm income opportunities to supplement farm income. It also includes increasing the species of livestock reared and the variety of crops grown. The main aim of diversification is to increase and stabilize household income as well as mitigate against risks. Diversification is characterized by "pull" factors such as access to new opportunities for employment and trade, "push" factors such as rising population and falling livestock holding (Little et al., 2001; Fratkin and Roth, 2004).

Previous studies have shown a relationship between household involvement in off-farm activities and their welfare (Barrett et al., 2001; Reardon et al., 2001; Stifel, 2010). Rural households that pursue off-farm activities are wealthy compared to those that are wholly dependent on farm activities. Poor households are often unable to engage in superior livelihood diversification options due to entry barriers such as household asset endowment, access to credit and information (Barrett et al., 2001; Brown et al., 2006; Stifel 2010).

Alternative uses of land have had an impact on pastoral livelihood options. Rangelands are today characterized by land fragmentation, market-oriented livestock production and reduction of nomadic pastoralism, the once dominant form of land use (Osterle, 2008). The decline in grazing land can be attributed to the expansion of cropland (Reid et al., 2008). The present changes can be considered as part of an intense process of rearrangement of pastoral societies, linked with socio-economic stratification, rangeland fragmentation and land privatization (Lesorogol, 2008; Galvin, 2009).

Education is a determining factor of a household's decision to diversify (Barrett et al., 2001). The likelihood of earning better wages improves with education. A study conducted in Baringo showed that households that had a member with education above the secondary level had access to salaried employment, could find employment outside the area and was likely to send remittances (Little et al.2009). Additionally, enrolment of children in primary school has pushed pastoralists towards sedentarization as school attendance makes them unavailable to herd livestock (Greiner et al., 2013). High literacy level among household heads in pastoral areas enables them to diversify out of pastoralism (Asfaw et al., 2016).

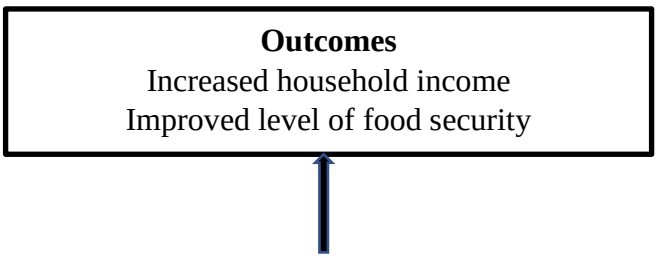
Conflict and drought are frequent occurrences in drylands and have a devastating impact. Conflict in pastoral areas has been based on the struggle to access scarce resources (Adano et al., 2012).

Conflict among neighbouring communities result in loss of livestock through raiding (Bollig and Österle, 2007). Households that lose their livestock to conflict and drought diversify into other enterprises for survival (Mutsoso, 2013).

Evidence from literature suggests that infrastructure and access to markets ease the process of diversification (Babatunde and Qaim, 2009). Asfaw et al. (2016) found that that crop diversification increases as the distance from the dense road network increases. People living close to an urban area are likely to access casual and permanent jobs and a ready market for goods and services compared to those living far away from urban areas (Watson and Binsbergen, 2008).

2.6 Conceptual framework

Over the years, pastoral communities have diversified their livelihoods in order to supplement income from pastoralism, which has been ineffective in meeting household and economic and social needs (Watson and Binsbergen 2008). The theory of adoption posits that there are multiple factors affecting adoption decision of an individual. These factors include individual socio -economic characteristics and knowledge of a product or innovation. The interactions among these factors are an integral part in agricultural research in developing countries. Innovations are often introduced by farmers' own experimentation or through external interventions. This makes access to extension services essential in providing information on innovations such as alternative enterprises. People make informed choices if they have access to all the available options as opposed to limited options that are determined by other people (WISP, 2010). Interactions between these institutional and socio-economic factors are shown in Figure 2.



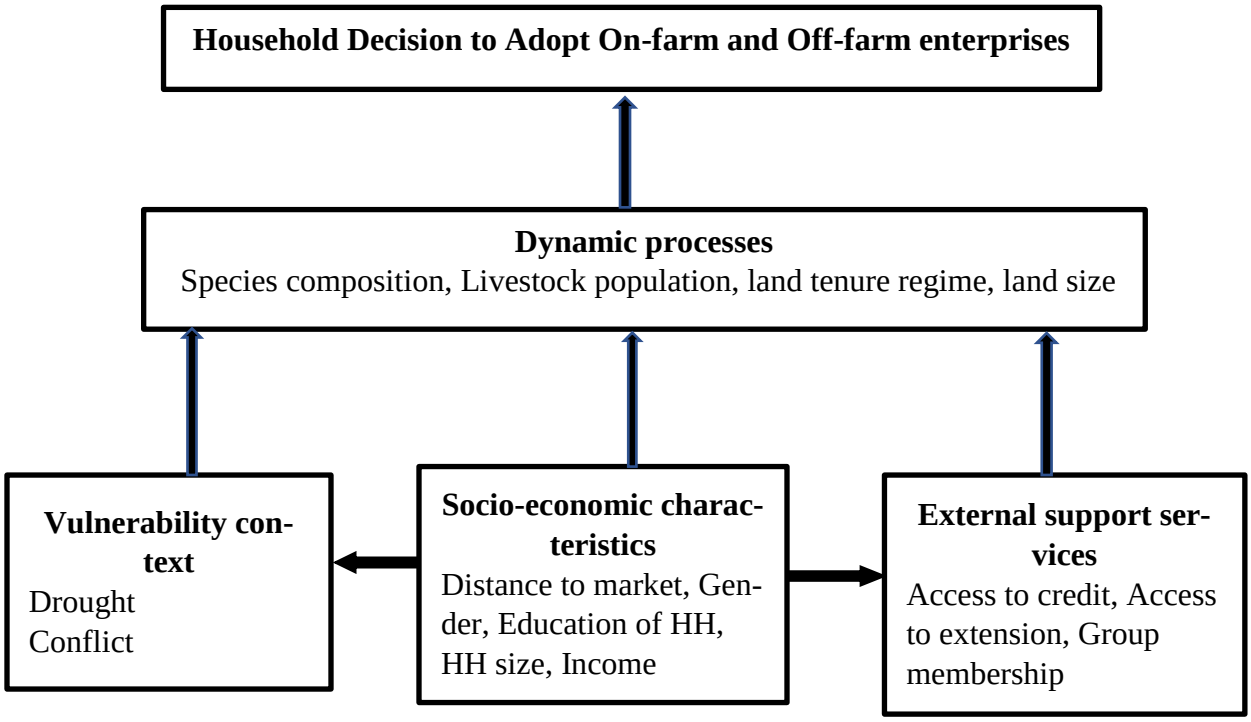


Figure 2: Interaction of factors in the Conceptual framework

Source: Author's own conceptualization

Following the human capital theory, allocative skills are learned or acquired. This is closely related to formal education which is obtained at an early age in Kenya. Education allows critical evaluation of adoption costs and productive characteristics of an enterprise. It is therefore expected that farmers with more formal schooling are better informed on the existence of a technology. They will also make more accurate assessment on the performance of an innovation on the farm hence, they are able to make effective adoption decisions (Huffman, 2001). Other household features such as age, household size, sex of the household head, distance to main market also play a significant role in the decision-making process.

The process of social learning is also integral in adoption. Abdulai and Huffmann (2005) hypothesized that in the absence of data for direct learning, pressure from local competition and social

emulation encourage firms to adopt new technologies. Therefore, farmers can effectively learn from neighbours and early adopters. It is expected that being a member of a social group is more likely to influence adoption of a livelihood enterprise.

Livelihood stresses are known to erode a farmer's confidence in adopting a technology (Teklewold et al., 2012). Pastoralism is often subject to social and environmental disturbance such as conflict and drought. Vulnerability of pastoral households is evidenced in the livelihood shocks they experience such as livestock diseases and drought (FAO, 2012). Scarcity of natural resources such as land and ambiguous property rights heightens conflict (Grimm et al., 2008). Shocks such as drought and conflict may discourage a household from pursuing on-farm enterprises. Nevertheless, such shocks may push a household into other off-farm activities for survival.

The theory of property rights points out the importance of private property rights in a country's economic development (Alchian and Demsetz1973; Demsetz, 1967). The pastoral areas in Africa have experienced significant social reorganization with experts suggesting a decline in pastoralism (WISP, 2010). Changes in land tenure over time are often due to policy interventions. The aim is to improve tenure security, investment in agriculture and conservation, access to credit and enhance land markets. However, the change in land tenure results in a change of in land size that a household control. In the wake of change in land tenure and climate change, pastoralists intensify their livestock production systems. This could be through herd diversification, reducing the herd size, changing breeds or feeding regime.

Land privatization in rangelands disrupts pastoralism which is hugely dependent on herd mobility. However, it allows households to grow fodder, food crops or participate in land markets (lease or rent out land) (Flintan, 2011). The households that become landless during subdivision are perceived to resort to alternative livelihood activities both on-farm and off-farm (Wernersson, 2013).

Nonetheless, other households diversify to increase their income portfolios, buttress against shocks or meet consumption needs (Watson and Binsbergen, 2008). A rural household may derive income from agricultural as well as non-agricultural activities.

The goal of livelihood diversification is not only to produce food to cater for the household food needs but also to produce a surplus to sell. Pursuing alternative income generating activities is expected to generate additional income to households. Income is obtained from the sale of live animals and livestock products, agricultural produce, renting out land and wages and salaries (Wernersson, 2013).

2.7 Theoretical framework

The study is anchored on the induced innovation theory by Hicks (1932). The theory proposes that, a change in price of the factors of production induces innovation. The innovation is intended to economize on the factors of production that become expensive. Improvements on the theory were made by Hayami and Ruttan (1971) to include institutions. They hypothesized that, institutions governing technology or production mode can be induced to change. The aim is to facilitate the society and individuals to change or transform positively. This will enable them to take benefit from the new technical opportunities available. Change in the agricultural sector occurs as a response to the economic environment a country finds itself in and the resource endowment of an individual at the onset of modernization.

Technical change also involves the evolution in institutions for the purpose of creating a favourable social and economic environment for effective reaction by individuals, public agencies and private firms. In specific cases, institutional innovation has involved restructuring of property rights, in order to take advantage of higher income brought by the innovations. The transformation of land

tenure relating to the shift from shared tenure to individual ownership or lease tenure is an example of a shift in property rights. Change in property rights is meant to internalize the gains from an innovative activity by individual farmers.

The question on whether an individual will adopt a particular innovation is addressed by Rogers's theory of innovation diffusion (Rodgers, 1962). Rodgers' theory has been widely used to predict change. Literature suggests that there are individual traits that predispose them to adopt an innovation faster that others (Agarwal and Prasad, 1998; Wood and Swait, 2002). Innovation compatibility with an individual's lifestyle also plays an important role in the adoption decision. Further, the contextual characteristics make up the environment of an individual during the process of adoption.

The technical feasibility and new scientific knowledge are required during the emergence of new innovation. In many cases, knowledge gives rise to new technologies. Potential demand for new technologies and appropriate knowledge is integrated to offer background for innovation activities. Measures of adoption may indicate both the timing and extent of utilization of a new technology by an individual. Adoption behaviour can be depicted as a discrete choice that indicates whether or not to use an innovation.

Discrete choices can be estimated using a latent regression modelling technique (Greene, 2003). A household decision on whether to adopt or not adopt an alternative livelihood enterprise can be modelled as the difference between benefit of adoption and its cost for an enterprise j by a decision unit in this case a household i which is an observed variable y_{ij}^{*} such that:

$$y_{ij}^{*} = X_{ij}\beta_{j} + \varepsilon_{ij} \quad (1)$$

where X is the set of explanatory variables comprising of specific household characteristics, resource constraints and individual preferences, β is the vector of parameter estimates and ε_{ij} is a normally distributed disturbance term. The net benefits of adoption are not observed, rather, the choice on whether the farmer chooses to adopt an enterprise is observed. Under the assumption of revealed preference, farmers adopt an enterprise that yields benefits and not adopt the enterprise otherwise. The observable latent net benefit variable is expressed as $y_{ij} = 1$ if $y^*_{ij} > 0$, or $y_{ij} = 0$ if $y^*_{ij} \leq 0$. In this case, y is a dichotomous predictor variable that takes the value of one when a household adopts an enterprise and zero otherwise.

CHAPTER THREE

3.0 CHARACTERIZATION OF DYNAMICS IN LAND, LIVESTOCK AND PASTORALISTS' LIVELIHOODS

3.1 Abstract

Pastoral rangelands have experienced a tremendous change in land tenure over the past decades. These changes have triggered social, ecological and economic changes that have implications on pastoral livelihoods. The change in land tenure has set in motion pastoral livelihood transformation from nomadism to sedentary agro-pastoralism. However, livestock production is still an important livelihood activity for many households in the ASALs. This chapter characterizes the changes in land tenure, livestock species and population and pastoral livelihoods. Data collected through a survey of 221 household and a focus group discussion. The data were analyzed qualitatively. The results showed that three tenure systems; communal ownership without title, private ownership with title and private ownership without title have been in existence in the area for the last three decades. The land size controlled by a household is rapidly decreasing. Further, the number of households that held land with formal title deeds was relatively low and communal land is still unregistered. The herds are being diversified to adapt to the changing environment. The stock levels of small animals (goats and sheep) were higher compared to that of cattle between 2007-2011. Poultry farming is also gaining importance based on increase in numbers stocked in the last decade. The findings of this study call for policy action that will shorten the process of acquiring title deeds. This will improve tenure security and enable households internalize the benefits of investing in land. It will also improve vibrance of other enterprises such as land markets that is hugely dependent on tenure security.

Keywords: land, livestock, livelihoods, diversification.

3.2 Introduction

Pastoralism has been proven as a sustainable means of livelihood in the drylands. The practice allows maintenance of a sustainable equilibrium between pastures, livestock and human population (Kaye-Zwiebel and King, 2014). Despite its importance, traditional livestock production system is becoming unsustainable. This has been caused by the disruption in the transhumance corridors. Transhumance is a strategy that creates a balance between the available resources, land and livestock. The change can be attributed to internal migration, change in land tenure systems and agricultural policies (Fratkin and Mearns, 2003).

Land fragmentation has resulted in induced sedentarization of pastoral communities and decline in livestock numbers (Abbink et al., 2014). It has also resulted in a new way of pastoralism and herd management and the emergence of new practices and values. Pastoralists are becoming more focused on profit making as opposed to traditional culture and safety nets such as redistribution of their livestock (Flintan, 2011). Pastoralists have pursued non-pastoral enterprises in order to buttress against shocks associated with climate variability, animal disease, market failure, insecurity and tenure change. Land tenure is a key feature in the interventions that target development of rural areas.

This chapter adds to the body of knowledge by highlighting current land and livestock dynamics that have occurred in Baringo in recent years and livelihood enterprises. This forms a basis for recommending asset and livelihood combinations that can help pastoralists withstand the adverse effects of the ongoing changes.

3.3 Methodology

3.3.1 Sampling and data collection

A total of 221 households were surveyed. A multistage sampling procedure was employed. Baringo south sub-county was purposively selected (as part of the paradox project) in the first stage to capture pastoral and agro-pastoral households. In the second stage, Ilchamus and Marigat wards were selected. In the third stage six sub-locations were selected; Meissori, Salabani, Endao, Kabusa, Yatoi and Kibirger. Persisting insecurity and conflicts in parts of the county prevented coverage of all the sub-locations. To minimize bias of responses, random sampling technique was used. The first household in a randomly selected village path was picked and then every third household after that. The formula in equation 2 was used to determine the sample size used:

$$n = \frac{(p(1-p)Z^2)}{E^2} \tag{2}$$

where *n* is the sample size to be determined, *p* is the population proportion that would be available at the time of the survey, *E* is the margin of error, whereas *Z* is the confidence interval. The proportion of the population that would be available for the survey could not be ascertained as the study was conducted among pastoralists who often migrate with their livestock. Therefore, *p* is set at 0.5 to obtain an optimum sample size, *Z* is 1.96 and *E* is 0.07 (Anderson et al. 2007). A sample size of 196 is arrived at as shown in equation 3.

$$n = \frac{(0.5(1-0.5)1.96^2)}{0.07^2} = 196 \tag{3}$$

However, following minimum sample sizes used by other studies on diversification such as Babatunde and Qaim (2010), Mengistu (2016), Lesogorol and Boone (2016) and Addisu (2017), a total

of 235 households were targeted. A sample of 221 was used for analysis after incomplete questionnaires were discarded.

Primary cross-sectional data were collected by use of a focus group discussion (FGD) and household interviews. The FGD was conducted in order to obtain responses on social dynamics and their relationships with the dynamics in land tenure, land use, livestock population, species and pastoral livelihoods. The FGD had 20 participants who were purposively selected from the interest groups whose ideas and opinions are relevant to the study; they included 7 women, 4 youth pastoralists, 1 extension officer and 8 men. Group interactions elicit recall and offers descriptions of shared experiences.

A semi-structured questionnaire was used to collect data. The questionnaire was organized into seven sections. Information pertaining to general trends in land and livestock, exposure to shocks and coping strategies, participation in the output markets, off-farm household income, farm inputs utilization, household socio-economic and institutional characteristics, household demographic characteristics were captured in various sections of the questionnaire. With the support of trained enumerators, face-to-face interviews were conducted to administer questionnaire using Kiswahili or the local dialect. The household head was selected as the primary respondent for the study.

3.3.2 Data analysis

This section describes the analytical methods applied to achieve the objective of characterizing the households. Qualitative analysis was done on the data from the FGD and household interviews. Data from the FGD offered insights on the historical trends in tenure and livestock production in the drylands. The Simpson diversity index (SDI) was applied to estimate livestock diversity in a household as follows:

$$SDI = 1 - \sum_{i=1}^{n} p_i^2 \quad (4)$$

where P_i is the number of individuals of a particular species *i* found in the herd.

3.4 Socio-economic characteristics of the respondents

Table 1 contains the sample respondents characteristics. The mean age of the respondents was found to be 46 years. This was similar to the findings of Muricho et al. (2017) in the case of West Pokot. Two-thirds of the household heads were male; this confirms the patriarchal nature of pastoral communities. This is consistent with the observation by Markakis (2004) that men own livestock and make most important decisions, while women perform domestic chores including child care.

Table 1: Sample characteristics

Variable	Mean (n = 221)	Std. deviation
Continuous variables		
Average age (years) of household head	46.22	14.74
Average years of schooling of household head	6.82	4.77
Tropical livestock units (TLUs)	12.44	13.94
Simpson diversity index (SDI)	0.47	0.21
Average number of livelihood strategies	3.65	1.36
Average total household income	142,825.00	158,911.80
Categorical Variables		
Sex of household head (1=male)	68.78%	
Access to credit (1= yes)	46.15%	
Access to extension services(1=yes)	30.77%	
Group membership (1= yes)	56.11%	

Note: Following WISP (2010), the TLU equivalents for various livestock were considered as: camels = 1, cattle = 1, donkeys = 0.8, goats and sheep = 0.2 and poultry = 0.04.

Source: Survey Data (2018).

The average years of completed formal schooling was 6. Majority of the respondents did not complete primary education. It is consistent with the observations by Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID) that only 16% of the population had attained secondary school education (KNBS and SID, 2013). However, this means that the respondents were not endowed with formally trained human capital. Therefore, the respondents may not be able to participate in livelihood strategies that require formal education.

The mean TLU was 12 and the mean SDI was 0.4. The SDI was used to measure the livestock species diversity in the household. The SDI ranges from 0 to 1, a value of 1 implies that the household had high diversity and 0 implies specialization in one livestock species. A mean of 0.4 shows that on average each household had more than one species in their herd. Following Sahal and Baha (2010) the respondents can be said to have a medium herd diversity measure since a value below 0.38 indicates low diversity, 0.38-0.63 medium diversity and a value higher than 0.63 shows high diversity.

On average, a household is dependent on at least three livelihood activities. This is a strategy to minimize risk associated with various pastoral challenges. The number of livelihood strategies varies for every household, but range from a minimum of 1 to a maximum of 8. The aim of maintaining a diversified source of income is to ensure a smooth flow of income by reducing fluctuations.

Approximately 46% of the respondents had access to credit. While 20% of the respondents who accessed credit received it from SACCOs, 45% received it from their social networks. Only 8% of the respondents accessed credit through banks. Most households in rural areas lack collateral to access credit from banks (Adhikari, 2011). Innovative techniques such as table banking, mobile money and joint liability partnerships improve financial access for resource poor households.

A third of the respondents had received extension services in the last 12 months. While 52% received livestock-based extension services, the rest received crop-based extension. The county government was the main provider of extension services and was accessed through farmer field schools. Agricultural extension services are an important conveyor of agricultural innovations to rural communities. Regarding group membership, 56% of the sampled population were members of social development groups. Membership to a social group is a means of access to information, credit and protect against unforeseen circumstances. Fifty percent of respondents who belonged to a social group rated gender as the basic characteristic of the members. Social networks may also influence the adoption of new enterprises by a household in numerous ways, such as offering a stable market for output, information sharing, reducing constraints to accessing credit and labour sharing.

3.5 Characterization of land and livestock dynamics

3.5.1 Land tenure

As noted in Figure 3 communal land tenure has been the leading form of tenure. Despite the inimical view towards communal land ownership and customary rules, it continues to exist in rangelands (Odote, 2003). This can largely be associated with the fact that the livelihoods in rangelands are hugely dependent on transhumance.

The period after 2002 was characterized by a rise in private ownership without title deed. This was around the same time when Rehabilitation Arid Environments (RAE) Trust advocated for the use of private enclosure in the Njemps flats (Mureithi et al., 2015). The RAE Trust is a non-governmental organization that advocated for the use of enclosures to rehabilitate degraded rangelands.

This explains the increase in the number of people who own land under private tenure after this period.

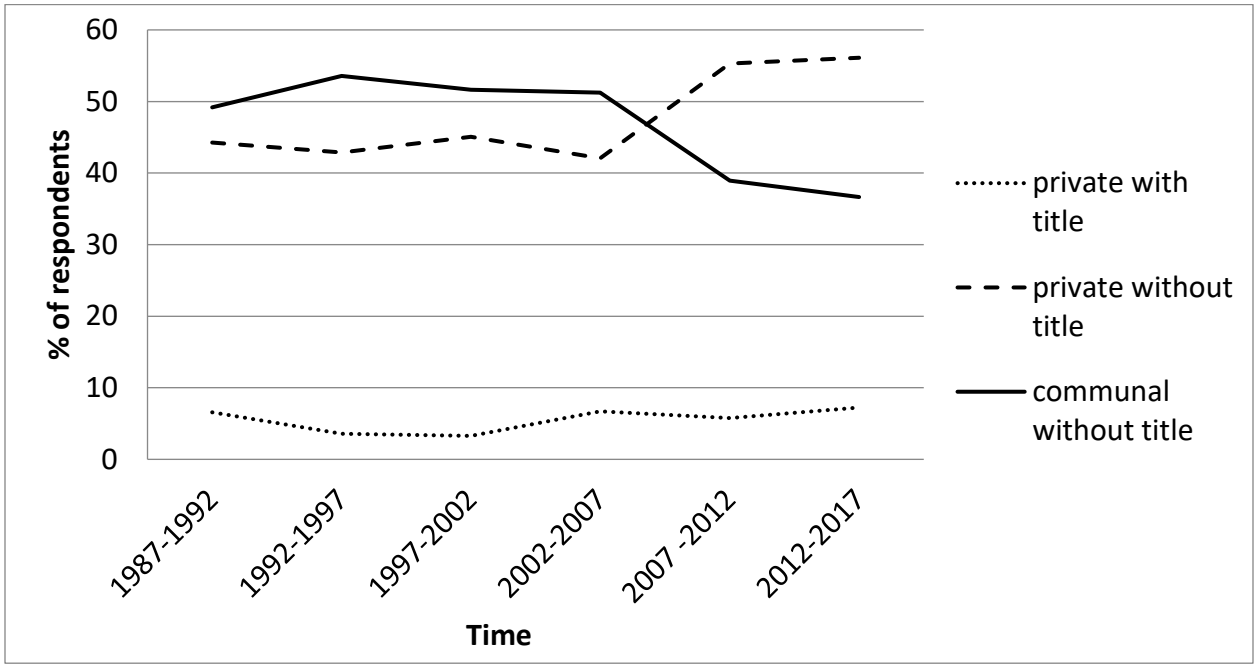


Figure 3: Land tenure change over a 30-year period

Source: Survey Data (2018).

Private tenure with title deed is the least common form of tenure in Baringo. However, the period between 2012 and 2017 shows a rise in the number of households with title deeds. Despite the emergence of individual tenure, formal registration has not been obtained by majority of the households. This is attributed to the fact that the procedure of acquiring title deed in Kenya is lengthy (CIDP, 2019). The FGD confirmed that land adjudication was in progress. Some households had been issued with an allotment letter. The land registration Act of 2012 was passed to justify the registration of communal land (Odote, 2013). It provides for the issuance of title deeds or leases for communal land by the registrar. Despite the passing of Communal Land Act 2016 by parliament, communal land is still unregistered. Further, the participants in the FGD and sampled respondents were not aware of the existence of the Communal Land Act 2016.

3.5.2 Land size

The change in land tenure system has resulted in a decline in the land size holding per household during the last three decades. Table 2 shows the mean land size accessed over time.

Table 2: Mean land size accessed over time

Time	Average land size per household (acres)	Std. deviation
1987-1992	11.40	10.99
1992-1997	10.73	10.22
1997-2002	9.68	8.65
2002-2007	8.49	8.23
2007-2012	7.29	8.39
2012-2017	6.55	8.15

Source: Survey Data (2018).

The declining land size is caused by a number of factors. Among them is the subdivision of communal land, increase in population and land degradation. The encroachment of invasive species *Prosopis Juliflora, cactus* and swelling of Lake Baringo were other factors mentioned as the reasons for the decline in land size. Insights from the FGD also showed that land sizes were rapidly declining around urban areas due to the growing demand for land by developers. The current land holding stands at 6.5 acres, this is close to the average land holding of 6.25 acres reported by CIDP (2019).

The standard deviation is higher than the mean for the period between 2007 and 2017. This implies that the data points are spread out over a wide range of values. The standard deviation is a measure that is used to quantify disparity in values of a data set. For example, the minimum acreage was 0.5 and the maximum was 61 for the period of 2012-2017. Land inequality in Kenya is a common phenomenon. While some families may own large tracts sometimes lying idle, others are landless and living in poor conditions (Syagga, 2006). Additionally, subdivision of communal land may

result in inequality of land sizes. Mwangi (2005) found that after subdivision in Kajiado, 60% of the pastoralists found themselves with parcels smaller than the average. Land had been concentrated in the hands of wealthy herders, committee members of group ranches, their friends and relatives.

3.5.3 Livestock population and species

Figure 4 shows the trends of livestock population and species over the last three decades.

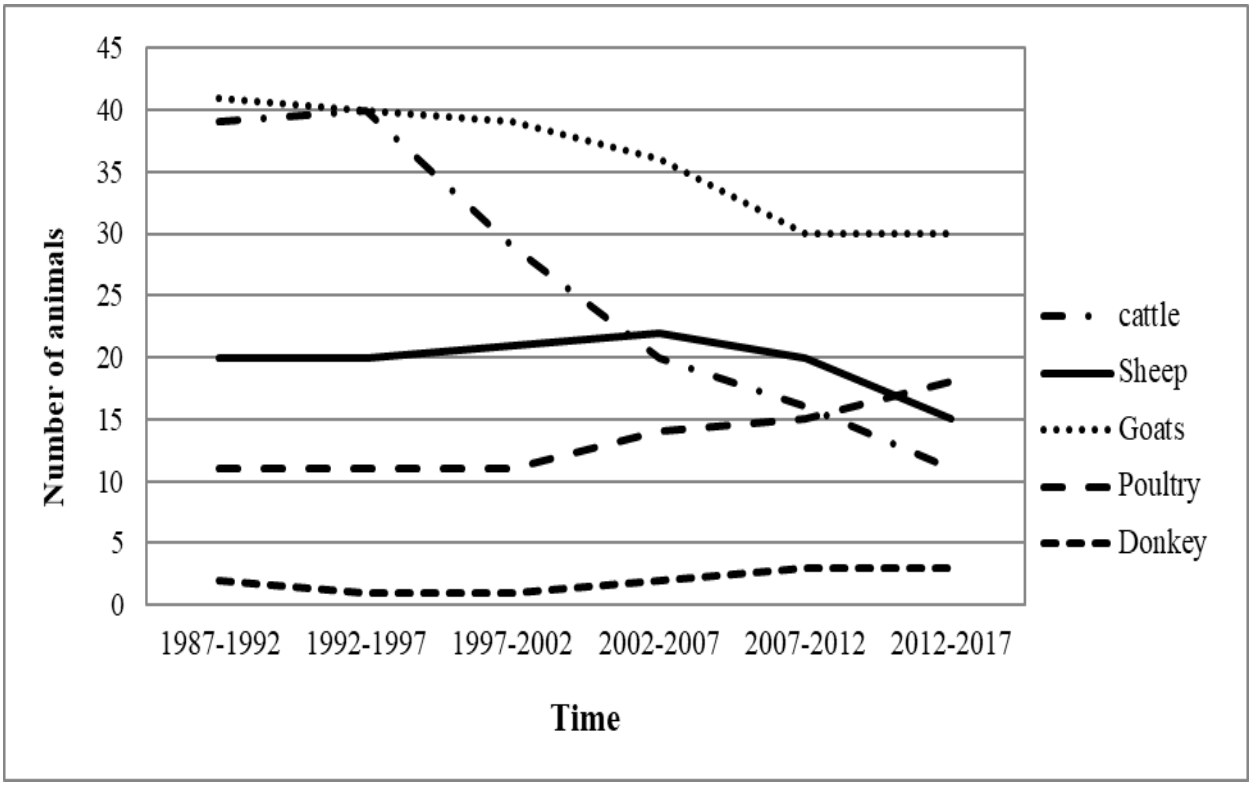


Figure 4: Livestock species and population over time

Source: Survey Data (2018).

There is a drastic decline in the number of cattle and sheep stocked. This change is linked to the encroachment of bushes, which made the environment suitable for browsers as opposed to grazers. Though goats and sheep show a declining trend they are stocked in large numbers compared to

cows. From the FGD, the abundance of goats was due to its ability to meet urgent cash requirement and being hardy. Moreover, the Ilchamus community has over the years relied on small stock to rebuild their stock and recover from drought shock (McPeak and Little, 2005). Poultry farming shows an upward trend between the year 2002 and 2017. According to Nyberg et al. (2015) the increase in poultry farming in rangelands is due to its low capital requirement and the short period for return on investment. The trend in poultry farming shows that the enterprise is gaining importance as a source of income and food.

Herd diversification is mechanism used by pastoral communities adapt to changes in their environment. Participants of the FGD stated that livestock mobility was declining and pastoralists have resorted to alternative feeding regimes such as rotational grazing within enclosures, use of crop residues and planted forages.

3.6 Pastoralists livelihood shocks

As shown in Figure 5, shocks undermine pastoral livelihoods. Over 96% of the households surveyed were affected by drought. Approximately 62% of the respondents had experienced drought at least once in the last 12 months. Historical climate data show that drought frequencies in the County have increased from 4 droughts in the 1980s to droughts in the 2000s every 10 years (Kosonei et al., 2017). Drought results in crop failure and death of livestock and is also a major cause of the inter-tribal conflicts over water and pasture. Nearly half of the respondents had been affected by conflict with neighbouring communities. Nearly 16% of the households had lost their livestock to due to cattle rustling during the conflicts. Data from the FGD showed that drought and conflict often occur concurrently. Drought results in scarcity of water and forages spurring resource conflicts. However, some conflicts are politically instigated. Conflict not only results in huge economic losses but also has social effects such as loss of human lives and forced migration.

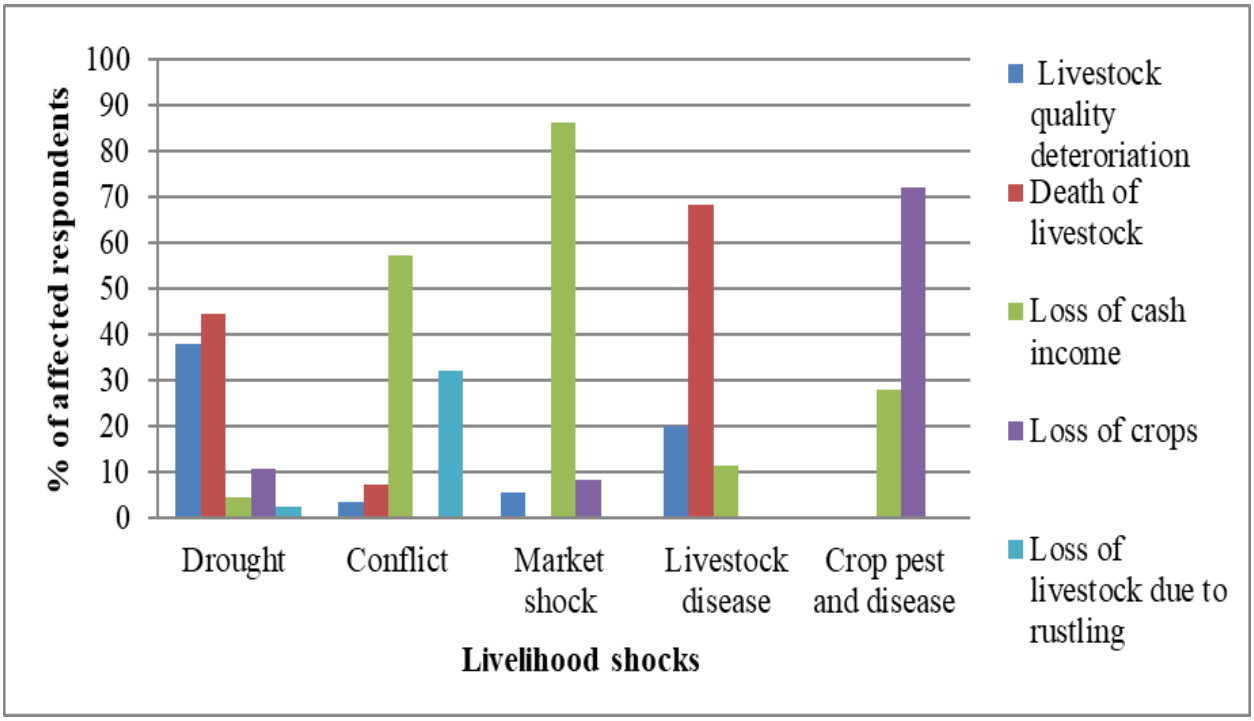


Figure 5: Livelihood shocks and their effects

Source: Survey Data (2018).

Ninety four percent of the sampled population were affected by livestock diseases. From the FGD the most common diseases are foot and mouth disease, goat pneumonia, *peste des petits* ruminant (PPR) and Newcastle in chicken. Livestock diseases result in deterioration of livestock quality, death and loss of income. Forty eight percent of the respondents were affected by crop pests and diseases. The fall army worm, maize lethal necrosis and maize streak and weevils were some of the main causes of crop losses.

Approximately one-third of the households were affected by market shocks mainly attributed to fluctuation in prices in the input and output market. During peak seasons when products are in abundance households are offered low prices in the market. Further, during the dry season farmers are offered extremely low prices for their livestock as the quality of livestock deteriorates.

3.7 Sources of household livelihoods

Figure 6 shows sources of household income. Being a pastoral area, livestock production was the leading source of income, more than three-quarters of the households relied on the enterprise. This conforms to the common notion that pastoralists derive most of their income and food from livestock (Little and McPeak 2014; Nyberg et al., 2015). Income from the livestock enterprise is earned through the sale of live animals and livestock products such as eggs, milk, hides and skin.

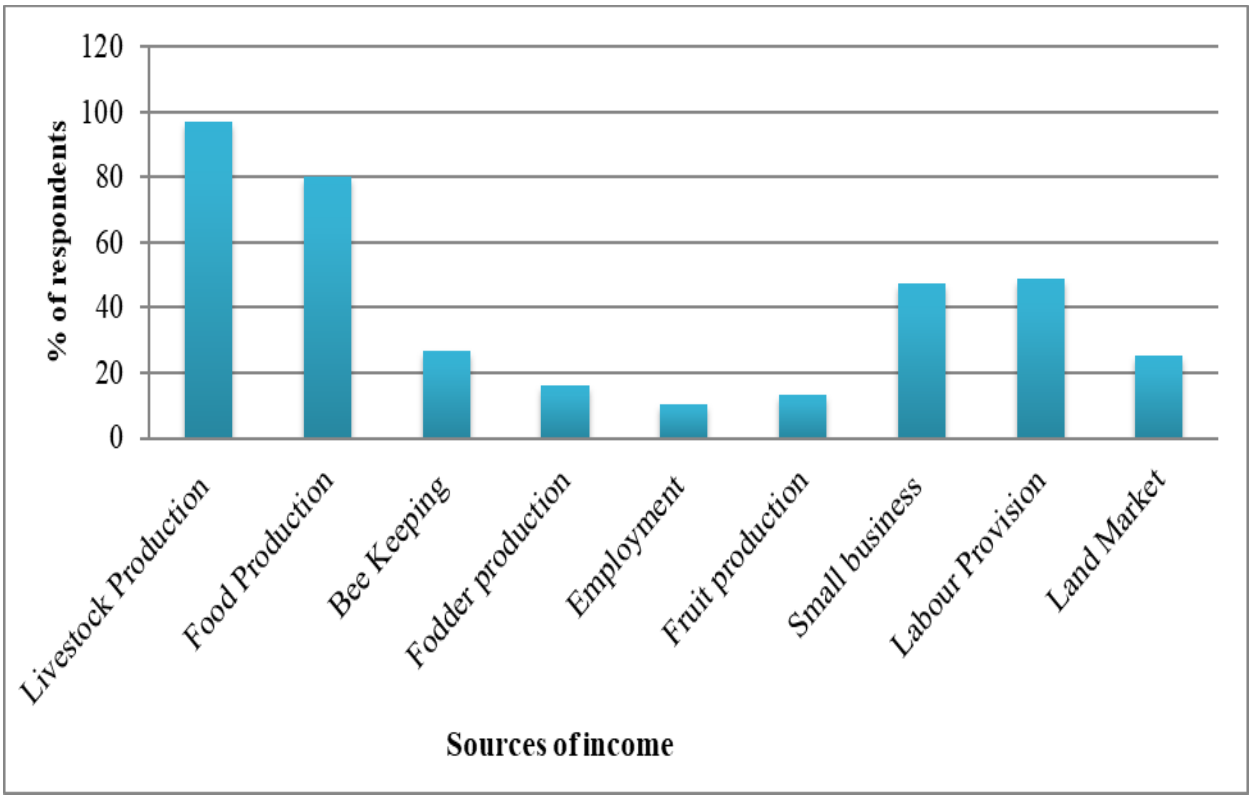


Figure 6: Sources of household livelihood

Source: Survey Data (2018).

The FGD revealed that pastoralism and farming have for a long time characterized the economic activities of people in Baringo. However, changes have been observed and households are pursuing alternatives such as commercial bee keeping and fodder farming in order to take advantage of emerging opportunities and as well as to adapt to the changing environment. Food crop production

was the second most common enterprise with four-fifths of the households being food crop producers. The popularity of food crop production among households can be attributed to its dual-purpose nature. While the harvested grain is used to meet household food requirements, the crop residues are stored and fed to livestock during the dry season. Much attention has also been paid to crop production in terms of technical and economic support in Africa. The crops grown include; maize, finger millet, sorghum and beans. Food crop farming helps households to cope with weather vagaries and also enhances household food security.

Fodder production was practiced by 16% of the respondents. Just like food crop cultivation, fodder production can only be done in private land or enclosures in communal land. Income from fodder production is earned from contractual grazing arrangements, sale of hay and grass seeds. Abebe (2016) found that the Borana pastoralists earned income from selling fodder in the local market and from renting out their enclosures. Approximately 25% of the sampled respondents obtained income from land markets. Land owners participated in land markets by renting out or leasing out land for cultivation. Renting out land is only possible where individual land rights exist. Land market is a new enterprise that comes with the change in land tenure from communal to private ownership. Saxer (2014) reported similar findings in West Pokot that private land ownership had enabled people sell and rent out their land; a phenomenon that was not part of the Pokot culture. A quarter of the respondents also received income from bee keeping. It is an economic activity that employs people of all ages. Honey produced is sold to earn the household income. Despite being an important source of food and medicine, honey has other uses such as brewing traditional beer (Gichora, 2003).

Additionally, fruit farming was practiced, though marginally. About 13% of the sampled households were fruit farmers. The main fruit crop grown was watermelon, which as noted by Lugusa

(2015) is preferred due to its fast maturity and ability to fetch high prices within a short period of time.

Fruit farming is a livelihood strategy that is increasingly being farmed under irrigated systems in the drylands. Fruit farming was carried out along the banks of river Endao, on the shores of Lake Baringo and the Perkerra irrigation scheme. Elsewhere in Garissa, pastoralists have been documented to grow mango, pawpaw, banana, sweet melon, and watermelon under irrigation (Mahmoud, 2016).

Respondents have also sought alternative livelihoods in small businesses with 47% of the households earning an income from it. This ranges from sale of natural resources (charcoal, wild foods, firewood and timber) to operating small shops in trading centers. Decentralization of government services and administration has resulted in urbanization bringing businesses into remote areas. This has created demand for labour, consumer goods and other commodities like charcoal. Only 10% of the sampled population were earning an income from salaried employment.

Nearly half of the households earned income from waged labour. The main aim of diversification into waged labour is to supplement low returns from pastoralism and food crop farming (Barett et al., 2001). Nearly 14% of the households received income through food for work programs ran by NGOs such as World Vision and World Food Programme.

CHAPTER FOUR

4.0 EFFECT OF LAND TENURE AND SOCIO-ECONOMIC FACTORS ON LIVELIHOOD DIVERSIFICATION

4.1 Abstract

Livelihood diversification is a process by which rural households establish a portfolio of activities for subsistence and improving their standards of living. The available land can no longer meet the family food as well as animal fodder requirements. Pastoralists are no longer confined to livestock and crop production but combine a range of alternative income sources. This chapter assessed land tenure system, farm practices and various socio-economic features that may have substantial influence on a farmers' decision to pursue on-farm livelihood diversification strategies in Baringo County, Kenya. A binary logit model was used to analyze survey data from a sample of 221 households. Use of enclosures, irrigation, land size, practice of pastoralism, tropical livestock units, age of the household head, and access to credit were found to have significant effects on on-farm livelihood diversification. The negative effect of access to credit on on-farm diversification was notable. Credit utilization at household level was in favour of off-farm strategies. This can be attributed to risky nature of most agricultural ventures. This calls for sensitization of pastoralists on the importance of investment in inputs for improved productivity. Further, lenders should take into consideration the unique asset ownership in rangelands when designing credit schemes. This will encourage pastoral communities to take up credit for agricultural purposes.

Keywords: land tenure, livelihoods, on-farm enterprises.

4.2 Introduction

Pastoralism relies on the availability of large tracts of land for livestock mobility. Over the last five decades common grazing resources have been transformed into individual resources. Land adjudication led by government in the 1960s and 1980s recognized new forms of tenure. This included land ownership in group ranches and complete privatization for individual ownership (Mwangi, 2007). Degradation and loss of communal land compromises effective utilization of rangeland resources by pastoralists.

Kenya is already experiencing extreme weather events in different parts of the country. Rainfall patterns have become unpredictable and irregular, droughts have become more frequent and floods more severe. The ASALs are particularly hard hit by the variability in climate putting the livelihoods of many pastoralists at risk (Republic of Kenya 2017). Further, dependence on limited income sources exposes households to food insecurity (MoALF, 2018). This is worsened by limited ownership of resources such as land and seasonality of food crop production.

Livelihood diversification among pastoral communities in East Africa is common and gained more importance after the 1979 and 1984 droughts (Little, 2016). The growth of towns, increased incidence of drought, conflict and change in land tenure are other factors that shape current diversification strategies. Diversification includes pursuance of activities that improve incomes, welfare and resilience to shock without conflicting with pastoralism. In many circumstances, diversification activities compliment livestock production (Little, 2016). It is therefore plausible to say that pastoral communities can adapt to the change in their environments and stand to benefit if the changes offer flexibility and opportunity for diversification (Lesogorol, 2008).

To address the rise in poverty and the vulnerability of pastoral communities to climate change, efforts have been made to encourage diversification. Having a diverse source of income reduces the household's exposure to risk associated with climate variability. Diversification results in improved food security and a rise in household income. However, it is necessary to understand the adoption decision of a household while putting into consideration discrepancies in resources, differences in households' demographics and farm practices. There is little evidence in literature on the effects of land tenure, farm practices and socio-economic characteristics on the adoption of on-farm livelihood diversification, especially among pastoralists. These issues may have a substantial bearing on a pastoralist's decision on the choice of diversification pathways. This chapter adds to the body of knowledge by highlighting the interaction of land tenure, farm practices and household socio-economic characteristics on livelihood diversification in pastoral areas.

4.3 Methodology

A binary logit model was used to examine a pastoralist's probability to pursue on-farm diversification. A household was classified to have adopted on-farm diversification if they derived more than 50% of total income from more than one on-farm enterprise. These enterprises include; food crop production, income from rented out land, beekeeping, livestock production and fodder production. The model is considered to be the most suitable owing to the binary nature of the dependent variable. A household can either diversify to on-farm or off-farm enterprises. Following Greene (2003) the model specification is as shown in equation 5:

$$Prob[Y_{ij} = 1] = \frac{\exp(\beta' \chi_i)}{(1 + \exp(\beta' \chi_i)} = \Lambda(\beta' \chi_i) \quad (5)$$

The subscripts *i* and *j*, respectively denote the farmer and the type of livelihood diversification enterprises (1 = on-farm, 0 = otherwise). A farmer was classified to be an on-farm if they had

derived more than 50% of their household income from on-farm enterprises. Equation 5 represents the reduced formula of the binary logit model. The row vector of dependent variables is represented by χ_i for the i^{th} farmer. The error terms ε*'s* are not observed though they are presumed to follow a logistic distribution with a density function given by equation 6:

$$F'(\beta'\chi_i) = (\Lambda(\beta'\chi_i)[1-(\Lambda(\beta'\chi_i)] \quad (6)$$

The model was empirically specified as;

$$\Pr\left[CABR_i = 1\right] = \beta_i X_i + \varepsilon_i \quad (7)$$

where X is the set of explanatory variables (land tenure, use of enclosures, use of irrigation, land size, distance to the input shop, share of income from from livestock production, age of the household head, household size, total household income, education of the household head and access to credit).The dependent variable is the farmer's decision to adopt a diversification option. The explanatory variables that were chosen for this study consist of socioeconomic factors and farm practices. Table 3 summarizes the variables and their expected signs.

Table 3: Description of variables in the binary logit model

Variables	Description of variables	Expected sign

Land tenure	Tenure system under which land is held (1=private tenure, 0= communal tenure	+
Enclosures	Use of enclosures (1 = yes, 0 = otherwise)	+
Use Irrigation	Use of Irrigation (1 = yes, 0 = otherwise)	+
Land Size	Farm size in acres	+
Dist. Input shop	Distance to the input shops in kilometers	+
Share of income from livestock	Share of income derived from livestock production (1= at least 50%, 0 = otherwise)	+
Age HHH	Age of the household head in years	±
HH size	Number of members of the household	+
HH Income	Annual household income in Kshs	-
Education HHH	Years of education attained by the household head	-
Access credit	Access to credit facility in the last 12 months (1 = yes, 0 = otherwise)	+
Access to extension	Access to extension services in the last 12 months	+
Exp. Food shortage	Experienced food shortage in the last 12 months (1 = yes, 0=otherwise)	+
TLU	Tropical livestock units	+
Sex HHH	Sex of the household head (1 = male, 0=otherwise)	±

Household endowment is a significant driver of diversification. The number of livestock that are kept by a household can result in adoption of economic activities that complement the pastoral livelihood (FAO, 2016). Tropical livestock units (TLUs) is used to express the number of livestock that a household owns. Pastoral communities are known to cultivate crops alongside livestock keeping. Crop residues are increasingly serving as a source of feed. Further, food crop farming reduces the need to sell livestock to meet household need thus accumulation of livestock assets (Solomon et al., 2007). Livestock production has been proven to be an efficient means of livelihoods that utilize scarce rangeland resources. However, in recent years, pastoralism has evolved

to include crop production and other livelihood enterprises. Nonetheless, pastoralists still derive a substantial amount of food and income from livestock production (Muricho et al., 2017). It is therefore expected that households that have large herds and derive substantial amount of income from livestock will pursue on-farm diversification. This is attributed to the complementarities that exist between livestock production and other on-farm enterprises.

Additionally, ownership of large land size is predicted to have a positive influence on the adoption of on-farm diversification. Over the years land use patterns in rangelands has transformed from nomadism to agropastoralism (Muriuki et al., 2005). It is therefore expected that households that control large parcels of land will dedicate their land to on-farm enterprises to improve household income.

Land ownership is an important aspect of diversification, it is illustrated by the variable land tenure. Private land ownership is likely to have a positive influence on involvement in on-farm diversification. The change in land tenure from communal to private tenure gives individuals exclusive land access and use rights. Geutjes (2014) observed that pastoralists who own land under individual tenure which is perceived to be more secure are able to pursue various investment opportunities on-farm.

The use of enclosures to rehabilitate degraded areas in pastoral areas have numerous benefits (Nyberg et al., 2015; Mureithi et al., 2015). The use of enclosures in both private and communal land generates income through the sale of agricultural products from the enclosures (Wairore, 2015). Additionally, Mureithi et al. (2015) found that the use of enclosures in degraded land in Baringo improved the soil quality. It is therefore expected that the use of enclosures will have a positive effect on on-farm diversification. Further, households in drylands use irrigation as an adaptation to climate change. Gichora, (2003) argues that sustainable crop farming in rangelands can

only be done under irrigation. This fact, therefore, presents an opportunity for other on-farm enterprises like beekeeping to be practiced in marginal areas. It is expected that households that use irrigation will pursue on-farm diversification as they are able to substitute rainfed agriculture with irrigation.

Household income is an important factor in livelihood diversification. Household income is expected to have a negative effect on the adoption of on-farm enterprises. Households that receive a higher income diversify into off-farm enterprises. Wealthy households often seek investment opportunities outside the pastoral economy to diversify their assets and enhance their economic prospects (Fratkin, 2012).

It is anticipated that credit accessed by a household will be invested in purchasing inputs that enhance agricultural productivity. This includes the purchase of inputs such as fertilizer, pesticides, irrigation equipment, hybrid seeds, which will result in increased income (Grimm and Lesogorol 2012). Further, access to extension facilitates the process of diversification. Households that had accessed extension services in the last twelve months at the time of the survey were expected to be engaged in more diversification strategies.

The present study hypothesized that households that earn at least 50% of the total household income from livestock, use of enclosures and use of irrigation have a positive influence on on-farm diversification. Further, socio-economic characteristics are anticipated to play a role in household choices. Education, sex of the household head, household size, age, access to credit and markets are some of the variables investigated.

To gain more insights on household livelihood diversification, an ordered logit regression was estimated to analyze the factors influencing the number of income sources that a household

depends on. On-farm and off-farm income sources were considered for analysis. An ordered logit was used due to the ordinal nature of the number of income sources. A household that depends on one income source is worse off compared to a household that has other alternatives.

The ordered logit is specified as;

$$y_i^* = \beta' x_i + \varepsilon_i \quad (8)$$

where x_i is the set of independent variables and ε_i is the error term. y_i^* is not observed, what is observed is:

$$y_i = 0 \text{ if } y_i^* \leq \mu_{0,} \quad (9)$$

$$=1 \text{ if } y_i^* \leq \mu_{0,} \leq y_i^* \leq \mu_1 \quad (10)$$

$$=2 \text{ if } y_i^* \leq \mu_{1,} \leq y_i^* \leq \mu_2 \quad (11)$$

……

$$8 \text{ if } y_i^* > \mu_7 \quad (12)$$

The μ's are unknown parameters that are to be predicted by the β. The respondents have their own intensity of livelihood strategies, which are dependent on certain measurable explanatory variables χ and unobservable factors ε. The key explanatory variable included in the model include: Land tenure, Simpson diversity index, total household income, age of the household head, distance to main market, household size, use of irrigation, land size, use of enclosures, share of income from livestock, access to extension, group membership and access to credit.

4.4 Results and discussion

In a binary choice model, the goodness of fit is measured by the pseudo R^2. A pseudo R^2 of 0.20 is within a satisfactory range according to McFadden (1974). The estimates of the binary logit model

in Table 4 show that land tenure had a positive but insignificant effect on farmer adoption of on-farm livelihood diversification. Perhaps, the effect of land tenure on the adoption of on-farm enterprises is insignificant because farmers who held land under private tenure system might invest less in on-farm enterprises. This could be due to preference for off-farm enterprises such as operating small businesses. Farmers who own land under private tenure system may use their land as collateral to access credit which they invest in off-farm enterprises that have high capital requirements. Mwangi (2007) found that the issuance of land titles upon completion of subdivision enables individuals to access capital markets.

Use of enclosures had a significant effect on the adoption of on-farm enterprises. Farmers that establish enclosures diversify their livelihood and pursue alternative income generating activities within the enclosures. This includes participating in fodder production, and engaging in contractual grazing. It has been noted that the high vegetation cover in enclosures is an indication that the enclosures are a potential tool for diversification and intensification in drylands (Catley et al., 2013; Verdoodt et al., 2010). Additionally, land size was found to have a significant effect on the choice of on-farm diversification. Ownership of large land size is likely to motivate a household to engage in more on-farm enterprises to improve household income. Additionally, in the existence of active land markets land can be sold or rented out for income.

Table 4: Binary logit estimates of factors influencing adoption of on-farm diversification

Variables	Coefficient	Std Error	p>Z
Land tenure (1= private ownership)	0.034	0.188	0.855
Use of enclosures (1= yes)	0.879	0.434	0.043**
Use of irrigation (1= yes)	-0.838	0.408	0.040**
Land size	0.095	0.053	0.073*
Distance to input shop	-0.033	0.042	0.432
Share of income from livestock (1= at least 50%)	1.789	0.796	0.025**
Age of the household head	0.031	0.018	0.087*
Household size	0.108	0.081	0.186
Household income	-0.000	0.001	0.773
Education of the household head	0.004	0.052	0.936
Access to credit (1= yes)	-0.858	0.424	0.043**
Experienced food shortage	0.467	0.464	0.314
Tropical livestock units	0.063	0.029	0.031**
Sex of the household head (1=male)	-0.559	0.452	0.216

Notes: Log likelihood = -91.469 LR $\chi 2$ (14) = 45.78; Prob $\chi 2$ = 0.000 Pseudo R^2 = 0.200

Statistical levels of significance: *10%, **5%, *** 1%, respectively.

Source: Survey Data (2018).

Age of the household was significant and had a positive effect on the adoption of on-farm diversification. As the age of the household head increases the household is more likely to diversify into on-farm enterprises. At an older age the prospects of getting jobs in the non-farm sector decreases. Further, older farmers usually have extensive knowledge of agronomic practices and climate change that they utilize on-farm. Households that are headed by younger people tend to diversify to non-farm activities (Khatum and Roy, 2012). Households headed by young people are often land constrained and exchange their labour off-farm in order to acquire land.

Household endowment is often associated with diversification. The existence of more livestock in a household generates other activities that are often in competition with crop production but coexist at farm level (FAO, 2016). Famers with more livestock had a higher probability of adopting on-farm enterprises. Watete et al. (2016) found that households that heavily relied on on-farm

livelihood strategies held more livestock units than those households who received more than fifty percent from off-farm enterprises. Households with higher TLUs are expected to be more inclined to the pastoral economy. The pastoral economy is an important source of income to a household. Given the agricultural orientation of the rangeland economy and the importance of livestock to livelihoods, most households rely on on-farm enterprises for employment.

The share of income from livestock had a significant positive influence on the adoption of on-farm diversification. Households that had received half of their income from the sale of livestock production were more likely to pursue on-farm diversification. This may be explained by the fact that extensive pastoralism is heavily dependent on the diminishing rangeland resources. Additionally, the prevailing land use in pastoral areas is livestock production and is often complimented by cultivation around water sources (Lugusa, 2015).

Farmer's access to credit had a negative influence on the adoption of on-farm diversification. This means that farmers who had accessed credit were less likely to adopt on-farm diversification. This can be explained by the utilization of the credit accessed. Only 10% of the farmers who had accessed credit had utilized it to purchase inputs, the rest used the credit to expand their businesses and to meet household needs (mainly food and school fees).

Contrary to expectation, the use of irrigation has a negative influence on the adoption of on-farm diversification. Irrigation is used as a mitigation strategy to cushion low agricultural production due to the little rainfall received in the drylands (Hassan and Nahemachena 2008). The low amounts of rainfall received limits the availability of water for irrigation this could explain the negative sign the effect of on-farm diversification.

Table 5 shows the results of the ordered logit model. The results show that age had a negative influence on the number of income sources. Age of the household head was included to reflect on the life cycle. Households headed by relatively older households were likely to choose fewer livelihood strategies. Older people commenced their path of economic activity before the accessibility of alternatives to livestock and crop production and maybe unwilling to venture into other enterprises. Agyeman (2014) also found a negative relationship between age of the household head and diversification of income sources. This was associated to the lack of monetary resources and physical strength to increase the number of income generating activities.

Table 5: Ordered logit estimates of the factors influencing the number of income sources

Socio-economic variables	**Coefficient**	**Std. Err.**	**P>z**
Land tenure (1= private ownership)	0.010	0.127	0.932
Simpson diversity index (livestock)	1.568	0.637	0.014**
Age of the household head	-0.015	0.009	0.085*
Ln Total household income	1.720	0.361	0.000***
Land accessed in acres	0.089	0.017	0.000***
Distance to main market centre	0.033	0.021	0.125
Household size	-0.108	0.043	0.012**
Use of irrigation (1= yes)	0.486	0.279	0.082*
Use enclosures (1= yes)	-0.612	0.285	0.032**
Share of income from livestock (1= at least 50%)	-1.046	0.279	0.000***
Institutional and policy variables			
Access to extension (1= yes)	1.158	0.327	0.000***
Access to credit (1= yes)	0.527	0.296	0.075*
Group membership (1= yes)	0.609	0.286	0.033**

Dependent variable: Number of income sources; Likelihood ratio Chi-square (14) = 154.32
Prob > chi-square = 0.000, Log likelihood = -286.336, Pseudo R^2 = 0.2123.
Statistical levels of significance: *10%, **5%, *** 1%, respectively.
Source: Survey Data (2018).

The total income of the household was significant and had a positive effect on the number of enterprises chosen when logged. Households with higher income were likely to be involved in

more income generating activities. Earning more income facilitates a household to invest in other enterprises to gain more income. Though livelihood diversification is often regarded as insurance, wealthy households diversify to acquire more wealth (McPeak and Barrett, 2001; Little, 2001).

Contrary to expectation, the use of enclosures had a negative effect on the number of income sources that a household chose. This contradicts prior studies such as Mureithi et al. (2015), Nyberg et al. (2015) and Wairore et al. (2015) who found that the use of enclosures increased the number of livelihood enterprises that a household engaged in. Households that are more sedentary divide their land into enclosures to allow rotational grazing and fodder production to last through succeeding periods. This could mean that the households that use enclosures become intensified livestock farmers as most of their time and land is devoted to livestock production and may be unable to take up other enterprises.

The number of acres accessed significantly explained the number of income sources. Access to land is important to pastoralists as well as agropastoralists who practice cultivation. Ownership of substantial quantities of land may enable households to engage in more activities on-farm including cultivation of food and cash crops, bee keeping and even renting out the land for income. However, households that earned at least 50% of their income from livestock production were less likely to pursue more livelihood strategies. Livestock production in the rangelands is characterized by extensive grazing. Scholars have pointed out that the privatization of commons threaten livestock production by substantially reducing the land available for grazing (Galvin, 2009). With the declining land sizes households that have livestock production as their economic mainstay may engage in fewer strategies due to land limitation.

Access to credit and group membership have a significant effect on the number of livelihood strategies. Being a member of a group influence access to productive resources, which facilitate

diversification. The lack of collateral has for a long time been a hindrance to smallholder farmers' access to credit. Social networks through mutual lending can be an alternate source of credit to commercial lending. Access to credit enables a household to overcome financial constraint and may diversify (Davis et al., 2008). On the other hand, Jackson (2007) points out that relations among people influence the behaviour of an individual. It has an effect on the information that they obtain, the opinion they form and this is paramount in their access to resources.

Access to extension had a positive effect on the number of enterprises that a household participates in. A household that had accessed extension services in the past 12 months was likely to choose more enterprises. Access to extension provides farmers with the technical know-how to undertake investment in alternative enterprises, which increases the degree of livelihood diversification. Agyeman (2014) explains that the existence of extension personnel within agricultural communities improves support to households and encourages them to participate in other income generating activities.

CHAPTER FIVE

5.0 EFFECTS OF CHANGES IN LIVESTOCK SPECIES AND POPULATION ON CHOICE OF LIVELIHOOD ENTERPRISES

5.1 Abstract

The government of Kenya in the "National Policy for the Sustainable Development of Northern Kenya and other Arid Lands 2017" recognizes livelihood diversification as an important strategy for reducing vulnerability in the ASALs (Republic of Kenya, 2017). However, livestock production remains a dominant economic activity even in areas that have experienced the highest rate of social change. Despite the existence of policies and strategies to improve livelihood diversification, the role of livestock dynamics in shaping both on-farm and off-farm diversification has not been studied. This chapter provides an assessment of the effect of the decline in TLUs and the number of new species introduced over the last ten years on the choice of livelihood enterprises. The SDI was also included in the analysis to account for species richness and evenness at the household level. A multivariate probit model was applied to analyze choice of both on-farm (fodder farming and beekeeping) and off-farm (small business and waged labour) activities. The results showed that a decline in TLUs had a negative effect on choice of fodder farming, while farmers who had higher species diversity were likely to pursue fodder farming. It is notable that off-farm strategies are pursued mainly by households that face distress in the livestock production. Establishing saving schemes will improve the ability of households to save and re-stock or move to other enterprises.

Keywords: livestock species, population, livelihood enterprises.

5.2 Introduction

Livestock production is an important source of income, supporting hundreds of millions of people in developing countries (O'Meagher, 2003). Pastoralism supports 90% of the population in Baringo County in Kenya (Republic of Kenya, 2013). Pastoralism is a subsistence economic activity in which individuals make a living by keeping animals in large numbers. The animal species kept varies for every region. Cattle are the most preferred species for East African herders. Over time, herd diversity has become a necessary strategy for pastoral communities' survival. This has seen the introduction of other species (camels, goats, sheep and poultry) to adapt to the natural resource changes that are ongoing in the rangelands (Abebe, 2016).

Rangelands are faced with changes which reorient pastoral livestock production. These changes include land fragmentation and a shift from communal to individual land tenure that reduces nomadic pastoralism, which was once a dominant form of land use (Lesorogol, 2008; Galvin, 2009). Exposure to concurrent shocks, for example drought, triggers clan and border conflicts often over grazing land and water (Muricho, et al., 2017). Pastoralists adopt a number of strategies such as changing herd composition, livestock off-take and migration to reduce vulnerability to unfavourable socio-economic factors and climate change (Opiyo et al., 2014).

Though Kenya recorded a decline in poverty rate from 46.6% in 2006 to 36.1% by 2016 (KNBS, 2018), poverty rates remain at levels above 70% in the arid areas (UNDP, 2019). Sustainable livestock production has a huge potential in reducing poverty in pastoral households since most of them derive food and income from livestock. There is also a need for the household to diversify their livelihood options for sustainability. Existing literature on pastoral livelihood diversification has explored the various aspects of diversification among pastoral communities (Watete et al., 2016; Addisu, 2017; Nyberg et al., 2015). Watete et al. (2016) points out that improvement in

education and access to water have a positive influence on diversification in northern Kenya. Even though livestock and crop production are still the main livelihood strategies, pastoral households combine on-farm, non-farm and off-farm strategies for income (Addisu, 2017). With agricultural diversification such as crop and poultry farming, pastoral livelihoods are increasingly becoming less dependent on livestock mobility. Further, efforts are being directed towards agribusiness and new opportunities such as fodder production (Nyberg et al., 2015).

A household's choice of livelihood enterprises is a dynamic procedure whereby, they combine a number of activities to meet the ranging household needs. For example, pastoralists are not essentially confined to pastoralism but often include other agricultural and non-farm activities in order to diversify their income sources. There is little empirical evidence on the role of the dynamics experienced in livestock production on the choice of alternative livelihood enterprises. This chapter bridges this knowledge gap by providing insights on the emerging trends in the pastoral livestock production system and how they affect participation in selected livelihood enterprises.

5.3 Analytical framework

The objective of this chapter is to analyze the effect of change in livestock population and species on the choice of livelihood enterprises. The assumption is that a household is involved in more than one enterprise. Four enterprises were considered in analysis namely; bee keeping, waged labour, small business and fodder production. All were dummy variables and took a value of 1 if a household obtained income from the enterprise and 0 otherwise.

A multivariate probit model (MVP) was estimated to explain a household's choice of livelihood enterprise. The MVP explains the effect of a set of variables and account for probable correlation among error terms that arise as a result of association between the multiple enterprises that a

household is engaged in. For example, when a household has exhausted the opportunities available in agricultural diversification, many may opt to expand their income portfolio and include labour diversification by prompting household members who are more educated to get off-farm jobs. The model encompasses the process of choosing a certain action when other interdependent alternatives are available (Rao and Winter 1978).

A Multinomial Logit model is often used in decision studies that involve multiple choices. The model is appropriate in explaining a combination of strategies of individuals (Hausman and Wise, 1978). However, it was not appropriate for the current study because analysis of household choice of an enterprise without controlling for interdependence and simultaneous choice in a complex pastoral system may result in overestimation or underestimation of the factors influencing choice an enterprise.

In order to overcome these shortcomings, the current study uses an MVP to assess the effects of climatic factors, household shock, institutional and socio-economic factors on the probability of choosing an enterprise.

The choice of livelihood enterprise can be modeled by following the random utility framework. A farmer only chooses a certain enterprise if $U_a > U_b$ meaning, $U>0$. The difference in utility is latent, which can be specified as a linear function of a set of independent variables

$$U_{ij} = \beta_i X_{ij} + \mu_{ij} \quad (13)$$

In this case, U_{ij} is the utility that the farmer *i* gains from choosing an enterprise. Using the indicator function, the unobserved preference in equation 13 translates to an observed binary outcome where *I* is equal to one if the farmer chooses that enterprise and zero otherwise, β is a vector of the coefficients to be estimated, *X* is a vector for independent variables influencing the decision to

choose an enterprise and μ represents the error term. A multivariate probit model is specified as a seemingly unrelated regression model (Mullahy, 2017).

$$I_1^0 = x'\beta_1 + \mu_1 \quad \text{for} \quad I_1 = (I_1^0 > 0) \tag{14}$$

$$I_2^0 = x'\beta_2 + \mu_2 \quad \text{for} \quad I_2 = (I_2^0 > 0) \tag{15}$$

$$I_3^0 = x'\beta_3 + \mu_3 \quad \text{for} \quad I_3 = (I_3^0 > 0) \tag{16}$$

$$I_4^0 = x'\beta_4 + \mu_4 \quad \text{for} \quad I_4 = (I_4^0 > 0) \tag{17}$$

where I_j^0 denotes a particular livelihood enterprise, x is the set of explanatory variables that are comparable for all the enterprises and are assumed to influence the decision to participate in a particular enterprise, β is a vector for the parameters to be estimated and μ is the error term.

5.4 Results and discussion

The chi-square test in the model is statistically significant and the explanatory variables taken together are important in explaining the differences in participation in the four enterprises considered in the study (Wald $\chi 2$ (60) = 161.02, p = 0.000). The likelihood ratio test results lead us to reject the hypothesis that the livelihood enterprises under consideration are independent ($\chi 2$) = 22.0969, p = 0.0012). This is a confirmation that the multivariate regression provides more valid information compared to distinct univariate regressions. Results from the multivariate probit are shown in Table 6 and 7.

Table 6: Complementarities and substitutability of on-farm livelihood enterprises

	Beekeeping	Fodder production	Small Business	Waged labour
Beekeeping	1			
Fodder production	- 0.253(0.150) *	1		
Small Business	-0.017(0.130)	0.181(0.130)	1	
Waged labour	-0.029(0.130)	-0.326(0.144) **	-0.403(0.117) ***	1

Note: Robust standard errors are shown in parenthesis

The negative correction between fodder production and waged labour supports the proposition that immediate cash needs and food security surpass the production of livestock feed. Fodder production is also a substitute for beekeeping, which is a long-term investment that affects farm planning. The negative correlation between running a small business and participating in waged labour is expected since both enterprises compete for time.

Table 7: Effect of changes in livestock species and population on choice of livelihood enterprises

	Beekeeping		Fodder farming		Small business		Waged labour	
	Coeff	(Std error)	Coeff	(Std. error)	Coeff	(Std. error)	Coeff	(Std. error)
Decline in TLU last 10 yrs (1=yes)	0.007	(0.007)	-0.005	(0.006)	0.001	(0.006)	0.013*	(0.007)
Number of new species introduced	0.087	(0.190)	0.068	(0.192)	0.439**	(0.193)	-0.115	(0.182)
Simpson diversity index	0.644	(0.556)	1.240*	(0.742)	-0.038	(0.486)	-1.014**	(0.496)
Land size accessed	0.071***	(0.019)	0.007	(0.013)	0.034**	(0.017)	-0.018	(0.014)
Share of income from livestock (1= at least 50%)	-0.354	(0.229)	-0.238	(0.235)	-0.648**	(0.203)	0.266	(0.201)
Ln household Income	0.284**	(0.132)	-0.019	(0.129)	0.258**	(0.117)	-0.238**	(0.120)
Distance to the main market	0.021	(0.017)	0.0155	(0.018)	0.062***	(0.017)	-0.036**	(0.015)
Age of the household head	0.009	(0.009)	-0.004	(0.010)	-0.017**	(0.009)	-0.020**	(0.009)
Education of household head	-0.007	(0.029)	0.034	(0.030)	0.026	(0.026)	-0.085***	(0.027)
Type of road (1= tarmarc)	0.141	(0.248)	0.474*	(0.243)	0.339	(0.220)	-0.526**	(0.224)
Affected by cattle rustling (1= yes)	-0.526	(0.328)	0.518*	(0.287)	-0.001	(0.280)	0.713**	(0.320)
Affected by drought (1= yes)	-1.750***	(0.637)	0.312	(0.783)	-0.013	(0.579)	0.980	(0.607)
Group membership (1= yes)	0.567**	(0.230)	-0.028	(0.244)	0.080	(0.208)	0.313	(0.207)
Access to credit(1=yes)	-0.156	(0.245)	0.304	(0.270)	0.118	(0.225)	0.165	(0.226)
Access to extension (1= yes)	0.275	(0.250)	0.003	(0.273)	0.075	(0.237)	0.932***	(0.247)

Following WISP (2010), the TLU equivalents for various livestock were considered as: cattle = 1, camels = 1, donkeys = 0.8, goats and sheep = 0.2 and poultry = 0.04.

Wald $\chi 2$ (60) = 161.02, p = 0.000, likelihood ratio test ($\chi 2$) = 22.0969, p = 0.0012).

Statistical levels of significance: *** 1%,**5% and *10%, respectively.

Source: Survey Data (2018).

The variables of interest were; decline in TLU, SDI and the number of new species introduced in the herd. A decline in TLUs has a negative influence on the choice of fodder production as a livelihood enterprise. A household that had experienced a decline in the TLU over the last 10 years is less likely to participate in fodder production. A decline in herd size implies a decline in the feed resource requirement the household is then less likely to participate in fodder production. Additionally, a decline in TLU had a positive influence on the choice of waged labour. Little et al. (2001) states that a decline in per capita stock holdings has seen many herders diversify into other IGAs.

The number of new species introduced into the herd has a positive and significant influence on choice of small business enterprises. Diversifying livestock species reduces the risk of drought and speeds recovery after drought (Abebe, 2016; Little, 2001). This implies that the household that introduced more species minimize their losses during drought. Choice of off-farm livelihood strategy, for example, operating a small business helps the household withstand shocks. Ellis (2000) noted that a diversified livelihood spreads risk, in the event of shocks on one activity, others offset the risks and the household minimizes loses.

The SDI was found to have a significant influence on the choice of fodder farming and waged labour. A household that has diversified their herds is assumed to be aware of its importance in minimizing drought risk. It is expected that such a household will pursue other strategies such as fodder production to further minimize risks. Fodder production is an adaptive strategy used to enhance stock survival during drought. Abebe (2016) found that during periods of feed shortages, pastoralists supply their animals with planted fodder. Though SDI is significant on the choice of

waged labour, it had a negative influence. This implies that households that had specialized their herds were more likely to diversify into waged labour. With respect to risk management, participation in paid labour is a strategy often used in times of adversities by pastoral communities (BurnSilver, 2009). A household that rears few species is vulnerable to losses during drought as they are not able to take advantage of the distinct rangeland resources. Perhaps, this informs the decision to venture into waged labour.

Loss of livestock to cattle rustling has a positive and significant influence on the choice of fodder production. Pastoralists who had lost their cattle to cattle rustling were more likely to diversify into fodder production. Cattle rustling diminish herds hence constrains livestock production which is the main source of livelihood. Diversification therefore becomes essential and a household is likely to choose fodder farming due to the readily available market among other livestock producers.

A negative effect of the share of income from livestock production on the adoption of fodder production was unforeseen. Conceivably, deriving a substantial amount of income from pastoralism had a negative influence on adoption of fodder production because pastoralists invest less on planted fodder. This could be due to the inimical view of pastoral communities towards planted forages or preference for other enterprises such as food crop farming. Lesorogol (2008) observed that pastoralists who derive a substantial amount of income from pastoralism spend most of it on consumption rather than investment.

Land size, total household income and distance to the main market were found to have a significant effect with the decision to operate a small business. Land size accessed and household income are important proxies for wealth. Wealthy individuals pursue non-pastoral economic activities to enhance their investments. This is because wealthy farmers have more flexibility and a lower

opportunity cost for resource allocation (Moshi et al., 2016). Distance to the main market was a continuous variable. Households that lived far from the trading centres were more likely to operate small businesses. This trend can be explained by the increase in demand for non-pastoral consumer items and other foods items such as sugar in the rangelands.

Age of the household head was significant and had a negative effect on the choice of waged labour. As the age of the household head increases the less they diversify into waged labour. Most paid labour opportunities in rural areas are intensive; at an older age one lacks the physical strength to perform these tasks. Beyene (2008) attributes the negative influence of age on participation in off-farm labour strategies to demand for leisure and decrease in labour hours among older people. Further, a household that had lost livestock to cattle rustling in the last five years was more likely to participate in waged employment. Participation in waged labour opportunities is a survival strategy used by pastoralists who are affected by extreme circumstances. Pastoralists affected by cattle rustling diversify into waged labour to accumulate income and move back to pastoralism. These findings are similar to those of Mutsoso (2013) who found that herders in East pokot who had lost their livestock during conflict often moved to Loruk to engage in waged labour. This strategy enables pastoralists re-stock their herds. The positive and significant effect of access to extension on the choice of waged labour was unexpected. This could be due to the quality and frequency of the extension visits. The respondents for this study mainly relied on extension services provided by the county government. Owing to the sparse population distribution in Baringo, this reduces the number extension visits per household. This may hinder the uptake of agricultural ventures in favour of off- farm opportunities such as waged labour.

Group membership had a positive and significant effect on the choice of bee keeping. Group membership is essential for learning and access to input and output markets. Bee keeping was practiced

by use of traditional log hives hence the quantity of honey harvested is low. Being a member of a group helps in bulking of honey for sale. According to Ngugi et al. (2007) being a member of a group increases one's bargaining power to access markets. Land size accessed was also found to have significant influence on the choice of bee keeping. Mainstream livestock and bees compete for shade, water and fodder plants that they utilize in common (Gichora, 2003). The importance of livestock production to the Tugen and Ilchamus communities creates a tendency for overstocking, which leads to degradation and undermines beekeeping. This competition has forced pastoralists to set aside land under beekeeping for environmental conservation (Gichora, 2003). This strategy is only possible if one controls a large land size and thus the positive influence of land size on beekeeping. The competition by bees and livestock for fodder plants could also explain the negative relationship between the choice of beekeeping as an enterprise by households affected by drought.

CHAPTER SIX

6.0 ECONOMIC RETURNS FROM ON-FARM LIVELIHOOD ENTERPRISES

6.1 Abstract

Livelihood diversification has great potential for improving pastoralists' productivity in SSA. However, the actual benefits of each individual enterprise have not been comprehensively documented. To address this gap in knowledge, this study sought to estimate the gross margins of four on-farm livelihood enterprises and their determinants. Economic returns that farmers obtain by pursuing livestock production, food crop production, beekeeping and fodder production were estimated. To determine the factors influencing gross margins, a multiple regression model was applied. Approximately 81% of the households received positive gross margins whereas the remaining households suffered losses in their enterprises. However, on average all the enterprises had positive gross margins with livestock production having the highest gross margin while food crop farming had the least. This shows that all the four enterprises studied are feasible. Further, access to communal land, access to extension, membership to a group, the share of income from livestock production and access to credit had a significant influence on the gross margins. Appraisal of extension services is essential to improve access by pastoral communities. Likewise, strategies that improve management of remaining common resources can promote access to communal land and enhance gains from on-farm enterprises.

Keywords: Gross margins, on-farm enterprises, alternative livelihoods.

6.2 Introduction

Approximately 80% of Kenya's total land surface is arid and semi-arid. While 9.6 million hectares can support marginal agriculture, 15 million hectares can sustain sedentary livestock production. Further, 24 million hectares are dry and only suitable for nomadic pastoralism (Republic of Kenya, 2014). The ASALs are the least developed areas and have the highest levels of poverty incidence. Reinforcing this is environmental degradation, climate change, and cycles of insecurity (Republic of Kenya, 2017).

Historically, livestock is deeply embedded in the functioning of the African rangeland ecosystems. Animals were defined as individual property representing a form of wealth used for exchange, a source of food as well as inheritable property (Fratkin, 1994). Pastoral communities practiced nomadism to utilize rangeland resources. Claims on *de facto* common property have risen and threatens the mobility of livestock (Greiner, 2017). Additionally, consequences of population growth, and expansion of agricultural land has infringed on the pastoralist's way of life. Today pastoralists are rapidly sedentarizing and adopting rainfed agriculture in areas that are suitable for farming. Pastoralists can no longer rely on their herds alone to meet their subsistence requirements by eating what their herds produce in the form of meat and milk (Gichora, 2003).

Pursuing alternative livelihoods and education can increase the array of choices and strategies that households use to cope with the changes. Evidence shows that pursuing multiple livelihood strategies is important for the improvement of household income. As a result, the household food security improves and vulnerability to shocks reduces. However, for alternative livelihood enterprises to succeed at the household level, pastoralists should be able to fully contextualize their resource limits and the technologies at the farm level. Though alternative enterprises such as food, fodder farming, and beekeeping have been practiced for decades, their economic returns have not

been estimated. This chapter provides estimates of the economic returns of on-farm livelihood enterprises and their determinants.

6.3 Gross margin analysis

Gross margins (GM) for four on-farm enterprises; livestock production, food crops farming, bee keeping and fodder production were estimated. Gross margins in the livestock production enterprise was obtained from four species of animals namely: cattle, sheep, goats and poultry whereas maize, beans, finger millet and sorghum were considered for food production. Further, they have been documented in literature to be important livelihood enterprises to communities in Baringo (Mureithi et al., 2015; Lugusa 2015; Gichora, 2003). Gross margins were calculated by subtracting the Total Variable Costs (TVC) from the Total Revenue (TR) as follows:

$$GM=TR-TVC \tag{18}$$

It can be expressed further as;

$$GM=P_Q Q-\sum_{i=0}^{n} P_i X_i \tag{19}$$

The gross margin is for a selected enterprise, the average price P_Q is the unit price of the product from the enterprise; Q is the quantity of the product per unit; P_i represents the price of the i^{th} variable input that is used in an enterprise. The costs that were considered for this study were the cost of inputs (seed, agrochemicals and fertilizer), animal feed and minerals, veterinary drugs and labour. This accounts for the variable costs of the on-farm enterprises and vary directly with the volume of output (Sullivan and Sheffrin, 2003). Fixed costs are not included in the calculation of gross margins. By definition, fixed costs are part of the total farm cost and do not vary with the volume of output. While fixed costs are crucial in assessing profitability, they are not accounted

for when calculating gross margins (Nemes, 2009). The average quantity and costs of inputs used in the year 2017 for each enterprise were computed.

Labour costs for all enterprise were calculated. Opportunity cost was used to value household labour. The monetary values from the prevailing market price are used to impute values for unpaid household labour. Opportunity cost captures the income the labourer would have earned in the paid labour instead of the domestic work.

To analyze the determinants of economic returns that a household receives the study used an Ordinary Least Square (OLS) regression model (Gujarati, 2003). It allows for many observed factors to affect the dependent variable. Additionally, the OLS regression can accommodate independent variables that may be correlated (Wooldridge, 2015).

The calculated gross margins for every household in the survey were regressed against a set of independent variables. The dependent variable for this objective is the gross margin of all on-farm enterprises. The explanatory variable for the study were institutional factors and socio-economic features (the respondents age, education attained, household size, access to extension services, membership to a social group, access to credit. Categorical variables for example sex of the household head were transformed into dummy variables. The equation for the OLS regression model was stated as;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots B_n X_n + \varepsilon \qquad (20)$$

where Y is the dependent variable (total gross margins), X_i are the explanatory variables, β_i represents the coefficients, whereas ε is the error term. The explanatory variables used in the model was empirically specified as;

Y = sum of gross margins from the on-farm enterprises

β_0 =distance to the main agricultural market from the homestead

β_1 = total household income received by the household from on-farm and off-farm activities

β_2 =number of household members that had lived in the household for the last 12 months

β_3 = whether the household had received at least 50% income from livestock production

β_4 =sex of the household head

β_5 = total number of acres of land accessed by the household for cultivation and grazing

β_6 = whether the household had taken any form of credit in the last 12 months

β_7 =whether the household head is a membership to social group

β_8 =access to extension services in the last 12 months

β_9 = whether the household still has access to communal land for grazing and cultivation

6.4 Results and discussion

6.4.1 Diagnostic test

A multicollinearity test was done to ensure that the model did not violate the requirements and assumptions of OLS. Multicollinearity exists when there is a linear relationship among the explanatory variables included in the model. Multicollinearity was tested through the computation of the variance inflation factors (VIF) for the explanatory factors. Following Gujarati (2003), variables that had a VIF<5 had no multicollinearity and were included in the model. The mean VIF was 1.22 and no variable exhibited a VIF of less than one or greater than 10, therefore the assumption of no multicollinearity has not been violated.

6.4.2 Gross margin estimates

The results from the costs and returns analysis for on-farm enterprises are shown in Table 8. The mean gross margin for the four on-farm enterprises was Kenya shillings (KShs) 70,466 (1 US Dollar = 100.3 Kenyan Shillings at the time of survey). All the enterprises had positive gross margins. The total revenue for all the four enterprises was higher than the total variable costs. This means that by engaging in any of the four enterprises a household earns profits. Therefore, more farmers should be encouraged to diversify their livelihoods to these enterprises to increase household income.

Livestock production had the highest gross margin, while food crop farming had the lowest gross margin. High gross margins from livestock production could be attributed to the suitability of ASALs for livestock production. Additionally, beef forms the most consumed form of animal protein in Kenya and hence has a readily available market due to the high demand. The low gross margin received from food crop farming can be attributed to the high cost of labour and inputs used in the enterprise. Labour formed 58% of total variable cost in food crop production. This includes the cost of labour for land preparation, weeding, planting and harvesting and shelling. Watete et al. (2016) noted that crop farming demands more labour compared to other enterprises, which may limit a household's ability to take up other income generating activities. The cost of buying seeds accounted for 25% of the total variable costs. However, expenditures on fertilizer and agrochemicals were minimal at 13% and 2% respectively. This demonstrates that there is low use of these inputs among the respondents.

Though fodder production was found to be profitable, high costs were incurred in the purchase of grass seed and fertilizer. Labour costs also accounted for 21% of the total variable costs.

Table 8: Costs and returns for on-farm enterprises

	Food Crops (n = 177)	% of TVC	Fodder (n = 36)	% of TVC	Livestock (n = 214)	%of TVC	beekeeping (n = 59)	% TVC
Total revenue	**24,003.67**		**8,916.11**		**79,350.93**		**19,319.49**	
Average labour cost	11,697.76	**58.43**	1,070.00	**27.46**	2,967.19	**21.61**	888.13	**100**
Average fertilizer cost	2,763.27	**13.80**	1,410.00	**36.19**				
Average seed cost	5,136.07	**25.65**	1,415.97	**36.34**				
Average agrochemical cost	421.86	**2.10**						
Average cost of animal feed and minerals					4,688.94	**34.15**		
Average cost veterinary drugs					6,070.30	**44.22**		
Average total variable costs (TVC)	**20,017.96**		**3895.97**		**13,726.47**		**888.13**	
Average gross margin	**3985.71**		**5020.14**		**65,624.50**		**18,431.36**	

Source: Survey Data (2018).

These findings corroborate those of Manyeki et al. (2015) who found purchase of grass seed, hay harvesting and weed management to be the largest contributors of production costs in fodder farming in the Southern rangelands of Kenya.

Beekeeping had the least total variable costs. Labour cost was the only contributor to the variable costs. Labour is required in harvesting and log/hive maintenance. Costs related to the purchase of veterinary drugs, animal feed and labour costs contributed to the largest proportion of expenditure by producers in the livestock enterprise. The high total revenue from livestock could be due to revenue received from a range of animals (sheep, goats, chicken and cattle) and their products (milk, eggs hides and skin).

6.4.3 Determinants of gross margins from on-farm enterprises

Results in Table 9 show that distance to the main market, total household income, access to communal land, access to credit, share of income from livestock production, access to extension services and being a member of a group significantly influenced gross margins.

Distance to main market was significant and had a positive effect on gross margin of a household. This means that the gross margins increase as the distance to the main market increased. This result was unexpected. Several studies have documented the role of marketing costs in limiting smallholder participation in markets **(**Barret, 2008; Alene et al., 2008). However, it can be attributed to the fact that the products produced are demanded by fellow farmers. In this case farmers could have found market for their produce within their social ties and kinship. Lugusa (2015) found that 20% of the marketed grass seed was sold to other farmers albeit at a low price compared to the market price.

Table 9: Determinants of the gross margins from on-farm enterprises

Variable	Coefficient	Std. error	*p*-value
Socio-economic variables			
Distance to main market	0.101	0.040	0.013**
Ln total household income	1.930	0.280	0.000***
Household size	-0.128	0.087	0.144
Share of income from livestock (1= at least 50%)	2.588	0.499	0.000***
Sex of the household head	-0.337	0.568	0.553
Acres accessed	0.037	0.032	0.249
Institutional and policy variables			
Access to credit (1= yes)	-1.769	0.566	0.002***
Group membership (1= yes)	1.022	0.536	0.058*
Access to extension (1= yes)	1.272	0.604	0.036**
Access to communal land (1= yes)	1.525	0.921	0.099*

Note: Adjusted R-squared=38%; Prob > F=0.000.

Statistical significance levels: *** 1%, **5%, and *10%.

Source: Survey Data (2018).

Household income had a positive effect on gross margins when logged. Households that receive higher income are able to purchase inputs and veterinary drugs hence increasing their earnings. Households with low income lag behind in use of agricultural inputs such as improved seeds and fertilizer hence low productivity. Low use of inputs together with with other constraints such as small land sizes, lack of access to credit and low literacy levels limits the ability of poor households to produce surplus for the market (Olwande and Mathenge, 2011).

Farmers who earn at least 50% of their total income from livestock and access to communal land had a positive influence on gross margins. Households that derive a substantial amount of their income from livestock tend to own more livestock and enjoy economies of scale in production. Further, access to communal land plays an important role during dry seasons to people who are

highly dependent on livestock production. While people in areas with fertile soils can sustain themselves during droughts, people in rangelands migrate to communal land for pasture and reduce losses associated with drought (Saxer, 2014).

Contrary to expectation, the effect of access to credit on household gross margins was negative and significant. Respondents who accessed credit used it in off-farm strategies and to meet household consumption needs. While 23% of the respondents used their credit to expand their businesses, 32% used it to pay school fees and 25% used it to buy food.

Group membership had a positive effect on gross margins. Membership to a group provides access to input and output market at lower costs compared to non-members. Farmers in groups are also able to lower the cost of inputs through bulk purchasing (Tolno et al., 2015).

Further, access to extension was found to increase the gross margins. Farmers who have access to extension receive training on the best farming practices, which improves their skills on various enterprises thus increasing their gross margins. This is similar to the findings of Onyango (2017) who showed that access to extension increased gross margins from grain legumes. Farmers who accessed extension were thought to receive training on the best crop production practices.

CHAPTER SEVEN

7.0 SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

7.1 Summary

The study evaluated the role of land and livestock dynamics on livelihood diversification. The specific objectives were to; characterize dynamics in land tenure and livestock population and species; assess effect of land tenure on type and number of livelihood enterprises; analyze effect of changes in livestock species and population on choice of livelihood enterprises; estimate economic returns and their determinants of on-farm livelihood enterprises.

Results from the first objective showed that the tenure system over the years has evolved towards private ownership. The herd is increasingly being diversified to include smaller animals and adapted to the climatic conditions and feed resources in the rangelands. The land size is also quickly decreasing and pastoralists are exposed to drought, land conflict and other shocks. Nonetheless, they depend on a number of livelihood strategies to manage risk.

The findings from the second objective showed that implications of land tenure on the adoption of on-farm enterprises are difficult to predict. Livelihood diversification is not a simple consequence of land tenure changes, but of other push and pull factors. This lays the foundation of future interventions that aim to support on-farm livelihood diversification for African dryland farmers.

The results of the third objective showed that decline in tropical livestock units had negative on choice of fodder production. Whereas increased diversity in species has a positive effect on choice of fodder production. Households that had introduced more species in their herd were more likely to venture into small businesses. A household that had experienced a decline in TLU were likely to participate in waged labour.

The final objective estimated the gross margins from on-farm enterprises. The results showed that food crop farming, fodder farming, livestock production and bee keeping are all viable. A multiple regression was used to estimate the factors influencing gross margins. Distance to the main market, household income, access to extension, access to communal land and being a member of a group had a positive and significant effect on gross margins. On the other hand, access to credit had a negative and significant effect on gross margins.

7.2 Conclusions and policy implications

It is apparent that the tenure system in Baringo is shifting towards private ownership. However, most households have not registered their land to obtain legal ownership. Putting in place measures to expediate the process of acquiring a title deed will improve tenure security for land that has already been privatized. Securing land rights at household level for pastoralists is likely to increase investment in alternative enterprises. Despite the change in tenure, communal land is still important to pastoralists this is evident in the positive effect of access to communal land on gross margins. However, communal land is still unregistered. Implementation of the 2016 communal land Act will safeguard pastoralist access to communal land which is paramount to sustainability of pastoralism. The county governments should also provide incentives for optimal use of private land and safeguard against uneconomical subdivision of communal land.

Encouraging farmers to keep a diversified species is essential for management of risks associated with the changing environment. Survival of pastoralism as a main source of livelihood in the rangelands is dependent on how well risks in the enterprise are managed. Effective management of risks will increase output and income, which will enable households invest in other enterprises. Results in Table showed that households that had introduced more new species were likely to diversify

into small business. On the other hand, those that had a high species diversity were more likely to pursue fodder farming.

Pastoralists maintain a diversified livelihood encompassing on-farm and off-farm enterprises. However, livestock production and food crop production are the most common enterprises. Based on the gross margins, livestock production is the most profitable enterprise. With the diminishing land sizes, it appears logical to encourage pastoralists to intensify livestock production. This will require training pastoralists on animal health management, pasture production and conservation. Further, provision of subsidized artificial insemination services for improved breeds is likely to improve productivity in the livestock enterprise and boost earnings.

Further, the low level of gross margins from food crop farming and fodder production is attributed to the high cost of labour in the enterprises. There is need for the adoption of simple mechanical technologies that would reduce the household labour costs. However, this would require a further assessment on what activities can be mechanized. Diverting labour away from all the activities may raise the risk of destitution among pastoralists. This is because households who have a smaller asset base rely on low- value labour-based activities for survival. Respondents who had experience a decline in TLU were more likely to diversify into waged labour. This shows that waged labour is an important livelihood strategy for households who have been affected by livelihood shocks.

Upscaling institutional support in form of extension need to be strengthened by county governments in the ASALs. Based on the findings of this study, households that had access to extension had higher gross margins and were likely to adopt more livelihood enterprises. The respondents relied on extension offered by the government which is often insufficient. There is a need for appraisal of extension services by the county government in order to improve farmer access. This can be done through the use of technology for dissemination of extension information through

short messages (SMS) and social media. Use of technology to deliver extension services will improve coverage and timeliness of information.

It is also imperative to promote farming as a business among pastoralists living away from main markets. This is informed by the significant effect of distance to the main market to the main market on gross margins. Training on agribusiness will enable pastoralists transform their enterprises from subsistent to commercial and take advantage of demand for food and fodder within their social ties.

7.3 Suggestions for further research

This study was limited by use of land registration in analyzing land tenure dynamics. Majority of the respondents owned land but had not received title deeds as proof of ownership of land rights. This reveals a complex tenure system that lacks legal certainty. Further research could provide more insights by investigating the role of individual bundle of rights to land; right to own, right to use and right to transfer and how this affects farmer participation in on-farm livelihood enterprises in ASALs.

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Appendices

Appendix 1: Focus group discussion guide

QUESTION GUIDE FOR FOCUS GROUP DISCUSSIONS FOR MAPPING OF THE LAND, LIVESTOCK AND LIVELIHOOD DYNAMICS IN BARINGO

SECTION A: Location information

Ward……

Village…….

SECTION B: General Information

1. Is livestock rearing the most popular form of livelihood?
2. Is there any change in the livestock numbers over the past years?
3. What is the current livestock holding size for a household?
4. Which is the most common breed for livestock?
5. Is herd mobility still common?
6. What are the most common reasons for loss of livestock?
7. Which feeding regimes are mostly practiced?
8. Which is the most common type of land ownership?
9. Which is the most common type of land uses?
10. Have you observed any changes in land size?
11. What are some of the causes for change in land size?
12. Do people rent out, lease or sell land?
13. Are there any changes in the sources of livelihood?
14. What are the main reasons for the change of livelihoods?
15. Is drought a common occurrence, how often does it occur?
16. How does drought affect a households' livelihood?
17. What are some of the drought coping strategies for households?
18. Do conflicts occur, how often?
19. What are the causes of conflict?
20. How does conflict affect the livelihood of a household?
21. What effect has the new governance had on the use of land?
22. How has the new Communal land Act affected you?

Appendix 2: Questionnaire

UNIVERSITY OF NAIROBI
AN ECONOMIC EVALUATION OF THE ROLE OF LAND AND LIVESTOCK DYNAMICS IN LIVELIHOOD DIVERSIFICATION

Household Survey Questionnaire, July 2018

Respondent

In this survey, household head, spouse or older family members above 18 years old, familiar with and involved in decision-making on household livelihood activities will be interviewed. Only households that rear **at least one type of livestock (cattle, sheep and goats)** will be interviewed.

Purpose of this Survey

The reason for conducting this field survey is to get some insights on the changes in land tenure system, livestock production, and any other forms of livelihoods that the people in pastoral areas Your voluntary participation in answering questions on these issues is highly appreciated. Your responses together with those from over 200 other households in other parts of Baringo South Sub County will be analyzed and the findings will be used to inform policy makers on better strategies for improving pastoral livelihoods in Baringo County and other pastoral areas. Information obtained from this study is meant for academic purposes and will be treated with utmost confidentiality. This interview will take approximately **ONE hour** to complete. I request your permission to start now.

SECTION A: GENERAL INFORMATION

A1) Enumerator's name: ……A2) Date of interview (dd-mm-yyyy):

……

A3) Ward …… A4) Village……...

SECTION B: GENERAL TRENDS

B1 Do you own/access land? 1- Yes 0- No (*If NO terminate interview)* Under what tenure system have you accessed land in the last 30yrs?

Duration of change	**Tenure system** 1. Private with title deed 2. Private without title deed 3.Communal with title deed 4. Communal without title deed 5. Other……	**Reason for change** **1=Subdivision** **2=Inheritance** **3=Bought** **4= Settlement Scheme** **5= Allocated by clan**
1987-1992		
1992-1997		
1997-2002		
2002-2007		
2007-2012		
2012-2017		

B2) What has been the dominant land use for your household over the last 30 years?

Duration of change	**Land use option** 1=Open grazing 2=Food production 3=Fruit production 4=Pasture production 5= Agroforestry 6=Land commoditization	**How did you view your land over the years?** 1= Agricultural land 2= Store of wealth 3= Inheritance 4=Residential place 5= Asset 6= Cultural heritage 7=Tradable commodity	**Effect of new governance on use of land** 1=Demand for commercial plots 2=Intensification of crop production 3=Rise in value of land	**Effect of new policies e.g communal land act 2016 on use of land** 1=Individualization of tenure 2=Women inheriting land 3=Access to community land by investors
1987-1992				
1992-1997				
1997-2002				
2002-2007				
2007-2012				
2012-2017				

B3 Do you still have access to communal land? 1=Yes 0= No If yes fill the table below

	Which season do you access pasture in communal land	**Number of years of access**	**What other activities do you carry out on communal land?** 1-collect firewood 2-Burn charcoal 3-Wild fruits 4- Timber	**Challenges encountered** 1-Overstocking 2- land degradation 3- Conflict with other communities 4-Invasive species 5 -Lack of exclusive use rights 6- Expansion of enclosures 7- Mismanagement	**Who is responsible for the management of communal land?** 1= Community Assembly 2= Clan elders 3= Family members 4= Elected group members 5= Other specify…..
Dry season					
Wet season					

B4 Has the size of your land changed over the last 30 years? 1=Yes 0=No. If yes fill the table below.

	Number of acres accessed/owned during this period	**How did you change the size you accessed/owned?** **1=**Sub-division of communal land 2= Selling out 3=Buying 4=Renting out 5=Leasing out 6=Renting in 7=Sub division 8=within the family 9=Donation 10=Expansion of enclosures 11=Swelling of the lake	**Reason for change** 1. School fee 2. Medical expenses 3. Inheritance 4. Encroachment 5. Conflict of ownership 6. Demand for grazing land 7.Limited grazing land 8.Expand source of income 9. Land adjudication 10.other (specify)……	**Effect of the changes on livelihoods** 1= Increase of crop yields 2= Increase in livestock products 3= Shift from nomadism to agro pastoralism 4=Rise of conservation efforts 5= Increase in number of income sources 6=Improved food security 7=land degradation 8=Individual dispossession 9=Frontier for conflict 10=Deprivation of pasture 11= Other specify…..
1987-1992				
1992-1997				
1997-2002				
2002-2007				
2007-2012				
2 012-2017				

B5 Over the last 30 years, have you experienced change in vegetation cover on your land? 1= Yes 0=No. If yes fill the table.

Duration of change	**What were the causes** 1= land clearing 2=Frequent droughts 3=Decline in number of rain days 4= Overgrazing 5=Invasive species 6= Other specify…...	**What effects did it have on livelihood?** 1= Loss of livestock 2=Decline in pasture 3= Loss of crops 4=Decline in grazing land 5= Individual dispossession 6=land degradation	**What conservation measures have you adopted** 1=Afforestation 2=Gabions 3=Terracing 4=Minimum tillage 5= Enclosures 6= other specify…...
1987-1992			
1992-1997			
1997-2002			
2002-2007			
2007-2012			
2012-2017			

B6 What type of livestock do you keep in your farm?

Livestock	**Number of years Practiced**	**Main purpose/reason for engaging in this enterprise** **1-Food** **2- Sale** **3-Food and Sale** **3- Drought power** **4-Cultural use e.g. dowry payment, status symbol** **5-Manure** **6-Store of wealth** **7- Insurance**	**Land size allocated for this enterprise –** **Housing** **Pasture** **Development** **Grazing** **(In acres)**
Cattle			
Sheep			
Goats			
Camels			
Donkeys			
poultry			
Bee keeping(hives)			

B7 Over the last 30 years have you changed the species in your herd? 1- Yes or 0- No. If yes fill the table below

Duration of change	**Species** **1=cattle 6=Bee keeping** **2=sheep 7=Donkey** **3=Goats** **4=Camel** **5=Poultry**	**Reason for change** 1-Scarcity of pasture 6-Breeding 2- Disease tolerance 7-Drought tolerance 3- High marketability 8-Fast maturity 4-Rustling 9- Low starting capital 5- Quality of meat 10- Other……
1987-1992		
1992-1997		
1997-2002		
2002-2007		
2007-2012		
2012-2017		

B8 Have you ever changed your livestock breed type in the last 30 years? 1- Yes 0- No. If yes, please fill the table below

Livestock Type	**The breed types** **1=local 2=exotic 3=crossbreed** *Apply to all species across the years*						**How did you change your breed?** 1- Buying 2-Artificial insemination 3-Gift/Donation 4-Bride price	**Motive for change** 1-More drought tolerant 2-More disease tolerant 3-Yields more milk 4- Takes short time to mature 5-Other……	**Challenges with this breed** 1-Needs more feed 2- More susceptible to diseases 3-Low productivity 4- Fetches low price 4-Other……..
	1987-1992	**1992-1997**	**1997-2002**	**2002-2007**	**2007-2012**	**2012-2017**			
Cattle									
Sheep									
Goats									
Camel									
Poultry									
Donkey									

B9 Have you ever changed your livestock population in the last 30 years 1- Yes 0- No If yes, please fill the table below

Livestock Type	*For every category indicate the number owned*						**Reasons for decrease / Increase** 1- Decline in land size 2. Bought stock 3- Drought 4. Gift 5-Conflict 6.Bride price 7.Cattle rustling 8. Breeding
	1987-1992	**1992-1997**	**1997-2002**	**2002-2007**	**2007-2012**	**2012-2017**	
Cattle							
Reason							
Sheep							
Reason							
Goats							
Reason							
Camel							
Reason							
Poultry							
Reason							
Donkey							
Reason							
Bee hives							
Reason							

B10) Has the role of livestock in your household changed for the last 30 years 1= Yes 0=No If Yes fill the table below.

	How do you view land or livestock 1= Store of wealth 2= Inheritance 3= Asset 4= Cultural heritage 5=Tradable commodity 6= Source of food 7=Other specify……	**Effect of new governance on use of livestock** 1= Intensified livestock production 2= Emergence on new markets for livestock 3= Access to new technologies e.g. dairy goats 4= Link to markets 5= Other specify……	**Effect of new policies on livestock** 1= Women owning livestock 2= Other specify…...	**What feeding regime have you practiced over the years?** 1= Open grazing in communal land 2= Open grazing in own land 3= Rotational grazing private land 4= Planted fodder 5= Commercial concentrate 6= Contractual grazing 7= Other specify…...
1987-1992				
1992-1997				
1997-2002				
2002-2007				
2007-2012				
2012-2017				

SECTION C: EXPOSURE TO SHOCKS AND COPING STRATEGIES

C1. What kind of shocks did you experience during the last 5 years (2012-2017) and how did you cope with them? Please fill the table below (Tick all that apply)

Type of Shock	Did you Experience this shock in the last 5 years? 1 = Yes; 0 = No	Frequency in the last 12 months (number of times it occurred)	Value of loss in monetary terms (Kshs)	**Main effects of the shock experienced** 1 Quality deterioration of livestock 2 Loss of livestock due to death 3 Loss of cash income 4 Loss of crops 5 Loss of livestock through rustling 6 Other……..	**What initiatives have/are you putting in place to manage this shock better in future?** 1 On-farm livelihood diversification 2 Off-farm livelihood diversification 3 Adopting new farming practices e.g. drought tolerant crops; new livestock breeds; conservation agriculture etc. 4 Move to Another area 5 Joined some peace Initiative for conflict resolution 6 Took an Insurance policy 7 Other……
Droughts					
Livestock diseases					
Conflict with other Communities					
Land grabbing					
Cattle rustling					
Crop pest and diseases					
Market Shocks- Market closure, Low Prices					

C2. Which livestock and crop practices have you put in place to cushion you against future shocks? Please fill table below:

Livestock practices	**Do you practice 1= yes 0= No**	**Crop practices**	**Do you practice 1= yes 0= No**
1. Herd diversification (grazers, browsers and different ages)		1.Crop diversification (Specify combinations)	
2.Improved breeds (Sahiwal cattle, gala goats, doper sheep,camels etc)		Planting drought tolerant varieties – Specify	
3.Enclosures for livestock grazing		3.Irrigation	
4. Conserving pasture (Specify method)		4. Took up crop insurance	
5.Vaccination		5.Soil conservation – afforestation; gabions; terracing; minimum tillage; organic manure	
6.Took up livestock insurance		6. intensification and use of chemical fertilizer	

C3 Besides being a livestock farmer, do you grow crops? 1= Yes 0=No

Type of crop	**Acres**	**Number of years Practiced** 1=less than 2years 2=2-6 years 3=more than six years	**Reasons for crop production** **1=**Exposure to crop farming 2= Minimize risk 3=Influence from neighbours	**Estimated yield in the last 12 months in units** 1=90 kg bag 2=Debes 3=50 kg bag 4= Bunches	**Selling price per unit**	**Total value**
Maize						
Beans						
Vegetables						
Bananas						
Millet						
Sorghum						
Water Melon						
Onions						
Others……..						

SECTION D: Household income

D1. Which other income generating activities are you engaged in?

Income source	**Amount of income derived**
Small Business	
Formal employment	
Waged Labour (Kibarua)	
Remittances from family or friends	
Remittances from NGO	
Sand harvesting	
Fishing	
Brick Making	
Hired out oxen/Donkeys	

SECTION E: Market Participation

E1. Please fill the table below if you have participated in the following markets during the last 12 months:

Product	Did you partic-ipate 1-Yes 0-No	Market type 1-Open air market 2-Slaughter house 3-Supermarket 4Schools/colleges 5-Hospitals 6-Prisons 7-Cereals board 8-livestock market 9-Contract market 10-Farm gate 11 -Other…….	Dis-tanc e To mar-ket (Km)	Frequency of partici-pation 1= Daily 2= Weekly 3=Monthly 4=Quar-terly 5=Yearly	BUYER		SELLER		Gender partici-pation 1=men 2=wome n	Challenges 1- Distance to market 2-Poor market infrastructure 3Exploitation by middlemen 4-Price fluctu-ations 5-Output fluc-tuations 6-High levies
					Qu an-tity Bou ght	**Buying Price Per unit**	**Qua ntity Sold**	**Selling Price Per unit**		
Cattle										
Goats										
Sheep										
Chicken										
Eggs (trays)										
Milk (Litres)										
Hides										
Land (acres)										
Hay/Fodder										
Timber products										
Honey										
Fattened bulls										
Grass seed										

E2. Have you participated in the following markets 1) = Land Market 1=Yes 0=No

2) = Livestock Market 1=Yes 0=No

E3. Have you experienced change in any of the following markets in the last 20-30 years? Yes= 1 No=0 If Yes fill the table b0elow.

		1987-1992	1992-1997	1997-2002	2002-2007	2007-2012	2012-2017
Which type of market have you participated in 1=Rental 4=Auction 2=Buying 5=Open air 3=Selling 6= Contractual	**Land market**						
	Livestock market						
Terms of transaction 1= Cash payment 4=Barter trade 2=Crop share 5=Formal contract 3=Fixed rent 6= Others…….	**Land market**						
	Livestock market						
What measurements are used during sale 1= Acres 2= Strides 3= Landmarks							
Challenges in markets 1=Breach of contract 2=Conflict 3=Unfair pricing 4=Customs 5= Bureaucratic procedures 6=Others (Specify)	**Land market**						
	Livestock market						
Institutional Requirements (LAND) 1= Title deed 2=Customary Right 3=Agreement 4=Permits							
Are the institutions efficient in market coordination? 1= Strongly agree 2= Agree 3= Disagree							

SECTION F: HOUSEHOLD INPUT AND LABOUR UTILIZATION

F1.Have you experienced change in the use of inputs in your farm over the last 30 years 1= Yes 0= No If yes fill the table below

List of inputs 1=Hybrid seeds 2= Fertilizer 3=Pesticides 4=Manure 5=Vet drugs 6=Traditional herbs	**Years**	**What inputs were you using**	**Reason for change**	**Possible reasons for change** 1= Declining land productivity 2=Access to the input in the market 3=Training on the use of input 4=Received donation of the input 5=Introduction of subsidized product
	1987-1992			
	1992-1997			
	1997-2002			
	2002-2007			
	2007-2012			
	2012-2017			

Labour

F2. Have you experienced change in the use of labour in your farm over the last 30 years 1= Yes 0= No If yes fill the table below.

List of inputs 1=Family 2=Hired labour	**Years**	**What was your source of labor**	**Reason for change**	**Possible reasons for change** 1= it was expensive 2= Children went to school 3=Aging 4= Migration of family to other places 5= It was unreliable
	1987-1992			
	1992-1997			
	1997-2002			
	2002-2007			
	2007-2012			
	2012-2017			

F3. This section requires farmers to fill in the inputs they used in their farm in 2017 and the respective costs

Enterprise	Expenditure item	Quantity used	Units	Price per unit	Cost per month

Enterprise	expenditure items	Units
1. Food Crops	1. Seeds	1. Kg
2. Livestock production	2. Fertilizer	2.50Kg bag
3. Hay bailing	3. Pesticide	3.90 KG bag
4. Grass Seed harvesting	4. Manure	4. Gorogoro
5. Bull fattening	5. Animal feed	5. Bottle top
6. Beekeeping	6. Ploughing land	6. Liters
7. Production of timber products e.g poles, charcoal, firewood	7. Renting land	7. Others……..
	8. Vet drugs	
	9.Purchase of hive	
	10. Other (specify…….	

F3. This section requires farmers to fill in the labour they used in their farm and the respective costs for the past year

Enterprise	Activity	Type of labour 1= Family 2=Hired 3=Both hired and family	Hiring mode 1=per day 2= per piece	Ksh paid per person	No. of People	No. days	Total cost if payed per day

Enterprise

1. Food Crops
2. Livestock production
3. Fodder production
4. Hay bailing
5. Grass seed harvesting
6. Beekeeping
7. Production of timber products e.g poles, charcoal, firewood,

Activity

1. Land preparation
2. Planting
3. Fertilizer application
4. Spraying
5. Harvesting
6. Threshing
7. Herding
8. Milking
9. Other…….

SECTION G: HOUSEHOLD CHARACTERISTICS

Assets owned by the household

G1. Which of the following assets does this household own? Fill the table below:

	Asset Item	Number	Estimated value of the asset
1	Livestock owned (all)		
2	Land size accessed		
3	Buildings for rent		
4	Bicycle, motorcycle and vehicle		
5	Mobile phones, radios and TV		
6	Spray Pumps, irrigation pumps, irrigation pipes		
7	Farm implements- hand hoes, panga, ploughs		

Source of information

G3. Do you normally receive any information regarding market prices, new technologies, employment opportunities and changes in weather conditions? 1= Yes 0= No Please the table below;

Source of information 1- County government 2- Private company 3- Farmer to farmer 4- Credit linked extension 5- Agro dealer	**Channel of dissemination** 1-Radio 2-Television 3-Mobile phone 4-Social media 5-Print Media 6- Extension Officer 8- Friends and family	**Access** **1-Yes** **0-No**	**Terms of access** **1-Free** **2-Paid for**	**Perception;** **1-Timely** **2-Accurate** **3-Reliable** **4-Useful**	**Challenges** **1-Costly** **2-Not timely** **3-Unreliable** **4-Other**

G4. Social Capital

Are you a member of any social group? **1.**Yes **2.**No	**How often do you attend meetings?** **1.**Always **2.**Sometimes **3.**Never	**How are decisions made in your group?** **1.**Member consensus **2.l**eaders only **3.**Imposed from outside **4.**Leaders consult members **5.**Voting	**Which of the following would you trust your group leaders with?** **1.** Group finances **2.** Group assets **3.** Leadership ability **4.** None	**Do most of your group members belong to the following**? Do MOST of your group members belong to the following? **1.** Neighborhood **2.** Age **3.** Income group **4.** Tribe **5.** Family/kin group **6.** Religion **7.** Gender **8.** Other (specify...	**Are you a member of any Savings and Credit institution/organization group?** **1.**Yes **2.** No	**If yes, which type** **1.**SACCO **2.**Table banking **3.** Merry go round **4.** Formal bank **5.** Mobile money **6.** Other (Specify)

Household food and nutrition security indicators

G5. Kindly provide information on your food security and nutrition situation

Does your household normally experience food shortages? 1=Yes 2=No	**What is the average number of meals consumed in a day in your family?**	**Number of meals missed per day (Specify the meal(s)** 1= One meal 2=Two meals 3= All three meals 4= None	**How much does your household spend in buying food items per month? (KSh)**	**During which months of the year do you experience food insecurity** (code 1-12 months)	**What are causes of food unavailability in the household?** 1=Low supply in the market 2=High prices 3=Poor harvest 4=Other specify ……..	**What coping strategies do you use during food unavailability 1= Selling livestock 2= use savings 3= reduce food ratio 4= Borrow money 5=Borrow food 6=Others……...**

Access to credit

G8. Have you received any credit in the last 12 months? 1= Yes 0 =No Fill the table below:

Source	**Amount Received**	**Use** 1=Buy farm inputs, 2. =Expand business 3=Pay school fees 4=Buy assets 5=Buy food 6=Acquire assets	**Challenges to credit access credit** 1= Lack of collateral 2 =High interest 3 =long procedures 4 =Other…..
Micro finance institution			
Formal Bank			

SACCO			
Community groups			
Relatives/friends			
Mobile Money			

G9. If the household doesn't have access to credit, what is the reason why you cannot access credit facilities?

1. No need 2. Not aware 3. Lack of enough collateral to secure a facility 4. High interests 5. Too procedural. 6. Other…

G10. Access to Extension services

In the last 12 months have you been able to have access any form of extension services? If so, please fill table below:

Provider 1- Private 2- County government 3- Farmer to farmer 4- Outgrower 5-Credit linked extension 6-Agro dealer 7-Church 8-Other…….	**Channel:** 1 Home visits 2 Phone 3 Field school 4 Other…….	**Terms of provision** 1 Free 2 Paid for 3 Other…	**Challenges** 1-Costly 2- Infrequent visits 3-Communication barrier 4- Distance 5-Farmers not willing to share information	**Solution to address challenges** 1-Reduce costs 2-Train more contact farmers 3-Establish field schools 4-Other……...

G11. Market Access

What is the type of road you use to access the main market? 1=All seasons tarmac 2=All season 3=Season marram 4=Other(specify)	**What is the distance from your home to the input shop?** **……. Kms**	**What is the distance to the nearest main market from the farm?** **……Kms**	**How do you transport your produce to the market?** 1=Car 2=Motorbike 3=Bicycle

SECTION H: DEMOGRAPHIC CHARACTERISTICS

H1. Please fill the table below on household demographic characteristics

Name of the household head (HH) Gender (Tick) Female…… Male…….
Age of Household head (years)
Marital status (1= Single, 2= Married 3= Widowed/divorced/separated)
Years of schooling of Household head…….
Number of males……
Number of females……...
Number of people who have lived in this household for the last 4 months……... …….

H2. Please fill the table below on the household Education and employment characteristics

	Aged below 15 years	Aged 15-35 years	Aged 36-65 years	Above 65 years
Number of Household members				
Labor disaggregation				
Working on-farm only				
Working off-farm only				
Working both off & on-farm				
Education (Quality of human capital)				
Completed Primary education				
Completed Secondary education				
Completed Tertiary education				
Dropped out at primary				
Dropped out at secondary school				

Thank you

Appendix 3: Results for multicollinearity test

Variable	VIF	1/VIF
Ln Total household income	1.67	0.599
Access to credit	1.35	0.740
Access to extension	1.32	0.759
Group membership	1.2	0.835
Acres of land accessed	1.17	0.854
Sex of the household head	1.16	0.858
Household size	1.12	0.890
Access to communal land	1.08	0.927
Distance to Main Market	1.05	0.948
Share of income from livestock	1.05	0.949
Mean VIF	**1.22**	

Source: Survey Data (2018).